EFFECTIVENESS OF VIDEO MODELING ON MOTOR PERFORMANCE FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

DEPARTMENT OF KINESIOLOGY

COLLEGE OF HEALTH SCIENCE

BY

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DENTON, TEXAS

AUGUST 2017

DEDICATION

To the brave. To the risk takers. To those who aspire to be and do more.

"Go confidently in the direction of your dreams. Live the life you have imagined."

Henry David Thoreau

ACKNOWLEDGMENTS

First, I want to give thanks to my vegan-eating, animal-loving, dissertation chair and mentor Dr. Lisa Silliman-French. I know I couldn't have accomplished what I did at TWU without you; as you truly go the extra mile for all your students. The late nights lesson planning, the long weekends writing papers, the crazy days collecting data, the wise advice for navigating higher education . . . all invaluable, and I can't thank you enough. TWU will always hold a near and dear place in my heart, and many of these reasons are because of everything you have taught me, and for that, I forever grateful.

I would also like to thank my committee members: Dr. David Nichols, Dr. Diane Myers, and Dr. Suzanna Dillon for their guidance throughout this process. Your feedback and direction challenged my abilities and pushed me to become a better professional. The passion you exude for teaching and research is contagious. Thank you for building a strong foundation and providing the tools for your students to succeed.

Next, a big thank you is necessary for the peers in my cohort. My experience would be significantly different without the opportunity to learn from you and collaborate together. I hope continued collaborative efforts are in our future to enhance the field of adapted physical education.

Finally, I saved the best for last. I want to thank my husband, Bryan, and our daughter Quin. Y'all are my everything. With your support, anything is possible.

ABSTRACT

MELISSA BITTNER, M.S.

EFFECTIVENESS OF VIDEO MODELING ON MOTOR PERFORMANCE FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

AUGUST 2017

The newly adopted *Every Student Succeeds Act* (Lam, Mercer, Podolsky, & Darling-Hammond, 2016) requires that school districts use evidence-based practices for student outcomes. Evidence-based practices are based on supported research that are specific to different fields within education (e.g., physical education) and have also reported evidence of increased positive behaviors with specific groups of students (e.g., children with autism spectrum disorder [ASD]). The development of fundamental motor skills in children with ASD is dependent on teachers using evidence-based practices (e.g., picture task cards [PTC], video modeling). The purpose of this investigation was to determine the impact of three types of motor performance instructional strategies (i.e., PTCs, *ExerciseBuddy* application [*EB* App], combination) on teaching motor performance to children with ASD. Six children (CA = 5 to 9 years) were purposively selected with ASD. A randomized alternating-treatment design with no baseline was conducted 3 days a week, for 15 min, for 4 consecutive weeks. To determine the raw score for each participant, the investigator and two research assistants evaluated the performance criteria of the *Test of Gross Motor Development-3* (Ulrich, 2018) and established an inter rater reliability score of 88% (range = 73% to 97%). Based on visual

analysis of the data, the average of overlapping data between protocol conditions across participants approached 100%. Within the limitations of this investigation, it was concluded that there was *no* functional relation between PTCs, *EB* App, or combination instructional protocols during motor performance for children with ASD.

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CHAPTER I

INTRODUCTION

Families and teachers are increasingly serving and supporting children with autism spectrum disorder (ASD). According to the Centers for Disease Control and Prevention, 1 in 68 children is currently diagnosed with ASD in the United States (2016). ASD is also five times more prevalent in males and occurs across all ethnicities and socioeconomic groups. Further, children with ASD have repetitive behaviors, deficits in social and communication skills, and motor development delays that manifest prior to 36 months of age (American Psychiatric Association [APA], 2013).

In addition, individuals diagnosed with ASD are generally categorized as one of three levels based on support needed: Level 1, requiring support; Level 2, requiring substantial support; and Level 3, requiring extreme support at all times (APA, 2013). In response to these deficiencies, families and teachers must consider instructional strategies to facilitate the development of children with ASD across learning domains, including motor performance. Therefore, the purpose of this investigation was to determine the impact of three types of motor performance instructional strategies (i.e., picture task cards [PTCs], *ExerciseBuddy* application [*EB* App], combination) on teaching motor performance to children with ASD. Understanding how human behavior is learned may better enable families and teachers to assist children and students with ASD when engaging in motor performance. This chapter is organized in three sections: (a) Social Cognitive Theory, (b) Fundamental Motor Skills, and (c) Instructional Strategies. The following sections provide support for the use of instructional strategies as a means to teach fundamental motor skills to children with ASD.

Social Cognitive Theory

The social cognitive theory posits that individuals acquire skills by watching others perform, rather than personal experiences alone (Bandura, 1977). Human behavior is learned predominantly by observing and modeling others. This observational learning is a component of the social cognitive theory where cognitive and behavioral changes occur through observation. Modeling is the process by which an individual demonstrates to others a behavior that can be replicated. Bandura (1986) postulated observational learning takes place when an observer watches a model demonstrate a novel behavior which the observer did not already possess but is able to reproduce following observation. Adopting the social cognitive theory as the theoretical framework for this investigation provides rationale to empirically test video modeling and visual supports as alternative methods to improve fundamental motor skill performance.

Fundamental Motor Skills

Fundamental motor skills encompass both locomotor skills (e.g., running, hopping, galloping) and ball skills (e.g., throwing, catching, striking). Mastery of fundamental motor skills is a prerequisite to participation in many sports and games (Jurimae & Jurimae, 2000; Karabourniotis, Evaggelinou, Tzetsis, & Kourtessis, 2002). Inadequate fundamental motor skills may negatively influence physical and motor activity performance in later life (Gallahue & Ozmun, 2006; Jurimae & Jurimae, 2000).

Current researchers have suggested that some children with ASD have delays or impairments in motor performance (Downey & Rapport, 2012; Vernazza-Martin et al., 2005). Motor performance is defined as the ". . . observable production of a voluntary action, or a motor skill" (Schmidt & Wrisberg, 2008, p. 11). Individual differences in motor performance have led to challenges for researchers trying to identify specific fundamental motor skill patterns for children with ASD (Haywood, Robertson, & Getchell, 2012). The development of fundamental motor skills during early childhood is particularly important, when developmental changes and delays can be identified and programs implemented (Gallahue & Ozmun, 2006).

Instructional Strategies

The newly adopted *Every Student Succeeds Act* (ESSA; Lam et al., 2016) acknowledges physical education and health as part of a student's well-rounded education. The term *well-rounded education* replaces *core subjects* previously used in legislation (i.e., No Child Left Behind). ESSA also requires that school districts use evidence-based practices that have shown a statistically significant effect on student outcomes (Lam et al., 2016). The development of fundamental motor skills in children with ASD is dependent on teachers using evidence-based practices (e.g., picture task cards, video modeling).

Picture Task Cards

One type of instructional strategy for children with ASD are picture task cards (PTC), which are visual pictures of a skill (Breslin & Rudisill, 2011). Picture task cards are an established evidence-based practice (i.e., visual support) for students with ASD (National Professional Development Center on ASD, 2015). PTCs have been reported to increase time-on-task for children with ASD (Breslin & Rudisill, 2013; Dooley, Wilczenski, & Torem, 2001). Further, Breslin and Rudisill (2011) reported the use of PTCs to elicit higher scores on the *TGMD-2* by children with ASD. These researchers suggested that implementation of PTCs for children with ASD can be an effective way to improve motor performance. Other evidence-based practices (e.g., video modeling) have recently received attention in literature (Trocki-Ables, French, Silliman-French, & Nichols, 2014; Wong et al., 2014).

Video Modeling

Video modeling includes the use of a model (e.g., self, peer, video animation) who is video recorded while demonstrating a skill. The observer watches the video and replicates the skill. Video modeling can be shown on a computer, television monitor, computer tablet, or cellular phone. With the use of video modeling, children with ASD may engage in more on-task behaviors and learn more motor skills compared to live modeling (Case & Yun, 2015). A video screen provides an area of focus for children with ASD, which minimizes distractions from other stimuli (Corbett & Abdullah, 2005). Traditional motor performance instruction relies strongly on verbal communication and social interaction, two areas in which children with ASD have weaknesses (Tissot & Evans, 2003). Video modeling, which incorporates visual and auditory information, may be an effective addition to instruction for children with ASD.

ExerciseBuddy Application

Using evidence-based instructional strategies (i.e., video modeling) supported by the National Professional Development Center on ASD (2015), the *EB* App was developed to teach motor performance techniques to children with ASD (Geslak, 2015). Because it can be installed on a standard tablet, the *EB* App provides families and teachers a portable video modeling resource for introducing motor skills to their children's or students' learning environment. The *EB* App is being used to instruct children with ASD, but its benefits during motor performance are currently only supported by anecdotal evidence. Empirical research is needed to determine if the *EB* App is an appropriate instructional approach for children with ASD. Therefore, before the actual dissertation investigation, concurrent validity was established for the assessment component of the *EB* App (see Appendix G).

Purpose

The purpose of this investigation was to determine the impact of three types of motor performance instructional strategies (i.e., PTCs, *EB* App, combination) on teaching motor performance to children with ASD.

Research Questions

1. Does the use of the *EB* App positively increase fundamental motor performance in children with ASD?
2. Does the use of the PTCs positively increase fundamental motor performance in children with ASD?
3. Does the use of combination instructional strategies positively increase fundamental motor performance in children with ASD?

Definition of Terms

The following terms and definitions are essential to the purpose of this study:

- Autism spectrum disorder (ASD): Developmental disorder characterized by deficits in social skills, communication and repetitive or restricted interests that typically manifest before 36 months of age. ASD is classified into three levels: Level 1, requiring support; Level 2, requiring substantial support; and Level 3, requiring extreme support at all times (APA, 2013).
- *ExerciseBuddy*: Visual exercise application that can be installed on a standard computer tablet. The primary purpose of this application is to ". . . provide supports and direction in creating an exercise profile" and programming for students with ASD (MacDonald & Wegis, 2016, p. 205).

- Fundamental motor skills: Fundamental motor skills, such as the run, leap, catch, and overhand throw, form the foundation for the learning of more complicated sport and movement skills. Without fundamental motor skill competence, students are less likely to learn more complex sport and movement skills (US Department of Education, 1996).
- Motor performance: “Observable production of a voluntary action, or a motor skill” (Schmidt & Wrisberg, 2008, p. 11).
- Picture task card: “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” (Breslin & Rudisill, 2011, p. 344).
- Social cognitive theory: Emphasizes that human behavior is primarily learned by observing and modeling others (Bandura, 1977).
- *Test of Gross Motor Development-3 (TGMD-3)*: Norm and criterion-referenced measure of common gross motor skills which assists in identifying children ages 3 through 10.9 years who are significantly behind their peers in gross motor skill development and who should be eligible for special education services in physical education (Ulrich, 2018).
- Video modeling: “A procedure in which a learner is shown a videotape of a model performing a target behavior or completing a desired task” (Sigafoos, O’Reilly, & de la Cruz, 2007, p. 1).

Delimitations

This study was subject to the following delimitations:

1. The participants were preschoolers in North Texas.
2. A small sample size of participants was used (N = 6).
3. The age of participants (i.e., 5 to 9 years).
4. The participants had Level 1 or 2 ASD.
5. The use of an alternating treatment design was used.
6. The investigator served as motor skill instructor.
7. The participants' degree of effort when performing the specified skill.
8. English may not be the primary language of some participants, so there may be differences in interpretation and terminology of key words and concepts.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this investigation was to determine the impact of three types of motor performance instructional strategies (i.e., picture task cards [PTCs], *ExerciseBuddy* application [*EB* App], combination) on teaching motor performance to children with autism spectrum disorder (ASD). The *EB* App uses video modeling as a means to implement motor performance activities for children with ASD. The following sections provide support for the use of instructional strategies as a means to teach fundamental motor skills to children with ASD.

Potentially relevant articles, published between 2004 (when the landmark Individuals with Disabilities Education Improvement Act was passed) and January 2017 were located through (a) electronic search engines, (b) texts and journals, and (c) references in selected literature related to key words used in the purpose of this study. These approaches were used to conduct the literature review searches.

The following electronic search engines frequently used in adapted physical education research were searched: ProQuest Nursing and Allied Health Source, PsycINFO, ERIC, SPORTDiscus, PubMed, and ScienceDirect. Keywords used for the electronic searches were chosen based on the purpose of this investigation. Keywords used for the electronic searches included “autism spectrum disorder,” “motor performance," "instructional supports," "picture task cards," and "video modeling." Additionally, issues from the last three years of the *Adapted Physical Education Quarterly, Journal of Physical Education Recreation and Dance,* and *Palaestra* (journals frequently denoting adapted physical education literature) were manually searched to prevent omitting relevant articles that were not available or not located through computer-aided searches. Finally, the reference lists of the articles located were manually searched for additional literature.

Adapted Physical Activity Taxonomy

The Adapted Physical Activity Taxonomy (APAT; Carano et al., 2014) was used to evaluate individual research articles, as well as, determine the strength of recommendation for a body of evidence. The APAT is comprised of two parts, (a) review for quality of study and (b) review for level of recommendation. Using this two-part review, the investigator can provide a systematic assessment of research in the field related to the current dissertation study. Data are provided at the end of this section to evaluate the articles as a group. Tables containing taxonomy evaluations of literature identified in this chapter are located in Appendix B. The tables within the appendix are sorted by headings and numbered by research article. Each taxonomy evaluation follows the reference and provides the level of evidence the study (L) and the table number attached to the specific study (T); for example: (Breslin & Rudisill, 2011) [L2; T2].

Quality of Strength of Study

The APAT is used throughout this review of literature to determine the strength of quality of a study. Strength of quality refers to evidence supporting a research article. Strength of quality can refer not only to an individual study but also to the quality of evidence from multiple studies about a specific question or the quality of evidence supporting an intervention. There are three levels of recommendation in APAT to assess studies, which are: Level 1 (highest quality), Level 2 (limited quality), or Level 3 (lowest quality). Each section of the article (e.g., introduction, method, results) is evaluated for quality. The current review of literature were: 13% (n = 1) of Level 1 studies, 54% (n = 7) of Level 2 studies, and 38% (n = 5) of Level 3 studies.

Research Methodologies

The APAT is divided into separate scales for four types of research designs, which are: (a) experimental/quasi-experimental, (b) single subject, (c) correlational, and (d) qualitative designs. *Experimental* and *quasi-experimental* research designs are the strongest interventions that include control and experimental group, consistency for the outcome measures, and evidence of validity (Odom et al., 2005). Experimental designs also include random assignment of participants to control and experimental groups. *Single-subject* research is considered stronger than correlational and qualitative designs because it has baseline and intervention phases (Odom et al., 2005). However, randomization of the population is not generally present in this design. *Correlational* studies determine associations between variables. Correlation can only predict relationships between variables; however, other confounding variables may be involved that are unknown (Odom et al., 2005). This is in contrast to experimental designs, which predict cause and effect (i.e., causation). The fourth methodology is the *qualitative* research design. Qualitative design is considered the weakest design, as there is no treatment or random selection in this design. Knowledge produced may not be generalizable to other participants or settings. A qualitative design is a systematic, albeit subjective approach used to describe life experiences and give them meaning (Odom et al., 2005).

Level of Recommendation

The APAT is also used to determine the level of recommendation for each research study. There are three levels of recommendation. A Level A recommendation can be made if one of the following criteria are met: (a) the results of the study hold significant value and can be applied to multiple settings related to adapted physical activity, (b) consistent findings using randomized trials or relating to a systematic review, or (c) interventions were validated and relevant to populations including individuals with disabilities. A Level B recommendation is reached when evidence-based recommendations provide direct benefit for individuals with disabilities that are not based on opinion or field-based experiences, but do not provide a significant outcome that can be applied to educational, recreational, or disability sport settings. Level B recommendations include limited or inconsistent evidence relating to adapted physical activity. A Level C recommendation includes studies with recommendations based on opinion, consensus, practice or field-based experiences, or studies that do not directly relate to benefiting individuals with disabilities through physical activity. The current review of literature is comprised of 69% (n = 9) Level A studies, 0% (n = 0) Level B studies, and 31% (n = 4) Level C studies.

Research support is needed for the use of the *EB* App as a means to teach motor skills to children with ASD. Understanding how fundamental motor skills are acquired may better enable families and teachers to assist children and students with ASD when engaging in motor skill performance. This chapter is organized in three sections: (a) Fundamental Motor Skills, (b) Motor Performance for Children with ASD, and (c) Instructional Strategies.

Fundamental Motor Skills

The fundamental movement phase occurs between 2 and 7 years of age (Gallahue & Ozman, 2006). The fundamental movement phase is separated into three stages: (a) initial (2 to 3 years), (b) emerging elementary (4 to 5 years), and (c) proficient (6 to 7 years). The initial stage is characterized by missing or improperly sequenced movements with poor rhythm, flow, or coordination. The emerging elementary stage involves gaining better motor control of these gross motor movements. Finally, the proficient stage is characterized by efficient, coordinated, and controlled gross motor movements. During these stages, children learn to develop fundamental motor skills such as locomotor (e.g., walking, running, hopping) and ball skills (e.g., throwing, catching, striking). Mastery of fundamental motor skills is a prerequisite to participation in many sports and games (Jurimae & Jurimae, 2000; Karabourniotis et al. 2002). Inadequate fundamental motor skills may negatively influence physical and motor activity performance in later life (Gallahue & Ozmun, 2006; Jurimae & Jurimae, 2000).

Developmental delays occur when children fail to meet fundamental motor skill milestones (see Table 1). Children who do not master these fundamental motor skills may experience difficulties later in exercise, recreational, or sport activities. Fundamental motor skill assessment and teaching is particularly important during the fundamental movement phase (i.e., early childhood) as developmental delays can be detected and interventions initiated if deemed necessary to improve movement skills (Gallahue & Ozman, 2006).

Table 1

Fundamental Motor Skill Milestones for Typically Developing Children

Fundamental Motor Skill Milestones for Typically Developing Children	
Walking	9-15 months
Running	4-5 years
Jumping	5-6 years
Hopping	5-6 years
Galloping	5-6 years
Skipping	5-7 years
Throwing	4-6 years
Catching	6-7 years
Kicking	5-6 years
Striking	5-7 years

Note. Gallahue & Ozmun, 2006

Fundamental Motor Skill Assessment

Assessment in adapted physical education is typically used to evaluate fundamental motor skills (Horvat, Block, & Kelley, 2007). Accurate assessment is critical to determine appropriate placement and program development for students with special needs. The Individuals with Disabilities Education Improvement Act of 2004 (IDEIA) requires that assessment of students with disabilities be conducted at least as often as assessment of peers without disabilities. Assessment is a complex, multi-faceted process focused on: (a) identifying appropriate services for students; (b) developing appropriate goals; (c) implementing appropriate instructional activities; and (d) determining the most appropriate placement for children and youth in physical education (Horvat et al., 2007).

The test most frequently used in adapted physical education is the *Test of Gross Motor Development* (*TGMD-2*; Johnson, Kim, Bittner, & Silliman-French, 2017; Ulrich, 2018). The *TGMD-2* has been used for children without and with disabilities (Evaggelinou, Tsigilis, & Papa, 2002). The *TGMD-2* is a norm-referenced measure designed to evaluate fundamental motor skills in children 3.0 to 10.9 years of age (Ulrich, 2018). Each fundamental motor skill includes numerous behavioral components that are presented as performance criteria. For example, the performance criteria for the ball skill subtest of catching are: (a) preparation phase where hands are in front of the body and elbows are flexed; (b) arms extended while reaching for the ball as it arrives; and (c) ball is caught by hands only (Ulrich, 2018). The examiner analyzes the fundamental motor skill to determine if a component is present (score of 1) or not present (score of 0). Results are then tallied across two trials and totaled for locomotor and object control subtests. Finally, each subtest score is compared with a normative sample for analysis.

In the *TGMD-3* (Ulrich, 2018), there are 6 locomotor and 7 ball skills (see Table 2). Locomotor skills are those that require fluid movements of the body as the child moves (Centers for Disease Control and Prevention [CDC], 2012). Ball skills are those that demonstrate efficient object control manipulation. The following adjustments were made from the *TGMD-2*: (a) skipping will be reinstated; (b) the one-hand forehand strike of self-bounced ball will be added to the object control subset; and (c) seven object control skills are now used, for a total of 13 skills.

Table 2

Ball Skills and Locomotor Skills in the TGMD-3

Ball Skills	Locomotor Skills
Two-hand Strike of a Stationary Ball	Run
One-hand Stationary Dribble	Gallop
Two-hand Catch	Hop
Kick a Stationary Ball	Skip
Overhand Throw	Horizontal Jump
Underhand Throw	Slide
Forehand Strike of a Ball	

Note. Ulrich, 2018

Motor Performance for Children with ASD

Researchers have suggested that some children with ASD have delays or impairments in gross motor performance (Downey & Rapport, 2012; Vernazza-Martin et al., 2005). Motor performance is defined as the ". . . observable production of a voluntary action, or a motor skill" (Schmidt & Wrisberg, 2008, p. 11). Specific motor performance delays include manual dexterity, balance, primitive reflexes, and the presence of hypotonia (i.e., low muscle tone; Adrien et al., 1993). Individual differences in motor performance for children with ASD have led to challenges for researchers who attempt to identify specific motor patterns for children with ASD (Haywood et al., 2012). This atypical development can be seen throughout the review of literature for gross motor performance skills in children with ASD.

For instance, Lloyd, MacDonald, and Lord (2013) [L2; T8] examined 162 children between 1 to 3 years of age and administered the *Mullen Scale of Early Learning* (Mullen, 1995) measuring motor performance skills (i.e., gross motor, fine motor). Based on the results, young children with ASD have significant motor performance delays (i.e., failing to meet motor milestones), which get exponentially larger as children age. Similarly, Provost, Lopez, and Heimerl (2006) [L3; T11] assessed motor performance delays in children with ASD (n = 19), with development delay (n = 19), and developmental concerns without motor delay (n = 18). The children, aged 21 to 41 months, were assessed using the *Peabody Developmental Motor Scales-2* (Folio & Fewell, 2000). Researchers reported toddlers in all three groups were delayed in at least one area of motor performance (i.e., locomotor skills, ball skills).

As children with ASD age, motor performance delays are still present. Berkeley, Zittel, Pitney, and Nichols, (2001) [L2; T1] examined locomotor and ball skills using the *Test of Gross Motor Development-2* of 15 children 6 to 8 years of age (*TGMD-2*; Ulrich, 2000). Gross motor quotient scores were compared to norms set by the *TGMD-2*. Based on the *Examiner's Manual*, the gross motor development quotient score for *TGMD-2* is described as very superior, superior, above average, average, below average, poor, and very poor. It was indicated that 73% of children with ASD scored poor or very poor in gross motor development.

Additionally, Liu, Hamilton, Davis, and El Garhy (2014) [L2; T7] examined 21 children aged 5 to 10 years with ASD and compared their motor performance skills to age-matched typically developing peers. Gross motor quotient scores consist of composite raw scores for all 12 gross motor skills. Gross motor quotient scores on *TGMD-2* for children with ASD indicated 81% were in the poor category and 76% received a very poor rating for skills (i.e., locomotor, ball skills).

Based on the results of these studies, compared to typically developing peers, children with ASD frequently have motor performance delays. The importance of instructional strategies to help improve motor proficiency while children are young is vital (Davis, 1997).

Instructional Strategies

The newly adopted *Every Student Succeeds Act* (ESSA; Lam et al., 2016) acknowledges physical education and health as part of a student's well-rounded education. The term *well-rounded education* replaces *core subjects* previously used in legislation (i.e., No Child Left Behind). ESSA also requires that school districts use evidence-based practices that have shown a statistically significant effect on student outcomes (Lam et al., 2016). The development of fundamental motor skills in children with ASD is dependent on teachers using evidence-based practices (e.g., picture task cards, video modeling).

Picture Task Cards

A PTC is a picture of a person, place, thing, or action that can be used when verbal communication is difficult for an individual (Welton, Vakil, & Carasea, 2004). PTCs are used to provide structure as a means for preferred communication for individuals with ASD (Bryan & Gast, 2000; Welton et al., 2004). The use of PTCs with verbal prompting has been reported to increase time-on-task and improve gross motor performance in students with ASD (Breslin & Rudisill, 2013; Dooley et al., 2001).

Researchers Breslin and Rudisill (2011) [L1; T3] examined the effects of visual schedules on the performance of the *TGMD-2* (Ulrich, 2000) for children 3 to 10 years of age with ASD. Participants (n = 22) performed the *TGMD-2* under three different protocols (i.e., verbal, PTC, picture activity schedule). Researchers reported the PTC protocol elicited higher gross motor quotient scores on the *TGMD-2* for children with ASD. Therefore, implementation of visual supports to accompany auditory instruction for children with ASD can be an effective way to improve gross motor performance.

Researchers have suggested that current motor performance protocols (i.e., no visual support) may not be appropriate for children with ASD (Berkeley et al., 2001; Breslin & Rudisill, 2011), which could potentially lead to inaccurate results. Berkeley et al. (2001) reported that during motor performance, children with ASD falsely interpreted skills as run or walk instead of performing other locomotor skills (e.g., galloping, skipping, leaping). Additionally, 1 participant from the 15 with ASD assessed walked with a ball to touch the target instead of throwing the ball to the target on the wall. Further research is needed to better assist children with ASD during motor performance (Yun & Case, 2016).

Traditional motor performance instruction (i.e., practice-style; Mosston & Ashworth, 2008) relies strongly on verbal communication and social interactions, two areas in which children with ASD have weaknesses (Tissot & Evans, 2003). By using more appropriate instructional methods, it is possible children with ASD may acquire better motor performance skills. If teachers have an accurate understanding of a child's needs, better quality instruction can be developed, thus allowing the student to learn more motor performance skills and increase activity engagement.

Video Modeling

Video modeling includes the use of a model (e.g., self, peer) who is video recorded while demonstrating a skill. The video recording is observed, and the observer must replicate the skill. Video modeling can be shown on a computer, television monitor, computer tablet, or telephone. Many children with ASD have relative strengths in processing visual information; however, they may have difficulty remembering verbal instructions (Tissot & Evans, 2003).

Dr. Temple Grandin, a noted speaker and author with ASD, described her thought processes as "completely visual" (Grandin & Scariano, 1986, p. 131), stating she recalled information by "visualizing a page in a book with the information and that she had difficulty remembering auditory information unless she was able to pair it with a visual image" (p. 131). This visual thinking may present challenges during motor performance for students with ASD, as many teachers use verbal instruction as a frequent method of communicating. If children do not understand instruction or have difficulty with a skill, they may see themselves as failures and engage in off-task behaviors (Obrusnikova & Dillon, 2011). Further, if children do not understand what is being asked of them during a movement skill, motor performance may be decreased.

Video modeling as an evidence-based practice for children with ASD has recently received attention in literature (Trocki-Ables et al., 2014; [L3; T12]; Wong et al., 2014). With the use of video modeling, children with ASD may engage in more on-task behaviors and learn more motor performance skills (Case & Yun, 2015). Researchers have shown children with ASD prefer video and television viewing to other leisure activities (Shane & Albert, 2008) [L2; T10]. Furthermore, video modeling has been reported to be overall more time and cost efficient than in person modeling when learning developmental skills (Charlop-Christy, Le, & Freeman, 2000; Flores et al., 2012). With more appropriate instructional methods, it is possible children with ASD will exhibit better motor performance.

ExerciseBuddy **Video Modeling Application**

Using evidence-based instructional strategies (i.e., video modeling) supported by the National Professional Development Center on ASD (2015), the *EB* App was developed to teach motor performance techniques to children with ASD (Geslak, 2015). A unique aspect of the *EB* App is that it uses models with ASD to demonstrate motor performance tasks. According to Bandura (1977), children are more likely to watch a model that is similar to themselves (e.g., physical characteristics, age, disability).

Concurrent validity has been established for the assessment component of the *EB* App (see Appendix G for manuscript). Thirty typically developing children (CA = 3 to 5 years) were asked to perform *TGMD-3* skills under two protocol conditions (i.e., verbal, video modeling). Data were collected on 2 different days, with 1 week separating the protocol conditions. A Pearson product-moment correlation was computed to determine differences between protocol conditions. Overall, there was a strong positive correlation between verbal and video modeling protocols $r = .95$, $N = 30$, $p < .001$. Concurrent validity indicates the assessment component of the *EB* App is a valid and reliable method of assessing motor performance in typically developing children 3 to 5 years of age.

With the ability to be installed on a standard tablet, the *EB* App provides parents and teachers a portable video modeling resource for introducing motor performance to their children's or students' learning environment. The *EB* App is being used to instruct children with ASD, but its benefits during motor performance are currently only supported by anecdotal evidence. Empirical research is needed to determine if the *EB* App is an appropriate instructional strategy for motor performance skills in children with ASD, related to PTC or combination.

In summary, researchers have suggested that some children with ASD have delays or impairments in fundamental gross motor performance (Downey & Rapport, 2012; Vernazza-Martin et al., 2005). Traditional motor performance instruction (i.e., practice-style; Mosston & Ashworth, 2008) relies strongly on verbal communication and social interactions, two areas in which children with ASD have weaknesses (Tissot & Evans, 2003). The development of fundamental gross motor skills in children with ASD is dependent on teachers using evidence-based practices (e.g., visual supports, video modeling). Using evidence-based instructional strategies supported by the National Professional Development Center on ASD (2015), the *EB* App was developed to teach motor performance techniques to children with ASD (Geslak, 2015). With more appropriate instructional methods, it is possible children with ASD will exhibit better motor performance.

CHAPTER III

METHOD

The purpose of this investigation was to determine the impact of three types of motor performance instructional strategies (i.e., picture task cards [PTCs], *ExerciseBuddy* application [*EB* App], combination) on teaching motor performance to children with autism spectrum disorder (ASD). Video modeling is an evidence-based practice for children with ASD that has recently received attention in literature in the field of physical activity (Trocki-Ables et al., 2014; Wong et al., 2014). With the use of video modeling, children with ASD may engage in more on-task behaviors and learn more motor performance skills (Case & Yun, 2015). To better understand the procedures used in the investigation, this chapter is organized in four sections: (a) Participants, (b) Procedures, (c) Research Design and Analysis, and (d) Results.

Participants

Participants in this investigation were six students identified with ASD as their primary disability, 5 to 9 years of age, enrolled in one school from north Texas. Students were diagnosed with Level 1 or 2 ASD, qualified and received adapted physical education by a qualified adapted physical educator (i.e., state teacher certified in teaching physical education, nationally certified in adapted physical education), and scored below the 50th percentile on at least three motor skills on the *Test of Gross Motor Development-3* (*TGMD-3;* Ulrich, 2018).

Procedures

After the prospective participants were identified, consent for participation was requested from parents/guardians through a consent form sent home (see Appendix A). Parents returned the signed form to their child's teacher, who returned it to the investigator.

Two *TGMD-3* assessors, masters' students in adapted physical education, participated in a 2-hr training session by the primary investigator. Assessors were chosen because of their successful passing of a graduate level adapted physical education assessment course. In the training session, assessors learned the proper administration of the *TGMD-3* as explained in the *TGMD-3 Examiner's Manual* (2017). Assessors (a) watched the YouTube *TGMD-3* assessment video, (b) practiced familiarization with the *EB* app, and (c) physically executed motor performance skills. Test and retest reliability amongst the assessors was demonstrated through successful completion (i.e., 90% or better; Zirpoli & Melloy, 1993) of an exit examination regarding assessment protocol (see Appendix C).

After approved IRB and parent/guardian consent forms were returned, the investigation was conducted 3 days a week (Borremans, Rintala, & Kielinen, 2009), for 15 min (Nicholson, Kehle, Bray, & Van Heest, 2010) per session, for 4 consecutive weeks (Bittner, Rigby, Silliman-French, Nichols, & Dillon, 2017). Throughout the duration of this study, the primary investigator served as motor skill instructor.

Week 1 consisted of the participants performing the 13 gross motor skills from the *TGMD-3* (Ulrich, 2018). The *TGMD-3* consists of ball skills (e.g., striking off a tee, dribbling, kicking) and locomotor skills (e.g., running, skipping, sliding). Three gross motor skills from the *TGMD-3* were chosen unique to each participant based on their performance results. Any skill the participant performed at the 50th percentile or below was selected for consideration.

The student's adapted physical educator and primary investigator then chose the three skills based on the participant's individual education program and performance in general physical education. Additionally, fundamental motor skill milestone acquisition was taken into account (see Table 3). The three motor skills unique to each participant closely reflected the child's chronological age. If a child was 5 years old, a skill such as striking (mature pattern typically achieved at 7 years) would not be a skill selected for this participant. If a participant performed above the 50th percentile on 12 or more skills, they were excluded from this investigation.

A recognition assessment of PTCs (see Figure 1) was also completed during Week 1. The investigator asked the child to identify through pointing at the correct PTC from a randomly selected set of three gross motor skills (e.g., galloping, dribbling, catching). The participant needed to correctly identify their three individually selected PTCs at mastery level (i.e., 70% or better; Texas Education Agency, 2015). Participants were administered three trials to successfully pass the recognition assessment. If a participant could not correctly identify the selected PTCs at mastery level, he/she was excluded from the study.

Table 3

Fundamental Motor Skill Milestones for Typically Developing Children

Fundamental Motor Skill Milestones for Typically Developing Children	
Walking	9-15 months
Running	4-5 years
Jumping	5-6 years
Hopping	5-6 years
Galloping	5-6 years
Skipping	5-7 years
Throwing	4-6 years
Catching	6-7 years
Kicking	5-6 years
Striking	5-7 years

Note. Gallahue & Ozmun, 2006

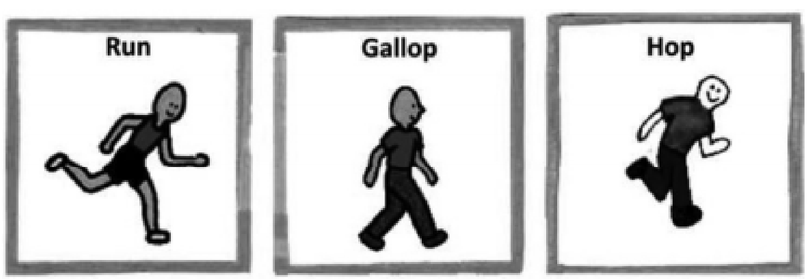

Figure 1. Picture task cards for instructional protocol. (Breslin & Rudisill, 2011; used with permission).

Next, the intervention was implemented as follows. Each of the four weeks, the participant had three intervention sessions. During each of these sessions, the participant engaged in the three different trials (for a total of nine data points per week). For each of these three trials, the participant selected a skill (e.g., one of the selected locomotor or ball skills) and an instructional protocol (i.e., PTC, *EB* App, combination). To ensure that the skills and protocol were both randomly administered *and* had an equal number of trials, the selection process was instituted as follows:

Day 1 (of the three weekly sessions; see Table 4):

- Student selected a skill written on paper from a bag; the paper was not returned to the bag.
- Student selected a protocol written on paper from a second bag; the paper was not returned to the bag.
- For the second trial, the student repeated the above process.
- For the third trial, the student engaged in the remaining skill with the remaining protocol.

Table 4

Example Timeline for Participant Randomly Drawn Protocol Day One

Day One					
Trial 1		Trial 2		Trial 3	
Skill Bag	Protocol Bag	Skill Bag	Protocol Bag	Skill Bag	Protocol Bag
Running	**PTC**	Catching	**Combination**	**Catching**	***EB* App**
Catching	*EB* App	**Sliding**	*EB* App		
Sliding	Combination				

Note. Bold = Randomly chosen skill/protocol. *EB* App = *ExerciseBuddy* application; PTC = Picture Task Card; Combination = PTC and *EB* App.

Day 2 (of the three weekly sessions; see Table 5):

- Student selected a skill written on paper from a bag; the paper was not returned to the bag.

- Student selected a protocol written on paper from a bag containing the two protocols not selected on Day 1 for that skill (e.g., if the student did "running" on Day 1 with "PTC," when the student selects "running," only "*EB* App" and "Combination" was in the protocol bag).
- For the second trial, the student repeated the above process. The skill was randomly selected from the remaining two skills (e.g., if running was randomly selected for the first trial it was not an option for the second trial). The protocol performed on Day 1 for the randomly selected skill may not be repeated (e.g., if sliding was chosen combination cannot be the protocol). Additionally, the protocol from the randomly drawn first trial may not be repeated (e.g., if *EB* App was randomly selected it may not be repeated). Thus, the protocol for Day 2 second trial was the remaining protocol not repeated.
- For the third trial, the student engaged in the remaining skill with the remaining protocol.

Table 5

Example Timeline for Participant Randomly Drawn Protocol Day Two

Day Two					
Trial 1		Trial 2		Trial 3	
Skill Bag	Protocol Bag	Skill Bag	Protocol Bag	Skill Bag	Protocol Bag
Running Catching Sliding	Combination ***EB* App**	Catching **Sliding**	**PTC**	**Catching**	**Combination**

Note. Bold = Randomly chosen skill/protocol; *EB* App = *ExerciseBuddy* application; PTC = Picture Task Card; Combination = PTC and *EB* App.

Day 3 (of the three weekly sessions; see Table 6):

- Student completed skill plus protocol combinations that have not been selected during the previous two days.

Table 6

Example Timeline for Participant Randomly Drawn Protocol Day Three

Day Three					
Trial 1		Trial 2		Trial 3	
Skill Bag	Protocol Bag	Skill Bag	Protocol Bag	Skill Bag	Protocol Bag
Running	**Combination**	**Sliding**	***EB* App**	**Catching**	**PTC**

Note. Bold = Randomly chosen skill/protocol; *EB* App = *ExerciseBuddy* application; PTC = Picture Task Card; Combination = PTC and *EB* App

During each day's trials, the process happened as follows: the first trial was practice. The second and third trial was scored. All trials were video recorded.

For the PTC protocol, motor performance skills were presented using verbal instruction with a PTC visual. For the *EB* App protocol, verbal instructions were used to explain the motor performance. No live demonstration from the assessor was shown. Instead, demonstration consisted of viewing the video modeling skill from the *EB* App. The combination protocol (i.e., PTC, *EB* App) consisted of being visually shown the PTC then viewing the video modeling skill from the *EB* App (see Figure 2). All protocol sessions were video recorded for scoring purposes.

A fidelity check of the protocols was completed by a research assistant. This was to ensure that intervention was delivered consistently across sessions. A fidelity checklist (see Appendix D) determined if key elements of the intervention were delivered according to plan. A fidelity checklist was conducted on a minimum of 20% of sessions (Barnet et al., 2014).

Picture Task Card	*ExerciseBuddy* Application	Combination

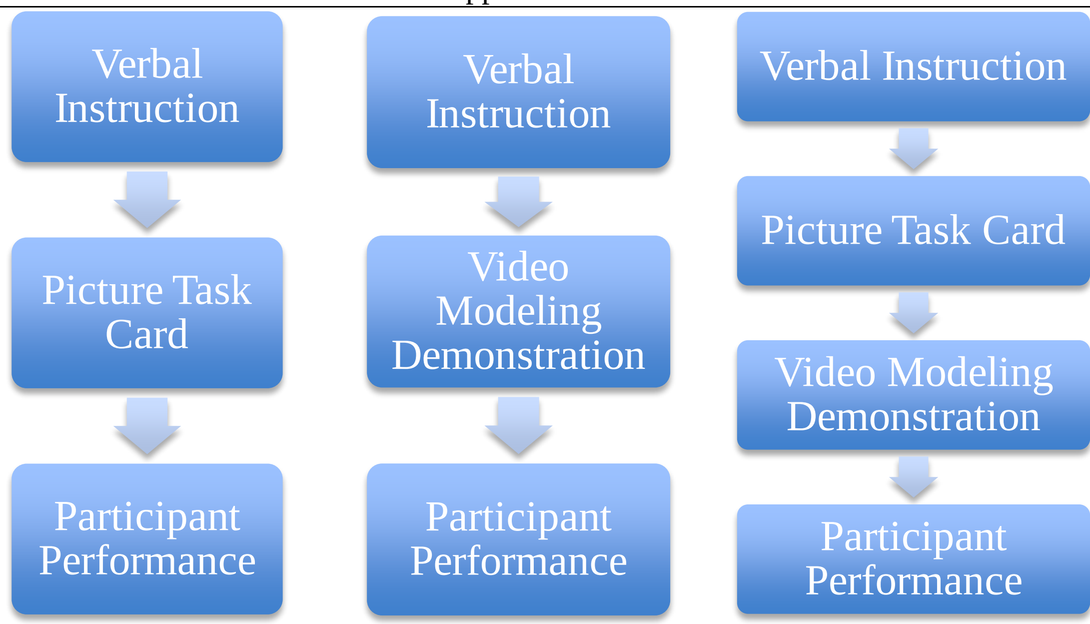

Figure 2. Instructional protocols for fundamental motor performance.

Two master's student research assistants completed a 2-hr training session for assessment scoring conducted by the investigator to learn and understand the criteria of test performance as indicated in the *TGMD-3 Examiner's Manual* (Ulrich, 2018). Training videos from the *TGMD-3* website were used for assessment scoring practice. Each research assistant needed 80% agreement with the scoring training video for subtest skills (i.e., ball skills, locomotor skills) for two consecutive assessments (Porges et al., 2014).

After completing scoring training, two research assistants and the investigator scored the *TGMD-3* assessments. Both of the research assistants then compared their results and produced a collective score to compare with the investigator. Inter rater reliability for *TGMD-3* assessment scoring was then calculated for the investigator and research assistants for subtests (i.e., ball skills, locomotor skills). Inter rater reliability was calculated by number of agreements divided by number of agreements plus number of disagreements, then multiplied by 100%. Acceptable agreement was a score of 80% or higher (Kennedy, 2005). The final subtest scores were calculated from an average of results obtained from the research assistants and investigator. The gross motor score was then determined by adding subtest scores as explained in the *TGMD-3 Examiner's Manual* (Ulrich, 2018).

Research Design and Data Analysis

According to Horner et al. (2005), single-subject research is a methodology ". . . used to define basic principles of behavior and establish evidence-based practices" (p. 165). A randomized alternating-treatment (i.e., PTC, *EB* App, combination) design with no baseline was used in this investigation (Richards, Taylor, & Ramasamy, 2014; see Figure 5) and from the data collected, repeated measurements of the dependent variable (i.e., percent performance criteria) were analyzed. The data from this study were analyzed through visual inspection of graphic data. Data were reported by percentage of performance criteria met.

CHAPTER IV

RESULTS

The purpose of this investigation was to determine the impact of three types of motor performance instructional strategies (i.e., picture task cards [PTCs], *ExerciseBuddy* application [*EB* App], combination) on teaching motor performance to children with autism spectrum disorder (ASD). A single-case alternating treatment design was used to determine which protocol, if any, was associated with the largest increase in raw score percentage on the *Test of Gross Motor Development-3* (*TGMD-3*; Ulrich, 2018) in children with ASD between the ages of 5 and 9 years. It was hypothesized, based on the social cognitive theory, that the *EB* App and combination protocols would achieve higher raw scores on the *TGMD-3* compared to the PTC instructional protocol. In this chapter, the results will be presented in the following order: (a) Participant Demographic Information, (b) Inclusion Criteria, (c) Inter-rater Reliability, and (d) Results.

Participant Demographic Information

Purposive sampling was used to recruit children identified with Level 1 (i.e., requires support) or 2 (i.e., requires substantial support) ASD as their primary disability, who were 5 to 9 years of age, and enrolled in one elementary school from north Texas. Although nine participants began the study, three were eventually excluded due to their performance (i.e., low scores) on an initial assessment. Data for these three excluded participants are available in Appendix F. Five males and one female with a mean age of 7 years, 7 months (*SD* = ± 1.39) participated in this investigation (see Table 7).

Table 7

Participant Demographics

Participant	Gender	Birthdate	Age	ASD Level	Passed Inclusion Criteria
1	M	3-5-09	8 years, 0 months	1	Y
2	M	4-3-07	9 years, 11 months	1	Y
3	M	5-3-09	7 years, 10 months	2	Y
4	F	9-8-08	8 years, 6 months	2	Y
5	M	5-10-07	9 years, 10 months	1	Y
6	M	10-31-11	5 years, 4 months	1	Y

Inclusion Criteria

TGMD-3

Prior to the initial investigation, during Week 1, potential participants performed the following: (a) the 13 gross motor skills from the *TGMD-3* (Ulrich, 2018*)* and (b) a skill word recognition assessment for PTCs. The *TGMD-3* assessment raw score results for students are presented in Tables 8 and 9. The assessment raw score results, and input from the adapted physical educator (i.e., child's individualized education program goals), were used to select three gross motor skills from the *TGMD-3* that were unique to each participant. Any *TGMD-3* skill the participant performed at the 50th percentile or below was selected for consideration as a possible skill for the current investigation. The *TGMD-3* skills chosen for each participant are indicated in Table 10.

Skill Word Recognition

A skill word recognition assessment of PTCs was also completed prior to the initial investigation during Week 1. Potential participants were asked to point to a selected PTC (containing one of their targeted skills) from a randomly selected set of three gross motor skills (e.g., galloping, dribbling, catching). A correct identification rate of 70% or higher (Texas Education Agency, 2015) indicated the participant comprehended the visual representation of the activity in the PTC. Potential participants were given three identification trials on three separate days. For example, Participant 1 passed the recognition assessment for all three skills on Attempt 1.

Table 8

TGMD-3 Locomotor Skills Raw Score Percentage Results

Participant	Run	Gallop	Hop	Skip	Horizontal Jump	Slide
1	50%	25%	0%	0%	25%	38%
2	50%	75%	38%	33%	50%	63%
3	25%	0%	0%	0%	25%	0%
4	0%	25%	25%	0%	0%	0%
5	100%	100%	50%	100%	38%	100%
6	25%	0%	0%	0%	25%	0%

Table 9

TGMD-3 Ball Skills Raw Score Percentage Results

Participant	Strike	Self-bounced	Dribble	Catch	Kick	Overhand Throw	Underhand Throw
1	0%	13%	33%	0%	50%	13%	25%
2	50%	38%	50%	100%	75%	75%	50%
3	13%	0%	0%	50%	38%	0%	25%
4	50%	0%	17%	0%	38%	0%	0%
5	100%	38%	33%	50%	50%	50%	88%
6	0%	0%	0%	0%	0%	0%	0%

Table 10

TGMD-3 Chosen Skills

Participant	Skill 1	Skill 2	Skill 3
1	Horizontal Jump	Kick	Overhand Throw
2	Dribble	Horizontal Jump	Strike off Tee
3	Dribble	Horizontal Jump	Kick
4	Dribble	Kick	Strike off Tee
5	Catch	Dribble	Horizontal Jump
6	Horizontal Jump	Kick	Run

Conducting recognition assessment attempts on separate days was recommended based on results of this investigation, as Participant 4 did not pass the recognition assessment for any skills on Attempt 1. However, on Attempt 2 (two days later), Participant 4 passed all three skills. When working with children with ASD, potential internal and external factors (e.g., behavior, illness, sleep) may affect motor performance. In this investigation, six participants passed the recognition assessment inclusion criteria (see Table 11) and went on to participate in the study.

Table 11

Picture Task Card Skill Word Recognition Assessment Results

	Attempt One			Attempt Two			Attempt Three		
Participant	Skill 1	Skill 2	Skill 3	Skill 1	Skill 2	Skill 3	Skill 1	Skill 2	Skill 3
1	100%	90%	70%		Passed				
2	100%	100%	100%		Passed				
3	100%	80%	80%		Passed				
4	0%	0%	0%	100%	100%	100%		Passed	
5	100%	100%	100%		Passed				
6	80%	90%	90%		Passed				

Inter-Rater Reliability

TGMD-3

Inter-rater reliability for *TGMD-3* skills was calculated between the investigator and the collective scoring of the research assistants. Inter-rater reliability was calculated by dividing the number of agreements by the number of agreements plus number of disagreements, then multiplying that score by 100 to achieve a percentage. Average inter-rater reliability for the investigator and research assistants for the *TGMD-3* gross motor score was 88% (range = 73% to 97%; see Table 12).

Table 12

Inter-rater Reliability Results

Participant	Gross Motor Score Investigator	Gross Motor Score Research Assistants	Inter-Rater Reliability
1	71	52	73%
2	151	134	89%
3	66	56	85%
4	110	98	89%
5	100	108	93%
6	66	68	97%
		Average	88%

Fidelity Check

A fidelity checklist (see Appendix D) was used to determine if key elements of the intervention were delivered according to protocol and if they were delivered consistently across sessions. A fidelity checklist was conducted for 33% of sessions (Barnet et al., 2014). The average fidelity score across sessions was 99% (range = 95% to 100%; see Table 13).

Table 13

Fidelity Checklist Results

Participant	Fidelity Check Raw Score	Percentage
1	40/40	100%
2	39/40	98%
3	40/40	100%
4	38/40	95%
5	40/40	100%
6	40/40	100%
Total	237/240	99%

Results

Based on the visual analysis, there was no indication of a clear separation in levels (i.e., mean and range of data within the intervention phase) and trend (i.e., direction of the data path) between protocols (i.e., PTC, *EB* App, combination). In an alternating-treatment design, clear separation indicates there was a distinction between protocol conditions. Average percent overlap (i.e., percent of data overlapping between protocol conditions) for each intervention across participants in this investigation approached 100%. The lower the percentage of overlap, the greater the impact the intervention has had on the target behavior. Therefore, visual analysis did not indicate a clinically significant difference between the PTC, *EB* App, or combination protocols during motor performance for children with ASD. A comparison between *TGMD-3* baseline and protocol raw score percentage (i.e., four session average) is presented in Table 14. Figures 3 to 8 contain graphs of participant results across the three interventions. In Figure 9 is a graph of *TGMD-3* raw score percentage by skill item.

Table 14

Raw Score Percentage Comparison of TGMD-3 Baseline and Protocols

Participant	Skill	Baseline %	PTC	VM	C
1	Horizontal Jump	25%	27%	23%	16%
	Kick	50%	53%	41%	38%
	Overhand Throw	17%	13%	6%	6%
2	Dribble	50%	44%	56%	52%
	Horizontal Jump	50%	50%	47%	36%
	Strike off Tee	50%	55%	53%	51%
3	Dribble	0%	2%	4%	13%
	Horizontal Jump	25%	11%	20%	25%
	Kick	38%	34%	39%	44%
4	Dribble	17%	8%	17%	15%
	Kick	38%	30%	41%	48%
	Strike off Tee	50%	44%	53%	48%
5	Catch	50%	71%	83%	75%
	Dribble	33%	50%	46%	52%
	Horizontal Jump	38%	11%	17%	16%
6	Horizontal Jump	25%	20%	23%	23%
	Kick	0%	19%	20%	33%
	Run	25%	22%	27%	23%

Note. PTC = Picture Task Card; VM = Video Modeling; C = Combination

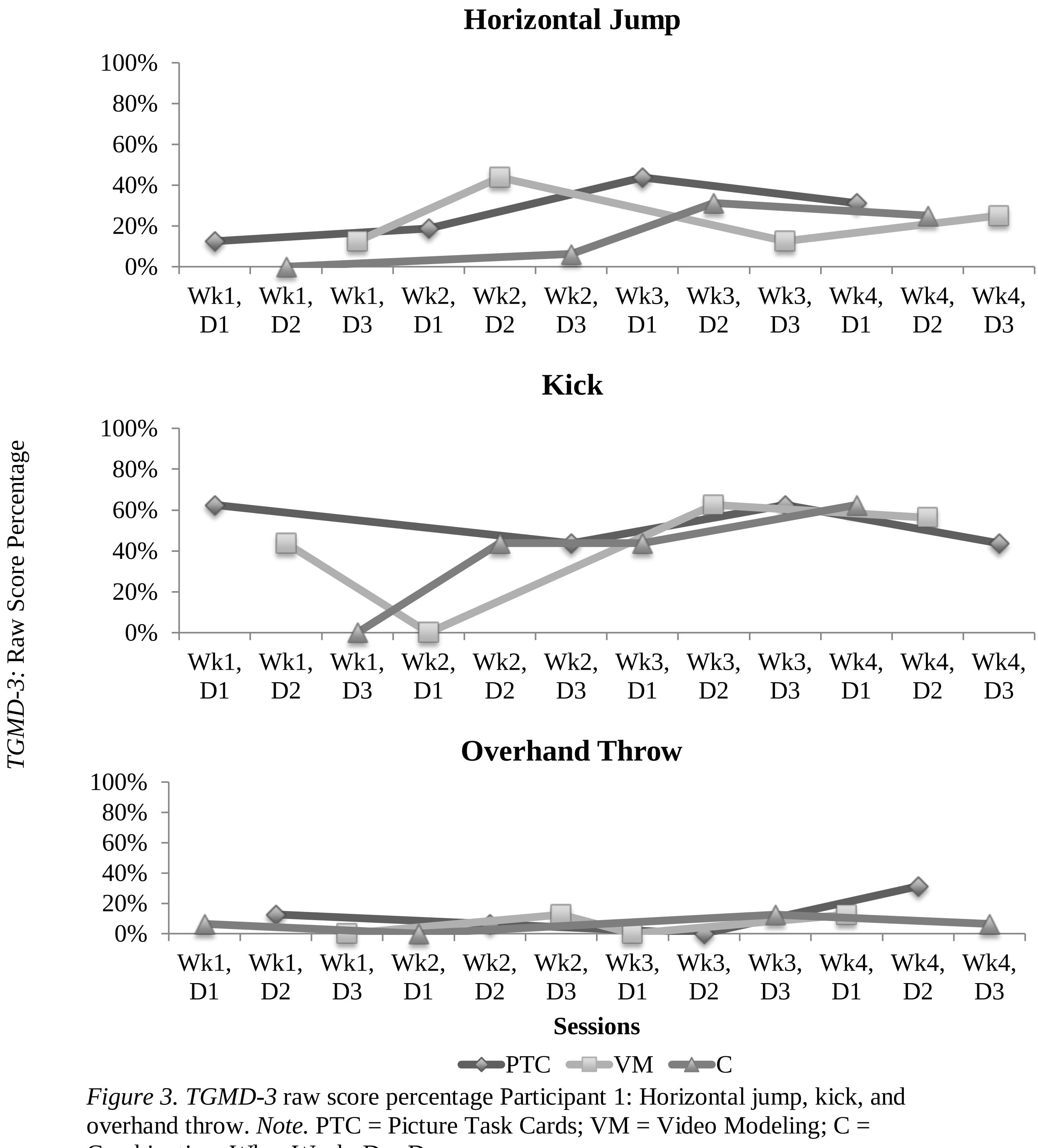

Figure 3. TGMD-3 raw score percentage Participant 1: Horizontal jump, kick, and overhand throw. *Note.* PTC = Picture Task Cards; VM = Video Modeling; C = Combination; Wk = Week; D = Day.

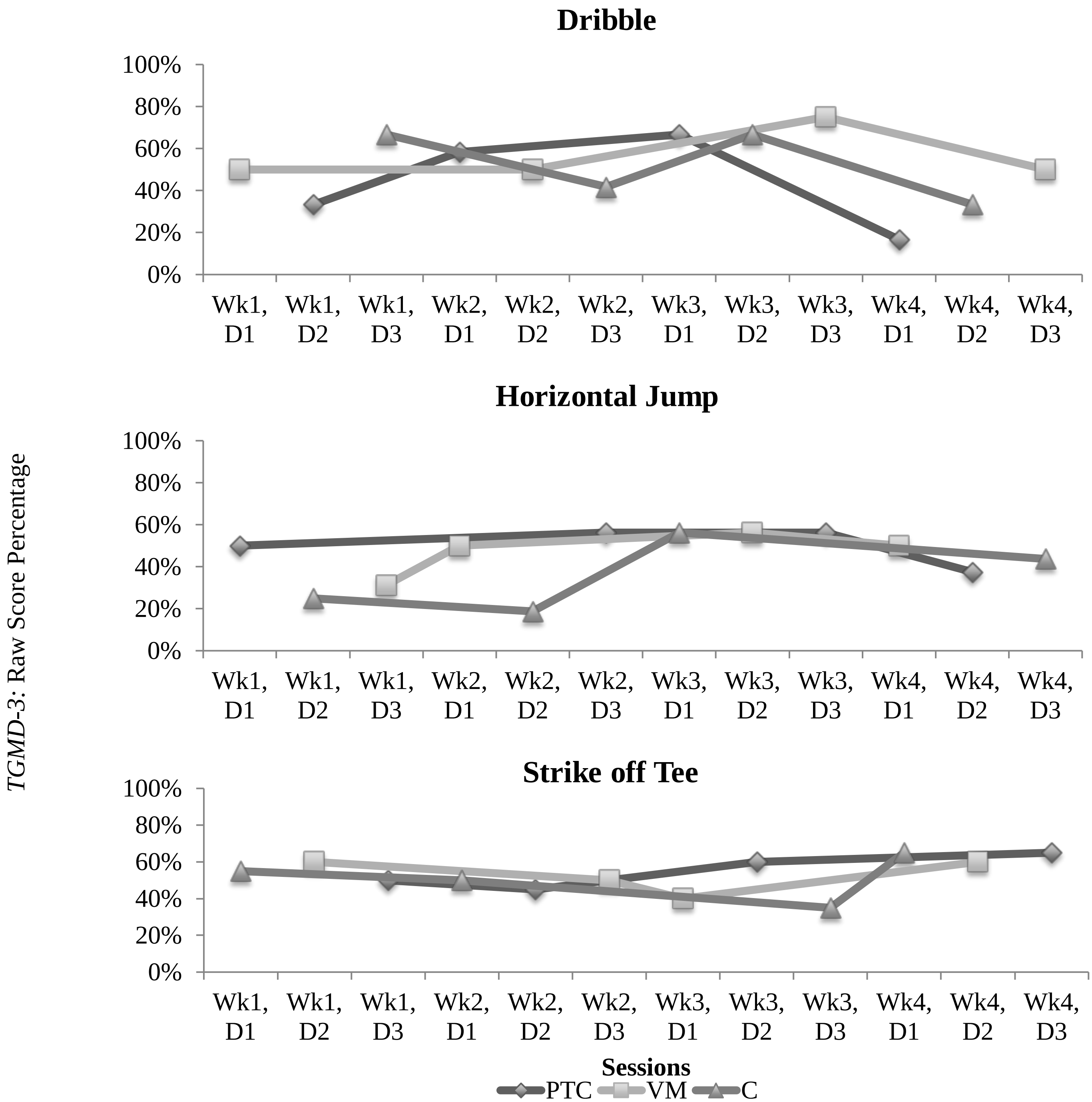

Figure 4. TGMD-3 raw score percentage Participant 2: Dribble, horizontal jump, and strike off tee. *Note.* PTC = Picture Task Cards; VM = Video Modeling; C = Combination; Wk = Week; D = Day.

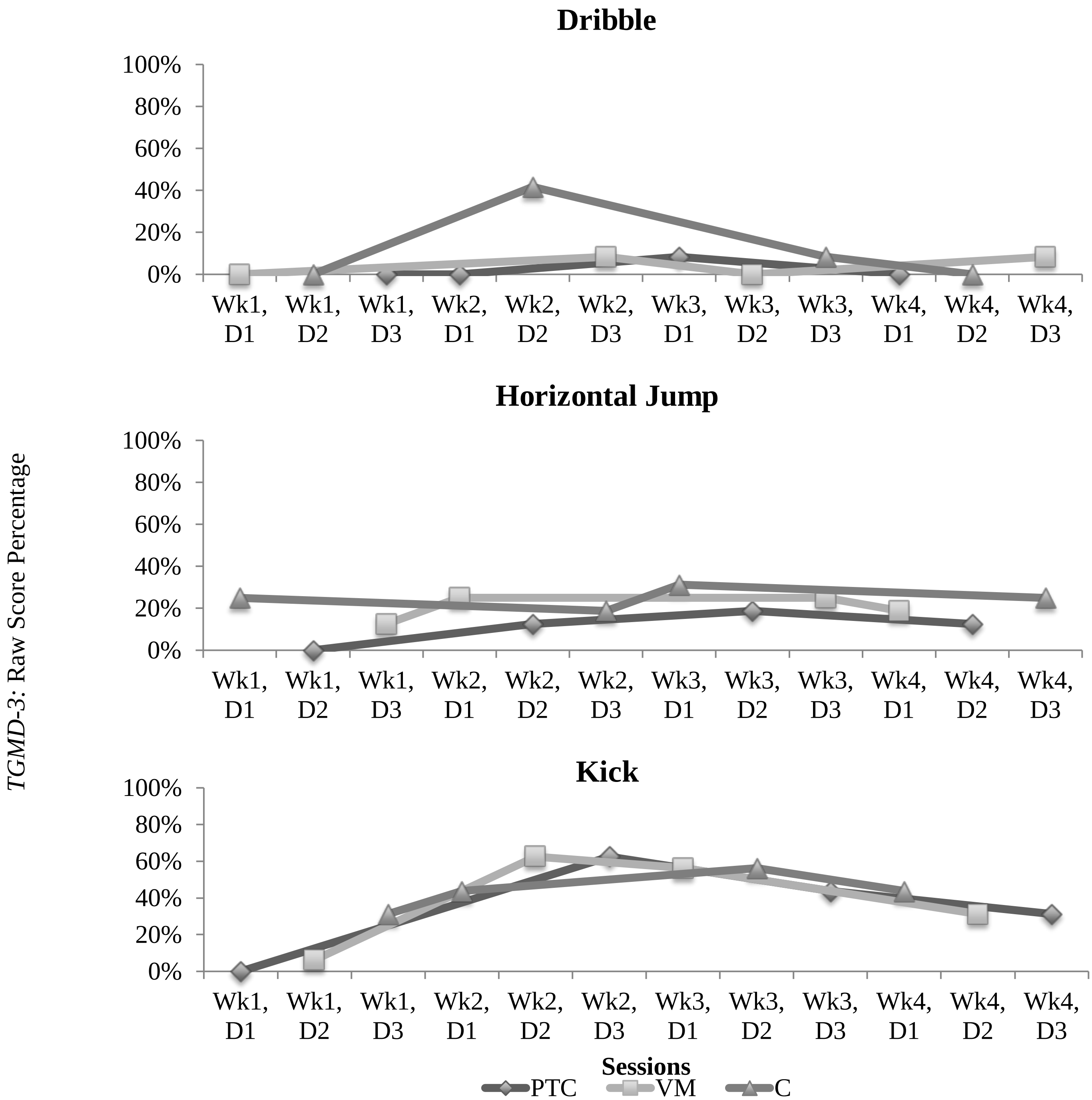

Figure 5. TGMD-3 raw score percentage Participant 3: Dribble, horizontal jump, and kick. *Note.* PTC = Picture Task Cards; VM = Video Modeling; C = Combination; Wk = Week; D = Day.

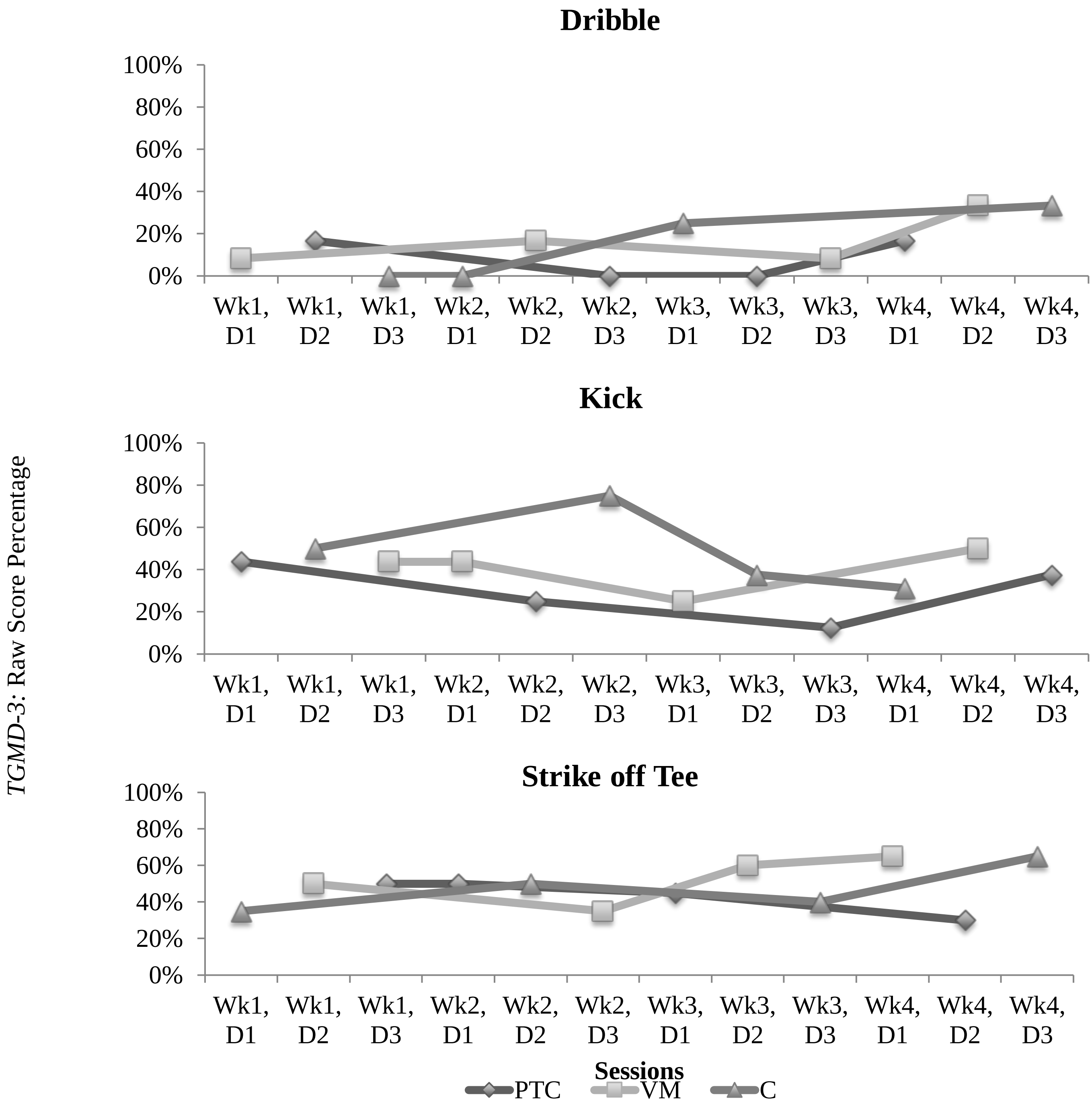

Figure 6. TGMD-3 raw score percentage Participant 4: Dribble, kick and strike off tee. *Note.* PTC = Picture Task Cards; VM = Video Modeling; C = Combination; Wk = Week; D = Day.

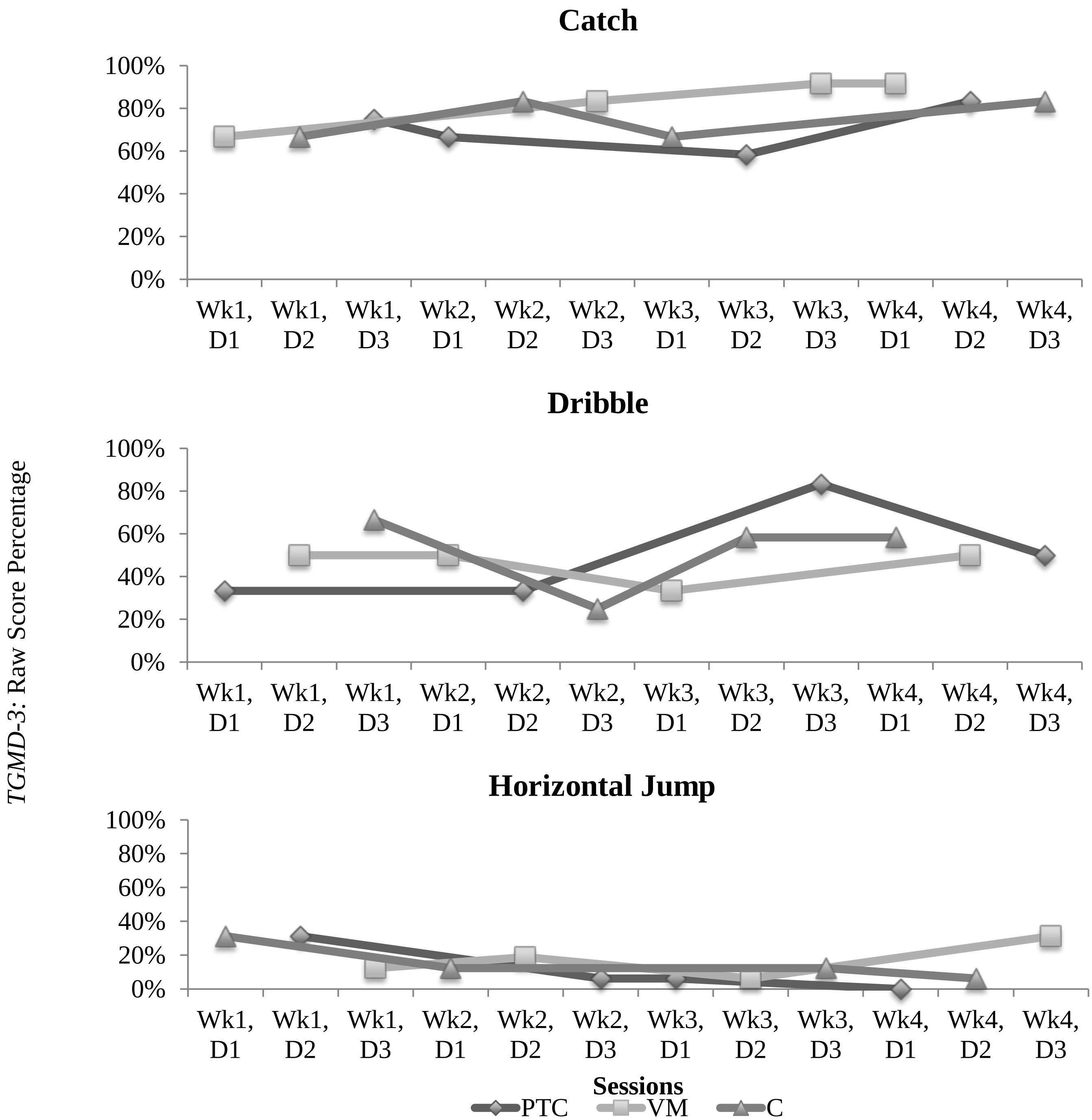

Figure 7. TGMD-3 raw score percentage Participant 5: Catch, dribble, and horizontal jump. *Note.* PTC = Picture Task Cards; VM = Video Modeling; C = Combination; Wk = Week; D = Day.

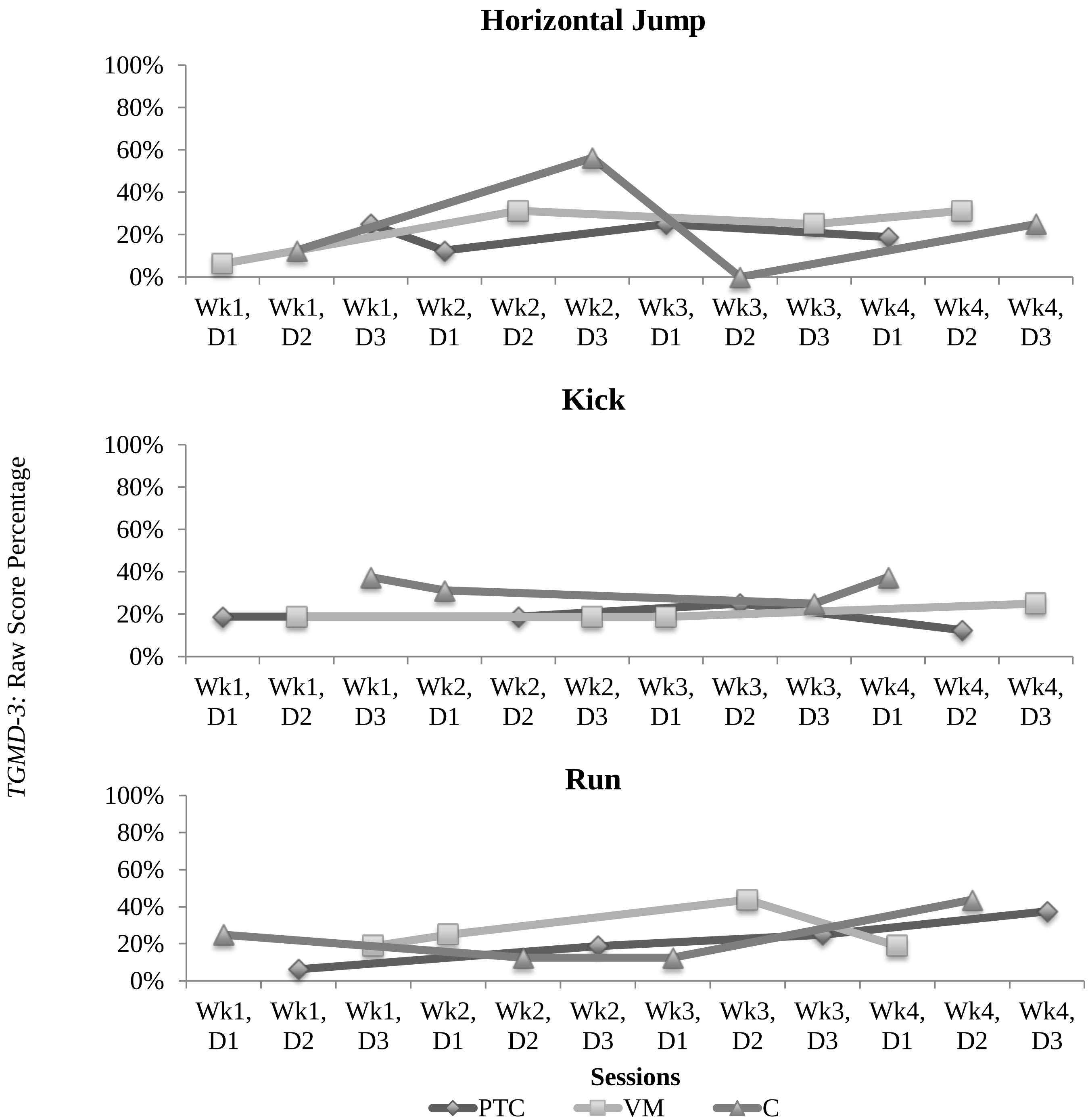

Figure 8. TGMD-3 raw score percentage Participant 6: Horizontal jump, kick, and run. *Note.* PTC = Picture Task Cards; VM = Video Modeling; C = Combination; Wk = Week; D = Day.

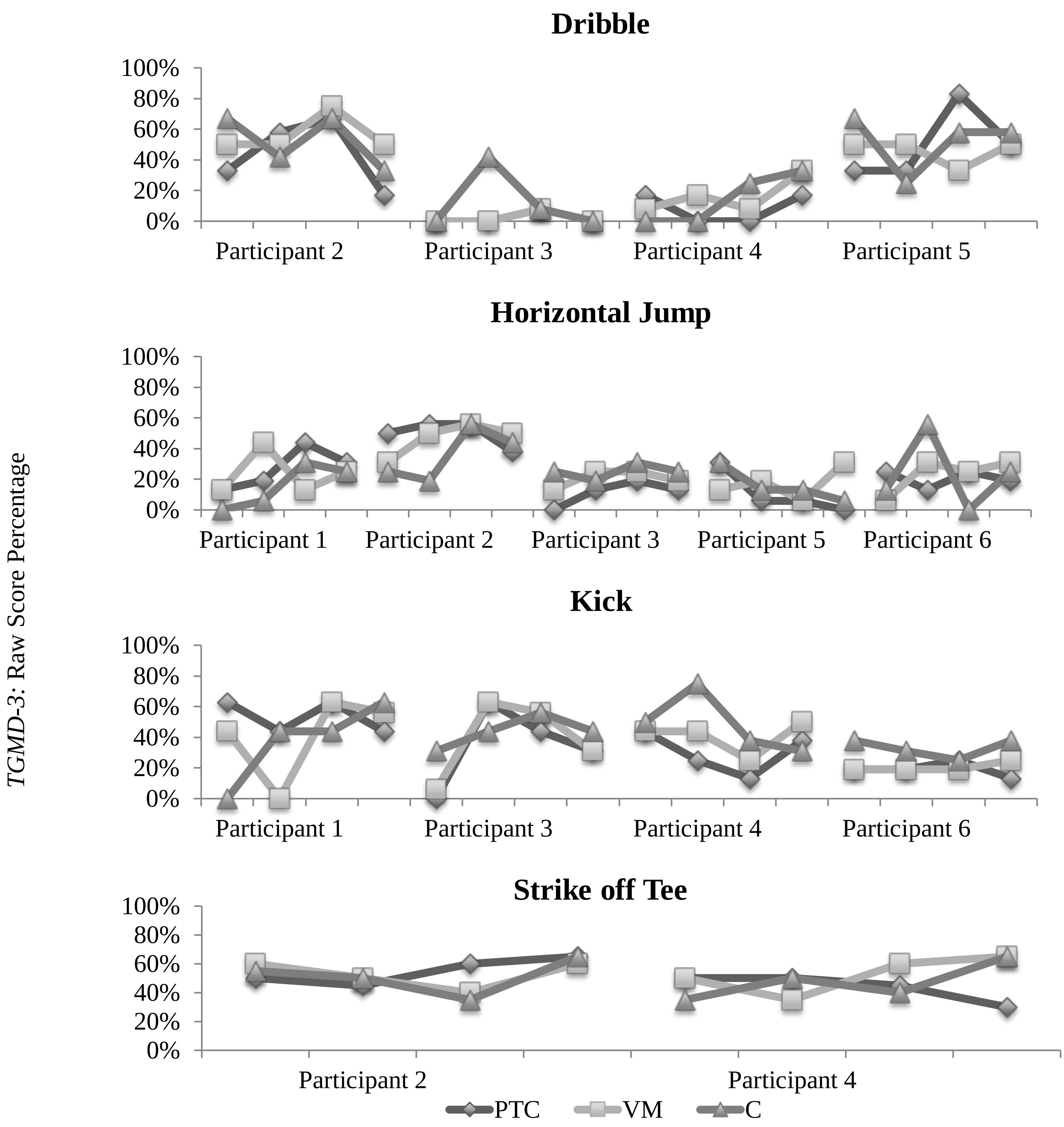

Figure 9. TGMD-3 raw score percentage skills: Dribble, horizontal jump, kick, and strike off tee. *Note*. PTC = Picture Task Cards; VM = Video Modeling; C = Combination.

CHAPTER V

DISCUSSION, IMPLICATIONS OF THE RESULTS, LIMITATIONS, CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE STUDIES

Within this chapter, a discussion is provided on the impact of three types of motor performance instructional strategies (i.e., picture task cards [PTCs], *ExerciseBuddy* application [*EB* App], combination) on teaching motor performance to children with autism spectrum disorder (ASD). The *EB* App has numerous activity-based videos, as well as, individual motor skills. For this investigation, the assessment component of the *EB* App was used that comprised of 13 gross motor skills of the *Test of Gross Motor Development-3* (*TGMD-3*; Ulrich, 2018). Information in this chapter is related to the findings which are presented in the following sections: (a) Discussion, (b) Implications of the Results, (c) Limitations, (d) Conclusions, and (e) Recommendations for Future Studies. The topics that are discussed across these sections are social cognitive theory, application of fundamental motor skills, and instructional strategies.

Discussion

Social cognitive theory (Bandura, 1977), which purports that human behavior is learned predominantly through observing and modeling others, was used as the foundation of this investigation. Adopting the social cognitive theory as the theoretical framework for this investigation provided rationale to empirically compare the use of PTCs, *EB* App, and combination of the two during fundamental motor skill performance for children with ASD.

Fundamental Motor Skills

Fundamental motor skills are considered both locomotor skills (e.g., running, hopping, galloping) and ball skills (e.g., throwing, catching, striking; Gallahue & Ozman, 2006). Researchers have suggested that some children with ASD have delays or impairments in fundamental motor performance (Downey & Rapport, 2012; Vernazza-Martin et al., 2005). For example, Liu, Hamilton, Davis, and El Garhy (2014) assessed 21 children aged 5 to 10 years with ASD and compared their motor performance skills to age-matched typically developing peers and found that 81% of their participants with ASD demonstrated a poor to very poor fundamental motor performance on the *Test of Gross Motor Development-2* (*TGMD-2*). In another study, Berkeley et al. (2001) reported that 73% (Berkeley et al., 2001) of their participants with ASD demonstrated a poor to very poor fundamental motor performance on the *TGMD-2*. The current investigation produced similar results; 83% (i.e., 5 of 6) of participants scored in the poor to very poor range of fundamental motor skill performance.

Researchers have suggested that current motor performance assessment protocols (e.g., teacher demonstration) may not be appropriate for children with ASD (Berkeley et al., 2001; Breslin & Rudisill, 2011), which could potentially lead to inaccurate results. Therefore, it has been suggested that PTCs (Breslin & Rudisill, 2011) or video modeling

(Charlop-Christy et al., 2000) may be instructional strategies to improve motor performance of children with ASD. Both of these strategies have been identified as evidence-based instructional strategies for children with ASD (National Professional Development Center on ASD, 2015).

Picture Task Cards

A PTC is a picture of a person, place, thing, or action that can be used when verbal communication is difficult for an individual (Welton et al., 2004). PTCs are used to provide structure as a means for preferred communication for individuals with ASD (Bryan & Gast, 2000; Welton et al., 2004). The use of PTCs with verbal prompting has been reported to increase time-on-task and improve gross motor performance in students with ASD (Breslin & Rudisill, 2013; Dooley et al., 2001).

However, after an extensive review of the literature, there was a paucity of information regarding the process of completing a recognition assessment before using PTCs. In the current investigation, three original participants were not able to recognize the PTCs, which supports the importance of conducting a recognition assessment to make sure students are able to identify and/or understand the content represented on the PTCs. If a potential participant could not correctly identify PTCs, he or she may not be developmentally ready to use this form of visual support and another method should be considered (e.g., providing an example). Because of the results of the current study, it is highly suggested to use a recognition assessment before implementing PTCs.

Breslin and Rudisill (2011) reported PTCs elicited a higher gross motor quotient score on the *TGMD-2* for children with ASD compared to traditional and picture activity schedule protocols. However, their results did not support PTCs to be a more effective protocol compared to video modeling or combination during assessment of gross motor performance. One possible explanation as to why PTCs were not a more effective strategy, when compared to video modeling or the combination, would be because a live demonstration was not provided with the PTCs as part of instructional methods. In the previous investigation (Breslin & Rudisill, 2011), a live demonstration was given after verbal explanation and before the participant was shown the PTC visual support. However, live modeling had previously been compared to the effectiveness of video modeling (Charlop-Christy et al., 2000) for teaching developmental skills to children with ASD. Video modeling led to a greater improvement of developmental skills (e.g., independent play, cooperative play) than live modeling (Charlop-Christy et al., 2000).

Video Modeling

Video modeling includes the use of a model (e.g., self, peer, video animation) who is video recorded while demonstrating a skill. The observer watches the video and replicates the skill. Video modeling can be shown on a computer, television monitor, computer tablet, or cellular phone. With video modeling, children with ASD may engage in more on-task behaviors and learn more motor skills (Case & Yun, 2015).

In the current investigation, the video modeling protocol was presented using the assessment component of the *EB* App. The *EB* App was developed to teach specific fundamental motor skills to children with ASD (Geslak, 2015). Results of this investigation did not indicate that the *EB* App was a more effective protocol than PTCs or combination protocols during gross motor performance. These results are similar to inconclusive results in literature supporting the use of video modeling during motor performance. Specifically, Yun and Case (2016) reported no significant differences in *TGMD-3* scores using video demonstrations of the skills compared to traditional assessment protocol in children with and without ASD. The development of motor skills (i.e., locomotor, ball skills) in children with ASD were dependent on teachers using evidence-based practices (e.g., visual supports, video modeling).

Combination

Evidence-based practices are instructional strategies, interventions, or teaching programs that are grounded in scientifically-based research (Wong et al., 2014). Both video modeling and PTCs (i.e., visual supports) are evidence-based practices for children with ASD (National Professional Development Center on ASD, 2015). However, after review of literature, limited research addresses the specific evidence-based practice combination of video modeling and PTCs for children with ASD during motor performance. The results of the current investigation did not support the combination protocol as the most effective intervention.

While not within the scope of this investigation, it should be noted that typically developing students learn and/or gain information through sight and hearing with other avenues, such as tactile, kinesthetic, and vestibular (Privitera, 2017). In the current investigation, it may be that the students with ASD were not able to handle the multisensory teaching technique (i.e., learning through more than one sense). Three-quarters of children with ASD have significant difficulty processing sensory information (Baranek, David, Poe, Stone, & Watson. 2006; Schoen, Miller, Brett-Green, & Nielsen 2009; Tomchek & Dunn, 2007). The ability to receive, interpret, and respond successfully to sensory information is key to the process of learning (Privitera, 2017).

Other possible explanations for the lack of significance in treatment response may be accounted to the nature of ASD and the high degree of variability in the population (i.e., Level, 1, 2, 3). Additionally, there are factors other than the treatment that may determine outcome. According to Schreibman (2012), these factors include: (a) child characteristics, (b) parent/family values, and (c) cultural considerations. With regard to all of the potentially influential factors, it would be highly surprising if one protocol would be most effective for all participants (Schreibman, 2012).

Implications of the Results to Practitioners

The findings from this investigation provide implications for practitioners who instruct children with ASD related to overall fundamental motor performance. The following information will address these instructional strategies for students with ASD.

Picture Task Cards

Based on the findings from the current study, conducting a recognition assessment before using PTCs during motor performance for students with ASD is recommended. The protocol established in this investigation (i.e., point to identify a selected PTC, success rate of 70% or higher, three trial attempts on three separate days) is suggested for practitioners. Additionally, interventionists should consider the developmental level of children to ensure that the children can successfully identify and/or understand the meaning of the PTCs. If a student cannot successfully identify PTCs, other visual support options should be considered (e.g., global visual schedule).

Furthermore, PTCs should be developed in collaboration with the special education teacher and parents so the PTCs can be used in multiple environments (e.g., classroom, gymnasium, home). As a practitioner, it is extremely important to collaborate with the students' classroom educators to determine the most effective instructional and learning strategies for the individual student. Knowledge sharing (i.e., mutually exchanging knowledge and skills) may better able educators to work together at developing new strategies to increase their ability to effectively reach individual student's educational goals (Choi, French, & Silliman-French, 2013).

***ExerciseBuddy* Application**

New behaviors are learned through observation and modeling (Bandura, 1977). However, if a model demonstrates the skill at less than mastery proficiency, the skill will not be learned at a mastery level. Seven *TGMD-3* skills were selected for use in this investigation (i.e., run, horizontal jump, two-hand strike of a stationary ball, one-hand stationary dribble, two-hand catch, kick a stationary ball, overhand throw).

The primary investigator and seven research assistants who passed a graduate-level Assessment in Adapted Physical Education course were selected to score the model used in the *EB* App on the seven *TGMD-3* skills used in this investigation. Of the seven selected skills, four of the skills performed by the model in the *EB* App did not meet Texas Education Agency mastery criteria of 70% or higher (i.e., run, horizontal jump, kick a stationary ball, overhand throw; TEA, 2015; see Table 15). In addition, see Appendix E for detailed raw scores for each of the seven selected motor skills. Participants need a mastery performance demonstration to appropriately acquire new skills. Therefore, practitioners should consider using only the *EB* App for videos that meet mastery criteria.

Table 15

EB App Model Score for Selected TGMD-3 Skills

TGMD-3 Skill	Average *EB* App Raw Score	Raw Score Percentage
Run	2.6	66%
Horizontal Jump	2.75	69%
Two-hand strike off tee	4.6	93%
One-hand stationary dribble	2.9	96%
Two-hand catch	2.5	83%
Kick a stationary ball	2.0	50%
Overhand throw	1.5	38%

Note. *TGMD-3 = Test of Gross Motor Development-3*; *EB* App = *ExerciseBuddy* application.

It is important that practitioners are aware that the videos in the assessment component of the *EB* app are performed by students with ASD and that their demonstration of skills are *not* mature. Practitioners must be aware of this fact because the participants in this investigation have the ability to observe and recognize a specific motor skill (i.e., horizontal jump) but do not necessarily have the ability to recognize the discrete motor components within that skill (i.e., prior to take off both knees are flexed and arms are extended behind the back). The assessment component of the *EB* App should be used with caution during motor performance according to results of this investigation.

Combination

Though no functional relation was indicated between the combination protocol compared to *EB* App or PTCs protocols, educators are still responsible for ensuring that effective evidence-based strategies are implemented. The newly adopted *Every Student Succeeds Act* (Lam et al., 2016) requires school districts to use evidence-based practices showing a statistically significant effect on student outcomes. In addition to evidence-based practices, school districts must recognize that each student with ASD is an individual, with unique needs and abilities. Therefore, the most effective interventions may be those tailored to meet the unique characteristics of each individual and not a one-size-fits-all approach.

Limitations

The limitations of this investigation should be considered in terms of generalizability and evaluation of the results. First, participants were not representative of a larger population due to the unique characteristics of ASD. Second, the participants' degree of effort when performing the specified skill was not measured. Third, potential internal and external factors (e.g., behavior, illness, sleep) may have affected motor performance. Fourth and finally, the *EB* App did not incorporate a model demonstrating mature motor performance skills.

Conclusions

Within the limitations of this investigation, it was concluded that there was no functional relation between PTCs, *EB* App, or combination instructional protocols during motor performance for children with ASD. There are numerous factors that could have impacted the results of this investigation. First, it is imperative for video modeling demonstrations to be models of mature motor performance skills. When motor skills are performed incorrectly by the model, the observer may copy the incorrect motor pattern. Finally, variability in treatment response may be accounted to the nature of ASD and the high degree of variability in the population. Considering all these influencing factors, it would be highly surprising if a single protocol during motor performance would be effective for all children with ASD.

Recommendations for Future Studies

Based on the current findings and the limitations of this investigation, the following recommendations are suggested for future researchers investigating the impact of video modeling on the motor performance of children with ASD:

1. Replicate this investigation using a larger number of participants to allow for parametric tests to determine if differences exist among treatments. *Experimental* and *quasi-experimental* research designs are considered the strongest intervention types (Odom et al., 2005). Results of an experimental/quasi-experimental investigation can be generalized to larger populations.

2. Replicate this investigation using the *EB* App only with *TGMD-3* assessment skills that meet TEA mastery criteria. If the demonstration does not show all performance criteria being performed correctly, the participant may model the incorrect behavior.
3. Further investigate the reliability and validity of the *EB* App before use.
4. Conduct a skill recognition assessment before implementing PTCs to ensure participants comprehend visual supports.
5. Investigate motor performance using all *TGMD-3* assessment skills. Of the 13 *TGMD-3* skills, only seven were used in this investigation. By using all 13 of the *TGMD-3* skills, students may have a more comprehensive understanding of fundamental motor skills before initiating an instructional program.

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Appendix A

Consent Form

Adapted Physical Education
Texas Woman's University
304 Administration Dr.
Denton, TX 76204-5647

PI: Melissa Bittner, MS
Phone: [redacted]
Fax: 940-898-2581
mbittner@twu.edu

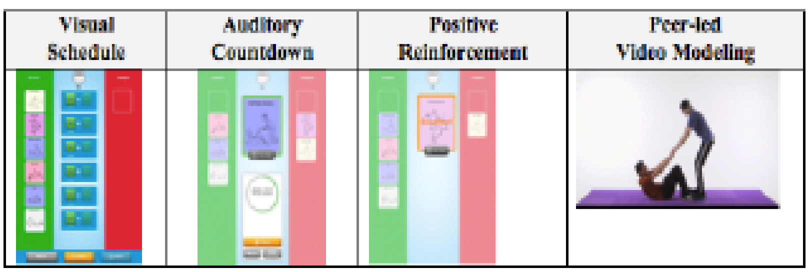
TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE
for a research study entitled

"Effectiveness of Video Modeling on Motor Performance for Children with Autism Spectrum Disorder"

PURPOSE

The purpose of this investigation is to determine the impact of the *ExerciseBuddy* application on motor performance for children with autism spectrum disorder (ASD).

Using evidence-based instructional strategies (i.e., video modeling) supported by the National Professional Development Center for ASD (2015), the *ExerciseBuddy* application (EB App) was developed to teach motor performance techniques to children with ASD (Geslak, 2015; see Figure 1). With the ability to be installed on a standard tablet, the EB App provides parents and teachers a portable video modeling resource for introducing motor performance to their children's or students' learning environment. The EB App is being used when instructing and assessing children with ASD, but only anecdotal evidence exists to support its benefits during motor performance. Further research is needed (i.e., validation) to determine if the EB App is an appropriate assessment and instructional approach for children with ASD.



PARTICIPANT REQUIREMENTS

Participants for this study will be children, 3 to 5 years of age, enrolled in Lake Dallas Independent School District (ISD). Enrollment is open to children of all ethnicities.

1. Children are enrolled at Lake Dallas ISD, which provides an assessment environment that is the same for all participants.
2. Parent confirmation of ASD diagnosis, which ensures that all participants are appropriate candidates for a study focused on this population.
3. If a participant cannot correctly identify the selected Picture Task Cards at mastery level (i.e., 70% or better), they will be excluded from the study, which ensures that participants have the cognitive capability to associate the picture with the desired action.

Initials ___________
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Approved by the
Texas Woman's University
Institutional Review Board
Approved: January 13, 2017

4. Need to be without a cardiovascular condition or any other heart condition, especially congenital heart defects.
5. Must be able to follow directions.
6. Must not have had injury or surgery within the past 6 months.
7. Should not be on any medication that could affect their motor performance.

EXPERIMENTAL METHODS and APPROACH

Testing Sessions

1. The primary researcher will be asking your child(ren) to perform the 13 gross motor skills from the *Test of Gross Motor Development-3 (TGMD-3;* Ulrich, 2017*)*. The *TGMD-3* consists of ball skills (e.g., striking off a tee, dribbling, kicking) and locomotor skills (e.g., running, skipping, sliding).
2. Your child(ren) will then perform three individually chosen motor skills based on their performance results. Any skill the child(ren) preforms at the 50th percentile or below will be selected for consideration. The adapted physical educator and primary investigator will then chose the three skills based on the child(ren)'s physical activity needs and performance in general physical education.
3. The three selected *TGMD-3* motor skills will be performed three times per week, for four weeks, using three different teaching methods (i.e., picture task card, video modeling, combination). Each session will take approximately 15 minutes (5 min for each skill). Your child(ren) will be asked to perform each skill for three trials (i.e., practice trial, two trials to be videotaped and scored).
    a. One teaching method will consist of your child(ren) performing the motor skills using pictures (see Figure 2).

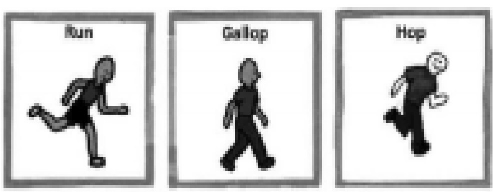

Figure 2. Picture task cards for instructional protocol (Breslin & Rudisill, 2011; used with permission).

    b. The second teaching method will consist of your child(ren) performing the motor skills after watching the video modeling mobile application *ExerciseBuddy*.
    c. The final teaching method will consist of your child(ren) performing the motor skills using pictures and the *ExerciseBuddy* application.

If your child(ren) does/do not meet the participation required criteria, they will continue at Lake Dallas ISD, but not continue with purposes of this study. Not participating will not affect their participation in Lake Dallas ISD. Video recording with sound will be used, only the primary investigator will have access to those recordings. f Child(ren) cannot participate in the study. i

Initials ___________
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Approved by the
Texas Woman's University
Institutional Review Board
Approved: January 13, 2017

Total time commitment: approximately 3 hours and 30 minutes

The following are potential risks for participants engaged in this study:

RISK	STEPS TO MINIMIZE RISK
Loss of Confidentiality	It is possible that there might be a loss of participant confidentiality with data stored offline. To minimize this risk, all data forms collected will be coded using alphanumeric IDs. A single identification form linking names with their respective IDs will be kept in a separate folder from the other data. Only the primary investigator and research assistants will have access. Data collection sheets will be locked in a file cabinet in Pioneer Hall 119A. There is also a potential risk of loss of confidentiality in all email, downloading, and internet transactions.
RISK	STEPS TO MINIMIZE RISK
Coercion	Participation in the study is completely voluntary. No incentives or penalties will be included. Participation in this study will not affect your child(ren)'s enrollment at Lake Dallas Independent School District.
RISK	STEPS TO MINIMIZE RISK
Loss of time	Assessments will be conducted in an efficient manner to avoid greater loss of time. Participants can withdraw from the study at any time.

Initials ___________
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RISK	STEPS TO MINIMIZE RISK
Risk of Fatigue	Your chid(ren) will be given rest breaks as necessary. This study measures instructional methods, thus if your child(ren) appear fatigued a rest break will be given.
RISK	**STEPS TO MINIMIZE RISK**
Loss of anonymity	Anonymity cannot be guaranteed due to the nature of the study.

All these steps reported to the IRB committee will be taken to minimize each of these risks.

At the beginning of each session, all of the procedures will be briefly reviewed by your child(ren). The researchers will try to prevent any problem that could happen due to this research project. Your child(ren) should let the researchers know at once if there is a problem, and they will help them. However, TWU does not provide medical services or financial assistance for injuries that might happen from taking part in this research project.

YOUR RIGHTS TO PRIVACY

Confidentiality will be protected to the extent that is allowed by law. All individual information obtained in this study will remain confidential and your right to privacy will be maintained. Data collected will be used for research purposes only and will be limited to access by the investigators of this study. Only data reported as group means or responses will be presented in scientific meetings and published in scientific journals. Data will be destroyed within 5 years of study completion.

QUESTIONS ABOUT THIS RESEARCH

As investigators, it is our obligation to explain all of the procedures to you and your child(ren). We want to make sure that you understand what is required, and what you can expect from us in order to complete this study. Please do not hesitate to inquire about the research project at any time throughout the study.

Initials __________

CONSENT TO PARTICIPATE

Participation in this research is entirely voluntary. Your decision whether or not to your child(ren) to participate will not jeopardize your future relations with Texas Woman's University and Denton City Day School. You may withdraw your consent and discontinue participation at any time and for any reason without prejudice. Discontinuing your child(ren)'s participation will not involve any penalty.

If your child does not want to or is unable to participate in this research, we will stop the study.

CONTACT INFORMATION

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You will be given a copy of this signed and dated consent form to keep if you have any questions about the research study, you should ask the researchers. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or through email at irb@twu.edu

Parent/Guardian Signature	Printed Name	Date

Approved by the
Texas Woman's University
Institutional Review Board
Approved: January 13, 2017

Appendix B

Data Set Tables

Table 1

Locomotor and object control skills of children diagnosed with autism (Berkeley, Zittel, Pitney, & Nichols, 2001).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation A	Independent t-test Data Collection: *TGMD-2*	15 children with ASD Age: 6-8 years Gender: male and female Setting: school gymnasium or university based facility	To examine the locomotor and object control skills of children, ages 6-8 years, with autism and to compare their performances with the norms reported by Ulrich (1985) for the *TGMD.*	Fundamental skill delays were demonstrated by 73% of participants, placing them in poor and very poor *TGMD* performance categories. These finding support the need to assess gross motor skills of young children with ASD.

Note. ASD = Autism Spectrum Disorder; *TGMD = Test of Gross Motor Development*

Table 2

The effect of visual supports on performance of the TGMD-2 for children with autism spectrum disorder (Breslin & Rudisill, 2011).

Strength Level & Recommendation Level	Research Method	Sample Population	Purpose	Summary of Results
Level 3 Recommendation A	Within subjects repeated measures ANOVA Data Collection: *TGMD-2*	22 children with ASD Age: 3-10 years Gender: male and female Setting: elementary school multipurpose room	To examine the effects of visual supports on the performance of the *TGMD-2* for children with ASD.	Statistically significant differences were reported between protocols (i.e., traditional, PTC, picture activity schedule). Post hoc tests indicated that the PTC condition produced significantly higher gross motor quotient scores than the traditional protocol and the picture activity schedule. The results suggest that more accurate gross motor quotient scores on the *TGMD-2* by children with ASD can be elicited using the PTC protocol.

Note. ASD = Autism Spectrum Disorder; *TGMD-2 = Test of Gross Motor Development-2*

Table 3

Heart rate profiles of children with and without autism spectrum disorder in response to physical play: A preliminary investigation (Breslin, Rudisill, & Wadsworth, 2015).

Strength Level & Recommendation Level	Research Method	Sample Population	Purpose	Summary of Results
Level 1 Recommendation A	Single subject design Data Collection: Actiheart heart rate monitors	7 children (i.e., 4 with ASD, 3 typically developing) Age: 4-6 years Gender: males Setting: preschool playground	To examine heart rate response of children with and without ASD exposed to outdoor free play sessions during preschool.	Children with and without ASD demonstrated a similar heart rate response to an outdoor free play session. All children did not engage in adequate amounts of moderate to vigorous physical activity during free play. Thus, interventions should be developed to determine best practices for children with and without ASD to participate in adequate amounts of moderate to vigorous physical activity during free play.

Note. ASD = Autism Spectrum Disorder

Table 4

A Comparison of Video Modeling with In Vivo Modeling for Teaching Children with Autism (Charlop-Christy, Le, & Freeman, 2000).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation C	Measurement: Single subject Data Collection: Multiple baseline across participants	5 participants with ASD Age: 7-11 years Gender: male and female Setting: therapy room; generalization probes were carried out either at a local restaurant or at the student store	To compare the effectiveness of in person and video modeling in increasing target behaviors of children with ASD.	Results suggest that video modeling led to faster acquisition of tasks (e.g., social play, daily living skills) than in person modeling and was effective in promoting generalization.

Note. ASD = Autism Spectrum Disorder

Table 5

A Comparison of Communication Using the Apple iPad and a Picture-based System (Flores, Musgrove, Renner, Hinton, Strozier, Franklin, & Hill, 2012).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation C	Single subject design	5 children with ASD Age: 8-11 years Gender: male and female Setting: university sponsored summer program	To investigate the utility of the Apple iPad as a viable communication device for making requests and to compare its use with picture task cards.	The results were mixed; 4 of 5 children had communication behaviors either increased when using the iPad or remained the same as when using picture task cards.

Note. ASD = Autism Spectrum Disorder

Table 6

The Effect of a Picture Activity Schedule on Performance of the MABC-2 for Children with Autism Spectrum Disorder (Liu, & Breslin, 2013).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation A	ANOVA Data Collection: *MABC-2*	25 children with ASD Age: 3-16 years Gender: male and female Setting: elementary school gymnasium	To examine the effects of a picture activity schedule implemented with the *MABC - 2* by children with ASD.	Picture activity schedule protocol elicited greater motor skill performance on the *MABC-2* by children with ASD. Researchers suggest practitioners incorporate a picture activity schedule into the *MABC-2* assessment protocol when examining the fine and gross motor performance of children with ASD.

Note. ASD = Autism Spectrum Disorder; *MABC-2 = Movement Assessment Battery for Children-2*

Table 7

Gross Motor Performance by Children with Autism Spectrum Disorder and Typically Developing Children on TGMD-2 (Liu, Hamilton, Davis, & ElGarhy, 2014).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation A	MANOVA **Data Collection:** *TGMD-2*	21 children with ASD and 21 age-matched typically developing peers Age: 5-10 years Gender: male and female Setting: local elementary school gymnasium	To compare the gross motor skills of children with and without ASD using the *TGMD- 2.*	For overall gross motor quotient scores, 81% children with ASD were below 79 and classified as poor and about 76% children scored below 70 and received very poor rating. There was a significant performance difference on the *TGMD-2* between children with ASD and typically developing children.

Note. ASD = Autism Spectrum Disorder*; TGMD-2 = Test of Gross Motor Development-2*; MANOVA = Multivariate Analysis of Variance

Table 8

Motor Skills of Toddlers with Autism Spectrum Disorders (Lloyd, MacDonald, & Lord, 2013).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation C	ANCOVA; Pearson Correlation Data Collection: *MSEL*	162 children with ASD Age: 12-36 months Gender: male and female Setting: Autism center or hospital	To describe and compare gross motor and fine motor skills, using the *MSEL*, of a group of 162 children with ASD. Secondly, to describe the gross motor and fine motor skills of 58 children with ASD longitudinally over two time points.	Young children with ASD have significant motor delays and the delays become more pronounced with age. Older children with ASD had more significant motor delays than the younger children.

Note. ASD = Autism Spectrum Disorder; *MSEL = Mullen Scale of Early Learning;* ANCOVA = Analysis of Covariance

Table 9

Motor Skills and Calibrated Autism Severity in Young Children with Autism Spectrum Disorder (MacDonald, Lord, & Ulrich, 2014).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation C	Pearson's correlation **Data Collection:** *Mullen Scales of Early Learning* & *Autism Diagnosis Observation Schedule*	162 participants (i.e., 136 with ASD, 23 typically developing) Age: 14 to 33 months Gender: male and female Setting: clinic	To determine the relationship of motor skills and the core behaviors of young children with ASD, social affective skills and repetitive behaviors, as indicated through the calibrated ASD severity scores.	Fine motor and gross motor skills significantly predicted ASD severity (i.e., Level 1, Level 2, Level 3). Children with weaker motor skills have greater social communicative skill deficits.

Note. ASD = Autism Spectrum Disorder

Table 10

Electronic Screen Media for Persons with Autism Spectrum Disorders: Results of a Survey (Shane & Albert, 2008).

Strength Level & Recommendation Level	Research Method	Sample Population	Purpose	Summary of Results
Level 2 Recommendation A	Qualitative Data Collection: Questionnaire	250 families with at least one child diagnosed with ASD. Age: Over 16 years of age Gender: male and female Setting: home	To determine (a) viewing habits among children with ASD for television, movies and computer activities, (b) preferences for certain characters, or (c) if parents modify rules around viewing media to accommodate strong preferences of children with ASD.	More time was spent engaged with ESM than any other leisure activity. Television and movie viewing was more popular than computer usage. Animated programs were more highly preferred.

Note. ASD = Autism Spectrum Disorder; ESM = electronic screen media

Table 11

Levels of Gross and Fine Motor Development in Young Children with Autism Spectrum Disorders (Provost, Heimerl, & Lopez, 2006).

Strength Level & Recommendation Level	Research Method	Sample Population	Purpose	Summary of Results
Level 3 Recommendation A	Measurement: MANOVA Data Collection: *Peabody Developmental Motor Scales-2*	38 participants (i.e., 19 with ASD, 19 with developmental delay) Age: 21 to 41 months Gender: male and female Setting: University Center for Excellence in Developmental Disabilities	To compare levels of gross motor development to levels of fine motor development in young children with ASD.	Children with ASD had poor levels of gross motor and fine motor development. The motor profiles of children with ASD were similar to those of children with developmental delay. Interventions are needed to aid children with ASD and developmental delay to acquire better gross and fine motor skills.

Note. ASD = Autism Spectrum Disorder; MANOVA = Multivariate Analysis of Variance

Table 12

Effect of Video Modeling and Primary Reinforcers on the Push-up Performance of Elementary Aged Male Students with Autism Spectrum Disorders. (Trocki-Ables, French, Silliman-French, & Nichols, 2014).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Single subject design Data Collection: *FITNESSGRAM*	5 males with ASD Age: 8-11 years Gender: male Setting: participant's home	To determine the effect video modeling and reinforcement, on the push-up performance of five elementary aged males with ASD and speech impairment.	Two of five participants performed their best push-ups using combination of video modeling and primary reinforcement. Three of five participants performed their best push-ups using video modeling only. Chi square results indicated significant differences between video modeling and primary reinforcers

compared to control.

Note. ASD = Autism Spectrum Disorder

Table 13

A Field-Based Testing Protocol for Assessing Gross Motor Skills in Preschool Children: The Children's Activity and Movement in Preschool Study Motor Skills Protocol (Williams, Pfeiffer, Dowda, Jeter, Jones, & Pate, 2009).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation A	Pearson's correlation Data Collection: *CMSP* & *TGMD-2*	297 typically developing preschool children Age: 3-5 years Gender: male and female Setting:	To describe the development of the *CMSP* and provide evidence for its validity and reliability.	The *CMSP* is an appropriate tool for assessing motor development of 3-, 4-, and 5-year-old children in field-based settings that are consistent with large-scale trials. Concurrent validity was achieved for the

		elementary school gymnasium	*CMSP* through compared scores to the gold standard assessment *TGMD-2*.

Note. CMSP = *Children's Activity and Movement in Preschool Study Motor Skills Protocol; TGMD-2 = Test of Gross Motor Development-2*

Appendix C

Exit Examination Research Assistants

1. How many times does the assessor demonstrate the skill?
    a. Once
    b. Twice
    c. Three times
    d. Once, with an additional demonstration if the child does not understand

2. How many locomotor and ball skills will the participant perform?
    a. 10
    b. 11
    c. 12
    d. 13

3. The assessor can give *specific* feedback to the participant.
    a. True
    b. False

4. Give an example of *general* feedback the assessor can say to the participant after performance of the locomotor skill of running.

5. The *ExerciseBuddy* videos are located in the assessment tab.
    a. True
    b. False

6. A live demonstration should be shown in conjunction with the *ExerciseBuddy* videos.
    a. True
    b. False

7. Participants perform a total of three trials (one practice, two for assessment scoring purposes).
    a. True
    b. False

8. The locomotor skill of slide will be performed on both the preferred and non-preferred side.
    a. True
    b. False

9. When performing the two-hand strike of a stationary ball, tell the participant to hit the ball hard, straight ahead.
    a. True
    b. False

10. During the one-hand stationary dribble the participant needs to dribble the ball on a specified side of the body.
    a. True
    b. False

11. Which of the following are cues specified by the directions given for the two-hand strike of a stationary ball?
    a. Hit the ball soft and straight; point straight
    b. Hit the ball hard, straight ahead; point straight
    c. Hit the ball soft and up; point up
    d. No cues are given in the directions

12. The participant should attempt to hop _____ consecutive times, and on which foot?
    a. 1, preferred
    b. 3, non-preferred
    c. 4, preferred
    d. 4, preferred and non-preferred

Appendix D

Fidelity Checklist

Observer name: Participant name:

Date: Week _________, Day __________

Fidelity Checklist

	Completed	Not Completed
The participant randomly selected the protocol condition.		
The participant randomly selected the skills to be performed.		
The skills were set up based on the *TGMD-2 Examiner's Manual* (Ulrich, 2000).		
All skills involved a demonstration (i.e., PTC, VM, combination) followed by a practice trial then two trials to be scored.		
The picture task card (PTC) protocol consisted of the investigator verbally explaining the skill, then showing the participant the PTC, then the participant performing the skill.		
The video modeling protocol consisted of the investigator verbally explaining the skill, then showing the participant the *ExerciseBuddy* application, then the participant performing the skill.		
The combination protocol consisted of the investigator verbally explaining the skill, then showing the participant the PTC, then showing the *ExerciseBuddy* application, then the participant performing the skill.		
The same person tests each time.		
Motivation was controlled through use of non-specific feedback (e.g., "Nice job").		
Trials were completed at approximately the same time in the same location.		

Appendix E

EB App Model Score for Selected *TGMD-3* Skills

Table 14

EB App Model Score for Selected TGMD-3 Skills

TGMD-3 Skill	Performance Criteria	PI	RA 1	RA 2	RA 3	RA 4	RA 5	RA 6	RA 7	Raw Score Percentage
Run	1. Arms move in opposition to legs with elbows bent	1	1	1	1	1	1	1	1	66%
	2. Brief period where both feet are off the surface	1	1	1	0	1	1	1	1	
	3. Narrow foot placement landing on heel or toes (no flat-footed)	0	1	1	1	0	0	0	0	
	4. Non-support leg bent about 90 degrees so foot is close to buttocks	1	0	0	0	0	1	0	1	
	Total	3	3	3	2	2	3	2	3	
Horizontal Jump	1. Prior to take off both knees are flexed and arms are extended behind the back	0	1	0	0	0	1	1	0	69%
	2. Arms extended forcefully forward and upward reaching above the head	0	1	1	1	1	1	0	0	
	3. Both feet come off the floor together and land together	1	1	1	1	1	1	1	1	
	4. Both arms are forced downward during landing	1	1	1	1	0	0	1	1	
	Total	2	4	3	3	2	3	3	2	

Two-hand strike of a stationary ball	1. Child's preferred hand grips bat above non-preferred hand	1	1	1	1	1	1	1	1	
	2. Child's non-preferred hip/shoulder faces straight ahead	1	1	1	1	1	1	1	1	93%
	3. Hip and shoulder rotate and derotate during swing	1	1	0	1	0	1	1	1	
	4. Steps with non-preferred foot	1	1	1	1	1	1	1	1	
	5. Hits ball sending it straight ahead	1	1	0	1	1	1	1	1	
	Total	5	5	3	5	4	5	5	5	
One-hand stationary dribble	1. Contacts ball with one hand at about waist level	1	1	1	1	1	1	1	1	
	2. Pushes the ball with fingertips (not slapping at ball)	1	1	1	1	0	1	1	1	96%
	3. Maintains control of the ball for at least four consecutive bounces without moving the feet to retrieve the ball	1	1	1	1	1	1	1	1	
	Total	3	3	3	3	2	3	3	3	
Two-hand catch	1. Child's hands are positioned in front of the body with the elbows flexed	1	1	0	1	1	1	0	1	
	2. Arms extend reaching for the ball as it arrives	0	1	1	0	1	1	1	0	83%
	3. Ball is caught by hands only	1	1	1	1	1	1	1	1	
	Total	2	3	2	2	3	3	3	2	

Kick a stationary ball	1. Rapid, continuous approach to the ball	1	1	1	1	0	1	1	1	50%
	2. Child takes an elongated stride or leap just prior to ball contact	0	0	0	0	0	0	0	0	
	3. Non-kicking foot placed close to the ball	1	1	1	1	1	1	1	1	
	4. Kicks ball with instep or inside of preferred foot (not the toes)	0	1	0	0	0	0	0	0	
	Total	2	3	2	2	1	2	2	2	
Overhand throw	1.Windup is initiated with a downward movement of hand and arm	0	0	0	0	0	1	0	0	38%
	2. Rotates hip and shoulder to a point where the non-throwing side faces the wall	0	0	0	0	0	0	0	0	
	3. Steps with foot opposite the throwing hand toward the wall	1	1	1	1	1	1	1	1	
	4. Throwing hand follows through after the ball release, across the body toward the hip of the non-throwing side	0	0	0	1	1	1	0	0	
	Total	1	1	1	2	2	3	1	1	

Note. PI = Primary Investigator; RA = Research Assistant

Appendix F

Participant Results: Did Not Meet Inclusion Criteria

Table 15

Participant Demographics

Participant	Gender	Birthdate	Age	ASD Level	Passed Inclusion Criteria
7	M	5-24-13	3 years, 9 months	2	N
8	F	9-14-12	4 years, 6 months	2	N
9	M	7-22-13	3 years, 7 months	1	N

Table 16

TGMD-3 Locomotor TGMD-3 Raw Score Percentage Results

Participant	Run	Gallop	Hop	Skip	Horizontal Jump	Slide
7	0%	0%	0%	0%	13%	0%
8	0%	0%	0%	0%	0%	0%
9	25%	0%	0%	0%	13%	0%

Table 17

TGMD-3 Ball Skills TGMD-3 Raw Score Percentage Results

Participant	Strike	Self-bounced	Dribble	Catch	Kick	Overhand Throw	Underhand Throw
7	0%	0%	0%	0%	13%	0%	0%
8	0%	0%	0%	0%	0%	0%	0%
9	25%	0%	0%	0%	38%	0%	0%

Table 18

TGMD-3 Chosen Skills

Participant	Skill 1	Skill 2	Skill 3
7	Gallop	Kick	Overhand Throw
8	Horizontal Jump	Kick	Run
9	Kick	Strike off Tee	Run

Table 19

Picture Task Card Retention Assessment Results

	Attempt One			Attempt Two			Attempt Three		
Participant	Skill 1	Skill 2	Skill 3	Skill 1	Skill 2	Skill 3	Skill 1	Skill 2	Skill 3
7	0%	0%	0%	0%	0%	0%	0%	0%	0%
8	0%	0%	0%	0%	0%	0%	0%	0%	0%
9	70%	10%	20%	Passed	70%	10%	Passed	Passed	0%

Appendix G

Concurrent Validity Manuscript

Concurrent Validity of Video Modeling as an Instrument for Administration of the

Abstract

Accurate assessment is critical to determine appropriate placement and program development for students with disabilities. The *ExerciseBuddy* application (*EB* App; Geslak, 2015) is being used for assessing fundamental motor skills in children with autism spectrum disorders (ASD), but only anecdotal evidence exists to support its benefits. Because of this, the purpose of this investigation was to determine the concurrent validity of the assessment component of the *EB* App. Concurrent validity is used to compare a target test (i.e., test to be validated; *EB* App) with a gold standard, which is already established to be valid (i.e., *Test of Gross Motor Development-3; TGMD-3;* Ulrich, 2018). Thirty typically developing children (CA = 3 to 5 years) performed the *TGMD-3* skills under two protocol conditions (i.e., verbal, video modeling). Data were collected on 2 days, with 1 week separating the protocol conditions. A Pearson product-moment correlation coefficient was computed to assess the relationship between verbal and video modeling protocols on fundamental motor skills using the *TGMD-3* (Ulrich, 2018). Overall, there was a strong, positive correlation between verbal and video modeling protocols ($r = .95$, $N = 30$, $p < .001$). Results may verify that the *EB* App provides appropriate modeling of mature fundamental motor skills and establishes concurrent validity.

Introduction

Accurate assessment is critical to determine appropriate placement and program development for students with special needs. The Individuals with Disabilities Education Improvement Act of 2004 (IDEIA) requires that assessment of students with disabilities be conducted at least as often as assessment of peers without disabilities. Assessment is a complex, multi-faceted process that focuses on: (a) identifying appropriate services for students; (b) developing appropriate goals; (c) implementing appropriate instructional activities; and (d) determining the most appropriate placement for children and youth in physical education (Horvat, Block, & Kelly, 2007). Assessment in adapted physical education is typically used to evaluate fundamental motor skills (Horvat et al., 2007).

The assessment most frequently used in adapted physical education to evaluate fundamental motor skills is the *Test of Gross Motor Development* (*TGMD-2*; Ulrich, 2018; Johnson, Kim, Bittner, & Silliman-French, 2017). The *TGMD-2* has been used for children without and with disabilities (Evaggelinou, Tsigilis, & Papa, 2002). The *TGMD-2* is a norm and criterion referenced test used to evaluate fundamental motor skills in children 3.0 to 10.9 years of age (Ulrich, 2018). Each fundamental motor skill includes several components presented as performance criteria. For example, the performance criteria for the ball skill subtest of catching are: (a) preparation phase where hands are in front of the body and elbows are flexed; (b) arms extended while reaching for the ball as it arrives; and (c) ball is caught by hands only (Ulrich, 2018). The examiner analyzes the performance criteria for the fundamental motor skills to determine if a component is present (score of 1) or not present (score of 0). Results are then tallied across two trials and totaled for locomotor and object control subtests. Finally, each subtest score is compared with a normative sample for analysis.

In the third edition of the *TGMD* (*TGMD-3*; Ulrich, 2018), there are six locomotor and seven ball skills (see Table 1). The following adjustments were made from the *TGMD-2*: (a) skipping reinstated; (b) leaping replaced; (c) one-hand forehand strike of self-bounced ball added; and (d) underhand roll switched to underhand throw.

Table 1

Ball Skills and Locomotor Skills in the TGMD-3

Ball Skills	Locomotor Skills
Two-hand Strike of a Stationary Ball	Run
One-hand Stationary Dribble	Gallop
Two-hand Catch	Hop
Kick a Stationary Ball	Skip
Overhand Throw	Horizontal Jump
Underhand Throw	Slide
Forehand Strike of a Ball	

Note. Ulrich, 2018

Researchers have suggested that current assessment protocols (i.e., no visual support) may not be appropriate for children with ASD (Berkeley, Zittel, Pitney, & Nichols, 2001; Breslin & Rudisill, 2011), thus potentially leading to inaccurate results. Berkeley et al. (2001) reported during assessment, children with ASD inaccurately interpreted skills as run or walk instead of performing other locomotor skills (i.e., galloping, skipping, leap). Additionally, 1 participant from the 15 with ASD assessed, held and walked a ball to touch the target, instead of throwing the ball to the target on the wall. Further research is needed to better assist children with ASD during fundamental motor skill assessment (Case & Yun, 2015).

Traditional assessment relies strongly on verbal communication and social interactions, two areas in which children with ASD have weaknesses (Tissot & Evans, 2003). By using more appropriate assessment methods, greater accuracy in assessment scores may be possible for children with ASD.

Video Modeling

Based on Bandura's social cognitive theory individuals acquire skills by watching others perform them, rather than personal experiences alone (Bandura, 1977). Human behavior is learned predominantly by observing and modeling others. Modeling is the process by which an individual demonstrates a behavior that can be replicated. Individuals, through observation and modeling, can learn new behaviors.

Video modeling includes the use of a model (e.g., self, peer, video animation) who is video recorded while demonstrating a skill. The observer watches the video and replicates the skill. Video modeling can be shown on a computer, television monitor, tablet, or smartphone.

Video modeling as an evidence-based practice for children with ASD has recently received attention in literature (Trocki-Ables et al., 2014; Wong et al., 2014). Video modeling has been reported to be overall more time and cost efficient than live modeling when learning developmental skills (Charlop-Christy, Le, & Freeman, 2000; Flores et al., 2012). Charlop-Christy et al. compared the effectiveness of video modeling with live modeling for teaching developmental skills to children with ASD. Video modeling consisted of participants watching a video recording of models performing the target behavior. Live modeling consisted of the children observing live models vocally explain and visually model the target behavior. Based on the results, video modeling led to faster achievement of developmental skills (i.e., independent play, cooperative play, social play) than live modeling (Charlop-Christy et al., 2000).

***ExerciseBuddy* Video Modeling Application**

Using evidence-based instructional strategies (i.e., video modeling) supported by the National Professional Development Center on ASD (2015), the *EB* App was developed to teach fundamental motor skills to children with ASD (Geslak, 2015). The *EB* App is being used when assessing children with ASD, but only anecdotal evidence exists to support its benefits. Further research (i.e., validation) is needed to determine if the *EB* App is an appropriate assessment approach to guide fundamental motor skills in children with ASD.

Concurrent Validity

Validity is the extent to which an instrument measures what it is supposed to measure (Thomas, Nelson, & Silverman, 2015). Concurrent validity is when the target test (i.e., *EB* App) and the gold standard (i.e., *TGMD-3*) are performed at (relatively) the same time (Portney & Watkins, 2009). Concurrent validity is useful in situations where a new or untested assessment instrument is potentially more efficient, easier to administer, more practical, safer than a more established method (i.e., gold standard), or is being proposed as an alternative (Portney & Watkins, 2009). The target test (i.e., test to be validated) is compared with a gold standard, which is already established to be valid. Both tests are then given to a group of participants, and the scores on the target test are correlated. The correlation coefficient should be high (i.e., close to 1.00) to be considered to achieve strong concurrent validity.

The most important element of concurrent validation is the ability to demonstrate validation of the gold standard test (Portney & Watkins, 2009). If the gold standard test is not valid, it will not work as a standard of comparison. Several elements must be demonstrated to judge the gold standard test. First, it must be reliable, such as in the test-retest situations. Second, the gold standard test should be independent and free from bias. Finally, the gold standard and target test must measure the same thing.

The *TGMD-2* (Ulrich, 2000) has frequently been used as the gold standard test for fundamental motor skill development research for children 3 to 10 years of age. For example, concurrent validity was used to evaluate the newly developed *Preschooler Gross Motor Quality Scale* compared to the gold standard *TGMD-2* (Sun, Sun, Zhu, Huang, & Hsieh, 2011). The *TGMD-2* was also used as the gold standard test to evaluate the *Children's Activity and Movement in Preschool Study Motor Skills Protocol* (Williams et al., 2009). Concurrent validity was assessed using Pearson product-moment correlation coefficients. In both these investigations, the newly developed assessments had a strong correlation with *TGMD-2*; thus, concurrent validity was established.

The present investigation will determine the effectiveness of video modeling during assessment. It is hypothesized that moderate to strong concurrent validity will be established between the *EB* App and the *TGMD-3* (Ulrich, 2018). Therefore, the purpose of this investigation is to determine the level of concurrent validity between the assessment component of the *EB* App and the *TGMD-3*.

Method

The *TGMD-2* (Ulrich, 2000) has been established as the concurrent validation gold standard assessment for use in fundamental motor skill research for children 3 to 10 years of age (Sun, Sun, Zhu, Huang, & Hsieh, 2011; Williams et al., 2009). Concurrent validity of the assessment component of the *EB* App will be determined by comparing results to the *TGMD-3*.

Participants

Thirty typically developing children (20 males, 10 females), 3 to 5 years of age (M = 3.75 years; SD = 8.3), from a preschool in North Texas with an enrollment of 69, participated in this investigation. Additional inclusion criteria included scoring at least one point on the *TGMD-3* (Ulrich, 2018) assessment in both protocol conditions (i.e., verbal, video modeling).

Procedures

After institutional review board approval, prospective participants were identified by the preschool principal through the inclusionary requirements of (a) age and (b) typical development. A consent for the prospective child's participation was requested from parents/guardians through a form sent home in the child's home folder. Parents returned the consent form to their child's classroom teacher, who returned it to the principal investigator.

Four *TGMD-3* assessors, master's students in adapted physical education, participated in a two-hour training session by the investigator. Assessors were chosen because of successful completion of a graduate level adapted physical education assessment course. In this session, assessors: (a) learned proper administration of the *TGMD-3* as explained in the *Examiner's Manual* (2017), (b) familiarization with the *EB* App, and (c) practiced motor skill demonstrations. Test and retest reliability amongst the master's students was demonstrated through successful completion (i.e., 90% or better; Zirpoli & Melloy, 1993) of an exit examination regarding assessment protocol.

Once parent/guardian written consent was received, assessors traveled to the participants' preschool to administer the *TGMD-3*. To collect data, the *TGMD-3* was administered twice, by the same assessor, with one week between protocol conditions

(Breslin & Rudisill, 2011). Participants completed 13 locomotor and ball control skills. Three trials of each skill was completed for each protocol. The first trial was a practice trial. The second and third trials were video recorded for assessment scoring.

The *TGMD-3* administration was completed using two protocol conditions (i.e., verbal, video modeling). The verbal protocol was conducted using the *TGMD-3* assessment (i.e., verbal instruction from assessor followed by live demonstration; *Examiner's Manual* 2018). The video modeling (i.e., *EB* App) protocol was administered following the instructions in the *Examiner's Manual* (i.e., verbal instruction from assessor), but instead of a live demonstration, a video recording of a child performing the skill was shown (see Figure 1). A second demonstration (live or *EB* App depending on protocol condition) was provided if the child does not exhibit appropriate behavior or did not comprehend the skills.

Data were collected twice a week, for two consecutive weeks. Fifteen participants participated each day, with one week separating the protocol conditions (Breslin & Rudisill, 2011). The order of the conditions were counterbalanced and randomly assigned to ensure learning will not influence results (Breslin & Rudisill, 2011). Both data collection days occurred in the same environment. All *TGMD-3* assessments were video-recorded and coded by the investigator to ensure the research assistants were not influenced by expectancy bias.

Verbal	*EB* App

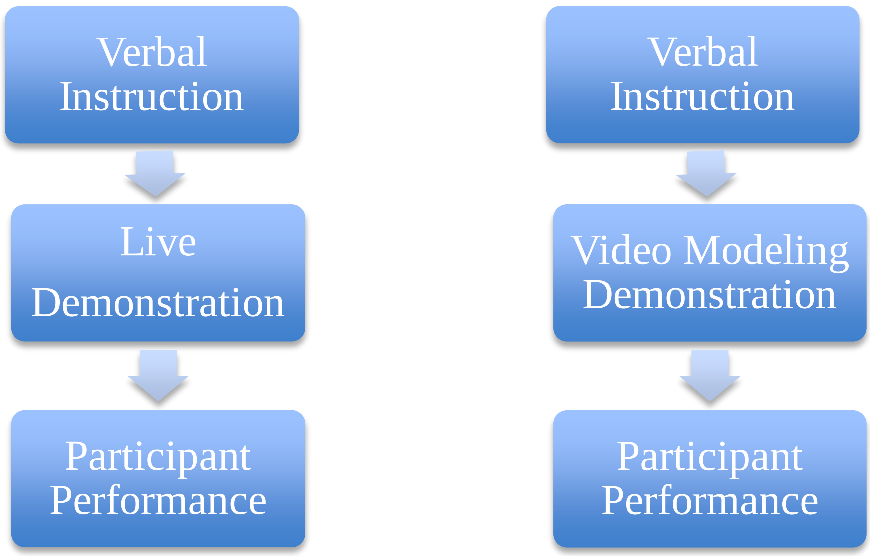

Figure 1. Protocol for assessment administration.

Two research assistants completed a two-hour training session for assessment scoring conducted by the investigator to learn and understand the criteria of test performance as indicated in the *TGMD-3 Examiner's Manual* (Ulrich, 2018). Training videos from the *TGMD-3* website were used for assessment scoring practice. Each research assistant needed 80% agreement with the scoring training video for skills (i.e., ball skills, locomotor skills) for two consecutive assessments (Porges et al., 2014).

After completing scoring training, two research assistants and the investigator scored the *TGMD-3* assessments independently. The research assistants then compared their results and produced a collective score to compare with the investigator. Interrater reliability for *TGMD-3* assessment scoring was then calculated for the investigator and research assistants for subtests (i.e., ball skills, locomotor skills). Interrater reliability was calculated by number of agreements divided by number of agreements plus number of disagreements, then multiplied by 100%. Acceptable agreement was a score of 80% or higher (Kennedy, 2005). The final subtest scores were calculated from an average of results obtained from the research assistants and investigator. The raw score was then determined by adding subtest scores as explained the *TGMD-3 Examiner's Manual* (Ulrich, 2018).

Results

A Pearson product-moment correlation coefficient was computed to assess the relationship between verbal and video modeling protocols on fundamental motor skills using the *TGMD-3* (Ulrich, 2018). All participants were asked to complete the *TGMD-3* twice, with one week separating protocol conditions.

Interrater reliability for *TGMD-3* assessment was calculated between the investigator and the collective scoring for the research assistants. Interrater reliability was calculated by number of agreements divided by number of agreements plus number of disagreements, then multiplied by 100%. Acceptable agreement was a score of 80% or higher (Kennedy, 2005) for the raw score. Interrater reliability for the locomotor subtest was 97% and ball skill subtest was 92.5%. Interrater reliability for the total raw score was 94%.

Overall, there was a strong, positive correlation between verbal and video modeling protocols. See the scatterplot in Figure 2 for results (r = .95, N = 30, p <

.001). Concurrent validity the assessment component of the *EB* App is a valid method of assessing fundamental motor skills in typically developing children 3 to 5 years of age.

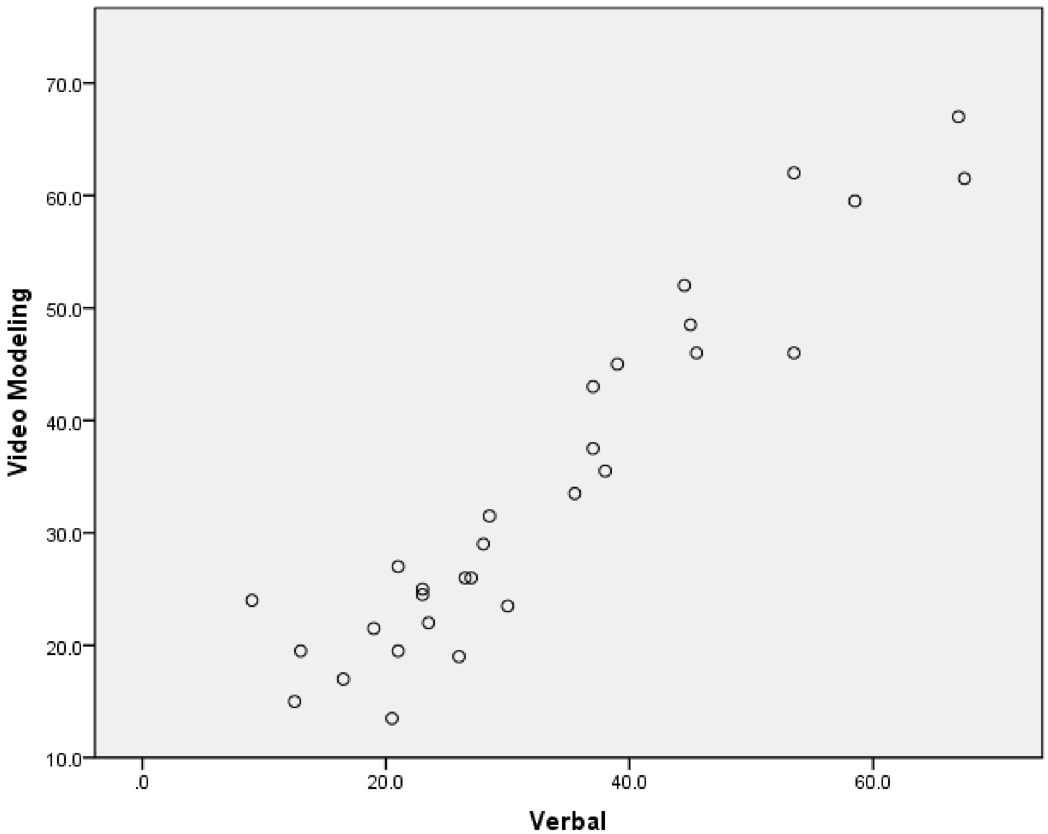

Figure 2. Scatterplot of verbal and video modeling raw scores.

Dependent T-test Results

A paired-samples t-test was conducted to compare *TGMD-3* scores using verbal and video modeling protocols. Based on these results, there was no significant difference in the scores for verbal (M = 32.98, SD = 15.7) and video modeling (M =

34.02, *SD* = 15.45) conditions using SPSS v.22 (IBM Inc., Armonk, NY); $t(29) = -1.1$, $p = .28$.

Discussion

The purpose of this investigation was to determine the level of concurrent validity between the assessment component of the *EB* App and the *TGMD-3* (Ulrich, 2018). The results supported the hypothesis that moderate to strong concurrent validity would be established between the *EB* App and the *TGMD-3* (Ulrich, 2018). Therefore, the *EB* App may be used when assessing fundamental motor skills.

This finding is important for individuals conducting fundamental motor skill assessment. The *EB* App can be a useful resource for physical educators who cannot use a live demonstration for motor assessment purposes. For example, a leg injury may prevent a teacher from being able to perform a live demonstration of locomotor skills. Furthermore, a physical disability (e.g., cerebral palsy, wheelchair user) may prevent an assessor from performing a mature demonstration. The *EB* App may be used when conducting fundamental motor skill assessments for those not able to perform a mature live demonstration.

In spite of these findings, certain limitations must be addressed. First, the participants' degree of effort when performing the specified skill was not measured. Second, participants' performance level may not have been at their highest level due to the children being asked to perform a skill by someone they had never met (i.e., assessor). Finally, this study should be replicated with older children with disabilities.

This replication may further validate the assessment component of the *EB* App for children during motor performance skills.

In summary, findings from this investigation indicate concurrent validity was established between the *EB* App and *TGMD-3.* A strong, positive correlation between verbal and video modeling protocols was reported. Because researchers have suggested that current assessment protocols (i.e., no visual support) may not be appropriate for children with ASD (Berkeley, Zittel, Pitney, & Nichols, 2001; Breslin & Rudisill, 2011), the *EB* App may help children with ASD understand the tasks to be performed during the *TGMD-3* assessment and may help them, in turn, obtain higher scores. Furthermore, because children are more likely to watch a model that is similar to themselves (e.g., physical characteristics, age, disability; Bandura, 1977), the *EB* App may be a viable source of video modeling for children with ASD. It is suggested that further research is needed to determine if children with ASD prefer the *EB* App to verbal protocol during the *TGMD-3* assessment.

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