EFFECTS OF VISUAL SUPPORTS ON THE PERFORMANCE OF THE TEST OF GROSS MOTOR DEVELOPMENT BY CHILDREN WITH AUTISM SPECTRUM DISORDER

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EFFECTS OF VISUAL SUPPORTS ON THE PERFORMANCE OF THE TEST OF GROSS MOTOR DEVELOPMENT BY CHILDREN WITH AUTISM SPECTRUM DISORDER

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A Dissertation

Submitted to

the Graduate Faculty of

Auburn University

in Partial Fulfillment of the

Requirements for the

Degree of

Doctor of Philosophy

Auburn, Alabama
August 10, 2009

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DISSERTATION ABSTRACT

EFFECTS OF VISUAL SUPPORTS ON THE PERFORMANCE OF THE TEST OF GROSS MOTOR DEVELOPMENT BY CHILDREN WITH AUTISM SPECTRUM DISORDER

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Doctor of Philosophy, August 10, 2009
(M.Ed., Auburn University, 2006)
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127 Typed Pages

Directed by Mary E. Rudisill

Daily physical education should be included as a direct service in the individualized education plan of each child with a documented disability as mandated by PL 94-142, the Education for All Handicapped Children Act. Autism spectrum disorder (ASD) is a developmental disability marked by the exhibition of repetitive and restrictive stereotypic behaviors as well as deficits and deficiencies in communication and social interaction that is increasing in prevalence. At present, ASD can be treated effectively only through educational interventions. Because education is based on the tenet that students are accurately assessed and placed in lessons appropriate for their skill level, the assessments used to place students should be presented in a format that is understood by these students. Children with ASD process information differently than neurotypical children. They have relative strengths in processing visual information compared to auditory information, and should therefore be assessed in a way that accommodates these strengths. Presently, the Test of Gross Motor Development (Second Edition; TGMD-2) is the most widely used physical education assessment in the United States, but it does not accommodate these strengths. The TGMD-2 utilizes verbal instructions and physical demonstrations to administer the assessment. Therefore, this study sought to examine the effects of incorporating visual supports on TGMD-2 performance.

The purpose of this study was to examine the effects of visual supports on the performance of the TGMD-2 by children with ASD. Participants (N= 22) received three different protocols of the TGMD-2 (traditional protocol, picture task card protocol, and picture activity schedule protocol). Gross motor quotient scores on the TGMD-2 and the percentage of time engaged in on-task behavior for each protocol were measured and statistically analyzed using two within-subjects repeated measures analyses of variance (ANOVA). Results indicated statistically significant differences between protocols for gross motor quotient scores, $F(2,21)= 6.655$, $p = .003$, while no significant differences were found between protocols for the percentage of time engaged in on task behavior $F(2,21) = .425$, $p = .657$. *Post hoc* tests for the analysis of gross motor quotient scores indicated that the picture task card condition produced significantly higher scores ($p= .008$) than the traditional protocol. A multivariate ANOVA was then employed using Wilks' criterion to assess differences on individual items of the TGMD-2. The analysis yielded nonsignificant results, $F(24,58) = .613$, $p = .707$, indicating that performance was similar for all items on the TGMD-2. In conclusion, higher gross motor quotient scores on the TGMD-2 by children with ASD can be elicited using the picture task card protocol.

ACKNOWLEDGEMENTS

First, I'd like to thank my parents for all their love and support in this endeavor. Thank you for teaching me to always "bee myself" and believing in me, even when I wanted to give up. To the extended family (particularly the Bogers, the Renwicks, Joe, Kevin, and Caitlin), thank you so much for the encouragement. Paul and Lori St. Onge, thank you for your support and friendship and for teaching me to "put my own oxygen mask on first". Leah Rigdon, Leah Robinson, Kristin Ferguson, John Malek-Ahmadi, Ann Louise Jones, Jeanine Fittipaldi-Wert, the Manleys, and the Eastmans…thank you for being my Auburn family. I love ya'll. Thank you, Allen, for standing beside me through this process. I look forward to standing beside you in the future.

Thank you, Tammi Bories, for introducing me to the world of motor development as a graduate student. To Lauren Stark, Alison Link, Elizabeth Gilchrist, John Jordan, and Katie Hayley, thank you for all your hours of dedication and work as research assistants. To my committee and outside reader, Dr. Alice Buchanan, Dr. Mark Fischman, Dr. Leah Robinson, Dr. Dave Shannon, Dr. Jennifer Gillis, and especially my advisor, Dr. Mary Rudisill, thank you for the countless hours of mentorship and guidance throughout this process. Thank you for believing in me and taking a chance on my ideas. Thank you, Dr. Robert Simpson, for introducing me to autism and inspiring this research project through your classes. To the children of the Auburn University Autism and Behavior Summer Clinic, I will never forget you. Thank you!

Style manual used: American Psychological Association Publication Manual (5th edition)

Computer Software Used: Microsoft Word 2007, Statistical Package for the Social Sciences, Version 16

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INTRODUCTION

When autism was first identified in 1943 by Dr. Leo Kanner, only one in 10,000 children were estimated to have it. This disorder, marked by difficulties and deficits in communication and social interaction and by the exhibition of repetitive and restricted stereotypic movements (American Psychiatric Association [APA], 2000), can cause varying degrees of difficulty in understanding one's environment. Today, one in 150 children are diagnosed with autism spectrum disorder (ASD), which is the fastest growing developmental disability in the United States (Centers for Disease Control and Prevention [CDC], 2007).

The increasing prevalence of ASD has tremendous implications for our nation's education system. PL 94-142, *The Education for all Handicapped Children Act of 1975*, mandated that all children in the United States have a right to a free and appropriate public education (U.S. Code, 1975). Daily physical education should be included as a direct service for all children with disabilities. Because of this legislation, teachers representing all curricular content areas, including physical educators, must be prepared to instruct children with ASD.

To develop effective instructional plans for children of all abilities, teachers must first be able to accurately assess the skills of their students. Assessments are used to measure student performance and learning and to determine the effectiveness of educational interventions (Short, 2005). Throughout history, educational researchers have been developing and validating assessments for use in neurotypical populations. In some cases, these assessments are adequate for use with special populations, but often they require modification to increase the understanding of the assessment and its behavioral requirements by students with special needs. Due to the nature of communicative impairments common to ASD, it is difficult to find appropriate assessments for this population, which has critical implications for parents, teachers, administrators, and public policy makers who are interested in student performance and learning (National Research Council, 2001).

Currently, the most widely used assessment tool in physical education in the United States is the Test of Gross Motor Development (Second Edition [TGMD-2]; Ulrich, 2000). The TGMD-2 assesses the performance of children between three and ten years old in twelve fundamental motor skills in two domains: locomotor skills and object control skills. The locomotor skills include running, galloping, hopping, leaping, horizontal jumping, and sliding. The object control skills include striking a stationary object, dribbling, catching, kicking, overarm throwing, and underhand rolling. These twelve motor skills are ones that most children between three and ten years old have experience performing. These skills function as the building blocks of sport-specific skills required by many games popular among children of all ages (Gallahue & Ozmun, 2006).

Acquisition of fundamental motor skills is important to a child's motor development, but it also contributes to a child's physical, social, emotional, and psychological development (Kovar, Combs, Campbell, Napper-Owen, & Worrell, 2007). For instance, early motor skill development can predict the likelihood of hypokinetic disease such as type II diabetes or obesity, thereby affecting physical development (Saakslahti et al., 1999). Children who exhibit more mature motor skills are viewed more favorably by their peers (Ulrich, 2000), influencing their social development. Furthermore, children with more mature motor skills have higher perceived competence in activities of daily living and self-concept, which impacts emotional and psychological development (Ulrich, 2000).

Although the TGMD-2 was designed to help identify children exhibiting fundamental motor skill delay so they might receive appropriate supplemental services, it is possible that the protocol is designed in a way that children with ASD may be labeled with motoric delays, when in actuality they are not motorically delayed. The test protocol instructs administrators of the TGMD-2 to demonstrate the motor skill and verbally request the child to perform that skill. Children with ASD may not respond to this testing protocol because they have difficulty in extracting meaning from a verbal request. This causes children with ASD to be evaluated as unable to perform a motor skill when in actuality they can as long as the instructions are delivered in a meaningful and comprehensible way. One study used the first edition of the TGMD to assess motor skill development in children with autism and mentioned that children with ASD seem to take a product, rather than process, approach to performing the motor skills (Berkeley, Zittel, Pitney, & Nichols, 2001). For example, rather than performing the motor skills as demonstrated, the children with ASD would focus on achieving an end result similar to the demonstration such as moving across the room instead of using a specific locomotor pattern, or placing a ball against a wall instead of throwing (Berkeley et al., 2001). This behavior, in conjunction with the poor quality of the children’s performance on other motor skills, led all but three of the fifteen participants in this study to be placed in the poor or very poor performance categories (Berkeley et al., 2001).

The most interesting, yet concerning, aspect of Berkeley et al.'s (2001) study is that they reported children with ASD to have low TGMD scores, suggesting motor skill delays, while other studies have reported that children with ASD have precocious or at the very least, typical motor development (DeMyer et al., 1972; Klin, Volkmar, & Sparrow, 1992; Stone, Ousley, Hepburn, Hogan, & Brown, 1999;Stone, Ousley, & Littleford, 1997). These studies did not use the TGMD-2 to assess motor skills, nor did they assess the specific fundamental motor skills assessed by the TGMD-2. Some of these studies used parent report data (Klin et al., 1992; Stone et al., 1999), whereas others assessed the participants' motor skills directly (DeMyer et al., 1972; Stone et al., 1997). The two studies using direct assessment approaches used different assessments; specifically, a random sampling of motor tasks from several validated motor assessments and the motor imitation scale, respectively. Because the TGMD-2 protocol does not cater to the unique characteristics of children with ASD, it may not be a reliable assessment for this population in its present form. Visual supports have been found to be beneficial in increasing on-task behavior and decreasing off-task behavior as visual supports help direct attention to the relevant stimuli within the task (Bryan &Gast, 2000; Fittipaldi-Wert, 2007; Rao & Gagie, 2006). It may be beneficial to incorporate visual supports into the protocol for assessment of motor skill performance by children with ASD, as they exhibit strengths in processing visual information.

Visual supports are promoted for use with children with ASD to increase student understanding (Broun, 2004; Odom et al., 2003; Rao & Gagie, 2006). These instructional aids may include line drawings, photographs, graphic organizers, social stories, or physical boundaries. They are believed to help the learner direct his or her 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 increasing the student's understanding of the social and verbal cues while reducing confusion in the surrounding environment (Quill, 1995; Rao & Gagie, 2006). Visual supports, such as task cards and/ or activity schedules, may provide an adaptation to TGMD-2 administration protocol, making it more appropriate for use with children with ASD. Because activity schedules provide information regarding what work is to be completed, how much work is to be completed, and what is to be done after the work is completed, activity schedules also serve to reduce the anxiety of a child with ASD (Downing & Peckham-Hardin, 2000; Welton, Vakil, &Carasea, 2004).

Statement of the Purpose

The purpose of this study was to examine the effects of protocol modifications (i.e., picture activity schedule and picture task cards) on the performance on the TGMD-2 by children with ASD as measured by gross motor quotient and the percentage of time engaged in on-task behaviors. These modifications were compared to the traditional protocol of the TGMD-2.

Hypotheses

This study has two hypotheses:

(1) 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. 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.

(2) The percentage of time engaged in on-task behavior during the TGMD-2 would be significantly higher for children with ASD when the assessment protocol included the picture activity schedule condition than when the assessment utilized the picture task card condition and the traditional protocol. It was also hypothesized that the percentage of time engaged in on-task behavior during the TGMD-2 would be significantly higher for children with ASD during the picture task card condition than the traditional protocol.

Assumption

It was assumed that the order of administrative protocol modifications (i.e., picture activity schedule and picture task cards) on the TGMD-2 received by children with ASD would have no effect on the gross motor quotient score of the TGMD-2 or on the percentage of time-on-task behaviors. Two univariate analyses of variance were used to test the assumptions that there is no statistically significant difference in gross motor scores or the percentages of time engaged in on-task behavior between the six different orders of protocol modifications received by the participants.

Definition of Terms

Time-on-Task Behavior

Time-on-task behavior assumes compliance with the instructions provided by the experimenter. Time-on-task behavior is defined as the time during which a participant (a) visually attends to appropriate equipment or demonstration, (b) looks at the picture task cards or activity schedule, (c) appropriately manipulates the equipment used to complete object control skills or appropriate demonstration of locomotor skills included on the TGMD-2 within one minute of skill demonstration by experimenter, or (d) is in transition from one skill on the subtest to another (Bryan &Gast, 2000).

Traditional Protocol

Traditional protocol is the protocol described in the *TGMD-2 Examiner's Manual* that utilizes auditory instruction as well as live demonstration by the examiner of the motor skills being assessed during the TGMD-2 (Ulrich, 2000).

Visual Supports

Although a physical demonstration is an instructional technique that provides visual information, in the context of this study, visual supports and visual information refer to pictoral representations of persons, places, things, actions, or behaviors. Specifically, the study examined the effectiveness of visual supports that represented actions and behaviors to be performed to complete the TGMD-2.

Picture Task Cards

Picture task cards are pictorial representations of the motor skills being assessed (Schultheis, Bowell, & Decker, 2000). During the TGMD-2, these skills include running, galloping, sliding, hopping, horizontal jumping, leaping, overarm throwing, catching, kicking, dribbling, underarm rolling, and striking a stationary object.

Picture Activity Schedule

Picture activity schedules are vertical displays of picture task cards of the work to be completed in a given environment. The picture task cards are mounted onto a vertical strip of Velcro®, and the child works through the list of picture task cards from top to bottom in the sequence in which they are displayed on the picture activity schedule (Mesibov, 2006).

Limitations

Since this study took place in an ideal assessment environment and the assessments were administered by a researcher trained in motor development, the results of this study may suggest a need for a controlled testing environment for children with ASD. Furthermore, other limitations for the scope of this study include:

1. Participants were not randomly selected from a large population.
2. The side effects of consumption of prescribed medication by children with ASD could have influenced their behavior and performance.
3. There is a possibility that the compliant behavior, as measured by the percentage of time engaged in on-task behavior of children with ASD during the assessment, could have increased as a function of experiences during the supplemental summer educational experience and not the implementation of the visual supports during the TGMD-2.
4. The children with ASD could have experienced changes in their daily routine beyond the control of the researcher that influenced their behavior during the assessment.
5. All assessments were conducted by the researcher, not an individual blind to the purpose of the study.

Delimitations

The delimitations for the scope of this study include:

1. The students with ASD were purposefully sampled from children enrolled in the supplemental summer educational program.
2. The participants in this study were included only if parent report data indicated that the participant had a documented diagnosis of ASD.
3. Outcome measures were limited to the gross motor quotient scores, scores on individual items on the TGMD-2, and the percentage of time engaged in on-task behaviors following administration of the TGMD-2 on three occasions.

LITERATURE REVIEW

It is important to understand autism spectrum disorder (ASD), the characteristics and symptoms of children with ASD, and the implications these symptoms have for students' educational needs. Research suggests that teachers from all disciplines should modify the environment to include visual supports when assessing and instructing children with ASD in order to help meet their educational needs (Quill, 1995). This is particularly important during the assessment of fundamental motor skills, which are considered the building blocks for future movement. The following review introduces the literature related to ASD and the learning styles of individuals with ASD, and the theoretical support for the use of visual supports as it relates to the information processing model. Furthermore, the review includes an explanation of the use of visual supports and types of visual supports including picture task cards and activity schedules, as well as how these relate to the assessment of motor skills.

Autism Spectrum Disorder

Autism spectrum disorder (ASD) includes five related neurological disorders of idiopathic etiology affecting development (Centers for Disease Control and Prevention [CDC], 2007). Included on the spectrum are autistic disorder, Asperger's disorder, child disintegrative disorder, Rett's disorder, and pervasive developmental disorder, not otherwise specified (American Psychiatric Association [APA], 2000). According to the APA Diagnostic and Statistical Manual, mild to severe deficits in communication and social interactions, as well as repetitive and restricted stereotypic behaviors, are characteristic of ASD (APA, 2000). Specifically, autistic disorder is marked by at least two deficits or difficulties in social interaction and at least one deficit in communication and at least one exhibition of repetitive and/or stereotypic behavior, interest, or activity at a level that interferes with cognitive function or the ability to speak and be easily understood by others. Furthermore, the exhibition of these symptoms cannot be better explained through the other disorders included on the spectrum.

Asperger's Disorder is similar to autistic disorder, except that individuals with Asperger's Disorder do not generally exhibit delays in cognitive processes or in the ability to speak to others. Beyond the restricted and repetitive behaviors and difficulties in communication and social interactions characteristic of all disorders that make up ASD, Rett's disorder is also characterized by the loss of previously acquired deliberate hand skills before the age of three years, whereas childhood disintegrative disorder is characterized by the significant loss of previously mastered language skills, social skills, play skills, and loss of control of bodily functions. Finally, pervasive developmental disorder, not otherwise specified, is the diagnosis given to a child exhibiting combinations of the preceding symptoms in patterns not described by the other diagnoses. Further explanation of the nuances of an ASD diagnosis is included in Appendix A.

As of late, ASD has received a considerable amount of media attention, likely due to the increasing prevalence of ASD (U.S. Department of Education, 2000). According to the CDC, approximately 1 in 150 children in the United States were diagnosed with ASD, up from the 2000 estimate from the CDC that 1 in 250 children were diagnosed with ASD (CDC, 2007). Although it is uncertain exactly why the prevalence of ASD is increasing, experts believe some of the increase may be due to the inclusion of Asperger's disorder as part of the ASD diagnosis and a decrease in other similar diagnoses (Shattuck, 2005). Given the increasing prevalence of ASD and the fact that the U.S. government has mandated that every child receive free and appropriate public education in the least restrictive environment through such legislation as the *Education for All Handicapped Children Act of 1975*, the *Americans with Disabilities Act of 1990*, and the *Individuals with Disabilities Education Act of 1990* (Winnick, 2005), it is important for educators to be aware of ASD and its effects on students' educational needs, specifically as it relates to assessment.

Learning Styles of Individuals with ASD

Individuals with ASD are often visual learners, meaning that they can interpret and use information more effectively if it is presented in a way that they can see, rather than hear (Broun, 2004; Bryan &Gast, 2000; Tissot& Evans, 2003; Welton et al., 2004). An instructional approach that uses visual supports capitalizes on the individual with ASD's strengths in processing visual information, while minimizing that individual's difficulty in processing information presented in other modalities (Simpson, 2005). Individuals with ASD understand information depicted in a visual-spatial format such as pictures which simultaneously depict both a visual and a time related concept better than signs (e.g., a "stop" sign; Quill, 1995). They struggle to understand information presented in time dependent formats like speech (Quill, 1995). As expressed by Temple Grandin, a Colorado State University professor who has autism, in her book, *Thinking in Pictures: And Other Reports From My Life With Autism*, people with autism "think in pictures" (Grandin, 1995).

Because individuals with ASD have difficulty understanding the spoken word and processing auditory information, it is important for educators to understand and accommodate the special needs of this diverse population by providing visual supports such as picture task cards and picture activity schedules during assessment and instruction (Broun, 2004; Cohen, 1998; Fittipaldi-Wert & Mowling, 2009; National Research Council, 2001; Quill, 1995; Tissot& Evans, 2003; Welton et al., 2004). Furthermore, it is suggested that visual supports should utilize line drawings, which provide adequate information with minimal distraction in order to help a child with ASD understand an otherwise abstract concept (Quill, 1997).

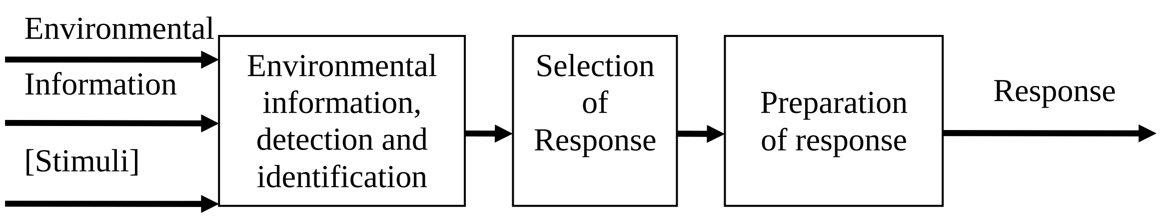
Justification for the Use of Visual Supports

The three specific ways individuals with ASD differ from their neurotypical peers (deficits and difficulties in communication and social interaction and repetitive and restricted stereotypic behaviors) are rooted in the differences in which individuals with ASD process sensory information (Cohen, 1998; National Research Council, 2001). These sensory processing issues cause individuals with ASD to have difficulty understanding orderly relationships, such as time, and experience tremendous confusion due to their inability to understand the world in which they live (Cohen, 1998). Individuals with ASD are very visual learners who perform best when they can engage in a routine, but often they cannot tolerate changes to their routine or generalize skills learned in one context to another context (Cohen, 1998; Grandin, 1995). Routines and rituals provide a source of stability and order to a person with ASD, which in turn can reduce the exhibition of contextually inappropriate behaviors, which are often the result of an inability to communicate a verbal response (Cohen, 1998).

Information Processing Model

Although individuals with ASD exhibit a range of symptoms and behaviors, it is clear that individuals with ASD perceive and process information differently than their neurotypical peers (Grandin, 1995; National Research Council, 2001). According to the information processing model (see Figure 1), there are three phases to processing information (Broadbent, 1958). Environmental information and stimuli are perceived by an individual through the senses, and it is up to the individual to recognize and identify the stimuli, select an appropriate behavioral response to the stimuli, and then program and execute the response. Although there are many sources of environmental stimuli and the neurotypical person perceives many of them, it is impossible for all of the stimuli to be attended to and processed. In some situations, it is most appropriate to ignore the stimuli and not engage in a behavior, and sometimes a stimulus merits a behavioral response (Norman, 1968).

*Figure 1.*The Information Processing Model (Magill, 2007, pg. 196)



For example, in an assessment setting, there are many environmental stimuli present, including noise from nearby equipment and visual information from the surrounding environment, including the assessment itself, the walls, ceiling, and carpets of the testing room. Furthermore, smells wafting from other parts of the building, and the tactile sensations received by the body from the position in which the assessment is supposed to be completed also exist as environmental stimuli during assessment. In order to attend to the appropriate stimuli to complete the assessment, some of these stimuli must be ignored. Depending on personal factors and approaches used by the teacher or assessment administrator, the participants in an assessment may attend to, recognize, and respond to different stimuli at different times. Immediately before lunch, a participant might pay attention to the smells of food coming from the kitchen and choose to ignore the instructions from the assessment administrator. The stimuli of smells from other parts of the building during another part of the day may not distract the child as he or she continues to attend to the assessment administrator, ignoring the olfactory input.

Due to the sensory processing difficulties of individuals with ASD, they often struggle to appropriately recognize and identify stimuli (Broun, 2004). However, once an individual with ASD has recognized and identified the stimulus, there is no known difference between the way an individual with ASD and a neurotypical peer would select and program a response. Individuals with ASD may recognize, identify, and attend to irrelevant stimuli in the environment (e.g., attending to the logo on the teacher's jacket instead of listening to the teacher's instructions) or misperceive certain stimuli, particularly verbal stimuli. For example, a child with ASD might love indoor soccer and want to spend all his or her time playing it, but engage in a temper tantrum prior to heading outside for a physical education unit on soccer, thus losing the privilege to participate in physical education class. The child's response stems from an inability to tolerate the sunlight, rather than his feelings about playing soccer, but the student's eyes are highly sensitive to bright sunlight, so to that student, the stimulus of hearing "time for outdoor soccer" is perceived as a cue to tantrum in order to escape the experience of bright sunlight. Although the child may have misperceived the stimulus, he or she has selected this response of frustration in an attempt to avoid bright sunlight.

Because individuals with ASD often have trouble processing information in their environment, they have difficulty completing tasks within a traditional environment. With simple environmental modifications, these individuals are better equipped to complete tasks. A simple environmental modification to assist the individual with ASD in understanding the environment is to introduce visual supports (Fittipaldi-Wert &Mowling, 2009; Johnston, Nelson, Evans, &Palazolo, 2003; Tissot& Evans, 2003). When a visual support is used, the environment is modified to assist in the individuals with ASD's ability to process information, enabling those individuals to obtain meaning from the information presented to them, thus influencing their perception and interpretation of the world (Gredler, 2005).

Visual Supports

Visual supports help the learner direct his or her 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 (Rao & Gagie, 2006). Furthermore, visual supports play to the strength in visual learning exhibited by individuals with ASD and reduce confusion for those individuals, in turn decreasing contextually inappropriate behaviors (Broun, 2004; Houston-Wilson & Lieberman, 2003; Mirenda & Santogrossi, 1995). 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). Activity schedules are visual depictions of the sequence of behaviors and activities in which the student is to engage, in order to complete the task at hand (Bryan &Gast, 2000; Welton et al., 2004).

Visual supports in the form of concrete boundaries, picture task cards, and picture activity schedules have been widely promoted to, and accepted by, practitioners as a means of decreasing disruptive behaviors, increasing on-task behaviors, and meeting individualized education plan objectives (Blubaugh & Kohlman, 2006; Broun, 2004; Dooley, Wilczenski, &Torem, 2001; Downing &Peckham-Hardin, 2001; Fittipaldi-Wert &Mowling, 2009; Groft-Jones & Block, 2006, Houston-Wilson & Lieberman, 2003; Mesibov, 2006; National Research Council, 2001; Quill, 1995; Rao & Gagie, 2006; Schultheis, Boswell, & Decker, 2000; Stromer, Kimball, Kinney, & Taylor, 2006; Tissot& Evans, 2003). Unfortunately, very little empirical evidence in the form of randomized, controlled clinical trials exists supporting this approach (Dettmer et al., 2000; National Research Council, 2001; Odom et al., 2003;Rao&Gagie, 2006; Simpson, 2005). A few studies have documented the effectiveness of one form of visual supports (i.e., activity schedules and/or picture task cards) using single subjects or case study designs (Bryan &Gast, 2000; Dooley et al., 2001; Johnston et al., 2003; MacDuff, Krantz, &McClannahan, 1993; Welton et al., 2004). When examining the empirical evidence for the use of activity schedules, Simpson (2005) found that most studies examine the use of activity schedules as a positive behavioral support in a single subject research design.

Only one study has examined the effectiveness of using all visual supports in an instructional setting (Fittipaldi-Wert, 2007).

Recently, visual supports were used in an inclusive elementary physical education classroom for instructing four students with autism (Fittipaldi-Wert, 2007). Following baseline data collection to determine how much time the students spent engaged in on- and off-task behaviors during physical education and the amount of physical prompting the traditional instructional approach required for the students with autism, visual supports were incorporated into the instruction. The visual supports included activity schedules, concrete boundaries, and task cards. The percentages of on-task behaviors, off-task behaviors, and tasks that required physical prompting for completion during the physical education lesson were measured. The results indicated that when the physical educator used visual supports, students with autism engaged in an average of 27% more time in on-task behaviors, 15% less time in off-task behaviors, and required 12% less physical prompting to complete the tasks. Ultimately, the intervention resulted in on-task behavior during 63% of the lesson, off-task behavior during 15% of the lesson, and a requirement for physical prompting to increase engagement during 21% of the lesson. The results indicate that visual supports increase the educational engagement level of students with autism in inclusive physical education settings, although it is difficult to elucidate how much of the results can be attributed to one individual type of visual support as compared to another type of visual support (Fittipaldi-Wert, 2007).

Although the Picture Exchange Communication System (PECS) and the Treatment and Education of Autistic and Related Communication-Handicapped Children (TEACCH) are two of the most widely known systems for working with children with autism, they were not included in this study (Bondy & Frost, 1994, 2001, 2002; Mesibov, 2006). PECS and TEACCH both utilize some form of visual supports, but the systems incorporate additional communication measures not of interest to researchers conducting motor skill assessments. Specifically, PECS was not included as it is a reciprocal communication system (Bondy& Frost, 1994, 2001, 2002; Schwartz & Garfinkle, 1998). This study did not require communicative responses of children with ASD beyond compliant and/or noncompliant behavior as measured by percentage of time on-task during each TGMD-2 protocol. The TEACCH method was not fully incorporated in this study since TEACCH uses physical boundaries and objects to create classroom and workplace arrangements conducive to work (Mesibov, 2006), not communicative techniques to improve understanding of assessment instructions. It should be noted that certain elements of both systems (i.e., picture task cards and activity schedules) were included in the two modified protocols.

Task Cards

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). When the picture card displays an image of an action that an individual is to perform, it functions as a picture task card. Visual supports of this nature have been found to be successful in increasing on-task behaviors and decreasing disruptive, off-task behaviors (Dooley et al., 2001; Fittipaldi-Wert, 2007; Johnston et al., 2003).

A single picture task card representing the phrase “Can I play?” was found to increase the frequency of social interactions within a sample of three preschool aged children with ASD (Johnston et al., 2003). Everyone in the classroom, students and teachers alike, were provided with a “Can I play?” task card, and instructed to display it to gain entry into a child’s play circle instead of making a verbal request. The frequency of the social interactions of the students was found to increase throughout the duration of the intervention, and also during follow-up data collection periods. This indicates that the students with ASD understood the task card could function as a means of communication and elected to use the card for this purpose (Johnston et al., 2003).

Activity Schedules.

Activity schedules consist of photographs, pictures, line drawings, or words that describe the order of behaviors and activities in which the student is to engage (Welton et al., 2004) as well as define exactly what tasks and how much work is to be finished (Bryan &Gast, 2000). The schedules can be presented in either paper form or as multimedia such as on a computer screen (Bryan &Gast, 2000; Downing, &Peckham-Hardin, 2000; Stromer et al., 2006; Welton, et al., 2004). For younger students who cannot yet read independently, paper activity schedules in picture format are usually displayed on the wall so that all students, teachers, and classroom visitors know exactly what and how much work the student is to complete throughout the day (Blubaugh & Kohlmann, 2006; Bryan &Gast, 2000; Downing, &Peckham-Hardin, 2000). Older students’ activity schedules may be placed in a binder or notebook for privacy and to increase student independence (Bryan &Gast, 2000; MacDuff et al., 1993). Visual activity schedules are theorized 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).

Activity schedules have been effective in decreasing aggression and increasing cooperation in classroom settings (Dooley et al., 2001). In this study, a modified reversal single subject design was implemented using a three-year-old diagnosed with pervasive developmental disorder to examine the effectiveness of a picture activity schedule in reducing problem behaviors during transitions between activities at preschool. Baseline data collection indicated that the child averaged approximately 13 times more disruptive than compliant behaviors at transition times. In the reversal phase of the study, a picture activity schedule, in the format of pictures attached to a vertical strip of Velcro®, was displayed on a classroom wall. The picture activity schedule was reviewed with the child at the start of each day and pictures were removed as the child completed the activities displayed on the schedule. In the first phase of the invention, the child was provided an edible reward for following the protocol displayed on the schedule board. During the second phase of the intervention, the edible reward was discontinued, but the picture activity schedule remained. Throughout both phases of the intervention, compliant behavior during transition time occurred approximately 10 times more frequently than disruptive behavior. The boy’s teachers decided to continue using a picture activity schedule even after the end of the intervention period, and it was reported that the rates of both compliant and disruptive behavior were maintained at levels comparable to those of the intervention phases (Dooley et al., 2001).

In another study, a picture activity schedule was found to increase on-task behaviors and decrease off-task behaviors in language arts activities (Bryan &Gast,

2000). In these activities, three elementary school students with ASD were provided an album depicting four activities the students were required to complete during the class period. On-schedule behaviors were defined as closely following the directions conveyed through the picture activity schedule within 10 seconds of attending to the information displayed on the schedule, while on-task behaviors were defined as attending to the task at the level displayed by the picture activity schedule, and off-task behaviors were defined as contextually inappropriate behaviors or inappropriate use of the materials required to complete the work described by the picture activity schedule. Data collection occurred using time sampling and a reversal single subject design. The picture activity schedule was found to increase on-schedule and on-task behaviors to above 90% of the total class time and decrease off-task behaviors by at least 70% of the class time (Bryan &Gast, 2000).

New leisure skills can also be taught using activity schedules. MacDuff et al. (1993) found that four adolescent boys with autism who were living in a group home spent the majority of their leisure time engaging in stereotypic behaviors, rather than leisure activities. The boys were trained to use a photographic activity schedule to structure their leisure time so as to increase engagement in appropriate leisure activities and decrease stereotypic behaviors. The boys were to follow the photographic activity schedule to gather the necessary materials required to complete each of six leisure activities depicted, and then engage in these previously mastered leisure activities such as reading, building with blocks, and board games (MacDuff et al., 1993). During the first intervention phase of the multiple baseline design, the subjects were taught how to progress through the activities on the photographic activity schedule. During this phase, the same six activities were presented in the same order each day and the percentage of time spent engaging in on-task and on-schedule behavior was above 90%. During the next phase, the order of the six activities was changed in order to determine whether the boys were actually attending to the information presented on the photographic activity schedule or were just engaging in a routine. In this phase, the percentage of time spent engaging in on-task and on-schedule behavior was again above 90%, indicating that the students attended to and followed the picture activity schedule. In the last phase of the intervention, novel leisure time activities were presented and the percentage of on-task and on-schedule behavior remained above 90%. The results of this study indicate that a photographic activity schedule can increase on-task behaviors and provide instruction in new skills (MacDuff et al., 1993).

Importance of Assessing Fundamental Motor Skills

Since Fittipaldi-Wert (2007) found visual supports to be an effective way to increase the educational engagement level of students with autism in inclusive physical education settings, it is reasonable to assume that visual supports may provide a means for more accurately assessing children’s motor skill development. Fundamental motor skills are important to a child’s overall development and should be mastered during the early childhood years (Payne & Isaacs, 2008). Given the importance of motor skill development, it is critical that practitioners and researchers have a means of accurately assessing motor skill development in children.

Fundamental motor skills influence a child’s ability to perform daily motor activities and engage in sport, dance, and life-time activities. Motor skill development is related to the risk for hypokinetic disease such as type 2 diabetes and/or obesity

(Saakslahti et al., 1999) and also impacts a child's self-esteem and self-concept (Valentini & Rudisill, 2004). Children who can competently perform fundamental motor skills have greater self-concept and self-esteem (Kovar et al., 2007). Furthermore, there are many opportunities for children to participate in organized sports activities today, and the experience is more positive if the child feels like he or she can competently perform the fundamental motor skills required of the sport (Payne & Isaacs, 2008). Improving a child's motor skill development and the ability to assess that development has far-reaching implications beyond that of developing an adequate individualized education plan for physical education. There is concern, however, that children with ASD are not being accurately assessed for fundamental motor skill development. The most widely used assessment of fundamental motor skills in the U.S. is the Test of Gross Motor Development (Second Edition [TGMD-2]) (Ulrich, 2000). The instructions for the TGMD-2 are presented in an auditory format, which may be difficult for children with ASD to understand, thus influencing their performance.

Test of Gross Motor Development (Second Edition)

The TGMD-2 assesses the gross motor skill development of children between three and ten years old on twelve skills (running, galloping, sliding, hopping, leaping, horizontal jumping, catching, kicking, dribbling, overarm throwing, underarm rolling, and striking a stationary object). Data from the TGMD-2 are compared to sex- and age-matched peer normative data (Ulrich, 2000), and are used to identify children in need of adapted physical education services. The results of the TGMD-2 are also used to develop instructional intervention strategies and to assess the effectiveness of such strategies on both an individual and (when conducted on all students in a group) on a group level.

Although the *TGMD-2 Examiner's Manual* encourages modifications to the testing environment to increase the likelihood of an appropriate response by the child being assessed, it does not specify how to modify the testing environment (Ulrich, 2000). Given what is known about the behavioral characteristics of children with ASD, it seems reasonable that including visual supports in the protocol of the TGMD-2 would provide an environmental modification that may improve performance on the TGMD-2 in this population.

Motor Skill Development and Children with ASD

A 2001 study found that a sample of children with ASD were likely to be labeled as *poor* or *very poor* compared to their age- and sex- matched peers in terms of fundamental motor skill development (Berkeley et al., 2001). Berkeley and colleagues (2001) used the first edition of the TGMD to examine motor skill development. Although this assessment is designed to use a process, not product, approach to evaluation of motor performance, the children in the Berkeley et al. (2001) study seemed to interpret the goal of the skill demonstrations to have a product rather than a process approach. When performing the locomotor skills on the TGMD-2, they would move from one place in the assessment environment to another without attempting to perform the various locomotor skills being asked of them. It is possible that these children did not understand the instructions, because the instructions were presented in an auditory modality, rather than visually. As this is the only study to date that has examined fundamental motor skills in children with ASD, there is a need for more research in this area in order to fully understand how motor skills are affected in children with ASD.

The results of studies examining motor skill development in children with ASD are inconclusive, possibly because the few studies conducted have used different assessments that are not validated for use with children with ASD (Berkeley et al., 2001; DeMyer et al., 1972, Klin, Volkmar, & Sparrow, 1992; Stone et al., 1997; Stone et al., 1999). DeMyer et al. (1972) determined each child's mental age and asked each child to complete items from motor skill assessments ranked as easy, possible, or difficult based on the child's individual mental age, but did not ask the child to complete any motor skill assessment in its entirety. Another study used the Motor Imitation Scale to determine if the level of imitation skills of the child with autism matched that of their maturational age as measured by 16 simple imitative tasks (Stone et al., 1997).Two other studies used parent report data derived from the Vineland Adapted Behavior Scales (Klin et al., 1992; Stone et al., 1999). Although the Vineland Adapted Behavior Scales used in these studies have high reliability and validity in measuring social functioning (Sparrow, Balla, & Cicchetti, 1984), perhaps a better assessment exists for measuring motor skills.

Although some studies have indicated that children with ASD experience normal or even precocious motor development (DeMyer et al., 1972; Klin et al., 1992; Stone et al., 1999), only one study examined fundamental motor skill development in children with ASD (Berkeley et al., 2001). The results of that previously mentioned study led to the conclusion that children with ASD exhibit poor performance on fundamental motor skills as measured by the TGMD; but the investigators also mentioned methodological issues that arose when working with this population during assessment that may have influenced the results (Berkeley et al., 2001).

DeMyer et al. (1972) compared children with autism to children with developmental delay in terms of their ability to imitate motor skills. The children were asked to perform 5-10 tasks out of a possible 531 body imitation, motor object imitation, and non-imitative object use tasks that were deemed easy, appropriate, or hard with respect to each child's mental age. Performance on the tasks was measured on a criterion basis; either the child could or could not perform the tasks. The results indicated that performance of object use tasks that did not require difficult sequences of imitation at all difficulty levels and performance on easy imitative tasks by children with autism exceeded that of children with developmental delay. DeMyer et al. concluded that children with autism demonstrate superior performance in object use tasks that do not require imitation because those tasks are not demanding with respect to attention to others. Because object use tasks that did not require imitation skills did not depend on communication or social interaction for success, the performance on these skills was better than the other skills assessed in this study requiring communication and social interaction. Furthermore, because children with ASD exhibit these difficulties, the authors also concluded that it is easier for children with autism to attend to others for only a short duration, which is possible when children with autism are requested to imitate an "easy" task rather than a more difficult one.

Another study that indicated children with autism imitate motor skills poorly sought to compare the motor skills of children with autism to both neurotypical children and children with developmental delay (Stone et al., 1997). This study used the Motor Imitation Scale to evaluate the children's ability to imitate motor skill performance. Half of the items on this scale are functionally meaningful, and the other half serve no functional purpose. It should be noted that none of the items on the motor imitation scale assess fundamental motor skills (Stone et al., 1997). Children with autism in this study performed imitation activities less accurately than children with developmental delay and neurotypical peers, but children with autism experienced less difficulty imitating movements requiring the movement of objects than the imitation of body movements alone. The results of this study have interesting implications for the TGMD-2, which requires imitation of both body movements and object manipulations. It may be that the imitation of locomotor skills, which do not require object manipulations, may be too abstract a motor task for children with ASD to understand, whereas object control skills represent a motor task with a concrete goal (i.e., manipulate the object from point A to point B) that children with ASD can understand.

Finally, two other studies used semi-structured parent interviews based on the Vineland Adaptive Behavior Scales asking parents to compare the fine and gross motor skills of their children with ASD to their neurotypical peers (Klin et al., 1992;Stone et al., 1999). Using this approach, children with ASD were reported to exhibit motor skill development at levels higher than their maturational age (Stone et al., 1999). Because these findings used a parent interview approach to evaluate the child's motor skill functioning, rather than a direct observation of children's behaviors(Stone et al., 1999), caution should be used when interpreting their findings. Questions can be raised regarding the validity of such results.

The other study using the Vineland Adaptive Behavior Scales included children with autism and peer groups matched to the children with autism's chronological and maturational ages as well as intelligence quotient (Klin et al., 1992). The conclusions reported from this study indicate that the motor skills of children with autism were not impaired. In fact, the children with autism’s motor skills were significantly higher than their maturational age matched peers, and no different than their chronological age matched peers (Klin et al., 1992).

The results of the studies conducted regarding motor skill development by children with ASD are inconclusive and sometimes even contradictory (Berkeley et al., 2001; DeMyer et al., 1972; Klin et al., 1992; Stone et al., 1997; Stone et al., 1999). There is a need for more research regarding the motor skill development of children with ASD that uses consistent, reliable, and valid assessment methodologies. Furthermore, care should be taken by researchers to ensure that the assessment methodology used is actually understood by children with ASD. In this way, validity and reliability of the research findings can be maximized.

Summary

Given the increasing prevalence of ASD, it is important for physical educators and researchers to understand the characteristics of ASD and to recognize the importance of adapting their instructional and assessment techniques to accommodate the needs of these students. These adaptations may increase these students’ motor skill development during physical education, because effective instructional programming for students with ASD is based on the tenet 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 present form of motor skill assessment may not be appropriate. Visual supports, such as picture task cards and picture activity schedules, may provide a means to increase the validity of motor skill assessments. This study sought to examine the effects of including such modifications to the protocol of the TGMD-2 in order to more accurately assess the motor skills of students with ASD. The ultimate intention of this study is that instructional programming in physical education can better meet the needs of these children.

METHODS

The purpose of this study was to examine the effects of protocol modifications that included visual supports (i.e., picture activity schedule and picture task cards) during the administration of the Test of Gross Motor Development (Second Edition; TGMD-2) to children with ASD between 3 and 10 years old, measured by the gross motor quotient score and the percentage of time on-task. It was hypothesized that TGMD-2 gross motor quotient performance and the percentage of time on-task during the TGMD-2 would be significantly higher during the picture activity schedule than the picture task card condition and the traditional protocol, respectively. It was also hypothesized that the TGMD-2 gross motor quotient performance and the percentage of time on-task would be significantly higher during the picture task card condition than during the traditional protocol. Further, it was assumed that the order of TGMD-2 protocol administration modifications would have no effect on children with ASD as measured by the performance variables of the gross motor quotient score and the percentage of time on-task.

Participants

This study was conducted during a summer supplemental educational program for students with ASD located in Auburn, Alabama. The summer program enrolled42 students, 35 of whom were diagnosed with ASD. The experimenter had over one year of experience working with children with ASD as the instructor of gross motor play and physical activity at a university-affiliated preschool program for children with ASD.

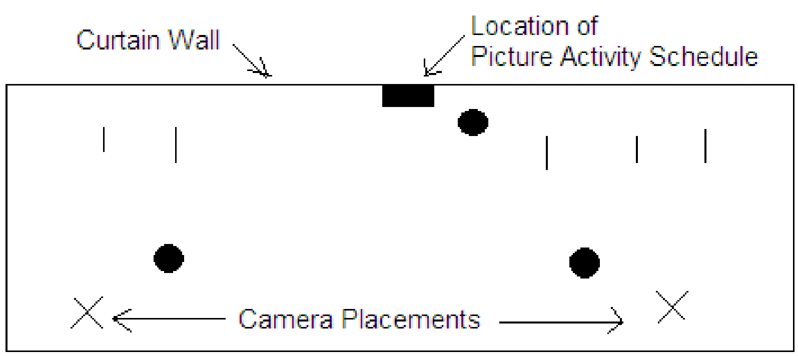
The participants in this study were selected because parent report data indicated they met the inclusion criteria for ASD according to the Diagnostic and Statistical Manual (Fourth Edition, Text Revision [APA, 2000]) as measured by a developmental pediatrician or a trained, licensed psychologist. For a complete list of inclusion criteria, refer to Appendix A. Upon approval from the Institutional Review Board for Research Involving Human Subjects and the return of parental informed consent forms sent in an informational packet to custodial caregivers containing a letter explaining the study and a participant demographic information form (refer to Appendices B, C, and D), $N = 30$ (male = 23, female=7) participants were recruited. Four of the participants were older than 10 years, and were therefore excluded from participation. Four participants were excluded from data analysis due to incomplete data sets, yielding a sample $N= 22$(male = 16, female = 6, African American = 5, Caucasian = 17, age range=3.5 years – 10.92 years). For a complete list of participant demographics obtained through parent report data, including age, sex, diagnosis, and date of diagnosis, refer to Appendix E.

Setting

All children enrolled in the supplemental summer educational program received educational programming incorporating best practice teaching techniques including discrete trial teaching, structured work stations, incidental teaching, social stories, and picture exchange communication system (PECS), with visual supports permeating the instructional climate. Data collection took place within a large multipurpose room located in the elementary school hosting the supplemental summer educational program.

Adjacent to the multipurpose room was a wing of eight classrooms, housing the summer educational program, and two hallways leading towards the main office and media center of the elementary school. The doors to the hallways were shut whenever possible and a sign was placed on the doors asking people to use alternate routes while testing was occurring. Additionally, the multipurpose room was divided in half by a plain white curtain to separate the multipurpose room from the wing where the children's classrooms were located. Data collection occurred on one side of the curtain to diminish the physical space and make the room less distracting to the participants. The dimensions of the area were data collection occurred was 10.97 m x 25.07 m. Figure 2 is a representation of the testing area.

Figure 2. Assessment Area Layout



Legend
Camera was placed on the right side of the room if the childrens' preferred hand was their right hand; and on the left side if the preferred hand was indicated as their left.

● Location of the polyspots (decorated with laminated foot prints) on the floor to provide the participant a specific location from which to observe demonstrations.

| | | Pieces of tape placed on floor to ensure that child's motor skill performance was captured by the camera and the distances specified for completing the TGMD-2 were maintained.

The TGMD-2 assessments were administered by the researcher, a female motor development specialist. Two other research assistants, also female, were present in the testing room, one serving as the videographer, and one responsible for setting up and collecting equipment prior to and following the performance of the motor skill trials. The same research assistants fulfilled the same roles each day of data collection. Because children with ASD are known to have difficulty attending to relevant environmental stimuli, measures were taken to decrease the amount of irrelevant stimuli in the assessment environment (Marks et al., 2003; Schultheis et al., 2000).Specifically, the researcher and research assistants wore plain shirts, shorts, and shoes for data collection. The windows in the multipurpose area were covered with plain paper.

Materials

To conduct the TGMD-2, the following equipment was required: an eight-to ten-inch playground ball, a four-inch lightweight ball, a basketball, a tennis ball, a soccer ball, a softball, a four- to five-inch square beanbag, tape, two traffic cones, a plastic bat, and a batting tee (Ulrich, 2000). Further, as the assessments were video recorded, a JVC GR-DVL9800 digital video camera, tripod, and digital video recording cassette tapes were required. The TMGD-2 assessments were video recorded so that the data could be reviewed to evaluate the effectiveness of the protocol modifications.

Picture task cards depicting the twelve motor skills assessed in the TGMD-2 were created and then laminated to make them more durable. The dimensions of each picture task card were 6 cm x 6 cm. (See Figure 3 for a picture of the picture task cards used in this study.) The picture task cards were pilot tested for use with children with ASD by showing the children the cards and demonstrating the skills depicted on the task cards, and asking the child to perform those skills. The cards were shown one at a time.

*Figure 3.*Picture Task Cards Used During the TGMD-2

The picture activity schedule used in this study measured 72 cm x 15 cm of laminated poster board. The same twelve picture task cards used in the picture task card condition were affixed to the picture activity schedule board using a vertical strip of Velcro® fastening tape.(See Figure 4 for a photograph of a sample picture activity schedule used in this study.) The picture activity schedule was pilot tested for use with children with ASD by showing one child at a time the picture activity schedule and asking the child to check the schedule. The child then successfully removed the top card from the picture activity schedule and handed it to the teacher, who demonstrated the skill depicted on that particular card, and asked the child to perform that skill.

Figure 4. Sample Picture Activity Schedule Used During the TGMD-2

Instruments

TGMD-2

The TGMD-2, the most widely used assessment in physical education, was used as the assessment instrument for this study (Ulrich, 2000). The TGMD-2's normative data are stratified based on age, sex, race, and geographic location, in accordance with the projections from the 2000 U.S. Census, in order to ensure that the results are generalizable to samples of participants drawn from throughout the country (Ulrich, 2000).

The TGMD-2 has high validity, as the results of the TGMD-2 correlate well with other assessments measuring gross motor development, and the results of the subtests of the TGMD-2 correlate well with each other (Ulrich, 2000). Furthermore, validity is also supported because the results of TGMD-2 performance can be used to differentiate motor skill performance by both high and low performers and older and younger children (Ulrich, 2000). The TGMD-2 is also valid, as the skills assessed by the TGMD-2 were selected as representative of gross motor development through the interview of three motor development experts (Ulrich, 2000). In order to determine the consistency of results over time, a sample of children ages 3 to 10 years (N= 75) completed the assessment twice in a two-week period in order to determine test-retest reliability, and correlation coefficients of r =.88, r =.93, and r =.96 were calculated for the locomotor subtest, the object control subtest, and the gross motor quotient scores, respectively. The *TGMD-2 Examiner's Manual* features detailed, clear instructions in an attempt to minimize differences between different experimenters, thus increasing the likelihood that results are reliable (Ulrich, 2000).

The TGMD-2 is scored quantitatively based on qualitative measures, so there is room for error in interpretation (although the detailed instructions in the *TGMD-2 Examiner's Manual* regarding assessment administration attempt to control for these errors). It is possible to receive a gross motor quotient score within the range of 46-160. Refer to Appendix F for scoring criteria for each of the twelve skills included on the TGMD-2. The author of the manual also explains that environmental modifications may be made to the protocol for assessment administration in order to increase the understanding of the assessment instructions by the student being assessed, but the manual's author makes no explanation of what kinds of environmental modifications should be made (D. Ulrich, personal communication, November 10, 2007).

Behavior Evaluation Strategy and Taxonomy (BEST) Software

BEST is a software system that enables quantitative data to be collected and analyzed from a physical activity environment (Sharpe &Koperwas, 1999). BEST uses computer codes programmed by the researcher to measure the frequency in which the participants engage or do not engage in specified motor and physical behaviors in a real time, observational format. Following software configuration, percentage of time engaged in on-task behavior recorded on the videotapes was analyzed using the BEST software. The computer keyboard was configured according to the researcher's pre-determined taxonomy which allowed for the recording of frequency and duration of operationally defined behaviors. After the quantitative data are coded for each observation period, total duration and/or frequency scores can be calculated for each key (representing a frequency and duration of an operationally defined behavior). Using these data, BEST is able to assess inter-rater agreement by calculating Cohen's kappa coefficient (Cohen, 1960). A kappa coefficient between .80 and 1.0 was considered appropriate, indicating high inter-rater agreement.

Specifically, in this study, BEST was programmed to produce an auditory tone every six seconds informing the researchers it was time to code the participant's behavior for the previous six seconds. The participant could be engaged in one of five behaviors: on-task behavior, administrative tasks, extra trials, off-task behavior, or not visible. Table 1 refers to both the behavioral descriptors and keyboard configuration of the BEST software for this study. In order for a participant's behavior to be coded as on-task, the participant must have engaged in behavior defined as on-task for the entire six second observation period. If the child engaged in behavior indicating he or she was off-task for part of the observation period, the child would be coded as off-task, irrespective of whether an administrative task was being completed. Whole interval data were used to reduce the likelihood that more than one behavior would occur in each six second observation period (van der Mars, 1989).

Table 1. BEST computer keyboard letter assignments, labels, and descriptions used for coding participant behavior.

Behavior	Key Label	Key	Description (output)
On Task Behavior	"OnTask"	O	On-task behaviors are defined as the time in which a participant (a) visually attends to appropriate equipment or demonstration, (b) looks at the picture task cards or activity schedule, (c) appropriately manipulates the equipment used to complete object control skills or appropriate demonstration of locomotor skills included on the TGMD-2 within one minute of skill demonstration by experimenter, or (d) is in transition from one skill on the subtest to another (Bryan &Gast, 2000).
Not visible	"CantSee"	Q	Participant cannot be seen on the videotape data for the entire six second interval.

Behavior	Key Label	Key	Description (output)
Extra trials	“Extra”	X	In the event that the participant is asked to complete more than two trials for a reason other than a mistrial, these trials are coded as “extra” and do not factor into the percentage of time on-task analysis.
Administrative Tasks	“Admin”	M	The researcher is performing some task not affiliated with the assessment, yet necessary for the assessment to continue. These include tying shoes, asking participant to remove shoes if they were wearing “croc” or “flip-flop” sandals, waiting for visitors to pass through assessment area, or comforting participants following an upsetting loud noise beyond the participant’s and researcher’s control.
Off-Task Behaviors	“OffTask”	T	Off-task behavior refers to defiant or insubordinate behavior or the exhibition of a tantrum.

Time engaged in the other four types of behavior, including “offtask”, “cantsee”, “admin”, or “extra” were collapsed together. “Extra” behavior referred to the researcher’s request for the performance of additional trials beyond what was necessary for data collection. Behavior coded as “extra” trials was not included in the calculations of the percentage of time on-task to eliminate statistical error. “Admin” behaviors(e.g., tying shoes, comforting participant following a loud noise) were also excluded from the calculation of the percentage of time on-task because the completion of these tasks did not contribute to assessment completion in the traditional sense, yet were necessary in the practical sense. “CantSee” was excluded from the analysis of the percentage of time on-task because the camera placement enabled data collection from any angle in the assessment area unless the participant was fleeing from the researcher.

Using the BEST software, total duration of five types of behavioral observations throughout the assessment was calculated. To calculate the percentage of time engaged in on-task behavior, BEST software divided the time duration in seconds coded as “ontask” into the time duration in seconds of the entire assessment (Sharpe &Koperwas, 1999). This number, multiplied by 100, yielded a percentage of time on-task.

Fidelity of Treatment

Fidelity of treatment administered by the experimenter was assessed by research assistants blind to the purpose of the experiment in order to ensure that the different protocols were actually implemented. These research assistants were asked to view the videotapes of the assessments and answer a 15-item questionnaire with behavioral descriptors that uniquely differentiated the three protocols as operationally defined by experimenter behavior during the assessments. Checkmarks next to the first five behavioral descriptors refer to the traditional protocol, while checkmarks beside the next five behavioral descriptors refer to the picture task card condition. The final five descriptors refer to the picture activity schedule condition. During the review of the videotapes, the responses to the fidelity of treatment questionnaire enabled the calculation of the percentage of instances in which the three protocols were accurately administered by the experimenter. The fidelity of treatment for each TGMD-2 used in this study was assessed using videotape review. See Appendix G for a copy of the fidelity of treatment questionnaire for this study.

Design and Procedures

Data were collected during a four-week period, in individual testing sessions lasting a maximum of thirty minutes each. TGMD-2 assessments were conducted one participant at a time, one assessment per participant per day, on three consecutive days so that each participant received all three protocols. The TGMD-2 was terminated upon completion of the assessment items or after thirty minutes, whichever came first. Thirty minutes was selected as the termination time because the *TGMD-2 Examiner's Manual* states that the assessment should take approximately 15-20 minutes per child (Ulrich, 2000) and pilot work revealed that spending more than thirty minutes with a child did not elicit better performance or the completion of more motor skills during the assessment. In the event that a child was sick and/or totally noncompliant during an assessment period, the child was given another opportunity to participate on the next scheduled day of data collection. The child still received the same order of protocol modification as originally scheduled, but on a different day.

Videotapes of the participants' TGMD-2 assessments were analyzed to determine if protocol modifications resulted in differences in performance as measured by gross motor quotient scores. The gross motor quotient score was used because it is a composite score of overall motor skill development as measured by both locomotor and object subscales (Ulrich, 2000). The researcher coded the quality of the child's performance of the motor skills according to the criteria provided on the TGMD-2 data sheet (located in Appendix F) while watching the videotape of the child's performance. A research assistant, blind to the purpose of the study but trained in scoring the TGMD-2, simultaneously coded the TGMD-2 assessments (without discussing the participants' performance) to ensure that the proper motor skills trials on the videotape were coded. High inter-rater reliability was desirable and indicated by a Cohen's kappa coefficient between .80 and 1.0 (Cohen, 1960). The videotapes were also analyzed by two research assistants to determine the participants' percentages of time engaged in on-task behavior during the TGMD-2. To code this data, both researchers were provided a list explaining which trials (i.e., the last trial of three trials) were to be coded as extra trials, but the data was coded individually, and inter-rater reliability was calculated using the BEST software after both researchers coded each assessment.

In all data collection periods, the participants were welcomed into the classroom and invited to participate in the activities included in the assessment. To invite participation, the experimenter asked the child "Are you ready? Let's Play!" The child was then asked to "First watch [Researcher's Name], then it's [Participant Name's] Turn." The experimenter then verbally named the activity to be demonstrated, demonstrated it, and then asked the child to perform it. If the participant was successful in performing the activity requested, that trial was counted as the first trial for the TGMD-2 and the experimenter then said to the child “Again please”, so that two test trials could be obtained. If, after successful performance on the first trial, the child made an error performing the skill on the next trial, that trial was coded as a mistrial and the experimenter asked the child to “first watch, then do” and again demonstrated the skill. The trial following the second demonstration was counted as the second trial. If the participant was unsuccessful during the first trial, the experimenter repeated the activity demonstration and asked the child to again perform the activity like the demonstration. If, after the second demonstration, the child’s performance indicated that the participant still did not understand, the elicited responses were documented as test trials. Following each successful trial, the researcher said “Good job following directions” or “Good listening!” At the conclusion of each data collection period, the researcher said “We are all done. Time to go back to Ms. (Teacher’s Name)’s class.”

Acclimation Period

Each child received20 minutes of acclimation time in the testing environment on the day immediately preceding the first day of data collection for that child, with the testing environment arranged as it was during the TGMD-2 assessments and with all data collectors present. The acclimation period familiarized the participant with the routine of coming to the classroom where the TGMD-2 assessments were conducted, the data collectors and testing equipment, and the participants were taught the meaning of the picture task cards included in the assessment through repetitive practice in a “follow the leader” style game.

Assessment Period

Following the 20 minutes of acclimation time in the testing environment, each child was escorted to the testing room on three consecutive days to complete the three different TGMD-2 protocols. A tripod video camera system monitored by a research assistant was arranged (as depicted in Figure 2 on page 33) to capture the child's performance during the assessment.

Traditional Protocol. In the traditional protocol, the motor skills to be assessed were presented to the child in the following way, as prescribed in the *TGMD-2 Examiner's Manual*. The basic protocol dictates for the experimenter to say "I want you to____ like this" and demonstrate the motor skill to be assessed. The participant then attempts to perform the motor skill. If the participant performs the skill, the participant is then encouraged to repeat the performance, as the *TGMD-2 Examiner's Manual* suggests that participants perform each skill twice during assessment in order to increase the reliability of the assessment results (Ulrich, 2000). If the participant does not perform the skill being requested (e.g., he or she runs when asked to hop), the experimenter again demonstrates and repeats the verbal instructions regarding the skill being requested (Ulrich, 2000). If, after a successful first trial, the child made an error performing the skill during the next trial, the protocol for mistrials was followed.

For each individual skill included on the TGMD-2, there are specific instructions that the experimenter must give to the participant (Ulrich, 2000). When asking the participant to run, the experimenter says "I want you to run like this as fast as you can from one cone to another". The verbal instructions for the gallop are "I want you to gallop like this from one cone to the other". When asking to hop, the experimenter says

“Hop three times like this”. When demonstrating leaping, the experimenter says “I want you to leap like this over the beanbag”. The verbal instructions for the horizontal jump are to “Jump like this as far as you can”. When demonstrating sliding, the instructions are to “Slide like this from one cone to another”. When striking a stationary ball, the verbal instructions are to “Hit the ball hard like this”. When demonstrating the stationary dribble, the verbal instructions are to “Dribble the ball using one hand like this four times without moving your feet”. The verbal instructions for catching are to “Catch the ball like this with both hands”. The verbal instructions for kicking are to “Kick the ball hard like this”. When instructing the participant to perform the overarm throw, the experimenter says “throw the ball as hard as you can at the wall like this”. When assessing the underhand roll, the experimenter instructs the participant to “roll the ball hard so that it goes between the cones” (Ulrich, 2000). Following each successful trial in this study, the researcher provided verbal praise such as “Good job following directions” or “Good listening!”

Picture Task Card Condition. In the picture task card condition, the motor skills to be assessed were presented to the child using physical demonstration and through a picture task card. Twelve picture task cards depicting the twelve skills included in the TGMD-2 were affixed to a metal ring and placed on a lanyard worn on the experimenter’s wrist for easy access by the experimenter. See Figure 3 on page 35 for the picture task cards used in this study. The experimenter again asked the child to “First look at _____, then watch me, then do.” The experimenter showed the picture task card depicting the motor skill to be assessed, and said “________, watch (Researcher’s Name), then ________.” The researcher would then demonstrate the skill and again ask the child to perform it. If the participant was successful in performing the activity, that trial counted as the first test trial for the TGMD-2 and the experimenter said to the child "Good job following directions. ____ again please" or "Good listening. _____ again please.", while displaying the picture task card, so that two test trials were obtained. If the participant was unsuccessful during the first practice trial, the experimenter repeated the activity demonstration, displayed the picture task card to the child again, and asked the child to again perform the activity the same as the demonstration. If, after the second demonstration and practice attempt, the child still did not correctly perform the skill, the elicited responses were documented as test trials. If the child performed an error during one of the two test trials, the mistrial protocol explained earlier was followed, so as to try to produce an accurate measurement of the child's skill level. Because picture task cards were used in this protocol, verbal instructions provided by the assessment administrator were minimized through the use of two to three word phrases explaining the skills to be performed to maximize effectiveness of the picture task card visual supports. The use of picture task cards to provide instruction, combined with the limited verbal instructions, differentiate this protocol from the traditional protocol.

Picture Activity Schedule Condition. In the picture activity schedule condition, the motor skills to be assessed were presented to the child in the following way. A picture activity schedule, consisting of a vertically displayed series of picture task cards depicting the activities to be completed during the assessment attached to a strip of Velcro® on a piece of laminated poster board, was displayed on the white curtain behind the experimenter and the participant. See Figure 4 on page 37for a photograph of a sample picture activity schedule. The experimenter said "Check schedule" and pointed to the picture activity schedule posted on the wall. The participant then walked to the wall, removed the picture task card at the top, and handed it to the experimenter. If the participant failed to move towards the picture activity schedule or failed to remove the picture task card located at the top of the picture activity schedule within one minute of being asked to check schedule, the participant was physically prompted, using a hand-over-hand technique (i.e., manual manipulation), by the experimenter so the participant attended to the picture activity schedule and removed the proper picture. The participants in this study had experience following this protocol as they used picture activity schedules throughout the day in all of their activities during the supplemental summer educational program.

Following selection, removal, and receipt of the proper picture from the picture activity schedule, the experimenter said: “Good checking schedule! Now _____ like this.” or “Good listening! Now ____ like this”, and then demonstrated the motor skill to be assessed. The participant then attempted to perform the motor skill. If the participant successfully performed the skill, it counted as the first test trial and he or she was then encouraged to repeat the performance so that two test trials were obtained. If the child did not perform the skill on the first try, the tester again displayed the picture task card to the child, and named the skill depicted on the picture task card. The demonstration procedure was then repeated by the experimenter and the child then performed the motor skills. An error in either of the two test trials resulted in the mistrial protocol being followed. It is important to note that although this protocol uses verbal praise for following the picture activity schedule, verbal instruction regarding how to perform the motor skill is minimized in a manner similar to the picture task card condition.

Because individuals with ASD experience difficulties in understanding time and instructions presented verbally, the picture activity schedule was hypothesized to elicit better performance on the TGMD-2 because it 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.

Experimental Design

The independent variable in this study was the different protocols for the TGMD-2. The traditional protocol incorporated the format of the TGMD-2 protocol that uses verbal commands and modeling. The other two protocols were modified formats of the TGMD-2 protocol. These protocols incorporated the use of task cards with modeling and verbal commands, and the use of a picture activity schedule with modeling and verbal commands. Because of the three protocols, and two subscales to the TGMD-2, there were six possible order combinations of protocols and all six were used. The dependent variables in this study were the participant's gross motor quotient score on the TGMD-2, and the percentage of time-on-task behavior.

A counterbalanced within-subjects research design in which participants were randomly assigned to receive one of six different orders of protocol modification conditions was employed. All children completed the skills within the TGMD-2 subscales in the same order, although participants were assigned to complete either locomotor or object control skills first.

Data Analysis

All data analyses were conducted using the Statistical Package for the Social Sciences, Version 16. Two univariate ANOVAs with alpha set at .05 were conducted *a priori* to test if there were significant differences in gross motor quotient scores or the percentage of time on-task due to the order of protocols. Two repeated measures univariate analyses of variance (ANOVA) with alpha set at .05 were conducted to assess the differences in the TGMD-2 gross quotient scores and the percentage of time-on-task behavior for each of the assessment protocols. When appropriate, Bonferroni tests were conducted as a *post hoc* analysis in order to determine which protocols were different from each other.

When a significant protocol main effect was found in the previous analyses, a multivariate analysis of variance (MANOVA), with alpha set at .05, was conducted to assess differences on the individual items of the TGMD-2. For all analyses, eta squared was reported as a measure of effect size.

Dependent Variable Inter-rater Reliability

To ensure inter-rater reliability, the data coders were trained to code the performance of motor skills in accordance with the *TGMD-2 Examiner's Manual*. Data coders were also trained to code participant behavior using the BEST software for the percentage of time-on-task behavior. Training continued until the data coders reached 90% agreement in their codes, and then all of the assessments were checked for agreement in their codes of both gross motor quotient performance and the percentages of time on-task behavior. Although no formal rule has been established in the literature, it is recommended that at least 20% of observations should be checked to ensure that inter-rater reliability is maintained (Foster, Bell-Dolan, & Burge, 1982). All of the observational data in this study were checked for inter-rater reliability to reduce the influence of expectancy bias because the primary investigator was one of the two data coders.

RESULTS

It was hypothesized that TGMD-2 gross motor quotient performance and the percentage of time on-task during the TGMD-2 would be significantly higher during the picture activity schedule than the picture task card condition and the traditional protocol. Additionally, it was hypothesized that the TGMD-2 gross motor quotient performance and the percentage of time on-task would be significantly higher during the picture task card condition than during the traditional protocol. It was assumed that the order of protocols received would have no impact on the gross motor quotient scores or the percentage of time on-task during the TGMD-2.

Presented in this chapter are the results of the data analyses. The underlying statistical assumptions necessary for conducting all analyses were met. First, aggregate inter-rater reliability for both dependent variables is presented. Then, the results for order of conditions are presented. Next, the results from the overall and follow-up analyses on the TGMD-2 gross motor quotient and the percentage of time-on-task behavior are presented. Last, the inter-rater reliability for fidelity of treatment is reported in the form of the percentage of instances the three protocols were implemented correctly.

Inter-rater Reliability

For both dependent variables, inter-rater reliability was calculated and found to be high. Specifically, aggregate inter-rater reliability between the researcher and the research assistant was calculated at 95.74% for the coding of the gross motor quotient scores on the TGMD-2. Inter-rater reliability between the researcher and the research assistant trained to code the percentage of time on-task was 95.84%. This calculation was necessary for all further analyses to be conducted to ensure data integrity.

Assumptions

Univariate ANOVAs testing the assumption that there was no statistically significant differences for TGMD-2 gross motor quotient and the percentage of time on-task as a function of the order of protocols (i.e., traditional protocol, picture task card condition, picture activity schedule condition) were both not significant, $F(5,16) = .372$, $\eta^2 = .104$, $p = .860$ for gross motor quotient, and $F(5,16) = .371$, $\eta^2 = .023$, $p = .693$, for the percentage of time on-task. These analyses indicate that the participants' gross motor quotient scores and percentages of time engaged in on-task behavior were not influenced by the order in which they received the three protocols was received first. These assumptions were examined to ensure that learning effects did not occur due to the repeat administration of the TGMD-2. Furthermore, these findings suggest that the acclimation period eliminated the influence of a tantrum or other exhibition of noncompliant or disruptive behavior by the participant due to a change in routine on the performance of the TGMD-2. Thus, it can be concluded that the results of the study were not influenced by a learning effect or a change in routine during the supplementary summer education program.

Research Question 1: TGMD-2 Gross Motor Quotient Scores

The first research question for this study examined if the protocol received by children with ASD influenced TGMD-2 performance as measured by gross motor quotient score. Specifically, it was hypothesized that the picture activity schedule condition would elicit higher gross motor quotient scores than the picture task card condition, and that the picture task card condition would elicit higher gross motor quotient scores than the traditional protocol. A repeated measures univariate ANOVA yielded a significant main effect for protocol, $F(2,21) = 6.655$, $\eta^2 = .241$, $p = .003$. The means and standard deviations for the TGMD-2 gross motor quotient performance by protocol (i.e., traditional protocol, picture task card, and picture activity schedule) were 63.05 $\pm$ 15.94, 68.91 $\pm$ 18.30, and 67.14 $\pm$ 17.46, respectively. The Bonferroni follow-up test indicated that gross motor quotient was significantly higher ($p = .008$) for the picture task card protocol than the traditional protocol. The Bonferroni follow-up test also revealed that the gross motor quotient did not differ between the picture task card protocol and the picture activity schedule protocol ($p = .636$) or between the picture activity schedule protocol and the traditional protocol ($p = .100$). Each participant's gross motor quotient scores for the three protocols and the net change in gross motor quotient scores respective to the traditional protocol are presented in Appendix H.

Because a main effect for protocol was found for the TGMD-2 gross motor quotient scores, a MANOVA was conducted to assess differences in each motor skill of the TGMD-2. The results of the MANOVA were not statistically significant, $F(24,58) = .813$, $\eta^2 = .246$, $p = .707$, indicating that there were no differences in performance on specific items of the TGMD-2. Table 2 provides the means and standard deviations for each individual item on the TGMD-2 for each protocol.

Table 2. 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

Research Question 2: Percentage of Time Engaged in On-Task Behavior

The second research question examined if the protocol received by children with ASD influenced TGMD-2 performance as measured by the percentage of time engaged in on-task behavior. Specifically, it was hypothesized that the picture activity schedule condition would elicit higher percentages of time on-task than the picture task card condition, that the picture task card condition would elicit higher percentages of time on-task than the traditional protocol. A repeated measures univariate ANOVA revealed the main effect for protocol was not significant, $F(2,21) = .425$, $\eta^2 = .020$, $p = .657$. The means and standard deviations for the percentage of time engaged in on-task behavior by protocol (i.e., traditional protocol, picture task card, and picture activity schedule) were 73.78% ± 15.29%, 76.16% ± 18.86%, and 75.49% ± 18.71%, respectively. These findings show that the protocol did not produce differences in the percentage of time on-task. Percentage of time engaged in on-task behavior for the protocols by each participant is presented in Appendix I.

Fidelity of Treatment Questionnaire

In order to ensure that the three protocols were implemented correctly, two research assistants, blind to the purpose of the study, completed the fidelity of treatment questionnaire for each TGMD-2. Prior to videotape analysis, the two research assistants obtained 99.4% inter-rater reliability on the fidelity of treatment questionnaire. The results of the fidelity of treatment questionnaire, presented as the means and standard deviations of the percentage of instances that the different protocols were accurately introduced to the participants, are listed in Table 3. The results indicated that the researcher implemented the three distinctively different protocols as planned. Inter-rater reliability for fidelity of treatment was also conducted for 30% of the assessments (20 assessments) and was calculated to be 98.8%, indicating the fidelity of treatment questionnaires were completed correctly by the two research assistants.

Table 3. Results of the Fidelity of Treatment Questionnaire.

	Traditional Protocol		Picture Task Card Condition		Picture Activity Schedule Condition	
Question	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	96.0%	.20%	0%	0%	0%	0%
2	95.8%	.20%	0%	0%	0%	0%
3	95.8%	.20%	0%	0%	0%	0%
4	95.8%	.20%	.05%	.21%	0%	0%
5	0%	0%	100%	0%	0%	0%
6	0%	0%	100%	0%	0%	0%
7	0%	0%	95.5%	.21%	0%	0%
8	95.8%	.20%	.05%	.21%	.05%	.22%
9	0%	0%	100%	0%	0%	0%
10	0%	0%	95.5%	.21%	0%	0%
11	.04%	.20%	0%	0%	100%	0%
12	.04%	.20%	0%	0%	100%	0%
13	.04%	.20%	0%	0%	100%	0%
14	.04%	.20%	0%	0%	100%	0%
15	.04%	.20%	0%	0%	100%	0%

DISCUSSION

Visual supports have been found to be effective for teaching new skills and for increasing on-task behavior by children with ASD in instructional settings (Bryan &Gast, 2000, Johnston et al., 2003; MacDuff et al., 1993). This is the first study reporting the effectiveness of visual supports on the performance of the TGMD-2 by children with ASD. The purpose of this study was to examine the effects of visual supports, in the form of a picture activity schedule and picture task cards, on the performance of the TGMD-2 by children with ASD. It was hypothesized that the picture activity schedule condition would elicit higher gross motor quotient scores and a higher percentage of time on-task than the picture task card condition and the traditional protocol. It was also hypothesized that the picture task card condition would elicit higher gross motor quotient scores and a higher percentage of time on-task than the traditional protocol.

This chapter begins with a discussion of the findings related to the gross motor quotient scores, followed by a discussion of an ancillary finding pertaining to the motor skill development of children with ASD. A discussion follows related to the hypothesis examining the percentage of time on-task. Finally, implications of the findings for future research and conclusions from this study are presented.

Gross Motor Quotient Scores on the TGMD-2

The results of this study partially supported the hypothesis for the TGMD-2 gross motor quotient score performance in that 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 to the other two conditions.

These findings endorse a growing body of literature empirically supporting the use of picture task cards with individuals with ASD. Previous literature has supported the use of picture task cards to improve the quantity and quality of social interactions in free play settings among preschool children (Johnston et al., 2003). In this study, all participants in a preschool classroom were provided a “Can I play?” picture task card to display to gain entry into a child’s play session, rather than verbally requesting to play. The frequency and duration of social interactions initiated by the three children with ASD enrolled in the class were found to increase with the use of the picture task card (Johnston et al., 2003).

Although the picture activity schedule condition did not result in higher scores on the TGMD-2, the picture task card condition did. These findings have important practical implications. PL 94-142 and IDEA mandates that all children with a documented disability be assessed and placed in educational programs appropriate for their skill levels (IDEA, 2004; U.S. Code, 1975). It also mandates that physical education must be included as a daily service for children with disabilities as part of their individualized education plan (IDEA, 2004; U.S. Code, 1975). Therefore, it is important that these children’s motor skills are accurately assessed. Visual supports have been used to teach new skills and routines to children with ASD while increasing time engaged in on-task behavior (Bryan &Gast, 2000; Dooley et al., 2001; Fittipaldi-Wert, 2007; Johnston et al., 2003; MacDuff et al., 1993; Welton et al., 2004). The present findings suggest picture task cards can also be useful in assessment situations; specifically, they can be effective at obtaining more accurate gross motor quotient scores on the TGMD-2 in this population.

A way to improve assessments in educational settings may be to utilize picture task cards. Picture task cards are pictoral representations of an action to be performed by an individual (Johnston et al., 2003). The picture task cards utilized in this study may have facilitated communication visually to most of the children with ASD as to what skills were to be completed during the TGMD-2. Research suggests that children with ASD are usually better at processing visual information than auditory information (Broun, 2004; Houston-Wilson & Lieberman, 2003; Mirenda & Santogrossi, 1995). The picture task card condition capitalized on that strength, through the display of one card at a time to the participant, a physical demonstration of the motor skills, and a minimization of verbal instructions. With the use of this assessment protocol children with ASD are more likely to be accurately assessed in their motor skills. This could result in the children being placed in physical education experiences more appropriate for their skill levels and ultimately, the children may achieve higher levels of motor skill development.

Although the incorporation of picture task cards into the TGMD-2 protocol may result in a more accurate assessment of the motor skills of children with ASD, care should be taken in interpreting these results. The effect size for this picture task card protocol was small (η^2= .241). Because the picture task cards used in both the picture task card and the picture activity schedule protocols displayed both a picture and the word describing the picture, it is difficult to determine if the children with ASD who had the ability to read used the information presented in the picture or read the word on the picture task card. Furthermore, because the verbal instructions were minimized in both the picture task card and the picture activity schedule conditions, it may be that the differences in protocols can be attributed to the verbal instructions rather than the picture task cards.

Individuals with ASD have difficulty interpreting auditory information, but a strength in processing information presented in a picture format (Grandin, 1995; Simpson, 2005). 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 in order to complete the TGMD-2. A visual support was presented in addition to the physical demonstration in order to capitalize on the child with ASD's strength in visual processing (Grandin, 1995; Simpson, 2005). The results of this study can be attributed to the three distinctively different protocols being properly administered during the TGMD-2 assessments. However, the picture task card condition was found to be effective in increasing gross motor quotient scores, while the picture activity schedule condition did not produce the expected results. The incorporation of a picture activity schedule into the protocol of the TGMD-2 did not produce statistically significant differences. With respect to the mean gross motor quotient scores for each protocol, there was less than a 2 point difference between the two visual supports conditions, and a nearly 6 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 6 point difference in scores is a 10% change in performance, which has practical significance for teachers measuring student performance.

Perhaps the nonsignificant statistical findings for the picture activity schedule condition may have been due to the variability in TGMD-2 performance as measured by gross motor quotient. The standard deviations of gross motor quotients for the three conditions were large, indicating high variability between performers on the TGMD-2. The participants produced a large range of scores on the TGMD-2. Specifically, the range of gross motor quotient scores for the participants in this study for all three conditions was between 46 and 103. Even though the participants ranged in age from 3.5 -10.92 years, gross motor quotient scores for all participants in this study can be compared to each other. This is possible because the gross motor quotient score is a standardized composite score measuring performance on the TGMD-2 compared to age- and sex-based normative data. Therefore, it seems feasible that the variability of performance indicated by the large standard deviations and range of gross motor quotient scores may have influenced the findings. However, this is not an unusual finding for this population. High standard deviations are typically found when assessing children's motor skill performance (Robinson & Goodway, in press; Valentini& Rudisill, 2004b). This is particularly true for children with disabilities (Valentini& Rudisill, 2004a).

Another possible explanation why the picture activity schedule condition did not elicit a significant difference in gross motor quotient scores as compared to the traditional protocol is that the location of the picture activity schedule could have interfered with the outcome. The picture activity schedule was placed on the fabric curtain in the center of the assessment area. After completing each skill on the TGMD-2, the participant was prompted to "check schedule". In order for the participant to check the picture activity schedule, the participant had to leave the area where he or she was performing the motor skills to walk approximately 15 meters to the schedule and remove the top card on the schedule. The participant then returned back to the motor skills area to continue the assessment. The picture activity schedule placement was ideal for collecting data on videotape regarding on- and off-task behaviors when accessing the picture activity schedule, but was perhaps less than ideal for TGMD-2 performance as it seems to interfere with the completion of the assessment.

A related explanation for why the picture activity schedule condition did not result in better performance than the traditional protocol pertains to the difference in the total duration of the assessment for each protocol. The means and standard deviations of the duration in minutes of the TGMD-2 assessments for the traditional protocol, picture task card condition, and picture activity schedule condition were 13.11 $\pm$ 3.88, 13.75 $\pm$ 4.77, and 15.43 $\pm$ 4.41, respectively. Significant differences emerged with respect to duration in minutes of the TGMD-2 protocols ($F(2,20) = 6.039$, $\eta^2 = .860$, $p = .005$). Bonferroni follow-up tests indicated that the picture activity schedule condition was significantly longer in duration than the traditional protocol ($p < .0001$), but there were no differences in duration between the picture task card condition and the traditional protocol ($p = 1.000$) or between the picture activity schedule condition and the picture task card condition ($p = .162$). This indicates that the picture task card condition was almost the same duration as the traditional protocol and the picture activity schedule protocol, yet better performance was elicited on the TGMD-2 using picture task cards. Thus, it seems that picture task cards are a feasible modification that assists in helping children with ASD understand the TMGD-2 assessment instructions better than during the traditional protocol and the picture activity schedule protocol. This occurs with a very small increase in the total duration of the assessment compared to the traditional protocol. It is possible that the children with ASD were unable to pay attention or lost interest during the picture activity schedule condition as a result of the extended time required for testing. The replication of this study with the picture activity schedule located closer to the motor skill performance area may elicit different results and possibly help to explain the nonsignificant findings related to time on-task. Because the variables of time on-task and gross motor quotient scores are not necessarily related, it is possible for a child to have a very low gross motor quotient score and a high percentage of time engaged in on-task behavior.

Another explanation for the nonsignificant findings regarding the picture activity schedule condition relates to the research design. In previous studies, picture activity schedules were found to be effective at reducing problem behaviors and instructing new skills during classroom instruction (Dooley et al., 2001; Fittipaldi-Wert, 2007; MacDuff et al., 1993). In these studies the visual support was used with more than one child (neurotypical or another child diagnosed with ASD) present in the room. However, picture activity schedules have not been previously applied to assessment situations. 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. In this study, the picture activity schedule had 12 pictures displayed to be completed in a thirty minute time period. This picture activity schedule displayed a greater number of items to be completed in a shorter duration of time than in previous studies. In previous studies supporting the use of picture task cards, the picture activity schedules that had more than 10 items displayed were used throughout the whole school day (Dooley et al., 2001). The picture activity schedules used to structure shorter duration activities (such as leisure time or class time) displayed fewer items to be completed (Bryan &Gast, 2000; Fittipaldi-Wert, 2007; MacDuff et al., 1993). Furthermore, there has been very little group design research (including within-subjects designs such as this study) conducted examining educational instructional techniques for children with ASD (Dettmer et al., 2000, National Research Council, 2001; Odom et al., 2003; Rao & Gagie, 2006; Simpson, 2005).

Another interesting finding that pertains to the TGMD-2 results is that five participants earned a gross motor quotient score of 46 regardless of the protocol. A gross motor quotient score of 46 is the floor threshold for the TGMD-2. Regardless of the assessment protocol used, these children were unable to perform the motor skills. It is also interesting to note that these five participants demonstrated limited communication skills. Three of the five participants had no verbal communication skills, and the other two participants communicated using very little speech. It is possible that due to the severity of their disability and the lack of communication skills of these children, their performance on the TGMD-2 did not differ regardless of the condition. Furthermore, it is possible that the severity of their disability outweighed the benefits received through the utilization of visual supports during the TGMD-2 protocol.

Recent literature suggests there may be a relationship between the severity of the disability and the presence of concomitant disorders such as seizure disorders (Breslin, Rudisill, & Wadsworth, in review; Turk et al., 2009). Specifically, Breslin et al. (in review) suggest that the level of communicative functioning possessed by a child with ASD may impact physiological markers such as heart rate making it difficult to compare heart rate responses among children with ASD with different communication skills. Turk et al. (2009) suggest that the presence of a concomitant seizure disorder may account for much of the variance in performance of social interactions and problem behaviors. As this study did not collect data on the prevalence of concomitant seizure disorders within the sample, nor was data collected on the level of verbal communication, it is possible that the statistical results of studies similar to this one may be impacted by the heterogeneous nature of the sample with respect to concomitant disorders or level of communicative functioning. If there were a way to differentiate between participants because of a measurable deficit in communicative functioning or the presence of some unstudied concomitant disorder, the results of this study may have been different. At present, there is no objective way to differentiate between high functioning and low functioning children with ASD. It is worth mentioning that the exclusion from data analysis of the five children whose scores did not change regardless of protocol did not change the statistical results of the present study.

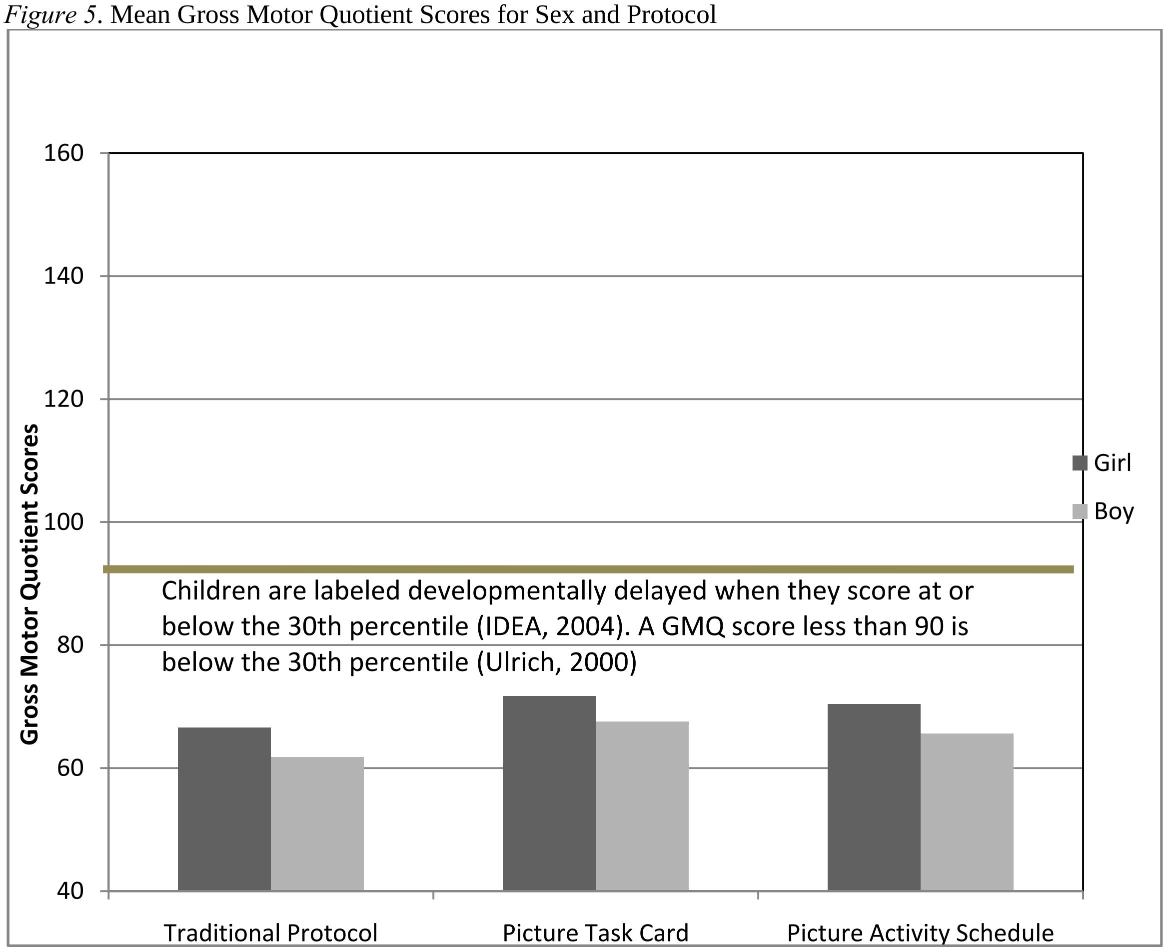
The results of this study suggest that picture task cards can serve as a valuable tool for practitioners to use to ensure a more accurate assessment of motor skills for children with ASD. Picture task cards are an easy, inexpensive way to provide a valid means of communication for children with ASD (Broun, 2004; Bryan &Gast, 2000; Dettmer et al., 2000; Fittipaldi-Wert, 2007; Houston-Wilson & Lieberman, 2003; Mirenda & Santogrossi, 1995). Furthermore, it is interesting to note that of the participants in the study who had the ability to communicate verbally, many inquired where the picture activity schedule was during the traditional protocol. During the picture task card condition, one participant suggested that, although the schedule was not displayed on the wall, he understood that the schedule was on “those cards” on the lanyard worn on the researcher’s wrist. It may be that picture task cards reduce anxiety in the assessment environment, similar to that which occurs in educational settings (Downing &Peckham-Hardin, 2000; Welton et al., 2004), and should be explored further in future studies.

ASD and Gross Motor Quotient Scores

A useful feature of the gross motor quotient score is that it easily converts to a percentile score based on normative data for the age and sex. The Individuals with Disabilities Act (IDEA) of 2004 states that children scoring at or below the 30^{th} percentile for their age are developmentally delayed and would therefore qualify for adapted physical education standards regardless of the child’s behavioral characteristics (IDEA, 2004). With a gross motor quotient score of 91, a child with ASD would qualify for adapted physical education services. This child would be in the 27^{th} percentile for motor skill development, and therefore, according to IDEA, the child would be labeled as developmentally delayed in terms of motor skill development. A gross motor quotient score of 94, results in a 35^{th} percentile score (Ulrich, 2000). A child earning that score would not qualify for adapted physical education services (IDEA, 2004). Therefore, a three point difference in gross motor quotient score between the traditional protocol and the picture task card condition could result in different outcomes with respect to physical education placement. In this sample, there were three participants whose gross motor quotient scores changed as a function of the use of visual supports, such that they qualified for adapted physical education services in the traditional protocol, but did not qualify for such services in the picture task card condition.

An interesting finding from this study deals with the motor skill development of children with ASD. Previous studies examining motor behavior in children with ASD have been inconclusive with respect to their capabilities (Berkeley et al, 2001; DeMyer et al., 1972; Klin et al., 1992; Stone et al., 1997; Stone et al., 1999). The only studies reporting that children with ASD were advanced in their motor skill development utilized parent report data obtained from semistructured interview questions, not behavioral observations (Klin et al., 1992; Stone et al., 1999). Although no hypotheses were directed toward the motor skill development of children with ASD in the present study, the results indicate these children have developmental delays in their motor skills. Figure 3 depicts the mean gross motor scores of children with ASD for both sexes and all protocols.

Figure 5. Mean Gross Motor Quotient Scores for Sex and Protocol



The most interesting finding displayed in Figure 5 is that participants in the present study were developmentally delayed in terms of their motor skills. The Individuals with Disabilities Act (IDEA) of 2004 stated that the 30th percentile serves as a floor threshold for indicating developmental delay. Gross motor quotient scores less than 90 correspond to a percentile score at or below the 30th percentile for the child's age and sex on the TGMD-2. As shown in Figure 5, both boys and girls in this sample had mean gross motor quotient scores that fell below the threshold indicating developmental delay in motor skill development. In examining the individual data obtained from this sample, there were only five instances where a participant scored at or above the 30th percentile. Only one participant scored at this level during all three testing conditions. The other two occasions a participant scored at or above the 30th percentile occurred during the picture task card condition. Furthermore, it should be noted that in examining TGMD-2 performance using percentile scores, seven of the participants scored at less than the first percentile compared to normative data for their age and sex. These findings suggest that children with ASD are delayed in their motor skill development as measured by the TGMD-2, and that the picture task card condition helps to elicit higher gross motor quotient scores. Although small, these increases in gross motor quotient scores can have significant practical implications for a population that has been found to be developmentally delayed in both previous studies (Berkeley et al., 2001; DeMyer et al., 1972; Stone et al., 1997) and this study.

A possible explanation for why children with ASD are delayed in terms of their motor skill development may be due to difficulties in communication and imitation. All of the studies that reported children with ASD were delayed in their motor skills asked the children to imitate motor skills performed by a research assistant (Berkeley et al., 2001, DeMyer et al., 1972, Stone et al., 1997). It is possible that although children with ASD may have difficulty imitating motor skills, the results of these studies may also have been influenced by the participants' failing to understand the assessment instructions. The present study required children with ASD to imitate the performance of motor skills included on the TGMD-2, but provided visual supports to increase their understanding of the assessment instructions. However, because the TGMD-2 utilizes imitation of motor skills, it is impossible to control for the difficulty children with ASD have in performing imitation skills.

In spite of this potential limitation, the TGMD-2 is the most widely used physical education assessment in the United States today (Ulrich, 2000). Therefore, it is important to investigate how to obtain accurate scores on this assessment for children with ASD. The results of this study indicate that the use of picture task cards to communicate assessment instructions may elicit more accurate measurement of motor skills on the TGMD-2, even when imitation is involved.

In summary, it appears that picture task cards may provide a more effective way to communicate instructions to children with ASD, regarding the task to be completed within the environment and also to organize and direct attention to relevant stimuli in the surrounding environment (Rao & Gagie, 2006). This study extends the body of literature to support the use of picture task cards during the TGMD-2. It seems that incorporating picture task cards into the TGMD-2 protocol may produce more accurate measurement of motor skill performance as measured by gross motor quotient scores compared to the traditional protocol, because it plays to the strength in visual processing of children with ASD (Grandin, 1995; Tissot& Evans, 2003).

Percentage of Time Engaged in On-Task Behavior

Picture task cards have also been found to increase time engaged in on-task behaviors while decreasing time engaged in off-task behaviors (Fittipaldi-Wert, 2007). Furthermore, the picture task cards were found to decrease the need for physical prompting among elementary school children with ASD during physical education (Fittipaldi-Wert, 2007). In Fittipaldi-Wert's study, picture task cards, picture activity schedules, and concrete boundaries were incorporated into physical education instruction, after a period of baseline data collection measuring the percentages of time engaged in on- and off- task behaviors and the amount of physical prompting required (Fittipaldi-Wert, 2007). Picture task cards have also been found to be effective in meeting behavioral intervention plan objectives (Welton et al., 2004), as indicated by the reduction in tantrum behavior during the school day by a preadolescent female with ASD. The results of the present study suggest that the picture task cards can also elicit better performance on the TGMD-2 as measured by gross motor quotients by children with ASD.

This study also sought to examine the effectiveness of visual supports on the percentage of time on-task during the TMGD-2 assessment. The percentage of time on-task was examined in this study because children with ASD frequently have problems attending to relevant stimuli in instructional settings. The results of this study did not support the hypothesis that the percentage of time on-task during the TGMD-2 would be significantly higher for children with ASD when the assessment protocol included the picture activity schedule condition than the picture task card condition, which would also yield higher scores than the traditional protocol. There were no statistically significant differences in the percentage of time on-task between the three protocols.

Perhaps the nonsignificant findings related to the percentage of time on-task can be attributed to the measures used to attempt to control for environmental distractions. It is possible that these measures eliminated the differences between the percentages of time engaged in on-task behavior as a result of the visual supports. In this study, the researcher attempted to control for distractions in the assessment environment by creating a routine (Groft-Jones, & Block, 2006; Mesibov, 2006) and utilizing concrete boundaries (Fittipaldi-Wert &Mowling, 2009; Groft-Jones & Block, 2006; Houston-Wilson & Lieberman, 2003). Beginning with the acclimation period, a routine was established where the participant followed the researcher’s instructions and performed a series of motor skills after the researcher demonstrated the skill. The order in which the motor skills were completed did not vary between the acclimation period and the assessment protocols. The physical environment was not changed between assessments. For each child, the assessment area was set up exactly as it had been the day before. This would not be replicated in most applied assessment situations. Therefore, it is possible that the researcher’s attempt to control for environmental distractions could have influenced the findings related to the percentage of time on-task. Specifically, the window coverings, the lack of decorations on the walls, and the curtain used to diminish the physical space in the assessment area could have eliminated the distractions present in previous studies examining time on-task in classroom settings.

It would be interesting to replicate the study in an environment where fewer measures were taken to eliminate distractions to determine if the percentage of time on-task changes between the three protocols. If differences are seen in a less controlled environment, it is plausible that controlling for many environmental distractions in the assessment environment was the reason the hypothesis examining the percentage of time on-task was not supported. Therefore, it would also be interesting to examine the impact of a less controlled environment on gross motor quotient scores. Children with ASD are usually assessed individually in terms of their motor skill development much like they were in this study, but they are not usually assessed in an environment where so many environmental distractions are controlled (i.e., fabric curtain, window coverings, etc). It could be that conducting this study in a more “real world” environment could elicit different results related to percentage of time on-task.

Another possible explanation as to why the percentage of time on-task was not significantly different between protocols was because this study examined the influence of visual supports on an assessment, rather than an instructional intervention. Previous studies utilizing visual supports resulting in significant differences in the percentage of time on-task were derived from intervention based studies in which baseline, intervention, and follow-up data was collected regarding the percentage of time engaged in on-task behavior (Bryan &Gast, 2000; Fittipaldi-Wert, 2007, MacDuff et al., 1993). Specifically, in these studies, data regarding on- and off-task behavior of elementary school aged children was collected using time sampling procedures during physical education, language arts education, and leisure time. In all three studies, baseline data was collected regarding behavior, then visual supports were introduced into the environment and intervention data was collected. During follow-up data collection, Fittipaldi-Wert (2007) reintroduced visual supports into the instructional setting after a period where the visual supports were removed. This was done to measure retention to determine if the students learned (and could recall) how to use the visual supports (Fittipaldi-Wert, 2007). The other studies measured on- and off- task behavior during a removal of the visual supports from the environment to see if differences emerged in behavior between the intervention and removal phases (Bryan &Gast, 2000; MacDuff et al., 1993). The visual supports were then removed from the environment, and behavior was assessed. In the present study, no baseline data examining the percentage of time engaged in on-task behavior by the participants was collected. Furthermore, previous studies utilized single subject research design, rather than the within-subjects group design utilized in this study. The present study did not incorporate an intervention, nor were the results presented using single subject research design.

Implications for Future Research

There are several implications for future research derived from this study. The results of this study provide a more effective approach to measure changes in motor skills as a result of protocol modification. By improving the measurement tools used to assess educational programming, researchers and teachers gain an opportunity to learn more about children's actual motor skill competencies. Future research should investigate the effectiveness of motor skill interventions using the modified TGMD-2 administrative protocol with picture task cards and other motor skill assessments. The protocol modifications discussed in this study may be beneficial to other populations (including neurotypical children). Therefore, one direction for future research is to examine the effectiveness of the modified TGMD-2 protocol utilizing picture task cards visual supports in other populations of children, including neurotypical children. Another direction should examine the effectiveness of the different parts (namely, the short verbal commands or the picture task cards) of the modified TGMD-2 protocol. Specifically, future research should examine the influence of the short verbal commands during the traditional protocol condition to determine the role verbal information plays in helping children with ASD understand assessment instructions. Future studies should also utilize a covariate analysis to address the issues of heterogeneity of symptoms in this population. Using a covariate approach (e.g., IQ or receptive language skills) may address participant differences and the high standard deviations. Furthermore, future studies examining motor skill development should only include participants who know how to perform the different skills included on the TGMD-2 assessment. In this study, five children were unable to perform their fundamental skills, as they scored on the floor threshold in all three conditions.

The body of literature could also examine the perceptions of children with ASD during motor skill assessments such as the TGMD-2 when visual supports are incorporated into the assessment protocol as compared to traditional assessment approaches. Examining the children's perceptions would provide information regarding the children's preferred approach to assessment. Teachers could also be trained on how to incorporate visual supports into the TGMD-2 protocol and be empirically assessed for both validity and reliability of the assessment administration. This could provide an opportunity for more children with ASD to be assessed in a way that capitalizes on their cognitive strengths while minimizing their weaknesses. It would also be useful to examine the teachers' perceptions regarding the ease of administration. Considering the behavioral characteristics of individuals with this disability, it may be more feasible to obtain information regarding the teachers' perceptions and preferences regarding assessment protocols.

Furthermore, the results of this study indicate that children with ASD are delayed in their fundamental motor skill development. Therefore, it would be beneficial to target these children for motor skill development and physical education instructional interventions. Higher levels of motor skill development are linked to reduced risk of hypokinetic disease such as type 2 diabetes and obesity (Saakslahti et al, 1999) and increased perceived competence, self-concept, and self-esteem (Kovar et al., 2007; Valentini& Rudisill, 2004). Future research should investigate the effectiveness of such interventions using the TGMD-2 protocol with picture task cards by children with ASD.

A follow-up study should examine if picture task cards depicting the TGMD-2 skills in greater detail than the ones used in this study can elicit even higher gross motor quotient scores. Another follow-up study could determine if moving the picture activity schedule to a location closer to the assessment area than the location used in this study, elicits significantly higher gross motor quotient scores compared to the traditional protocol. Future research should also seek to investigate if picture task cards elicit scores more reflective of the true skill level of children with ASD on other motor skill assessments, such as the Movement Assessment Battery for Children (Henderson & Sugden, 1992). Researchers should continue to conduct empirical studies to contribute to the body of literature supporting the use of visual supports in both motor skill and educational assessments.

Conclusions

This is the first study providing empirical evidence supporting the use of visual supports in the TGMD-2 protocol for assessing motor skills of children with ASD. The purpose of this study was to examine the effects of protocol modifications (i.e., picture activity schedule and picture task cards) on the performance of the TGMD-2 by children with ASD as measured by gross motor quotient scores and the percentages of time on-task. The results of this study indicate that the use of picture task cards in the TGMD-2 protocol results in higher gross motor quotient scores by children with ASD, although the incorporation of these same picture task cards had no effect on the percentage of time on-task.

This study provides an initial indication that picture task cards are somewhat useful in the administration of a motor skills assessment for children with ASD. It is imperative for researchers and practitioners to understand how to effectively assess the motor skills of children with ASD. Although each child with ASD is unique, in this study, picture task cards were effective in improving performance on an educational assessment examining motor skills. This study endorses the use of picture task cards for achieving a more accurate assessment of gross motor quotient scores on the TGMD-2 for children with autism spectrum disorder.

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APPENDICES

Appendix A-American Psychiatric Association Definition of ASD

Appendix A-American Psychiatric Association

Diagnostic and Statistical Manual-Fourth Edition (Text Revision)

Definition of Autism Spectrum Disorder

Autistic Disorder, 299.00

A. A total of six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):

(1) qualitative impairment in social interaction, as manifested by at least two of the following:

(a) marked impairment in the use of nonverbal behaviors, such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction

(b) failure to develop peer relationships appropriate to developmental level

(c) a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)

(d) lack of social or emotional reciprocity

(2) qualitative impairments in communication as manifested by at least one of the following:

(a) delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)

(b) in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others

(c) stereotyped and repetitive use of language or idiosyncratic language

(d) lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level

(3) restricted, repetitive, and stereotyped patterns of behavior, interests, and activities as manifested by at least one of the following:

(a) encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus

(b) apparently inflexible adherence to specific, nonfunctional routines or rituals

(c) stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting or complex whole-body movements)

(d) persistent preoccupation with parts of objects

B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years:

(1) social interaction,

(2) language as used in social communication, or

(3) symbolic or imaginative play.

C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disinegrative Disorder.

Childhood Disintegrative Disorder, 299.10

A. Apparently normal development for at least the first 2 years after birth as manifested by the presence of age-appropriate verbal and nonverbal communication, social relationships, play, and adaptive behavior.

B. Clinically significant loss of previously acquired skills (before age 10 years) in at least two of the following areas:

(1) expressive or receptive language

(2) social skills or adaptive behavior

(3) bowel or bladder control

(4) play

(5) motor skills

C. Abnormalities of functioning in at least two of the following areas:

(1) qualitative impairment in social interaction (e.g., impairment in nonverbal behaviors, failure to develop peer relationships, lack of social or emotional reciprocity)

(2) qualitative impairments in communication (e.g., delay or lack of spoken language, inability to initiate or sustain a conversation, stereotyped and repetitive use of language, lack of varied make-believe play)

(3) restricted, repetitive, and stereotyped patterns of behavior, interests, and activities, including motor stereotypies and mannerisms

D. The disturbance is not better accounted for by another specific Pervasive Developmental Disorder or Schizophrenia.

Rett's Disorder, 299.80

A. All of the following:

(1) apparently normal prenatal and perinatal development

(2) apparently normal psychomotor development through the first 5 months after birth

(3) normal head circumference at birth

B. Onset of all of the following after the period of normal development:

(1) deceleration of head growth between ages 5 and 48 months

(2) loss of previously acquired purposeful hand skills between ages 5 and 30 months with the subsequent development of stereotyped hand movements (e.g., hand-wringing or hand washing)

(3) loss of social engagement early in the course (although often social interaction develops later)

(4) appearance of poorly coordinated gait or trunk movements

(5) severely impaired expressive and receptive language development with severe psychomotor retardation

Asperger's Disorder, 299.80

A. Qualitative impairment in social interaction, as manifested by at least two of the following:

(1) marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction

(2) failure to develop peer relationships appropriate to developmental level

(3) a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest to other people)

(4) lack of social or emotional reciprocity

B. Restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:

(1) encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus

(2) apparently inflexible adherence to specific, nonfunctional routines or rituals

(3) stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)

(4) persistent preoccupation with parts of objects

C. The disturbance causes clinically significant impairment in social, occupational, or other important areas of functioning.

D. There is no clinically significant general delay in language (e.g., single words used by age 2 years, communicative phrases used by age 3 years).

E. There is no clinically significant delay in cognitive development or in the development of age-appropriate self-help skills, adaptive behavior (other than in social interaction), and curiosity about the environment in childhood.

F. Criteria are not met for another specific Pervasive Developmental Disorder or Schizophrenia.

Pervasive Developmental Disorder, Not Otherwise Specified, 299.80

This category should be used when there is a severe and pervasive impairment in the development of reciprocal social interaction associated with impairment in either verbal or nonverbal communication skills or with the presence of stereotyped behavior, interests, and activities, but the criteria are not met for a specific Pervasive Developmental Disorder, Schizophrenia, Schizotypal Personality Disorder, or Avoidant Personality Disorder. For example, this category includes "atypical autism" - presentations that do not meet the criteria for Autistic Disorder because of late age at onset, atypical symptomatology, or subthreshold symptomatology, or all of these.

Appendix B-Letter to Caregiver

Appendix B-Letter to Caregiver

AUBURN UNIVERSITY

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KINESIOLOGY

May 1, 2008

Dear Parents:

The Test for Gross Motor Development (TGMD-2) is an assessment that evaluates running, galloping, sliding, leaping, jumping, hopping, throwing, catching, kicking, dribbling, rolling, and hitting a ball off a tee. It is a fun assessment to complete! Your child may have already completed this assessment in school this year, as it is the most widely used assessment in physical education to measure motor skill performance. Currently, the assessment uses verbal instructions and demonstrations, but I would like to examine the effectiveness of using visual supports (picture task cards and picture activity schedule) when administering the TGMD-2 assessment.

Picture task cards are pictorial representations of the motor skills being assessed. Picture activity schedule is a vertical display of picture task cards on a velcro strip. Both visual supports have been shown to help children with ASD better understand (through visual communication) what is being communicated and the schedule of future events. It is our belief that this modification to the assessment protocol will provide a better way to assess the children's motor skill performance.

The assessment poses no additional risk to the child beyond that of a normal playground. The child will receive the benefit of play, and the outcome of this study may impact physical education practice in the future. Refusing to participate in the study will not affect your child's standing at the Auburn University Department of Rehabilitation and Special Education Autism Summer Clinic.

I need your permission in order for your child to participate. Please review and return the attached form, if you are willing to let your child to participate. If you have any questions, please feel free to contact me (breslcm@auburn.edu; 301-491-1591) or Dr. Mary Rudisill (rudisme@auburn.edu; 334-844-1458).

Thank you,

Casey Marie Breslin
Doctoral Candidate
Auburn University
Department of Kinesiology

2050 Beard-Eaves
Memorial Coliseum
Auburn, AL 36849-5323

Telephone:
334-844-4483

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334-844-1467

www.auburn.edu

Appendix C-Informed Consent Form

Appendix C - Informed Consent

Form

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KINESIOLOGY

INFORMED CONSENT FOR THE MODIFICATION OF THE PROTOCOL OF THE TEST FOR GROSS MOTOR DEVELOPMENT TO INCLUDE VISUAL SUPPORTS AT THE AUBURN UNIVERSITY REHABILITATION AND SPECIAL EDUCATION AUTISM SUMMER CLINIC

I will be conducting assessments of the children participating in the Auburn University Summer Clinic. I am interested in determining the effects best protocol to assess children's motor skill development. The assessment measures actual motor skill performance (measured by the Test of Gross Motor Development). Additionally, descriptive information, including height, weight, Body Mass Index, sex, race, and date of birth, will be collected.

Children will also be assessed on the Test of Gross Motor Development (TGMD). The TGMD should take approximately 30 minutes to complete and will be administered and videotaped three times using different protocols. Participants will receive the traditional protocol using auditory instructions and visual skill demonstrations. Participants will also receive a picture task card condition where one picture task card will be shown to a child, the skill depicted in the picture task card will be demonstrated, and skill instructions will be presented in a short verbal command. A third protocol, the picture activity schedule, will use picture task cards arranged in a picture activity schedule format with short verbal instructions and skill demonstrations. All sessions within the motor development assessment will be video-taped so that we can determine the level of motor skill development of your child using TGMD criterion. The results will be used for future assessment and instruction of Motor Development as well as provide specific instructional information about the progress of your child. Following is an explanation of the TGMD assessment:

The Test of Gross Motor Development is a measure of fundamental motor skill competence in children ages 3- to 10- years. The 12-item test includes 6 locomotor skills (running, jumping, hopping, leaping, galloping, and sliding) and 6 object-control skills (rolling, throwing, catching, striking, bouncing, kicking).

Descriptive Information including height, weight, Body Mass Index, sex, race, and date of birth will be gathered for your child. Height will be measured using a standard tape measure. Children will be asked to take off their shoes and stand with their back against a wall. Height will then be measured to the nearest centimeter. Children will be asked to take off their shoes and stand on a standard scale to measure their weight to the nearest kilogram. Body Mass Index, a measure of overweight and obesity, will be calculated from the height and weight measures using the formula height divided by weight^2. Parents/guardians will be asked to report their child's sex, race, and date of birth.

There are no foreseeable risks or discomforts associated with the Test of Gross Motor Development. Please note that any child who expresses a desire to quit the assessments will be allowed to stop immediately. Participants will also be told that they can remain in the Autism Summer Clinic without completing the assessments. To preserve confidentiality, the children's performance and responses will be reported as group results only. I am informing you that any information obtained from the assessments may be used in any way thought best for education and publication. Unless otherwise notified by you, I plan to present the results of this program assessment at a scientific conference and publish the results in an appropriate journal. In any presentation or publication, the data will remain anonymous.

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Parent Guardian Initials _______________

The Auburn University Institutional Review Board has approved this document for use from 5/25/08 to 1/28/09. Protocol # 06-262 EP 0701

Your decision whether or not to allow your child to participate will not jeopardize his/her future relations with Auburn University, the Department of Health and Human Performance, or Auburn University Autism Clinic. Your child's performance or responses will in no way affect your child's standing in the Autism Clinic. At the conclusion of the assessments, a summary of group results will be made available to all interested parents and educators. Should you have any questions or desire further information, please call Dr. Mary Rudisill at (334) 844-1458 (phone) or rudisme@auburn.edu (email). You will be provided a copy of this form to keep.

For more information regarding your rights as a research participant you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED YOU MUST DECIDE WHETHER OR NOT TO ALLOW YOUR CHILD TO PARTICIPATE. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO ALLOW YOUR CHILD'S PARTICIPATION IN THE STUDY.

Child's Name ________________________________

Parent/Guardian Signature ____________________________ Date ________

Investigator Signature ______________________________ Date ________

The Auburn University
Institutional Review Board
has approved this document for use
from 5/25/08 to 1/28/09.
Protocol # 06-262 EP 0701

Page 2 of 2

Appendix D-Participant Demographics Parent Report Form

Appendix D- Participant Demographics Parent Report Form

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Participant Information

Please answer ALL questions. It is very important that you be as complete as possible in answering these questions.

Your Child's Name: ______________________________

Your Name: ______________________________

Your Mailing Address**: ______________________________

____

Your Child's Birthdate: ____________

Your Child's Birth Order (i.e., oldest of three, youngest of five):

____

Your Child's Height: ____________

Your Child's Weight: ____________

Please Check Your Child's Diagnosis:

____ Autistic Disorder
____ Asperger's Disorder
____ Child Disintegrative Disorder
____ Rett's Disorder
____ Pervasive Developmental Disorder, Not Otherwise Specified
____ Other

Date of Diagnosis: ____________

**Please provide this information in order to receive a report regarding your child's motor skill development and performance.

This information is highly confidential and will not be shared with anyone outside of the Auburn University Department of Rehabilitation and Special Education Autism Summer Clinic staff.

Appendix E - Participant Demographics

Appendix E-Participant Demographics

Participant	Sex	Age (Years)	Diagnosis	Date of Diagnosis
1	Boy	6.7	autistic disorder	2/2004
2	Boy	7.0	pervasive developmental disorder, not otherwise specified	12/2005
3	Boy	8.8	autistic disorder	2/2002
4	Girl	9.5	autistic disorder	2001
5	Girl	9.6	Asperger's disorder	3/2007
6	Boy	4.3	autistic disorder	4/2008
7	Boy	5.3	autistic disorder	8/2007
8	Boy	5.3	pervasive developmental disorder, not otherwise specified	2005
9	Boy	7.0	autistic disorder	1/2004
10	Boy	5.8	autistic disorder	2006
11	Boy	7.0	autistic disorder	3/2007
12	Boy	5.1	pervasive developmental disorder, not otherwise specified	8/2006
13	Boy	4.5	autistic disorder	12/2005
14	Girl	3.5	autistic disorder	2/2008
15	Girl	9.2	autistic disorder & pervasive developmental disorder, not otherwise specified	2003
16	Boy	4.6	autistic disorder	4/2006
17	Girl	5.3	autistic disorder	6/2004
18	Boy	8.8	autistic disorder	2002
19	Girl	3.6	autistic disorder	9/2007
20	Boy	9.4	pervasive developmental disorder, not otherwise specified	5/2001
21	Girl	10.6	autistic disorder	2000
22	Boy	10.9	autistic disorder	2007
M		6.5		
SD		2.6		

Appendix F-TGMD-2 Data Recording Sheet

Appendix F-TGMD-2 Data Recording Sheet

ID #		Assessment Date:		
Preferred Hand		LOCOMOTOR SKILLS		
Preferred Foot				
Skill	Performance Criteria	Trial 1	Trial 2	Score
Run	Arms move in opposition to legs, elbows bent			
	Brief period where both feet are off the ground			
	Narrow foot placement landing on heel or toe (i.e., not flat footed)			
	Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)			
Gallop	Arms bent and lifted to waist level at takeoff			
	A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot			
	Brief period when both feet are off the floor			
	Maintains a rhythmic pattern for four consecutive gallops			
Hop	Nonsupport leg swings forward in pendular fashion to produce force			
	Foot of nonsupport leg remains behind body			
	Arms flexed and swing forward to produce force			
	Takes off and lands three consecutive times on preferred foot			
	Takes off and lands three consecutive times on nonpreferred foot			
Leap	Take off on one foot and land on the opposite foot			
	A period where both feet are off the ground longer than running			
	Forward reach with the arm opposite the lead foot			
Horiz-ontal Jump	Preparatory movement includes flexion of both knees and arms extended behind body			
	Arms extend forcefully forward and upward reaching full extension above the head			
	Take off and land on both feet simultaneously			
	Arms are thrust downward during landing			
Slide	Body turned sideways so shoulders are aligned with the line on the floor			
	A step sideways with lead foot followed by a slide of the trailing foot to a point next to the			

	lead foot			
	A minimum of four continuous step-slide cycles to the right			
	A minimum of four continuous step-slide cycles to the left			
ID #		Assessment Date:		
Preferred Hand		OBJECT CONTROL SKILLS		
Preferred Foot				
Skill	Performance Criteria	Trial 1	Trial 2	Score
Striking a Station-ary Ball	Dominant hand grips bat above nondominant hand			
	Nonpreferred side of body faces the imaginary tosser with feet parallel			
	Hip and shoulder rotation during swing			
	Transfers body weight to front foot			
	Bat contacts ball			
Station-ary Dribble	Contacts ball with one hand at about belt level			
	Pushes ball with fingertips (not a slap)			
	Ball contacts surface in front of or to the outside of foot on preferred side			
	Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it			
Catch	Preparation phase where hands are in front of the body and elbows are flexed			
	Arms extend while reaching for the ball as it arrives			
	Ball is caught by hands only			
Kick	Rapid continuous approach to the ball			
	An elongated stride or leap immediately prior to ball contact			
	Nonkicking foot placed even with or slightly in back of the ball			
	Kicks ball with instep of preferred foot (shoelaces) or toe			
Over-arm Throw	Windup is initiated with downward movement of hand/arm			
	Rotates hips and shoulders to a point where the nonthrowing side faces the wall			
	Weight is transferred by stepping with the foot opposite the throwing hand			

	Follow-through beyond ball release diagonally across the body toward the nonpreferred side			
Underhand Roll	Preferred hand swings down and back, reaching behind the trunk while chest faces cones			
	Strides forward with foot opposite the preferred hand toward the cones			
	Bends knees to lower body			
	Releases ball close to the floor so ball does not bounce more than 4 inches high			

Appendix G -Fidelity of Treatment Protocols Questionnaire

Appendix G-Fidelity of Treatment Protocols Questionnaire

Tape #   Participant #

Please place an X in the box if it applies to the tape currently being viewed.

1.	Did the experimenter show no task card to the participant?	
2.	Did the experimenter use no environmental cues?	
3.	Did the experimenter speak in complete, conversational sentences?	
4.	Did the experimenter prompt the participant without using any external cues?	
5.	When introducing a new skill, did the experimenter say, "Look at ______"?	
6.	Did the experimenter only show one task card at a time to the participant?	
7.	Did the experimenter consult the task card prior to skill demonstration?	
8.	In regards to object control skills, did the experimenter refer to an object before introducing a new assessment item?	
9.	Did the experimenter refer to a task card before introducing a new assessment item?	
10.	Did the experimenter show the child the task card?	
11.	Did the experimenter show more than one task card at a time to the participant?	
12.	Did the experimenter refer to the picture activity schedule displayed on the wall before introducing a new assessment item?	
13.	Did the experimenter say "Check schedule"?	
14.	Did the experimenter prompt toward the picture activity schedule?	
15.	Did the experimenter take the task card out of the child's hand?	

Additional comments:

Appendix H-Gross Motor Quotient Scores for Each of the Protocols

Appendix H-Gross Motor Quotient Scores for each of the Protocols

Participant ID Number	Administrative Protocol		
	Traditional Protocol	Picture Task Card (Net Change from Traditional)	Picture Activity Schedule (Net Change from Traditional)
1	46	46 (0)	46 (0)
2	88	103 (15)	91 (3)
3	46	46 (0)	46 (0)
4	82	91 (9)	97 (15)
5	73	91 (18)	88 (15)
6	64	70 (6)	64 (0)
7	58	61 (3)	61 (3)
8	52	52 (0)	55 (3)
9	73	76 (3)	82 (9)
10	100	97 (-3)	91 (-9)
11	46	73 (27)	58 (12)
12	61	79 (18)	79 (18)
13	64	61 (-3)	61 (-3)
14	85	88 (3)	85 (0)
15	46	46 (0)	46 (0)
16	70	79 (9)	79 (9)
17	49	55 (6)	49 (0)
18	46	46 (0)	46 (0)
19	73	73 (0)	58 (-15)
20	46	46 (0)	46 (0)
21	58	58 (0)	70 (12)
22	67	79 (12)	79 (12)
M	63.3	68.9 (5.6)	67.1 (3.8)
SD	15.9	18.3 (8.0)	17.5 (8.1)

Appendix I-Percentage of Time Engaged in On-Task Behavior for Each of the Protocols

Appendix I-Percentage of Time Engaged in On-Task Behavior for Each of the Protocols

Participant	Administrative Protocol		
	Traditional Protocol	Picture Task Card (Net Change from Traditional)	Picture Activity Schedule (Net Change from Traditional)
1	53.69	69.22 (15.53)	46.50 (-7.19)
2	83.80	84.01 (.21)	82.55 (-1.25)
3	40.95	29.05 (-11.9)	31.49 (-9.46)
4	88.46	94.51 (6.05)	93.36 (4.9)
5	91.19	89.10 (-2.09)	94.02 (2.83)
6	87.29	80.84 (-6.45)	51.50 (-35.79)
7	62.15	43.16 (-18.99)	61.38 (-.77)
8	70.31	85.62 (15.31)	76.24 (5.93)
9	84.64	71.73 (-12.91)	76.45 (-8.19)
10	82.80	93.72 (10.92)	91.06 (8.26)
11	76.62	68.07 (-8.55)	62.24 (-14.38)
12	63.90	97.53 (33.63)	91.41 (27.51)
13	78.02	70.70 (-7.32)	85.46 (7.44)
14	86.20	95.49 (9.29)	92.63 (6.43)
15	59.59	78.79 (19.2)	73.26 (13.67)
16	84.51	80.78 (-3.73)	84.25 (-.26)
17	60.12	45.16 (-14.96)	64.04 (3.92)
18	44.64	53.93 (9.29)	44.63 (-.01)
19	70.86	77.30 (6.44)	84.82 (13.96)
20	72.37	77.32 (4.95)	91.34 (18.97)
21	84.18	96.31 (12.13)	87.05 (2.87)
22	96.82	93.18 (-3.64)	95.10 (-1.71)
M	73.78	76.16 (2.38)	75.49 (1.71)
SD	15.29	18.86 (3.57)	18.71 (3.42)