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THE EFFECTS OF GROSS-MOTOR FLUENCY TRAINING ON PHYSICAL ACTIVITY LEVELS IN YOUNG CHILDREN

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Abstract

Engaging in regular physical activity is one of the most important factors related to good health. Encouraging and promoting physical activity in young children aids in preventing overweight and obesity, promoting health, preventing disease, and supporting bone and overall growth development. However, physical activity levels in young children are low, and efficient and effective interventions to increase physical activity in young children are unclear. One creative method to increase physical activity in young children is gross-motor fluency training. A multielement single-case experimental design was employed to assess the effects of fluency training in six gross-motor skills on children's levels of physical activity during free play sessions. Four typically developing preschool-aged children participated. Overall, results indicated that training skills relevant to two contexts (i.e., outdoor toys and open space) increased levels of moderate-to-vigorous physical activity (MVPA) for all four participants. Supplementary analyses suggested that fluency training increased three participant's preferences for training play contexts, the effects of non-social reinforcement on MVPA increased for two participants following fluency training, and overall gross-motor competency increased for all four participants. Fluency-based instruction likely increased the proficiency, and decreased the response effort required for skill performance; enabled the participant's to combine gross-motor component skills into composite chains; and facilitated generalization of gross-motor skills training to play. Fluency-based gross-motor instruction with young children represents a promising strategy to improve overall fitness levels, thereby increasing health and well-being and establishing a foundation for an active lifestyle.

Keywords: physical activity, preschool, health, fluency training, gross-motor

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The Effects of Gross-Motor Fluency Training on Physical Activity Levels in Young Children

The positive implications of physical activity on overall health in children and adolescents have been well documented (e.g., Janssen & LeBlanc, 2010; Janz et al., 2010; Strong et al., 2005; USDHHS, 2008). In general, increasing levels of moderate-to-vigorous physical activity (MVPA) promotes health and prevents disease (Strong et al., 2005). Benefits of physical activity in middle childhood and adolescence include higher cardiorespiratory fitness, improved muscular strength, lower adiposity, improved cardiovascular and metabolic health, increased bone mineral content and density, and reduced symptoms of depression and anxiety (USDHHS, 2008).

Although the benefits of physical activity on health and well-being are widely known, current estimates of physical activity levels remain low. Furthermore, sedentary behavior is evident in children aged 2 to 5 years, which has implications for subsequent ages (Strong et al., 2005). Therefore, interventions aimed at increasing physical activity levels in young children are warranted. The current review will cover several distinct literature bases. First, the health benefits and current levels of physical activity in children will be discussed. Next, current estimates of overweight and obesity will be reviewed. Subsequently, theoretical and conceptual approaches and interventions to promote physical activity will be considered, followed by a review of fundamental movement skills and interventions aimed at increasing these skills. Finally, a section on behavioral principles underlying fluent performance will be described. Following this review, I describe a study evaluating a novel and systematic approach to increase physical activity levels in young children (i.e., gross-motor fluency training). Results of the study are provided as well as implications and suggestions for future research.

Physical Activity Levels in Children

Currently, the Centers for Disease Control (CDC, 2017) recommends 60 min of physical activity per day for children and adolescents, with the majority of that time spent engaged in MVPA (e.g., brisk walking, running, jumping). Furthermore, participation in muscle strengthening activities (e.g., gymnastics, push-ups) and bone strengthening activities (e.g., jumping rope, running) are recommended (CDC, 2017). However, estimates suggest that children, adolescents, and adults do not engage in recommended levels of physical activity (e.g., Hallal et al., 2012; Reilly, 2010; Strong et al., 2005; Troiano et al., 2008). Recent estimates of objectively measured physical activity across a representative sample of the U.S. population suggest generally low and decreasing levels of physical activity across successive age groups (Troiano et al., 2008). For example, the estimated prevalence of adherence to physical activity guidelines decreased from 49% of males and 35% of females in the 6-11 age group to 10% of males and 5% of females in the 16-19 age group. Furthermore, adherence to physical activity guidelines remained less than 5% for adults (Troiano et al., 2008).

The early years (i.e., 3-5 years of age) represent a critical period for promoting physical activity habits; however, there are data to suggest that preschool-aged children too are not as active as commonly perceived (Reilly, 2010). Due to the long-standing assumption that young children are naturally very active, there is little research on physical activity within this age range (Pate et al., 2013). Subsequently, physical activity recommendations for this population are less clear (U.S. Department of Health and Human Services [USDHHS], 2008). Nevertheless, the National Association for Sport and Physical Education (NASPE, 2009) recommends that preschoolers accumulate at least 60 min of unstructured activities (free-play) and 60 min of structured activities (adult-led), per day, though these guidelines are not based on an evaluation of scientific evidence.

To assess the physical activity levels of preschoolers, Reilly (2010) reviewed research on physical activity and MVPA in childcare centers. Studies published between 2005-2008 were included if they incorporated an objective measure of physical activity (i.e., accelerometers, direct observation, pedometers, Heart Rate (HR) monitors) during childcare time with 3- to 6-year-old children. Overall, 12 studies were included from 96 childcare centers with data from more than 1,900 children. Results indicated that: (1) in all six studies using accelerometers, measures of MVPA were low, and when extrapolated to represent a full day would not provide 60 min of MVPA, (2) in all four studies using direct observation, levels of MVPA were between 1%-12% of observations, and (3) in both studies using pedometers, levels of physical activity were also low and varied across centers. Additionally, studies reported very high levels of objectively measured sedentary behavior (e.g., 98% of time spent in the lowest two categories of physical activity engagement from the Children's Activity Rating Scale [CARS] direct observation recording measure; Reilly, 2010).

Overall, young children, children, adolescents, and adults are not meeting physical activity guidelines that are aimed at increasing overall health and preventing disease (e.g., Hallal et al., 2012; Reilly, 2010; Strong et al., 2005; Troiano et al., 2008). One implication of low levels of physical activity is the current overweight and obesity epidemic.

Overweight and Obesity

Overweight and obesity are associated with a range of health concerns including diabetes mellitus, hypertension, dyslipidemia, heart disease, cerebrovascular disease, respiratory disease, osteoarthritis, cancer, and even death (Malnick & Knobler, 2006; Must et al., 1999). For children, overweight is defined as a body mass index (BMI) between the 85th and 95th percentile for children of the same age and sex, and obesity is defined as a BMI at or above the 95th percentile (Ogden, Carroll, Kit, & Flegal, 2012).

Recently, the National Health and Nutrition Examination Survey (NHANES), was conducted by the National Center for Health Statistics (NCHS) of the CDC to assess prevalence rates of obesity among children and adolescents in the United States (Ogden et al., 2012). Data were collected in 2009 and 2010 and consisted of an at-home interview and measures of height and weight for 4,111 children and adolescents. Overall, the prevalence for high weight-for-recumbent length among infants and toddlers was 9.7%. Among children and adolescents (2-19 years of age), the prevalence for obesity was 16.9% and for overweight and obesity combined was 31.8% (Ogden et al., 2012). However, there were significant sex differences with a higher prevalence of obesity in males 2-19 years old (18.6%) compared to females (15.0%, $p = .01$). There were also significant race/ethnicity differences in obesity, with higher prevalence rates in Hispanic children and adolescents (21.2%), and non-Hispanic black children and adolescents (24.3%), compared to non-Hispanic white children and adolescents (14%). Based on current population statistics, more than 23 million children across the United States are considered overweight or obese (Ogden et al., 2012).

Evidently, many biological, sociocultural, and environmental factors are associated with increased prevalence rates of overweight and obesity, and lower physical activity levels. Ethnic minorities and those of lower education are at highest risk for obesity (Gordon-Larsen, Adair, & Popkin, 2003; Mokdad et al., 2003). Additionally, lower socioeconomic status (SES) is related to obesity and lower levels of physical activity (e.g., Gordon-Larsen, Nelson, Page, & Popkin, 2006). Relatedly, the inequality in availability of recreational facilities in lower-SES and high minority areas may contribute to ethnic and SES disparities in physical activity and overweight patterns (Gordon-Larsen et al., 2006).

Behaviors associated with overweight and obesity (i.e., eating and physical inactivity) track from childhood to adolescence and adulthood, and appear to impact adult health (Dietz, 1998; Janz, Burns, & Levi, 2005; Jones, Hinkley, Okely, & Salmon, 2013; Mikkila, Rasanen, Raitakari, Pietinen, & Viikari, 2005). Therefore, establishing recommended levels of physical activity during the early years is likely to impact overall health across the lifespan. In order to alter the overweight and obesity epidemic, it is imperative to treat or, better still, to prevent behaviors associated with overweight and obesity. One of the primary methods by which to tackle overweight and obesity prevention and intervention is to increase physical activity levels and decrease sedentary behaviors.

Theoretical and Conceptual Approaches to Promoting Physical Activity

Throughout the past 2 decades, theoretical and conceptual approaches aimed at increasing our understanding of factors that influence physical activity have expanded (King, Stokols, Talen, Brassington, & Killingsworth, 2002). Predominant theoretical orientations have focused on an individual's cognitive, affective, social, and behavioral influences surrounding the choice to be active (i.e., personal-level perspectives; King et al., 2002). However, other approaches have also highlighted environmental influences impacting the individual. Although many conceptual and theoretical approaches to the promotion of physical activity are evident; few theories have been specifically developed for the promotion of physical activity in young children. However, social-cognitive, learning, and social-ecological theories are developmentally appropriate, and appear to be the most common theoretical frameworks for the development of physical activity interventions in children (e.g., Campbell & Hesketh, 2007;

Kamath et al., 2008; Metcalf, Henley, Wilkin, 2012; Salmon, Booth, Phongsavan, Murphy, & Timperio, 2007; van Sluijs, McMinn, & Griffin, 2007).

The *social-cognitive approach* to promoting physical activity suggests that personal, behavioral, and environmental factors are reciprocally influential in determining behavior and behavior change (Bandura, 2001). According to the social-cognitive approaches, personal factors that affect adherence to physical activity include demographic factors (e.g., age, SES, gender, race) and psychosocial factors. Psychological factors include *self-efficacy* (i.e., belief in one's ability to lead an active lifestyle); *outcome expectations* (i.e., realistic expectations in terms of time and accomplishment); and *self-regulation* (i.e., ability to monitor, set goals, and evaluate exercise behavior; e.g., Anderson, Wojcik, Winett, Williams, 2006). Environmental factors related to physical activity adherence include social support (e.g., modeling by family and friends), support from other exercisers, and feedback from exercise leaders (e.g., Anderson et al., 2006).

Learning theories posit that the development of new, complex-motor chains requires the modification of component behaviors (Skinner, 1965). According to behavioral perspectives on promoting physical activity, the development and maintenance of higher levels of physical activity can be accomplished through behavioral strategies such as self-monitoring, goal setting, positive reinforcement, and shaping (e.g., Epstein, Saelens, & O'Brien, 1995; Normand, 2008). However, these strategies have often failed to show long-term increases in behavior (Dishman, 1991). Additionally, behavioral economic theory has been used to illustrate choices in physical activity and inactivity (e.g., Epstein, Saelens, Myers, & Vito, 1997). For example, sedentary behaviors (e.g., watching TV, sitting on the computer) may be more reinforcing than physically active behaviors (e.g., running), therefore an individual may choose to allocate more of his time to sedentary behaviors (Epstein et al., 1997).

Social-ecological approaches to physical activity promotion emphasize that the most effective interventions occur on multiple levels (i.e., personal, social, environmental). King and colleagues (2002) emphasized five important principles of the social-ecological model. First, engagement in physical activity is promoted or hindered due to intrapersonal, interpersonal, environmental, and sociocultural factors. Second, cycles of reciprocal relationships exist between environment and behavior. Third, environmental factors that influence physical activity levels should be analyzed at the micro- (e.g., conditions within one's home), meso- (e.g., conditions in the neighborhood), and macro-scale (e.g., features of the community such as transit systems). Fourth, practitioners and researchers should aim to identify the most relevant factors that influence physical activity levels. Finally, interventions to promote physical activity should address environmental conditions at the micro-, meso-, and macro- levels of the environment (King et al., 2002).

Interventions for Increasing Physical Activity

Considering the overall high levels and related health problems of physical inactivity, effective prevention and intervention methods are needed. Furthermore, physical inactivity tracks from childhood to adulthood (e.g., Janz et al., 2005); therefore, interventions aimed at increasing physical activity in children are a priority. In particular, the push to increase physical activity often targets the school context because school-aged children spend more than half of their waking hours in this environment (Levi et al., 2013). Currently, every state within the United States has enacted some physical education standards or requirements for students; however, these requirements vary significantly and are often limited, are not enforced, or are inadequate (Levi et al., 2013). Specifically, many states have started enacting laws that require schools to adhere to a certain number of min and/or a certain difficulty of physical activity. For example, 12 states (i.e., Arizona, Colorado, Connecticut, Illinois, Indiana, Kentucky, Louisiana, Maine, North Carolina, North Dakota, Ohio, and Tennessee) require schools to provide physical activity or recess during the school day (Levi et al., 2013).

Although state requirements exist for school-aged children within the United States, physical activity policies in preschools and childcare centers are uncommon (Pate et al., 2013). Preschools in the United States are generally regulated at the state level, except for Head Start programs, and few states currently mandate daily physical activity standards (Pate et al., 2013). Furthermore, physical activity standards and laws alone may not be sufficient at increasing the particularly low levels of physical activity currently seen across the United States. Therefore, interventions aimed at increasing physical activity levels may be more effective at engendering results.

Children and Adolescents

Theoretical approaches to increase physical activity and decrease sedentary behavior in children and adolescents vary; however social cognitive, learning, and social-ecological theories targeting developmentally appropriate skills are prevalent (e.g. Kamath et al., 2008; Metcalf et al., 2012; Salmon, et al. 2007; van Sluijs et al, 2007). For example, common school-based interventions aimed at increasing physical activity in children and adolescents include (1) curriculum only strategies, (2) curriculum and physical education strategies, (3) environment only strategies (e.g., painting fluorescent markings such as a pirate hopscotch layout on a playground; or providing games equipment and activity cards), (4) curriculum, physical education, and environment strategies combined; (5) activity breaks; (6) special classes to promote activity; (7) tailored advice and/or counseling; (8) after-school programs; and (9) inclusion of school/family based strategies. Furthermore, additional strategies to increase physical activity in children and adolescents have included family-based interventions, primary care interventions, and community-based interventions (Salmon et al., 2007).

Overall, systematic reviews and meta-analyses of various interventions have generally found small, negligible increases in children's overall physical activity levels (e.g. Kamath et al., 2008; Metcalf et al., 2012; Salmon, et al. 2007; van Sluijs et al, 2007). However, the effectiveness of many physical activity interventions with children and adolescents remains questionable due to several limitations. First, many studies rely on questionable, indirect measures of physical activity (e.g., questionnaires). Second, many studies only measure physical activity levels during intervention periods of the day (e.g., during physical education classes) and generalizable effects are often unclear. It is possible that increased levels of physical activity during an intervention period may result in subsequently lower levels of physical activity throughout the day to compensate for the increased energy expenditure. Third, many studies only target specific populations (e.g., obese, low socioeconomic minority groups) making generalizable effects difficult to assess. Fourth, multicomponent interventions are common, and component analyses have not been conducted to assess for particular strategies within an intervention that may or may not be effective. Fifth, studies often do not report integrity data, resulting in questionable intervention implementation. Finally, methodological and measurement flaws (e.g., no baseline data, poor study design, atheoretical interventions, physical activity measures with unknown reliability and validity) are common, making it difficult to assess intervention effectiveness.

Recently, a meta-analysis conducted by Metcalf and colleagues (2012) addressed many limitations of previous reviews by including only randomized controlled trials or controlled clinical trials that used direct measures of physical activity (e.g., accelerometers) across whole day activity. Overall, this review included 30 studies published between 2003 and 2011 and included data from 6,153 children under the age of 16. Of the 30 studies, 21 reported total physical activity, 23 reported moderate or vigorous physical activity, and 14 reported both measures. Across all studies, the pooled analysis showed a significant effect for the intervention group on total physical activity (standardized mean difference 0.12, 95% confidence interval 0.04 to 0.20; $P < 0.01$) and on moderate or vigorous physical activity (0.16, 0.08 to 0.24; $P < 0.001$). However, the small to negligible increases in physical activity suggest minimal clinical significance (e.g., increase in ~4 min of walking or running/day). Although Metcalf et al. (2012) followed more stringent inclusion criteria, the results are consistent with other meta-analyses suggesting that physical activity interventions have little effect on overall levels of physical activity in children and adolescents (e.g. Kamath et al., 2008; Metcalf et al., 2012; Salmon, et al. 2007; van Sluijs et al, 2007).

Young Children

Although research exists on interventions aimed at increasing physical activity levels with children and adolescents, the published evidence base for physical activity interventions in young children is small (Campbell & Hesketh, 2007; Chau, 2007). To date, theoretical approaches to increase physical activity and decrease sedentary behavior in young children have varied, although social-ecological theories (e.g., modifying environmental variables to promote increased levels of physical activity) and social learning theories (i.e., providing knowledge and skills to teachers and caregivers on how to develop and maintain higher levels of physical activity in young children) are prevalent (e.g., Campbell & Hesketh, 2007). Center-based early education settings are the most common context for intervention implementation because a large percentage of children under the age of 5 years are in some sort of regular child care (Ward, Vaughn, McWilliams, & Hales, 2010); however, physical activity interventions also target other settings such as family child care homes (Trost, Messner, Fitzgeral, & Roths, 2011). Thus far, strategies to increase physical activity in young children include (1) environmental changes, (2) curricula emphasizing structured physical activity, motor skills training, or reductions in television viewing, (3) structured physical activity curricula embedded into preexisting preschool activities.

Environmental approaches to physical activity promotion generally include some manipulation of the environment to increase the probability of engaging in higher levels of physical activity and lower levels of sedentary behavior. For example, Hannon and Brown (2008) assessed pre- and post- effects of adding portable equipment (e.g., hurdles, tunnels, balance beams, target toss/throw sets, bean bags, balls) to an outdoor preschool playground. Results suggested that the addition of play materials increased the percentage of engagement in light (+3.5%), moderate (+7.8%), and vigorous (+4.7%) activities while decreasing the engagement in sedentary (-16%) behaviors (Hannon & Brown, 2008).

Additional environmental approaches may include the provision of increased opportunities to be outdoors, because research suggests that young children are more active in this context (e.g., Brown et al., 2009). For example, Brown and colleagues (2009) used a modified version of the Observational System for Recording Physical Activity in Children (OSRAC) to examine physical activity levels and social/environmental variables that predicted increased levels of physical activity with children in preschool settings. The Observational

System for Recording Physical Activity in Children- Preschool (OSRAC-P) includes eight observational categories (i.e., physical activity levels, physical activity types, primary locations, indoor activities, outdoor activities, activity initiator, group composition, and adult/peer prompts) and observers code activity based on five levels (i.e., stationary/motionless, stationary with limb or trunk movement, slow easy activity, moderate activity, and vigorous activity). Brown and colleagues (2009) observed the outdoor activities of 372 preschool children for an average duration of 34 min per child. With respect to activity context, the highest percentages of moderate-to-vigorous physical activity (i.e., MVPA) were recorded when the children were engaged with ball and object use (26.9% of intervals), in open-space (23.1% of intervals), on fixed equipment (13.9% of intervals), using wheel toys (13.5% of intervals), or engaging with sociodramatic props (10.8% of intervals). In terms of activity initiation, children engaged in MVPA more often when a child initiated (19.5% of intervals) than when an adult initiated (15.4% of intervals). Finally, focal children engaged in higher levels of MVPA when they were solitary (28.5% of intervals) than when they were in the presence of one peer (21.1% of intervals), in the presence of two or more peers without an adult (19.4% of intervals), or in the presence of adults (11.2% of intervals).

Researchers have also experimentally manipulated environmental contexts correlated with MVPA in young children. Hustyi, Normand, Larson, and Morley (2012) utilized the OSRAC to code activity level in a multielement experimental design that alternated presentations of three experimental conditions (i.e., Fixed Equipment, Open Space, Outdoor Toys) and one control condition. Observers used 5-s partial-interval recording to code the highest level of physical activity observed during each interval. In the *Fixed Equipment* condition, participants were guided to a jungle gym area and directed to play. In the *Outdoor Toys* condition, participants were guided to an adjacent session area where objects used in gross-motor activities were available (e.g., balls, Frisbees, jump ropes, several throwing objects) and were directed to play. In the *Open Space* condition, participants were guided to an area on the playground void of any materials and directed to play. In the *Control* condition, participants were guided to a small area with a table and activities not anticipated to evoke high levels of MVPA (e.g., army toys, coloring books, crayons). Overall, participants engaged in relatively high levels of sedentary behavior throughout the analysis, although differentiated patterns across conditions were observed. Fixed equipment evoked the highest levels of MVPA for all participants, although open space also evoked MVPA for three of the four participants. These results suggested a promising avenue for the behavioral assessment of physical activity; however, the results were limited because participants were exposed to the experimental conditions alone, unlike typical outdoor play compositions one might expect in young children.

A follow-up study assessed the effects of group composition and activity context on MVPA in preschool children (Larson, Normand, Morley, & Hustyi, 2014). Eight typically developing children participated. Procedures and experimental conditions (i.e., Fixed Equipment, Outdoor Toys, Open Space, Control) were identical to those described by Hustyi et al. (2012), except that the participants were exposed to the conditions across three group compositions (i.e., solitary, one peer present, two or more peers present). Results indicated that the participants engaged in the highest levels of MVPA when at least one peer was present and fixed equipment (i.e., jungle gym with two slides, monkey bars, stairs, and several climbing areas) was available. Furthermore, differential responding was observed for all participants across activity contexts and compositions (Larson et al., 2014).

Although the experimental manipulation of environmental contexts has the potential to identify settings that are more likely to evoke MVPA, it is also important to consider consequent events that may affect activity levels. For example, Larson, Normand, Morley, and Miller (2013) employed functional analysis methods whereby the effects of attention, adult interaction, and escape contingent on MVPA were evaluated. Two preschool children participated and the effects of the aforementioned conditions were evaluated in a multielement experimental design. Overall, results indicated that both children were more active when attention and interactive play were delivered contingent on MVPA. Furthermore, MVPA varied as a function of the arranged contingencies. A follow-up replication by Larson, Normand, Morley, and Miller (2014) indicated that four typically-developing preschool children were most active when interactive play was delivered contingent on MVPA. Additionally, elevated levels of MVPA were observed for two of the participants in the attention condition. The results from Larson and colleagues (2013, 2014) suggest that positive reinforcement (i.e., adult attention, adult interaction) might help increase levels of physical activity in young children.

Curriculum-based approaches to the promotion of physical activity generally include strategies such as exercise training routines (e.g., jumping, hopping, circuit training) and physically active imagination games and skits (Eliakim, Nemet, Balakirski, Epstein, 2007; Fitzgibbon et al., 2005; Fitzgibbon et al., 2006; Reilly et al., 2006). In general, curriculum-based strategies (i.e., training staff to increase MVPA opportunities by implementing developmentally appropriate games and activities) have not proven effective at increasing physical activity levels in preschool children (Fitzgibbon, et al., 2005; Fitzgibbon et al., 2006; Reilly et al., 2006). Several reasons could explain the failure of these curricula to demonstrate effectiveness. First, the focus of these studies was on the prevention of obesity, therefore primary measures were BMI, with physical activity outcomes used as secondary measures. It is possible that the measures used to assess physical activity were not sensitive enough to detect changes. Second, the length, duration, or intensity of the interventions may not have been sufficient to affect overall changes in activity levels.

Another strategy that has been implemented to increase physical activity levels in preschool children is to incorporate movement opportunities into existing curricula. For example, Trost and colleagues (2008) assessed the effectiveness of an 8-week "move and learn" curriculum among 3- to 5-year-old children in preschool classrooms within one childcare center. The purpose of the curriculum was to increase MVPA by adding opportunities for physical activity during all aspects of the preschool curriculum (i.e., math, science, language arts, nutrition education; Trost et al., 2008). Teachers were required to include two move and learn curriculum activities that lasted at least 10 min during 2.5 hr sessions. Activities varied, and were often repeated throughout the week (e.g., a teacher scattered balloons around the classroom and asked the children to kick the balloons and count for 1 min, stop, then repeat the activity). Four classrooms participated ($n = 42$) and were randomly assigned to the intervention group ($n = 20$) or the control group ($n = 22$). Teachers and staff in the experimental group participated in a 3-hr training session including an introduction and discussion of the curriculum objectives, demonstration of activities, practice of the activities, and a viewing of a video demonstrating different activities.

To monitor intervention integrity, teachers and staff completed structured checklists at the end of every session. Overall, teacher- and staff-reported integrity data remained high; however, direct observation suggested that teachers were not consistently meeting requirements during the initial 4 weeks of the intervention. Subsequently, investigators met with teachers to repeat the project requirements and review the training session. Following this meeting, implementation integrity appeared to remain high via direct observation and integrity data. Levels of physical activity were assessed in each classroom twice/week via accelerometers that were affixed to the children's right hips from arrival to dismissal. Additionally, the OSRAP direct observational system was used to conduct direct observations for 15 min across all participants.

A mixed-model repeated measures ANOVA was used to assess the effects of condition and time on the accelerometer-derived activity variables. Additionally, logistic regression analyses were used to calculate the relative likelihood of MVPA during circle time, indoor free-choice time, snack time, transitions, and outdoor free-choice time on the observation-derived data. Overall, preschoolers in the intervention condition engaged in significantly higher levels of MVPA within the classroom compared to the control group during the last 4 weeks of the intervention ($p < .05$). Additionally, preschoolers in the intervention group were significantly more likely than preschoolers in the control group to engage in MVPA during circle time (Odds Ratio = 2.6), free-choice outdoor time (Odds Ratio=1.4), and free-choice indoor time (Odds Ratio = 1.2, $P < .05$). Results from Trost and colleagues (2008) suggest that integrating regular movement breaks into existing curricula might be a feasible and effective way to increase overall activity levels in preschool children.

In summary, relatively few studies have rigorously evaluated interventions aimed at increasing physical activity levels in young children. Preliminary results suggest that simple modifications to the outdoor play environment may be effective at increasing activity levels and decreasing sedentary behavior in young children. Furthermore, curricula targeting opportunities to engage in MVPA have demonstrated limited effectiveness; however, as previously mentioned, there are several limitations to the few studies completed thus far. Finally, training teachers to incorporate movement into existing curricula may be an effective and feasible way of increasing physical activity levels in young children. It should be emphasized that the results of interventions aimed at increasing physical activity levels in preschool children should be interpreted with caution as this field of research has only recently begun to emerge.

To date, explanations and interventions for low levels of physical activity in young children are not well understood. However, one hypothesis suggests that there might be a positive relationship between motor skill performance and higher levels of physical activity. Nevertheless, to assess the potential relationship between gross-motor skills and physical activity, it is first important to understand the development and consequent health implications of these gross-motor skills in children.

Fundamental Movement Skills in Children and Adolescents

Development of Fundamental Movement Skills

Fundamental Movement Skills (FMS) are specialized movement sequences that are commonly developed in childhood and are required as building blocks for participation in physical activity (i.e., both organized and non-organized) by children, adolescents, and adults alike (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Furthermore, FMS are the component skills required for children to participate in all types of games, physical activities, and sports. FMS include locomotor (e.g., running and hopping), manipulative or object control (e.g., catching and throwing), and stability skills (e.g., balancing and twisting; Lubans et al., 2010). A common misconception is that FMS develop “naturally” through maturational processes; however, opportunities to respond through instruction, practice, and reinforcement are requisites to FMS development (e.g., Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012).

Several theories exist to describe the developmental process of motor skill acquisition (Branta, Haubenstricker, & Seefeldt, 1984). For example, some researchers propose rigid versions of stage theories that hypothesize hierarchical, qualitative changes in skills (Branta et al., 1984). Conversely, other researchers propose theories of developmental change along a continuum based on interactions between the skill, the learner, and the environment (Newell, 1984). FMS are acquired in a developmental sequence that is contingent on many factors. For example, biological and demographic (e.g., gender, age), behavioral attributes and skills (e.g., physical activity and sport participation), cognitive, emotional, and psychological factors (e.g., self-esteem, self-efficacy, attitudes, self-motivation), cultural and social factors (e.g., adoption status, parent skill confidence), and environmental factors (e.g., playground size, equipment availability) have been purported to affect the development of fundamental movement skills in children. However, until recently, few studies had investigated the correlates of motor skills in children and adolescents.

Barnett and colleagues (2016) completed a systematic review and meta-analysis on the correlates of gross-motor competence in children and adolescents that included 59 studies from 22 countries. According to results, age/grade and BMI were the most commonly researched biological and demographic correlates (Barnett et al., 2016). Overall, results indicated that there was a positive correlation between age and motor skill development; boys had higher levels of motor coordination than girls; and adiposity was negatively correlated with motor coordination, stability, and competence. Additionally, higher socioeconomic status was a positive correlate of locomotor skill stability and motor competence. Within the behavioral attributes and skills domain, the most frequently assessed correlates were physical activity and sport participation, with evidence suggesting physical activity was a positive correlate of motor coordination and competence. Studies assessing cognitive, emotional, and psychological factors, as well as cultural and social factors, were limited and contributed mixed findings precluding any conclusions regarding these outcomes to-date. Similarly, few studies investigated the correlates of physical environmental factors indicating the need for future research (Barnett et al., 2016). Considering the dearth of potential correlate evidence on motor skill performance, future research is needed to identify at-risk children and adolescents.

Early childhood physical activity guidelines (e.g., the National Association for Sport and Physical Education's [NASPE] *Active Start* program) suggest that early physical activity programs should include the development of gross-motor movement skills (NASPE, 2009). However, despite recommendations encouraging the early development of FMS mastery, the prevalence of FMS mastery appears low (Erwin & Castelli, 2008; Okely & Booth, 2004). Although recommendations have commonly supported the development of FMS competency among young children, the psychological, physiological, and behavioral benefits in children and adolescents have only recently been assessed.

Health Implications of Fundamental Movement Skills

A review article by Lubans and colleagues (2010) evaluated the benefits of FMS competency. Studies that were included in the review were required to meet the following inclusionary criteria: (1) participants were aged 3-18 years old, (2) assessment of at least two FMS (e.g., run, vertical jump, horizontal jump, hop, dodge, leap, gallop, side gallop, skip, roll, throw, stationary dribble, catch, kick, two-handed strike, static balance), (3) measure of FMS competency, (4) quantitative assessment of potential health benefit, (5) quantitative analysis of relationship between health benefits and FMS competency (i.e., psychological, physiological, or behavioral), (6) cross-sectional, longitudinal, or experimental/quasi experimental design, and (7) published in English. The authors and expert panel identified 21 articles that examined the relationship between FMS competency and eight potential benefits (i.e., global self-concept, perceived physical competence, cardio-respiratory fitness [CRF], muscular fitness, weight status, flexibility, physical activity and reduced sedentary behaviors).

The relationship between FMS competency and health benefits was reported by determining the percentage of studies that reported a statistically significant relationship. If fewer than four studies assessed the relationship between FMS competency and a given health benefit then the relationship was considered uncertain. If 0-33% of the studies reported a relationship between FMS competency and a health benefit then the result was classified as no association. If 34-59% of the studies reported a relationship between FMS competency and a health benefit then the result was classified as inconsistent or uncertain. If 60-100% of the studies reported a relationship between FMS competency and a health benefit then the result was classified as a positive or negative association. Finally, if 60-100% of high quality studies reported a relationship between FMS competency and a health benefit then the result was classified as strong evidence for positive association (Lubans et al., 2010).

Overall, results indicated a strong positive association between FMS competency and physical activity in children and adolescents. However, associations between various psychological, physiological, and behavioral benefits varied. First, results suggested an uncertain relationship between FMS competency and psychological benefits. Three studies assessed the relationship between FMS competency and perceived physical competence (i.e., individual's perception of their actual motor proficiency), and all studies demonstrated that perceived competence was associated with at least one aspect of FMS competency. Additionally, one study assessed the relationship between FMS competency and self-concept, however this relationship was nonsignificant at baseline and post-test. Together, the relationship between FMS competency and psychological benefits is uncertain due to the lack of quality studies (Lubans et al., 2010).

Second, the relationship between FMS competency and physiological benefits varied. Across eight studies, five demonstrated a significant inverse relationship between FMS competency and weight status. Additionally, a positive relationship between FMS competency and CRF was suggested. The relationships between FMS competency and muscular fitness, flexibility, and overall physical fitness were uncertain due to the lack of quality studies. Overall, weight was the most commonly assessed physiological benefit of FMS competency demonstrating a significant inverse relationship (Lubans et al., 2010).

Third, the relationship between FMS competency and behavioral benefits varied. Across 13 studies assessing the relationship between FMS competency and physical activity, 11 studies suggested a significant positive relationship and due to the number and quality of studies, the overall evidence suggests a strong positive association. Additionally, two studies assessing the relationship between FMS competency and sedentary behavior found no significant relationship, however the number of quality studies is insufficient to determine an overall association (Lubans et al., 2010).

Although promising, results from Lubans and colleagues (2010) included relatively few studies. Furthermore, due to the limited number of studies, the results were combined for gender. According to previous studies, gender differences have been found for FMS competency (e.g., Hardy et al., 2012). For example, research suggests that boys are more likely to master object-control skills (i.e., skills required for ball sports), and girls are more likely to master locomotor skills (i.e., skills required for dance, gymnastics). It is possible that these observed differences are attributable to gender norms, and the activities that young girls and boys are exposed to in order to develop these skills (Hardy et al., 2012). Also, results were collapsed across age, and as such this review could not assess how FMS competency varies across childhood and adolescence. Future studies should continue to examine the relationship between FMS competency and overall health benefits in children and adolescents.

Together, preliminary findings suggest that if children develop FMS competency, they are more likely to participate in physical activities that could provide opportunities to improve fitness and reduce the risk of unhealthy weight gain (Lubans et al., 2010). Additionally, Lubans and colleagues (2010) suggest that preschool and early elementary years are optimal ages for motor skill learning. Considering that many children appear to lack basic FMS proficiency (Erwin & Castelli, 2008; Okely & Booth, 2004), interventions aimed at increasing FMS proficiency in young children have potential health implications and warrant further consideration.

Interventions to Increase Fundamental Movement Skills in Young Children

Although research suggests a number of potential psychological, physiological, and behavioral benefits from motor skills development, efficacious interventions designed to improve motor development in young children are unclear (Riethmuller, Jones, & Okely, 2009). Riethmuller and colleagues (2009) systematically reviewed evidence from controlled studies on the efficacy of motor development interventions in young children. Articles were included if they involved an objective measure of motor development and reported an intervention targeting children under five years of age. Two reviewers assessed articles for methodological quality on a 10-item quality assessment scale and agreement was set at 80% a priori. A study was considered to have high methodological quality when the score was ≥ 5 for a controlled trial and

≥ 6 for a randomized, controlled trial. Due to varying instruments used to assess motor skill development across studies it was not possible to pool the results. Instead, an intervention was deemed efficacious if a statistically significant improvement compared to the control group was observed.

In all, Riethmuller and colleagues (2009) evaluated the effects of 17 (i.e., ten published and seven unpublished) studies on interventions designed to encourage motor development in preschool children. Overall, Riethmuller et al. (2009) suggested that 11 studies reported statistically significant improvements in gross-motor skills at follow-up. In addition, the interventions implemented more frequently throughout the week and across at least 8 weeks total appeared to be more efficacious. However, conclusive evidence on intervention effectiveness is currently unknown for several reasons. First, specific intervention components were difficult to identify because each study was unique in design, length, instructional time, and participants. For example, sample sizes varied from 19 – 545 participants; interventions ranged from 9 – 20 weeks; instruction time varied from 5 – 40 hr; intervention delivery varied from researchers, to teachers, to parents; and the number and type of motor skills and measures varied. Second, over 80% of studies employed poor methodology (e.g., the inability to ascertain whether assessors were blind to group allocation). Third, demographics of the facilitator (e.g., gender, experience, competence) were absent from most studies. Fourth, implementation integrity was difficult or impossible to assess. Finally, although frequently not reported, different theoretical frameworks may have also affected the outcomes.

Though research suggests that the early development of FMS competency may provide opportunities to improve fitness and reduce the risk of unhealthy weight gain (Lubans et al., 2010), there is a dearth of high quality research assessing interventions to improve motor development in young children (Riethmuller et al., 2009). Therefore, developing efficacious mechanisms to increase motor skill performance in young children is a priority. Currently, motor skill interventions aim to teach specific skills (i.e., acquisition); however, the effects of training gross-motor skills to fluency levels are unknown. Research on behavioral fluency suggests that one indication of competent skill performance is *fluency* or the ability to perform skills both accurately and rapidly (Binder, 1996). Fluency training has increased proficient performance across a variety of domains (e.g., academic skills, athletic performance; Martens et al., 2007; Martens & Collier, 2011; Martens & Witt, 2004) and similar strategies could systematically be applied to increase gross-motor skill performance in young children.

Behavioral Principles Underlying Fluent Performance

In order to develop proficient performance, a model commonly known as the *Learning Hierarchy* (LH) has been conceptualized (Daly, Martens, Barnett, Witt, & Olson, 2007; Haring, Lovitt, Eaton, & Hansen, 1978; Martens & Collier, 2011; Martens & Witt, 2004). According to the LH, the learner passes through several levels, leading to sequentially higher levels of proficiency. First, a skill must be performed accurately in response to discriminative stimuli (i.e., *acquisition*). For example, discriminative stimuli for gross-motor skills in young children might involve teacher directives (e.g., "Jump!"), modeling of jumping by peers, pretend-play activities, or outdoor toys (e.g., jumping bags, jump ropes, hop scotch layout). Several strategies are appropriate to promote acquisition, including modeling, prompting, and error correction (Daly et al., 2007; Haring et al., 1978). Second, after a learner has acquired a skill he must learn to complete the skill quickly with a high degree of accuracy (i.e., *fluency;* Binder, 1996). To increase skill fluency, reinforcement and drill strategies in isolation are often effective. The third step in the LH is *maintenance* where the learner continues to display the behavior for longer periods of time, under more demanding practice conditions, and to more naturalistic stimuli. Finally, the learner can display the behavior across novel conditions, and as part of more complex composite skills (i.e., *generalization*). Eventually, he becomes capable of modifying and adjusting the skill in response to environmental changes (i.e., *adaptation*; Binder, 1996; Johnson & Layng, 1996; Martens & Collier, 2011).

Behavioral fluency evolved from the methodology of free-operant conditioning and can be defined as the "fluid combination of accuracy plus speed", the "combination of quality plus pace", "automatic", "second nature", or "doing the right thing without hesitation" (Binder, 1996, p. 164). In general, fluent performance is associated with *mastery* and carries several benefits to the learner (Johnson & Layng, 1996). If a learner reaches a functional fluency aim in a skill, he is more likely to (1) *retain* that skill in the absence of practice, (2) demonstrate *endurance* of the skill for longer intervals, (3) perform the skill with *stability*, even in the face of distraction, (4) *apply* the skill to composite behaviors in novel environments, and (5) spontaneously alter the skill in the face of novel demands (i.e., *adduction*; Johnson & Layng, 1996; Martens & Collier, 2011). The acronym RESAA (i.e., Retention, Endurance, Stability, Application, and Adduction) stands for the learning processes affected by fluency building and are required for behavior to be considered fluent (Johnson & Layng, 1996). Application studies have demonstrated that fluency building affects composite performance across a range of academic skills such as reading, spelling, and mathematics (e.g., Chafouleas, Martens, Dobson, Weinstein, & Gardner, 2004; Daly, Witt, Martens, & Dool, 1997; McDowell, & Keenan, 2002; Singer-Dudek & Greer, 2005).

Furthermore, research suggests that practicing component motor skills to high levels of fluency makes them more stereotyped and efficient, more easily combined into composite chains, and more likely to be retained in the absence of practice (e.g., Driskell, Willis, & Copper, 1992; Martens & Collier, 2011). For example, Eastridge and Mozzoni (2005) increased fluency of component motor skills and assessed performance on activities of daily living in four individuals who had suffered traumatic brain injury. The objective of this study was to increase functional use of both the impaired and non-impaired hand. Two males and two females ranging in age from 16 to 52 yr old, who were diagnosed with a traumatic brain injury, and who were attending a post-acute inpatient neurorehabilitation program participated. All participants were selected based on impairments of the hand and arm (i.e., they were unable to close the fingers of the impaired hand). All sessions were conducted in the participants' room and lasted 50-min. Intervention focused on increasing fluency of the 'Big 6' (i.e., reach, point, touch, grasp, place, release), which are motor movements that have been hypothesized to increase composite skills such as activities of daily living. During fluency training, one bowl with ping-pong balls was placed on a tray to the right of the participant, and one empty bowl was placed to the left. A timer was set for 10-s (which eventually increased to 30-s) and the participant was instructed to move as many ball as possible within the designated time period. Social praise was delivered following every timing and each session consisted of 15-20 timings, alternating movement of the balls from left-to-right (Eastridge & Mozzoni, 2005).

Overall, results indicated that fluency increased for all four participants across 11-21 sessions. Furthermore, improvements of Functional Independence Measures (FIMS) increased for all participants. For example, FIMS for one participant increased across outcomes of upper body dressing, grooming, and bathing from a score of 3 (moderate assistance) to 6 (modified independence (Eastridge & Mozzoni, 2005). Although promising, this study was limited in the lack of experimental control demonstrated between increases in activities of daily living and fluency of component skills.

Twarek and colleagues (2010) attempted to address several limitations from previous research by assessing the effects of motor fluency training on completion of daily living skills for three 3-5 yr old boys diagnosed with autism. In this study, all participants had unrestricted mobility of both hands and arms. Three to five sessions were conducted per week across several rooms in the participant's homes. Prior to fluency training, at least one composite skill was chosen for each participant in order to train related component skills. Parents completed an informal interview adapted from the self-help skills assessment and motor skills assessment sections of The Assessment of Basic Language and Learning Skills- Revised (ABLLS-R). Subsequently, the composite skills were chosen based on the lowest scores and highest ranked priority according to the parents. Across all three participants the composite skills included putting on socks, putting on shirts, and putting on underwear. Component skills were chosen from the 'Big 6 + 6' skill elements (i.e., reach, touch, point, grasp, place, release, push, pull, shake, squeeze, tap, twist). Component skills that were chosen to correspond to the composite skills across the three participants were reach, grasp, pull, and place.

Fluency training involved 15-s timings where the participant was instructed to complete the motor task as many times as possible (e.g., "Let's see how fast you can reach today. Ready? Go!") A terminal reinforcer was delivered to that participant following each timing, and timing intervals continued until the participant met the recommended fluency aim or until he was able to complete the composite skill independently. If the participant met the fluency aim of a component skill but was not independently completing the composite skill, a new target component skill was introduced. Retention and endurance (i.e., 45-s timings) of component skills were also assessed one week post-training (Twarek et al., 2010).

A non-concurrent multiple baseline design across participants was used to evaluate the intervention effects of fluency training on composite skills, with within-subject replication for one participant. Results indicated that all three participants achieved fluent levels of target component skill performance. Furthermore, follow-up results demonstrated retention and endurance of most component skills. All three participants also increased completion of the identified activities of daily living. Although the non-concurrent multiple baseline design affords no experimental control, the within-subject replication for one participant provides validation for the potential utility of motor fluency training as a method to increase composite skill performance.

In addition to targeting fluency as a means of establishing efficient behavior that is more easily combined into composite motor chains, research suggests that fluency also aids in retention. Driskell and colleagues (1992) conducted a meta-analysis on research assessing overlearning (i.e., learning beyond an acquisition criterion) on retention of physical and cognitive tasks. In all, 15 studies with 88 hypotheses addressing the behavior of 3,771 individuals were included. Results suggested that the mean effect size of overlearning on retention was 0.44 for physical tasks and 0.75 for cognitive tasks. Additionally, the degree of overlearning and the effect size on retention were significantly correlated ($r = 0.48$). Overall, results of the meta-analysis suggest the effectiveness of overlearning on the retention of physical and cognitive tasks. The authors suggest several potential hypotheses to explain the effectiveness of overlearning. First, overlearning presents a greater degree of learning due to the increased number of repetitions and feedback associated with correct responding. Second, overlearning takes into consideration individual differences, whereby training an individual to his level of proficiency, then overtraining, ensures mastery and retention of the skill (Driskell et al., 1992).

The overall effectiveness of fluency training across domains (e.g., academic skills, athletic performance; Martens et al., 2007; Martens & Collier, 2011; Martens & Witt, 2004) suggests potential utility of similar strategies to increase gross-motor skill performance in young children. Based on research suggesting a significant positive relationship between FMS competency and physical activity levels (Lubans et al., 2010), fluent gross-motor skill performance could affect overall levels of physical activity in children for several reasons.

First, fluency training could increase the proficiency with which children perform gross-motor skills. By increasing proficiency and thereby decreasing the effort required for skill performance, fluency training could serve as a motivating operation for reinforcement derived from engaging in these skills. A motivating operation is an antecedent stimulus that temporarily alters the value of a reinforcer (i.e., value-altering effect) and therefore alters the probability of the behavior that previously earned that reinforcer (i.e., behavior-altering effect; Laraway, Snycerski, Michael, & Poling, 2003). Second, training gross-motor component skills to fluency could enable children to combine these skills into composite chains of increased physical activity. Third, training gross-motor skills that are directly relevant to play activities in certain contexts (e.g., hopping related to the hop scotch layout in the outdoor toys context) may facilitate their generalization from training to play probes.

A preliminary study by Morley and Martens (2014) evaluated the effects of gross-motor fluency training on two typically-developing preschool children's levels of moderate-to-vigorous physical activity (MVPA) in subsequent free-play sessions. A concurrent multiple-probe design across two play contexts (outdoor toys, open space) was used to assess the effects of training three gross-motor skills relevant to the outdoor toys context (i.e., hop, jump, alternate 1-foot, 2-feet hop) to a fluency criterion. Results showed increased levels of MVPA only in the outdoor toys context after fluency training for both participants. Furthermore, results indicated increased engagement in target gross-motor skills on pre- to post-training outdoor play probes.

Morley and Martens (2014) presented several likely reasons for the effects on MVPA that were observed. First, fluency training increased the proficiency with which the children could perform the gross-motor skills. By increasing proficiency, fluency training may have served as a motivating operation for reinforcement derived from engaging in these skills in subsequent play probes. Second, training skills that were directly relevant to play activities in the outdoor toys context (e.g., alternate 1-foot/2-feet hopping and the hop scotch layout) may have facilitated their generalization from training to play probes in that context. Third, because the children in this study participated in all play probes together, it is possible that modeling of skill performance by one child or the other may have contributed to increased levels of MVPA.

Although promising, results from Morley and Martens (2014) are limited because (1) play probes were conducted soon after children met the fluency criterion for skill training, (2) only two play probe sessions were conducted post training, and a decreasing trend was evident, and (3) there was an absence of within-subject replications. Therefore, the extent to which fluency training in gross-motor skills can be used to promote increased levels of physical activity in free play activities with preschool children warrants further attention.

Purpose of the Present Study

Evidence suggests that physical inactivity tracks from childhood to adulthood (e.g., Janz et al., 2005) and establishing physical activity during the early years may have the greatest impact on overall health across the lifespan. Although the early development of FMS competency has a significant positive relationship with physical activity, may improve fitness, and reduce the risk of unhealthy weight gain (Lubans et al., 2010), research assessing interventions to improve motor development in young children is limited (Riethmuller et al., 2009). Research in behavioral fluency suggests that fluency of component motor skills makes them more stereotyped and efficient, more easily combined into composite chains, and more likely to be retained in the absence of practice (e.g., Driskell, Willis, & Copper, 1992; Eastridge & Mozzoni, 2005; Martens & Collier, 2011; Twarek et al., 2010). Subsequently, similar strategies could be implemented to develop FMS fluency to promote increased levels of physical activity with preschool children. Considering the importance of FMS development on improved health and fitness, and the reduction of unhealthy weight gain, early intervention is warranted. In particular, the provision of early intervention to children at-risk for FMS development (e.g., children who are overweight, from lower SES households) could mitigate the negative health and developmental implications of poor FMS development.

The purpose of the present study was to evaluate the effects of fluency training in six gross-motor skills (i.e., jumping, hopping, kicking, running, galloping, leaping) on preschool children's levels of physical activity during free play sessions. Specifically, a multielement single-case experimental design was employed to assess the effects of fluency training on the cumulative percentage of intervals engaged in MVPA during play probes across three play contexts (i.e., outdoor toys, open space, fixed equipment), with one context serving as a no-training control (i.e., fixed equipment). Several benefits to conducting a single-case multielement experimental design include: within-subject replication to provide a strong demonstration of experimental control, the ability to examine change for each participant, a reduction in potential confounds as each participant serves as his own control, the necessity of producing robust effects to be seen amidst daily variability in MVPA, and potential clinical benefits for the participants by conducting fluency training in two skill areas.

In addition to the play probes, response-restriction assessments were conducted three times throughout the study (i.e., following baseline, following fluency training for skills relevant to the first context, and following fluency training for skills relevant to the second context) to assess participant's preference of environmental play contexts as a function of fluency training (e.g., Hanley, Iwata, Lindberg, & Conners, 2003). Finally, functional analysis conditions were conducted pre-and post-training to evaluate the effects of social positive (i.e., attention, interactive play) and nonsocial (i.e., automatic) reinforcement on MVPA.

The primary hypothesis of the study was that by increasing children's fluency in fundamental movement skills relevant to an environmental context (i.e., hop, jump, and kick were relevant to the outdoor toys context; run, gallop, and leap were relevant to the open space context), overall levels of physical activity in subsequent free-play sessions will increase in that context. Secondary hypotheses stated that participant's preference for an environmental play context will increase following fluency training in skills relevant to that context, and that maintaining consequences of MVPA will shift from social positive (i.e., interactive play and attention) to nonsocial (i.e., automatic) reinforcement following fluency training.

Method

Participants and Setting

Four typically developing, 4 year old children who attended a half-day city preschool (i.e., 8am to 1pm) in the Northeast participated. Several recruitment criteria were used for participant selection. First, the preschool teacher nominated children who engaged in low levels of physical activity and who were particularly at-risk for low levels of physical activity and increased body weight (e.g., ethnic minorities, living in low SES neighborhoods). Additionally, the teacher nominated participants who did not have any physical disabilities and did not qualify for physical or occupational therapy. Next, a brief informal observation of the proposed participants was conducted during regularly scheduled outdoor recess times to assess physical activity levels. Finally, an informed consent form (Appendix A) explaining the purposes, procedures, and potential risks of the study was sent to all legal guardians of children who met the aforementioned inclusion criteria. The children of the first four legal guardians to return consent forms were selected to participate. Prior to every session with each participant, assent (Appendix B) was obtained. Throughout the course of the study, all participants provided assent when asked by the experimenter. Jimmy, Tina, and Louise (pseudonyms) were African-American children who were normal weight and spoke English. Gene (pseudonym) was a Hispanic bilingual child who was overweight and spoke English and Spanish. Tina was classified by New York State as a preschooler with a disability and received Speech and Language services for articulation deficits. Her receptive and expressive language scores were typical as reported by a Speech and Language evaluation. The local Institutional Review Board (IRB) approved all aspects of the study. There were no adverse physical events across the course of the study.

All sessions were conducted on an outdoor playground at the preschool. The preschool had a secure playground (i.e., fenced with a clear view of the entire play area) and contained both an open play area and fixed equipment (e.g., jungle gym, bars, slide, stairs). Training sessions were conducted individually and lasted approximately 10 min. The present study aimed to assess the specific effects of fluency training on MVPA, and previous research has demonstrated that MVPA appears to be affected by group composition (e.g., Larson, Normand, Morley, & Hustyi, 2014), therefore, play probes were conducted individually and lasted 5 min.

Experimenters and Observers

The principal investigator (a female doctoral candidate in the School Psychology program) ran all preliminary assessment and training sessions. An undergraduate student was trained to code observation videos and to document procedural integrity. The undergraduate student was required to reach a 90% interobserver agreement criterion across three sessions prior to coding videos for the study. Protocols were created for the functional analyses (Appendix C), response-restriction assessments (Appendix D), play probes (Appendix E), accuracy training (Appendix F), and fluency training (Appendix G). The undergraduate student collected step-by-step integrity data on the experimenter's implementation of protocols.

Materials

Play equipment. Outdoor toys included a small trampoline, two jumping bags, two hopscotch layouts, a small basketball hoop, and six small/medium sized playground balls. The outdoor toys area also contained six adult-sized basketball hoops within the fenced-in enclosure. A jungle gym on the playground of the preschool served as the Fixed Equipment structure. The jungle gym included four areas with stairs, a slide, bars, swinging rings, and two climbing areas.

Test of Gross Motor Development – Second Edition (TGMD-2). The TGMD-2 is a commonly used standardized test that measures basic competency of gross-motor abilities across six skills involving locomotion (i.e., run, hop, gallop, leap, horizontal jump, and slide) and six skills involving object control (i.e., ball skills such as striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll; Ulrich, 2000). Each skill includes three to five observable performance criteria. Multiple performance criteria allow children to receive credit for any aspect of the movement skill they are able to perform and provide more detailed understanding of the movement patterns children use. Scoring is based on the presence (1) or absence (0) of each performance criterion, and two trials of each skill are scored. For example, scoring criteria for *hop* include: (1) foot of nonsupport leg is bent and carried in back of the body, (2) nonsupport leg swings in pendular fashion to produce force, (3) arms bent at elbows and swing forwards on take off, (4) able to hop on the right and left foot. The sum of scores for the six skills in each subtest is the raw score (i.e., ranging from 0 to 48), with a higher score indicating greater proficiency.

The TGMD-2 was normed on a representative (i.e., age, gender, region, race, rural/urban, parental education and disability) sample of 1,208 preschool and school-aged children across 10 states in the U.S. The TGMD-2 assesses gross-motor skills frequently taught to this age group (content validity), and subtest scores correlate with the Basic Motor Generalizations subtest of the Comprehensive Scales of Student Abilities (concurrent validity). Internal consistency reliability coefficients for subtest and composite scores on the TGMD-2 are all above 0.90.

Recording equipment. All functional analysis, response-restriction, and play probe sessions were recorded using a video camera and all videos were uploaded to an external hard drive immediately following sessions. Observers coded activity levels or engagement in environmental contexts from the videotapes using the DataPal program loaded onto laptop computers. All training sessions were scored on-site by at least one observer equipped with a stopwatch, clipboard, and scoring sheet (Appendices H and I).

Response Definitions and Measurement

Play probe sessions were videotaped at approximately the same time each day, and observers coded activity levels from the videotapes. The DataPal Program was used to code sessions using a 1-s continuous recording method. Broadly speaking, physical activity can be measured in two categories including indirect and direct methods. Although many indirect measures have been developed for use with older children and adolescents (e.g., activity interviews, diaries, and checklists), they should not be considered as reliable and valid measures of physical activity unless they have been rigorously assessed with the target population (Pate, O'Neill, & Mitchell, 2010).

Direct measures of physical activity include mechanical measures such as pedometers, accelerometers, and heart rate monitors. They often are used to assess the intensity, duration, or frequency of physical activity and thus can provide an estimate of calorie expenditure. Mechanical measures can provide useful information when assessing physical activity in children. In particular, triaxial accelerometry appears to provide a promising method of physical activity assessment with young children (Eston et al., 1998). However, a more comprehensive assessment of physical activity would incorporate concurrent direct observation.

Direct observation, a method of observing children and coding physical activity based on this observation, is often viewed as the "gold standard" criterion measure of assessing physical activity due to the practical and comprehensive nature of the assessment (Oliver et al., 2007). Several systems of direct observation have been developed for measuring physical activity in young children (e.g., BEACHES; McKenzie, et al., 1991; CARS; Puhl, Greaves, Hoyt, & Baranowski, 1990; FATS; Klesges, 1984; OSRAC; McIver, Brown, Pfeiffer, Dowda, & Pate, 2009; OSRAP; Trost, Sirard, Dowda, & Pfeiffer, 2003; SOFIT; McKenzie, Sallis, & Nader, 1992).

Based on the apparent intensity of physical activity, observers score the level of physical activity according to five categories that have been established to reflect levels of energy expenditure in children. Observers coding activity levels score stationary activities (e.g., lying, sitting) as a "1," stationary with movement activities (e.g., standing/coloring) as a "2," translocation at a slow/easy pace (e.g., walking on flat ground) as a "3," translocation at a moderate pace (e.g., walking uphill) as a "4," and translocation at a fast / very fast pace (e.g., running) as a "5" (e.g., McIver et al., 2009; Puhl et al., 1990). Additionally, varying durations of observe-record intervals exist for different measures (e.g., BEACHES employs a momentary time sampling procedure at 1-min intervals; FATS employs a 10-s observe, 10-s record procedure; OSRAC employs a 5-s observe, 25-s record procedure).

The Observational System for Recording Physical Activity in Children (OSRAC) activity codes were used to score the children's activity level during play probes and functional analyses using a continuous recording method (Table 1). Stationary activities (e.g., lying, sitting), and stationary with movement activities (e.g., standing/waving arms) were scored as sedentary. Translocation at a slow/easy pace (e.g., walking on flat ground) was scored as light activity. Translocation at a moderate pace (e.g., walking uphill) and translocation at a fast/very fast pace (e.g., running, jumping) were scored as MVPA (McIver et al. 2009). The OSRAC was chosen to record physical activity levels because preliminary validity evidence suggested that the OSRAC activity codes more accurately depicted physical activity levels compared with pedometer and heart rate monitors (Larson, Normand, & Hustyi, 2011). Environmental activity context was also scored during the response-restriction assessments using a continuous recording method (Table 2). The playground was separated into four distinct areas (i.e., jungle gym for the fixed equipment [FE] context, paved area for the open space [OS] context, fenced-in paved area with toys for the outdoor toys [OT] context, and table for the control context), and the environmental activity context was scored.

Three gross-motor skills relevant to the outdoor toys context (i.e., hop, jump, kick), and three gross-motor skills relevant to the open space context (i.e., run, gallop, leap), were targeted for fluency training. All six skills were selected from the list of gross-motor skills considered fundamental for children ages 3 to 10 years (Ulrich, 2000). Skills relevant to the outdoor toys context included *hop* (foot of the nonsupport leg bent and carried behind the body while the support leg bent at the knee then projected the child forward), *jump* (flexion of both knees followed by the simultaneous take off and landing of both feet), and *kick* (rapid approach to the ball, nonkicking foot placed even with or slightly behind ball, and kick with instep of preferred foot or toe). Skills relevant to the open space context included *run* (nonsupport leg bent approximately 90 degrees, arms in opposition to legs, elbows bent, and a brief period where feet were off the ground), *gallop* (a step forward with the lead foot, followed by a step with the trailing foot to a position adjacent to or behind the lead foot involving a brief period where both feet were off the ground), and *leap* (take off on one foot and land on opposite foot with a brief period where both feet were off the ground longer than running). During accuracy training, the hop, kick, and gallop skills were targeted with both the right and left leg for each child; however, during fluency training the child could choose the right or left leg, or a combination thereof.

During accuracy training, one trial included three repetitions of the target skill and observers scored the target skill as either correct or incorrect. In order for the trial to be scored as correct, all three repetitions of the target skill had to meet the target definition and occur within 1 s from the termination of the preceding behavior (e.g., the second jump had to occur within 1 s from the first jump and the third jump had to occur within 1 s from the second jump). Once the child could complete all of the observable performance criteria, fluency training began. If a child could not complete the observable performance criteria for a skill within 2 days, a new target gross-motor skill was selected. Gene was the only participant who failed to meet the observable criteria for the target skill *kick*. Subsequently, a replacement skill, *hopscotch* (flexion of both knees followed by the simultaneous take off and landing of one foot, followed by the flexion of that knee followed by the simultaneous take off and landing of both feet), was targeted due to the relevance to the OT context. During fluency training, observers recorded the frequency of correct target behavior during a 20-s period.

Preliminary Assessments

Test of Gross Motor Development- Second Edition (TGMD-2). In this study, the TGMD-2 was used to assess the children's gross motor abilities prior to training and at the conclusion of the study. The results from the pre- and post-TGMD-2 were used to assess skill acquisition as a possible explanation for increased levels of physical activity within the play probes. If pre- to post-TGMD-2 scores increased, fluency training could have increased the proficiency with which the children were able to perform fundamental movement skills and could have enabled the children to combine these skills into composite chains of increased physical activity.

Functional analysis. Skinner (1965) argued that behavior is caused by external variables and empirical demonstrations of such relationships are best termed a functional analysis. The goal of a functional analysis is to control the behavior under study and this control is asserted through the systematic manipulation of environmental events. Iwata and colleagues (1982/1994) published the first experimental procedure for assessing antecedent and consequent variables related to self-injurious behavior (SIB). Results contributed to the assessment of problem behavior by demonstrating between and within-subject variability as well as orderly relations of within-subject data (Iwata et al., 1982/1994). Throughout the past 25 years, the use of functional analysis methodologies has proven to be the most potent and effective assessment of behavior (Hanley, Iwata, & McCord, 2003). Not only has this assessment methodology become the gold standard for assessing problem behaviors such as SIB, but it also lends itself to the assessment of other socially significant behaviors such as physical activity.

The present study replicated the physical activity functional analysis methodology by Larson et al. (2013, 2014) to evaluate the effects of consequent variables (i.e., interactive play, attention, alone) on physical activity. A functional analysis was conducted prior to the start of baseline and following the third response-restriction assessment to assess the role of social and nonsocial consequences on participant's levels of MVPA (e.g., Larson et al., 2014). The results from the functional analyses were used to assess if fluency training served as a motivating operation for automatic reinforcement derived from engaging in these skills. If participant's levels of MVPA were observed to increase in the post-FA alone compared to the pre-FA alone condition, fluency training could have served as a motivating operation for automatic reinforcement for engaging in these skills. Experimental conditions were arranged according to a multielement design. Each session lasted 5 min, and four to eight sessions were conducted per day. To enhance the discriminability of the conditions, the experimenter began each session by making a statement about the contingencies in place. Additionally, each condition began in a specific location on the playground. One experimenter and one data collector were always present on the playground, except during the alone condition when only the data collector was present.

In the *interactive play* condition, the experimenter guided the participant to the playground and stated, "If you run, jump, or climb, I'll play with you, but if you don't, I have some work to do." Contingent on MVPA, the experimenter engaged in the activity with the participant for as long as he/she continued to engage in MVPA. When the participant stopped engaging in MVPA, the experimenter walked away from the participant and pretended to "be busy." The interactive play condition assessed whether MVPA was sensitive to social positive reinforcement in the form of adult engagement.

In the *attention* condition, the experimenter guided the participant to the playground and stated, "If you run, jump, or climb, I'll watch you and I'll talk to you, but if you don't, I have some work to do." Contingent on MVPA, the experimenter made eye contact and delivered brief specific praise (e.g., "I like how you're jumping!") If the participant continued to engage in MVPA, statements of praise were delivered every 10s. When the participant stopped engaging in MVPA, the experimenter pretended to "be busy." The attention condition assessed whether MVPA was sensitive to social positive reinforcement in the form of adult attention.

In the *alone* condition, the experimenter guided the participant to the playground and stated, "I have to go inside and do some work. Play out here for a little bit." The experimenter then walked away from the play area. The experimenter remained out of sight; however, the data collector remained on the playground to ensure the participant's safety. No attention or consequences were delivered. The alone condition assessed whether MVPA was sensitive to automatic reinforcement (i.e., reinforcement that was not socially mediated but resulted simply from the child's play behavior within the activity context).

Finally, in the *control* condition, the experimenter guided the participant to a table and stated, "Let's color." Sessions were conducted at a table in the play area. No prompts for activity were provided, the experimenter engaged in the activity with the participant, and attention in the form of praise was delivered approximately every 30s. There were no programmed consequences for MVPA. This condition served as a control for the social variables in the other conditions.

Response-restriction assessment. Response-restriction (RR) assessments were conducted three times throughout the study (i.e., following baseline, following fluency training for skills relevant to the first context, and following fluency training for skills relevant to the second context) to assess participant's preference of environmental play contexts as a function of fluency training. The results from the response-restriction assessments were used to assess a value-altering effect as a motivating operation. If preference for a context increased following training within that context it could be hypothesized that fluency training increased the reinforcing properties of the context, thereby increasing the participant's preference for engaging in activities within that context. In general, two broad categories of direct methods have been developed for assessing an individual's preference. First, stimuli are presented to the individual (i.e., singly, in pairs, or in grouped arrays) and approach behavior is objectively measured. Second, all stimuli are simultaneously available to the individual and item manipulation is measured. However, both trial-based and free-operant preference assessments have limitations. Trial-based preference assessments permit only limited access to the stimulus chosen on a given trial, and free-operant assessments permit exclusive interaction with one item, and may not yield a hierarchy of preference. Consequently, response-restriction assessments are a combination of trial-based and free-operant preference assessments that attempt to alleviate the problems associated with each respective assessment. Within response-restriction assessments, an individual is provided with an initial free-operant choice. Subsequently, the assessment is repeated after removing the most preferred activity from the pool of available items. Response allocation is measured among several concurrently available activities and responding is progressively restricted to fewer and fewer options (Hanley, Iwata, Lindberg, & Conners, 2003).

At the beginning of each response-restriction session, the experimenter asked the participant to play in one, all, or none of the play contexts. During the session, no prompts or consequences were delivered, and the participant was free to engage in play in all of the contexts. Sessions were 5-min in duration and four to eight sessions were conducted per day. Activity contexts were restricted when the participant engaged in the context for 60% or more of intervals across two consecutive 5-min sessions. An activity context was also removed if engagement occurred for 60% or more of intervals in two of three sessions and no other activity context was engaged in for 60% or more of intervals in those same sessions. Sessions continued until a hierarchy of activity context preference was attained.

Experimental Design and Procedures

The effects of gross-motor fluency training on the cumulative percentage of intervals engaged in MVPA during play probes were evaluated using a multielement design (Barlow & Hayes, 1979; Sidman, 1960). Multielement designs are single-subject experimental designs used to compare the effects of two or more conditions, alternated in rapid succession. Within a multielement design, treatments are alternated across sessions, with several conditions conducted on the same day. Data are graphed and are visually inspected to assess differential responding across conditions. Often, salient cues are associated with particular conditions to aide in discrimination and to decrease the probability of carry-over effects. However, multielement experimental designs are limited in the possibility of undifferentiated results due to carry-over effects from multiple treatment interference. Nevertheless, multielement experimental designs can be completed quickly, do not require the withdrawal of treatment, minimize irreversibility problems and sequence effects, and can be used with unstable data.

Physical activity data are often highly variable (cf. Valbuena, Miller, Samaha, & Miltenberger, 2017) and young children engage in short bouts of physical activity (Larson et al., 2013). As such, the play probe data were assessed on a cumulative record to allow for a more fine-grained analysis of training effects. Sessions were presented along the x-axis and the cumulative percentage of MVPA was along the y-axis. The cumulative percentage of MVPA was calculated by adding the percentage of MVPA for a particular session to the previous total. Therefore, the steeper the slope, the higher the level of MVPA within that context. The data were assessed via visual inspection and by calculating ordinary least-squares trend lines per context and phase. The slopes of the lines were compared both across and within contexts and phases.

Play probes. Five-min play probes were conducted in the OT, OS, and FE contexts in a multielement design. The order of play probes was randomized so as to mitigate any possible order effects. For all play probes, the child was guided to the designated area on the playground. The experimenter then prompted the child to "play with the toys" (OT), "play in the open area" (OS), or "play on the jungle gym" (FE), and activated the video recorder. If a child attempted to leave the session area, the experimenter guided him/her back to the session area. All play probes lasted 5 min after which the experimenter thanked the participant for playing nicely and turned off the video recorder. Two to six probes were conducted per day and the cumulative percentage of MVPA was graphed across sessions.

Training sessions. Training was described to each child using themes from the Olympic games and consisted of "training sessions" and "time trials". Training sessions for skills relevant to the OT and OS contexts were conducted within the OT and OS areas, respectively. Training focused on first increasing accuracy and then fluency of all skills targeted in that context.

Accuracy training consisted of modeling by the experimenter followed by attempts to execute the skill by the child with gestural prompting as needed (e.g., "place both feet side by side, here and here") and corrective feedback. Once the child could complete three consecutive repetitions of the skill with 100% accuracy, training continued with the next two skills in the set. Once the accuracy criteria were met for all three skills, sessions focused on fluency building or "time trials".

During the fluency portion of training, the child was told, "Now that you can (skill) the right way, it's time to start time trials like in the Olympics!" To establish an initial fluency level in each skill, the child was instructed to "perform the skill as quickly as she could and still do it right every time" for 20 s. The child was then told to "beat your score" on subsequent time trials. After each session, the number of gross-motor skills was written on a sticker and the child was prompted to place the sticker on a graph. Once the fluency criterion was met, the child was given a certificate to take home that stated, "Today I (activity and number of repetitions)!" If the child stopped engaging in the target behavior, or began to incorrectly complete the target behavior, he/she was prompted by the experimenter to "start again and do it the way we practiced last time." Time trials for all three skills were conducted in random order with four to eight sessions conducted per day. When fluency levels stabilized in the three skills (i.e., increased by less than 10% on two consecutive time trials), a response-restriction assessment was conducted. Following completion of the response-restriction assessment, training sessions resumed for the next skill set in an identical manner to those of the first skill set.

Interobserver Agreement and Implementation Integrity

Exact interobserver agreement (IOA) was collected on MVPA during the play probes and functional analysis sessions for 33% of sessions for each child. An agreement was defined as both observers scoring MVPA in the same 1-s interval. IOA was calculated by dividing the number of intervals of agreement by the total number of intervals in the session and multiplying by 100%. The mean agreement across children during the play probes was 96% (range 93 – 99%). The mean agreement across children during the functional analysis sessions was 93% (range 90 – 95%).

Exact interobserver agreement (IOA) was collected on engagement with each activity context during the response-restriction assessments for 34 - 36% of sessions for each child. An agreement was defined as both observers scoring an activity context in the same 1-s interval. IOA was calculated by dividing the number of intervals of agreement by the total number of intervals in the session and multiplying by 100%. The mean agreement across children during the response-restriction sessions was 98% (range 98 – 99%).

IOA was also calculated during fluency training for 50 - 54% of trials for each child. IOA was calculated by dividing the smaller number of gross-motor skills scored by the larger number of gross-motor skills scored and multiplying by 100%. The mean agreement across children during the fluency trials was 97% (range 95 – 98%).

Finally, IOA was calculated for the TGMD-2 for 50% of assessment sessions across children. IOA was calculated by dividing the number of performance criterion agreements by the total number of criterion and multiplying by 100%. The mean agreement across children during the TGMD-2 assessment was 93% (range 91 – 93%).

A step-by-step integrity protocol was used for integrity checks across all preliminary and experimental sessions. The mean correct implementation was 100%.

Results

Play Probes

For all four participants, the play probe data (Figure 1, Table 3) indicated that the slope of the cumulative percentage of MVPA within the OT context increased during training of skills relevant to the OT context compared to baseline. Similarly, for all four participants, during training of skills relevant to the OS context, the steepness of the OS slope increased compared to both the baseline and OT training phases. The slope of the FE context (i.e., the no-training control) remained relatively stable (Tina) or decreased (Jimmy, Louise, Gene) across phases for all four participants. Although the slopes of the OT and OS contexts increased during respective training for all four participants, the degree of change was less pronounced, or occurred more gradually, for some participants. For example, results from Jimmy's play probes indicated that the slope of MVPA within the OT context increased from baseline immediately upon OT skills training, but the increased slope of MVPA within the OS context was more delayed upon OS skills training. Comparatively, for Gene, the MVPA slope remained stable upon training skills relevant to the OT context across the first three OT play probes, before demonstrating an increase in MVPA, and the MVPA slope gradually increased within the OS context upon training OS skills.

Response Restriction Assessments

The response-restriction assessment results are presented in Table 4. As shown in the table, preference for the OT context increased following OT skills fluency training and preference for the OS context increased following OS skills fluency training for Jimmy, Tina, and Louise. However, Gene's preference for the OT and OS contexts decreased following respective OT and OS training. A paired-samples t-test was conducted to compare preferences for the OT and OS contexts pre- to post-training. When data for Gene were omitted (because he was shown to be a non-responder) results from the 2-tailed paired samples t-test indicated that there was a significant difference in the pre-RR (M=21.3, SD=13.8) and post-RR (M=47.7, SD=10.3) results ($t[5]=5.95$, $p = 0.002$).

During the first RR assessment, conducted following baseline, Jimmy's most preferred activity context was Control, and his second-preferred activity context was FE. During the second RR, conducted following OT skills fluency training, Jimmy's highest preferred activity context was OT. During the third RR, conducted following OS skills fluency training, Jimmy's highest preferred activity context was Control followed by an increase in preference for the OS context.

Results from Tina's first RR indicated a preference towards the Control context, followed by the FE, OT, and OS contexts. During the second RR, Tina's most preferred context was FE, however, her preference for the OT context increased. During the final RR, Tina's most preferred activity context remained FE, and her second-preferred activity context remained OT; however, her preference towards the OS context increased and her preference towards the Control context remained low.

Results from Louise's RR suggested that during the first RR, she demonstrated a preference towards the FE context, followed by the OT, Control, and OS contexts. During the second RR, her highest preferred activity context remained FE, and her preference towards the OT context increased. During the final RR, Louise's highest preferred activity context was OT, followed by FE; however, there was an increase in her preference towards the OS context and a decrease in her preference towards the Control context.

Finally, results from Gene's RR indicated that during the first RR, his most preferred activity contexts were FE and OT, followed by Control and OS. During the second RR, his first-preferred activity context was FE followed by Control. His two least preferred activity contexts were OT and OS. During the final RR, Gene's most preferred activity context remained FE, and his second-preferred activity context was Control. His least preferred activity contexts remained OT and OS.

Functional Analyses

Results from the pre- and post-functional analyses (FA) suggested that the highest levels of MVPA were observed within the interactive play and attention conditions for all four participants (Table 5). However, results for Jimmy and Tina suggested that the overall percentage of MVPA within the alone condition increased from the pre- to the post-FA.

The functional analysis (FA) data for all participants are depicted in Figure 2. For Jimmy, results from the pre-FA indicated that the interactive play condition produced the most MVPA. Levels of MVPA were moderate within the attention condition, and low in the alone condition. Results from the post-FA demonstrated similarly high levels of MVPA within the interactive play condition and a slightly lower overall level of MVPA in the post-attention condition compared to the pre-FA. The overall level of MVPA in the post-FA alone condition averaged 14% of intervals compared to the pre-FA alone condition that averaged 2% of intervals.

For Tina, during the pre-FA, MVPA was roughly equivalent during the interactive play and attention conditions, with low levels of responding within the alone condition. The post-FA data suggested high levels of MVPA in the interactive play condition and lower levels of MVPA in the attention compared to the pre-FA data. The overall level of MVPA in the post-FA alone condition averaged 21% of intervals and was on an increasing trend compared to the pre-FA alone condition that averaged 14% of intervals.

The pre- and post-FA data for Louise indicated that the attention and interactive play conditions produced the highest levels of MVPA, with lower responding in the post- compared to the pre-attention condition. The level of MVPA within the alone condition remained relatively consistent averaging 17% of intervals in the pre-FA and 18% of intervals in the post-FA.

For Gene, results from the pre-FA indicated that MVPA was higher in the interactive play and attention conditions, while the post-FA results were less clear. Results from the post-FA indicated lower levels of MVPA across conditions compared to the pre-FA, with undifferentiated results. Although the overall level of MVPA in the pre-FA alone condition averaged 18% of intervals compared to 14% in the post-FA alone condition, an increasing trend in the post-FA alone condition was observed.

Gross-Motor Skills

Finally, results from the pre- and post-TGMD-2 suggested increased gross-motor competency across all participants (Table 6). Prior to intervention, Jimmy's overall Gross Motor Quotient was 91 (27^{th} percentile). During the post-intervention TGMD-2 assessment, Jimmy's Gross Motor Quotient increased to 109 (73^{rd} percentile). For Tina, her pre-Gross Motor Quotient was 100 (50^{th} percentile) and her post-Gross Motor Quotient was 115 (84^{th} percentile). Louise's pre- Gross Motor Quotient was 91 (27^{th} percentile) and her post-Gross Motor Quotient was 109 (73^{rd} percentile). Lastly, Gene's pre-Gross Motor Quotient was 76 (5^{th} percentile) and his post-Gross Motor Quotient was 85 (16^{th} percentile).

Discussion

The primary purpose of the present study was to evaluate the effects of fluency training in six gross-motor skills (i.e., jumping, hopping, kicking, running, galloping, leaping) on preschool children's levels of physical activity during free play sessions. Specifically, hypotheses stated that a) by increasing children's fluency in fundamental movement skills relevant to an environmental context (i.e., hop, jump, and kick were relevant to the outdoor toys context; run, gallop, and leap were relevant to the open space context), overall levels of physical activity in subsequent free-play sessions would increase in that context, b) participant's preference for an environmental play context would increase following fluency training in skills relevant to that context, and c) that maintaining consequences of MVPA would shift from social positive (i.e., interactive play and attention) to nonsocial (i.e., automatic) reinforcement following fluency training.

With respect to the first hypothesis, results suggested that training skills relevant to the OT context (i.e., jump, hop, kick), increased levels of MVPA in the OT context for all four participants. Similarly, for all four participants, levels of MVPA increased in the OS context following fluency training of skills relevant to the OS context (i.e., run, gallop, leap).

In regards to the effects of fluency training on children's preferences for play contexts, results indicated that for three of four participants (Jimmy, Tina, and Louise), preference increased for the OT and OS contexts following fluency training. However, for Gene, his preference for both the OT and OS contexts decreased following fluency training.

The effects of social positive (i.e., attention, interactive play) and nonsocial (i.e., automatic) reinforcement on MVPA were also assessed via pre- and post-FAs. Overall, results from the pre- and post-FAs across all four participants were consistent with previous research indicating that the highest levels of MVPA were observed within the interactive play and attention conditions (e.g., Larson et al., 2013, 2014). These results suggest that the reinforcement for higher levels of physical activity were socially mediated. However, results from the present study suggested that for Jimmy and Tina, the overall percentage of MVPA within the alone condition increased from the pre- to the post-FA.

Finally, supplementary results from the pre- and post-TGMD-2 also suggested that overall gross-motor competency increased for all participants. Although only six of the twelve skills from the TGMD-2 were trained to fluency, the post- Gross Motor Quotient indicated substantial improvement in the participant's gross-motor skills. Direct instruction, feedback, and repeated practice opportunities, increased gross-motor proficiency, thereby increasing the likelihood that the participant's would participate in physical activities to improve fitness and reduce the risk of unhealthy weight gain. This finding is important and suggests that brief fluency training can enhance children's developmental levels of gross-motor skills. These findings also suggest that even incidental training in FMS may be beneficial for increasing physical activity in young children.

There are several explanations for why fluency training in fundamental movement skills relevant to each play context increased children's overall levels of physical activity in that context. First, fluency training likely increased the proficiency with which children were able to perform fundamental movement skills. This explanation is supported for all four participants by results of the TGMD-2, which indicated that the Gross Motor Quotient increased from pre- to post-assessment. The increased scores suggested that the children had a higher basic gross-motor competency following fluency training, which likely enabled them to more readily complete fundamental movement skills during free-play. Relatedly, training gross-motor component skills to fluency could have enabled the children to combine these skills into composite chains of increased physical activity.

Second, by increasing proficiency, and thereby decreasing the response effort for skill performance, fluency training could have served as a motivating operation for reinforcement derived from engaging in these skills. This explanation implicates both response effort as a motivating operation for the value of reinforcement derived from vigorous play and the role of automatic reinforcement in supporting children's play behavior. That is, fluency training likely decreased the response effort, thereby increasing engagement in fundamental movement skills (i.e., behavior-altering effect), and increased the value of automatic reinforcement (i.e., value-altering effect). These explanations are supported for two of the four participants (Jimmy and Tina) by results of the pre- and post-functional analyses. For Jimmy and Tina, the average percentage of MVPA in the alone condition increased from the pre- to the post-FA providing further support that fluency training may have served as a motivating operation for reinforcement to engage in higher levels of physical activity. Although levels of MVPA remained higher within socially mediated conditions (i.e., interactive play and attention) during the pre- and post-FAs, the increased average percentage of MVPA within the alone condition for these participants suggest a possible motivating operation for reinforcement derived from engaging in higher levels of physical activity. It is possible that across time and repeated practice, reinforcement for higher levels of physical activity could continue to shift from socially mediated to automatically maintained reinforcement.

Third, training gross-motor skills that were directly relevant to play activities in certain contexts (e.g., hopping related to the hop scotch layout in the outdoor toys context) may have facilitated their generalization from training to play probes. This explanation is supported for all four participants by results of the play probes. When skills relevant to the OT context were trained, there was an increase in the slope of MVPA within the OT context, but not within the FE and OS contexts. These data suggest that the skills trained relevant to the OT context likely generalized to play within the OT context. Similarly, when OS skills were trained, there was an increase in the slope of MVPA within the OS context, but not within the FE context. Again, these results suggest that the OS skills likely generalized to play within the OS context.

Additionally, results from the response restriction assessments suggest that for three of our participants (Jimmy, Tina, and Louise), fluency training may have functioned as a motivating operation by producing a value-altering effect. Specifically, it could be hypothesized that fluency training increased the reinforcing properties of the OT and OS contexts, thereby increasing the participant's preference for engaging in activities within those contexts. However, for Gene, it is possible that fluency training functioned as an abolishing operation decreasing the reinforcing properties of both the OT and OS contexts. The response restriction results provide further support for the potential utility of fluency training with young children. Although fluency training demonstrated that participants were more active within the OT and OS contexts following training, a more thorough analysis including the response restriction assessments demonstrated that they were also more likely to choose those contexts following training. Combined, these results suggest that children may choose contexts that are more likely to evoke higher levels of physical activity following fluency training for skills relevant to those contexts.

The participants in the current study assented to participate across 100% of sessions. Furthermore, Jimmy, Tina, and Louise also anecdotally requested time trials across sessions in which other assessments (i.e., functional analyses, response-restriction, TGMD-2) were conducted. The participant's consistent assent and requests for fluency training suggest preference for the intervention and provide further potential clinical utility for gross-motor fluency training.

Taken together, these data suggest that training gross-motor skills to a fluency criterion may be a practical and efficient way to encourage increased levels of MVPA in preschool children. As the sedentary academic requirements within school settings continue to increase, constraints are often placed on potential active periods of the school day (i.e., recess, lunch, physical education). Therefore, finding effective and efficient interventions to increase overall physical activity levels is paramount. The duration of the current intervention was significantly less time-intensive than the interventions designed to improve motor development in young children reported by Riethmuller and colleagues (2009), which ranged from 5 – 40 hr. The total duration of the fluency training intervention ranged from 13-17 minutes across participants. Additionally, the intervention was inexpensive, required few materials, and was easy to implement within school constraints. The materials used for gross-motor fluency training were all readily found within the school setting. The procedures for fluency training were also simple and involved few steps. It is feasible that teachers could be trained via consultation to implement fluency-training procedures. Based on results from the current study, the addition of brief gross-motor fluency training could increase children's ability to engage in higher levels of physical activity during presented opportunities to be active.

Gross-motor fluency training also aligns with current conceptual and theoretical approaches to increasing physical activity in young children. Specifically, gross-motor fluency training aligns with learning theories suggesting that the modification of component behaviors (i.e., through instruction, feedback, and repeated practice) results in the development of new, complex-motor chains. Furthermore, gross-motor fluency training could be conceptualized within a social-ecological framework with the interaction of personal (e.g., gross-motor competency), social (e.g., feedback), and environmental factors (e.g., physical activity context) determining behavior. Finally, the social-cognitive approach suggests that personal (e.g., age, self-efficacy), behavioral, and environmental (e.g., modeling, feedback, context) factors are reciprocally influential in determining behavior and behavior change.

Although training skills relevant to the OT and OS contexts increased levels of MVPA in each respective context following training for all participants, the results for Gene varied compared to the other participants. Overall, Gene's levels of MVPA did not increase to levels comparable to other participants, his preference towards the OT and OS contexts decreased following training, reinforcement for MVPA appeared to remain socially mediated, and gross-motor competency increased the fewest standard scores and remained at the low-end of the Average range following intervention. There are several hypotheses for Gene's results. First, Gene was the only participant classified as overweight. Second, Gene's pre-Gross-Motor Quotient score was substantially lower than those from other participants. Gene was not classified as a preschooler with a disability and was not receiving any additional services, but it is possible that he could have qualified for Physical Therapy (PT) based on his low pre-Gross-Motor Quotient score. Gene was also the only participant who failed to meet the observable criteria for a target skill (i.e., *kick)*, and required the instruction of a replacement skill (i.e., *hopscotch*). The inability to meet the observable criteria for kick may also lend support to the possibility that Gene could have qualified for PT services. Despite reaching our fluency criterion, it is possible that Gene may have required a longer, or more intensive, intervention to produce results commensurate to those of our other participants.

Regardless of the positive results and implications from the current study, a number of areas warrant further investigation. First, due to the novelty of this intervention, 20-s time trials were arbitrarily chosen due to the seemingly appropriate duration for young children. Future research could assess modifications to the duration of time trials. Second, six fundamental gross motor skills that appeared most relevant to the OT and OS contexts were trained; however, anecdotal observations suggested that certain skills (i.e., jump, kick, run) were more readily generalized during the play probe sessions. It is possible that training fewer, or perhaps different, fundamental movement skills could alter results. Third, the intervention contained several components including practice, verbal, and visual feedback, and it is unknown if certain components of the intervention were more effective than others. Fourth, the current study assessed immediate changes in levels of physical activity across participants; however, maintenance probes were not completed due to time constraints. Future research should continue to evaluate any potential long-standing changes in levels of physical activity. Next, all participants were first exposed to training skills relevant to the OT context, followed by skills relevant to the OS context. This decision was made so as to decrease the probability of losing experimental control by first training skills that could be generalized to all contexts (e.g., run). Future research should assess any potential order effects of training. Finally, there were certain aspects of the outdoor environment that were beyond experimental control (e.g., weather, birds, insects, people).

Low levels of physical activity in young children are an increasing concern considering physical inactivity tracks from childhood to adulthood (Dietz, 1998; Janz, Burns, & Levi, 2005; Jones, Hinkley, Okely, & Salmon, 2013; Mikkila, Rasanen, Raitakari, Pietinen, & Viikari, 2005). Therefore, establishing recommended levels of physical activity during the early years is likely to impact overall health across the lifespan. Considering that many children appear to lack basic Fundamental Movement Skill proficiency (Erwin & Castelli, 2008; Okely & Booth, 2004), interventions aimed at increasing Fundamental Movement Skill proficiency in young children have potential health implications. The ability to intervene quickly and effectively is crucial considering the limitations and expectations for increased sedentary academic time within current school systems. Gross-motor fluency training represents a promising strategy to encourage and promote the development of Fundamental Movement Skills to improve overall fitness levels, thereby increasing health and well-being, and establishing a foundation for an active lifestyle.

Table 1
Activity Level Codes specified by McIver et al. (2009)

Level	Activity	Operational Definition
1	Stationary or motionless	Stationary or motionless with no major limb movements or major joint movement (e.g., sleeping, standing, riding passively in a wagon)
2	Stationary with limb or trunk movements	Stationary with easy movements of limb(s) or trunk without translocation (e.g., standing up, holding a moderately heavy object, hanging off of bars)
3	Slow, easy movements	Translocation at a slow and easy pace (e.g., walking with translocation of both feet, slow and easy cycling, swinging without assistance and without leg kicks)
4	Moderate movements	Translocation at a moderate pace (e.g., walking uphill, two repetitions of skipping or jumping, climbing on monkey bars, hanging from bar with legs swinging)
5	Fast movements	Translocation at a fast or very fast pace (e.g., running)

Note. Adapted from "Assessing Children's Physical Activity in their Homes: The Observational System for Recording Physical Activity in Children-Home" by K. L. McIver, W. H. Brown, K. A. Pfeiffer, M. Dowda, and R. R. Pate, 2009, *Journal of Applied Behavior Analysis, 42(1)* 1-16.

Table 2
Activity Context Codes specified by McIver et al. (2009)

Outdoor Activity Context	Operational Definition
Fixed equipment	Engaging in activity on, under, or around fixed playground equipment
Open Space	Engaging in activity in an open outdoor space
Outdoor Toys	Engaging in activity in an open outdoor space with objects used for gross motor activities (e.g., jumping bag, small trampoline, hopscotch layout, basketball hoop, small/medium sized playground balls)
Control	Engaging in activities not anticipated to evoke high levels of physical activity at a table (e.g., coloring)

Note. Adapted from "Assessing Children's Physical Activity in their Homes: The Observational System for Recording Physical Activity in Children-Home" by K. L. McIver, W. H. Brown, K. A. Pfeiffer, M. Dowda, and R. R. Pate, 2009, *Journal of Applied Behavior Analysis, 42(1)* 1-16.

Table 3

Play probe slopes for Jimmy, Tina, Louise, and Gene across Baseline, OT fluency training, and OS fluency training phases

	Context	Baseline Slope	OT Fluency Training Slope	OS Fluency Training Slope
Jimmy	FE	2.19	1.52	1.09
	OT	2.85	11.17	7.11
	OS	0	0.25	4.90
Tina	FE	1.44	4.83	1.63
	OT	7.25	10.90	7.96
	OS	2.63	0.18	3.43
Louise	FE	9.24	5.53	3.12
	OT	5.77	9.17	8.66
	OS	1.96	0.29	3.46
Gene	FE	2.52	2.00	1.92
	OT	2.50	4.88	5.42
	OS	0	0.14	0.47

Table 4
Mean percentage engagement for Jimmy, Tina, Louise, and Gene across pre-, mid-, and post-Response Restrictions

		Pre Response-Restriction	Mid Response-Restriction	Post Response-Restriction
	Context	Mean % Engagement	Mean % Engagement	Mean % Engagement
Jimmy	Control	49	49	97
	FE	46	0	31
	OT	24	57	1
	OS	16	32	51
Tina	Control	60	0	8
	FE	51	63	97
	OT	27	58	38
	OS	4	28	36
Louise	Control	33	32	9
	FE	47	99	46
	OT	43	50	64
	OS	14	1	34
Gene	Control	32	40	48
	FE	41	66	65
	OT	41	33	25
	OS	12	15	6

Table 5

Mean percentage MVPA for Jimmy, Tina, Louise, and Gene across pre- and post-Functional Analyses

		Pre-Functional Analysis	Post-Functional Analysis
	Condition	Mean % MVPA	Mean % MVPA
Jimmy	Attention	38	26
	Interactive Play	70	70
	Alone	2	14
	Control	0	0
Tina	Attention	33	21
	Interactive Play	36	44
	Alone	14	21
	Control	0	0
Louise	Attention	50	18
	Interactive Play	41	33
	Alone	17	18
	Control	0	0
Gene	Attention	26	12
	Interactive Play	32	20
	Alone	18	14
	Control	0	0

Table 6
Pre- and post-TGMD-2 results for Jimmy, Tina, Louise, and Gene

	Pre TGMD-2		Post TGMD-2	
	Gross Motor Quotient	Percentile	Gross Motor Quotient	Percentile
Jimmy	91	27th	109	73rd
Tina	100	50th	115	84th
Louise	91	27th	109	73rd
Gene	76	5th	85	16th

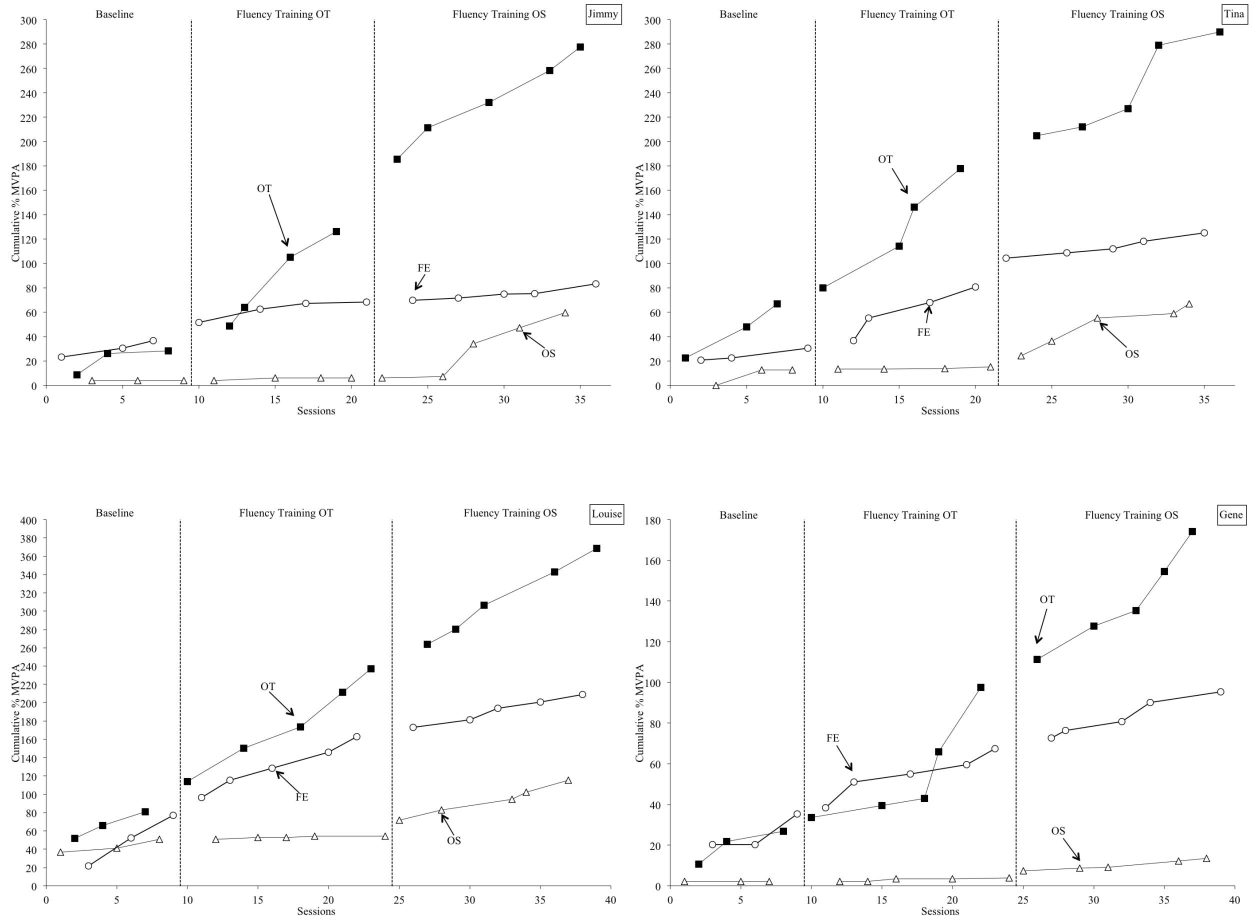

Figure 1. Cumulative percentage of MVPA during play probes for Jimmy (top left panel), Tina (top right panel), Louise (bottom left panel), and Gene (bottom right panel).

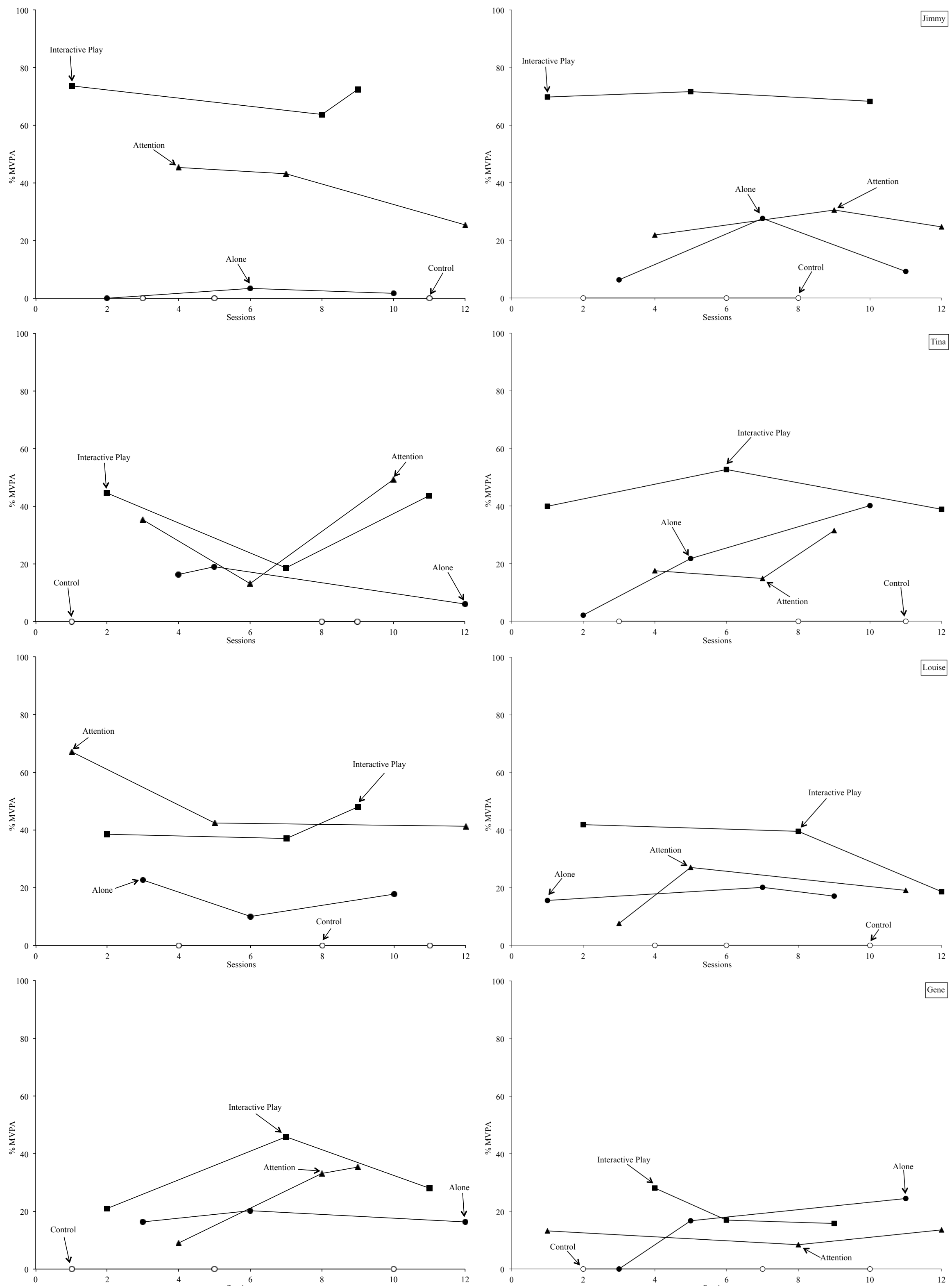

Figure 2. Percentage of MVPA across conditions during pre- (left panel) and post-Functional Analyses (right panel) for Jimmy (top row), Tina (second row), Louise (third row), and Gene (fourth row).

Appendix A
Informed Consent Document

Dear Parent or Guardian:

My name is Ms. Allison Morley and I am a Doctoral Candidate at Syracuse University. I am inviting your child to participate in a research project being conducted at ______________ by myself and under the supervision of my advisor, Dr. Brian Martens. The project is titled, "The Effects of Gross-Motor Fluency Training on Physical Activity Levels in Young Children".

Your child might benefit from participating in a study looking at a way to increase children's levels of activity during outdoor playtimes. Participation in this project is voluntary; therefore you may choose whether or not you would like your child to participate in this project. Below is a description of what the project is about. If, after reading the description or at any time during the course of the study, you have any questions, concerns, or complaints about the research, please feel free to contact me at 315-446-3220. If you have questions about your rights as a participant or other questions, concerns, or complaints that you wish to direct to someone other than me or if you cannot reach me, please contact the Syracuse University Office of Research Integrity and Protections at 315-443-3013.

We are interested in assessing the effects of having children practice basic motor skills like hopping, running, and kicking a ball on their choice to play more actively during playtime. Our hypothesis is that helping children to be good at these specific motor activities will encourage them to choose activities that involve these skills during play time, thereby increasing their overall levels of activity. Prior to practicing the skills, the experimenters will assess your child's level of activity during playtime in three contexts (Outdoor Toys, Open Space, and Fixed Equipment) at the preschool. Next, your child will practice three motor skills associated with the Outdoor Toys context (hop, jump, and kick). Your child will then practice three motor skills associated with the Open Space context (run, gallop, and leap). The levels of active play during play probes in the three contexts will be continuously measured throughout training. Additionally, your child's preference for the three activity contexts will be assessed throughout the study by measuring the duration of time he/she spends in each context. Ms. Morley will work with your child on the outdoor playground under teacher supervision, 3-5 days per week, and the study will take about 6 weeks to complete. Each session is expected to last no more than 10 minutes. During practice sessions, Ms. Morley will track your child's progress as he/she practices each skill and send a note home celebrating your child's accomplishments.

Play probes will be video recorded to collect information on your child's activity level. Research assistants involved in the study will be the only people to view the video recordings and all video recordings will be erased upon completion of the study. Your child's name and identifying information will only appear on this consent document and will not appear on any of the data collected in connection with the study. All data collected on your child will be stored in a locked cabinet in my office until the study is complete, at which point they will be destroyed.

This study may provide information about how to increase your child's level of physical activity. By participating, your child will be encouraged to play actively which may improve his/her overall health. The potential risk of your child's participation is possible frustration or anxiety when learning new motor skills that he/she cannot currently do. If your child becomes upset, the session will be ended. Your child will also be asked to perform specific motor tasks during training, and there is always the possibility of injury when engaging in physical activities; however, your child's safety is our top priority. To reduce any potential risks, sessions will be brief, your child will always be praised for working hard and following directions, and all sessions will occur in the preschool's outdoor play area under supervision of the preschool teaching staff.

If, at any time, you or your child no longer wishes to participate, you have the right to withdraw from the project at any time without hurting your relationship with _________________________ or Syracuse University. Thank you for considering my request.

Sincerely,
Allison J. Morley, M.A. BCBA
Doctoral Candidate
Syracuse University

After reading the above, I give permission for my child, __________________________________ to participate in the research project, and to have my child's data (with identifying information removed) used for research purposes at Syracuse University. I have received a copy of this document for my records.

______________________________	__________________________	___________
Printed Name of Parent/Guardian	Signature of Parent/Guardian	Date

______________________________	___________
Allison J. Morley, M.A, BCBA	Date

______________________________	___________
Brian K. Martens, Ph.D.	Date

Appendix B
Student Assent Statement

1. Read the following information to the student during the first session:

"Hello, my name is Allison Morley. Your parents and teachers said that it is okay if I work with you today. I am doing a research project at my college to find out how to help kids be more active when they are playing outside. I will be here for the next 6 weeks. When I am here, I will work with you when it is time to play outside. Sometimes, you will just play outside, sometimes you will get to put a sticker on a chart with the number of skills you did, and sometimes you will get to take a certificate home. I will not tell anyone how you do when we are working together and you can stop working with me whenever you want."

2. Ask the student the following question:

"Do you have any questions?"

3. Read the following instructions to the student the first and each subsequent session:

"Although your parents said it is okay that I work with you, I want to make sure that it is okay with you. Would you like to work with me today?"

4. Please document the student's response and the date assent was obtained.

	Student's response			Student's response	
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N
Date_________	Y	N	Date_______	Y	N

Signature: ____________________________________
(Researcher's Signature)

Appendix C

Functional Analysis Integrity Protocol

Interactive Play Condition

- ☐ Data collector turns on the video camera and states the session number (e.g., "This is Interactive Play, session 1.")
- ☐ Experimenter guides the child to the playground and states, "If you run, jump, or climb, I'll play with you, but if you don't, I have some work to do."
- ☐ Data collector counts down the session (i.e., "Session start in 3, 2, 1), while simultaneously starting a stopwatch.
- ☐ Contingent on MVPA, the experimenter engages in the activity with the participant for as long as he/she continues to engage in MVPA.
- ☐ When the participant stops engaging in MVPA, the experimenter walks away from the participant and pretends to "be busy."
- ☐ At the end of 5 min, the experimenter ends the session.
- ☐ Experimenter begins the next session or returns the child to the preschool.

Attention Condition

- ☐ Data collector turns on the video camera and states the session number (e.g., "This is Attention, session 2.")
- ☐ Experimenter guides the child to the playground and states, "If you run, jump, or climb, I'll watch you and I'll talk to you, but if you don't, I have some work to do."
- ☐ Data collector counts down the session (i.e., "Session start in 3, 2, 1), while simultaneously starting a stopwatch.
- ☐ Contingent on MVPA, the experimenter makes eye contact and delivers brief specific praise (e.g., "I like how you're jumping!") If the participant continues to engage in MVPA, statements of praise will be delivered every 10s.
- ☐ When the participant stops engaging in MVPA, the experimenter walks away from the participant and pretends to "be busy."
- ☐ At the end of 5 min, the experimenter ends the session.
- ☐ Experimenter begins the next session or returns the child to the preschool.

Alone Condition

- ☐ Data collector turns on the video camera and states the session number (e.g., "This is Alone, session 3.")
- ☐ Experimenter guides the child to the playground and states, "I have to go inside and do some work. Play out here for a little bit."
- ☐ Experimenter walks away from the session area & remains out of sight as much as possible.
- ☐ Data collector counts down the session (i.e., "Session start in 3, 2, 1), while simultaneously starting a stopwatch.
- ☐ At the end of 5 min, the experimenter ends the session.
- ☐ Experimenter begins the next session or returns the child to the preschool.

Control Condition

- ☐ Data collector turns on the video camera and states the session number (e.g., "This is Control, session 4.")
- ☐ Experimenter guides the child to a table states, "Let's color."
- ☐ Data collector counts down the session (i.e., "Session start in 3, 2, 1), while simultaneously starting a stopwatch.
- ☐ No prompts for activity are provided, the experimenter engages in the activity with the participant, and attention in the form of praise is delivered approximately every 30s.
- ☐ At the end of 5 min, the experimenter ends the session.
- ☐ Experimenter begins the next session or returns the child to the preschool.

Number of steps completed correctly:____________

Percentage of steps completed correctly:__________

Appendix D
Response-Restriction Integrity Protocol

☐ Experimenter ensures all required materials are in place (e.g., all outdoor toys are in the designated Outdoor Toys location).

☐ Experimenter turns on the video camera and states the session number and context (e.g., "This is Response-Restriction, session 1).

☐ At the beginning of the analysis, the experimenter tells the child "you can play in the grass, play with the toys, play on the jungle gym, play nowhere, or play in all of the areas." After the restriction of a context the experimenter no longer states the availability of that particular context.

☐ Experimenter counts down the session (i.e., "Session start in 3, 2, 1), while simultaneously starting a stopwatch.

☐ Experimenter, data collector, and staff member do not interact with the child except to ensure his/her safety or to ensure that the child does not play in a context that is no longer available.

☐ At the end of 5 min, the experimenter ends the session.

☐ Experimenter praises the child for playing and listening to the instructions.

☐ Experimenter begins the next session or the experimenter, child, and data collector return to the preschool.

☐ Experimenter restricts access to a context when the child has engaged in the context for 60% or more of intervals across two consecutive sessions.

☐ Experimenter continues sessions until a hierarchy of activity context preference is attained.

Number of steps completed correctly:____________

Percentage of steps completed correctly:__________

Appendix E
Play Probe Integrity Protocol

- ☐ Experimenter ensures all required materials are in place (e.g., all outdoor toys are in the designated Outdoor Toys location).

- ☐ Experimenter turns on the video camera and states the session number and context (e.g., "This is Open Space, play probe session 1.")

- ☐ Experimenter tells the child that he/she can "play in the grass" for the Open Space context, "play with the toys" for the Outdoor Toys context, or "play on the jungle gym" for the Fixed Equipment context.

- ☐ Experimenter counts down the session (i.e., "Session start in 3, 2, 1), while simultaneously starting a stopwatch.

- ☐ Experimenter, data collectors, and staff member do not interact with the child except to issue minimal prompts as required to keep him/her in the designated session area.

- ☐ At the end of 5 min, the experimenter ends the session.

- ☐ Experimenter praises the child for remaining in the session area and listening to the instructions.

- ☐ Experimenter cleans up the session area.

- ☐ Experimenter, child, and data collector walk to the designated area for the next session, or return to the preschool.

Number of steps completed correctly:____________

Percentage of steps completed correctly:__________

Appendix F

Accuracy Training Integrity Protocol

- ☐ Experimenter enthusiastically explains to the child “I’m going to help you get really good at <skill>!”
- ☐ Experimenter models the skill while providing verbal instructions.
- ☐ Experimenter tells the child, “Now you try to <skill> like I did!”
- ☐ Experimenter enthusiastically praises the child for all attempts.
- ☐ Experimenter provides verbal, model and/or physical prompting, as required, to ensure correct completion of the skill according to the operational definition.
- ☐ Once the child can complete the skill independently one time, the experimenter says, “Now <skill> three times in a row.”
- ☐ (If 3 corrects in a row) Experimenter enthusiastically praises the child and continues accuracy training with the next skill in the target context. (If not 3 corrects in a row) Experimenter enthusiastically praises the child for trying his/her best and continues to provide verbal, model, and/or physical prompting, as required, to teach the skill.
- ☐ Once the child has correctly completed accuracy training for all three skills in the target context, the experimenter praises the child, and allows the child to place the accuracy achievement stickers on his/her chart.
- ☐ Experimenter provides a note to the child to take home and show his/her parents about the accuracy accomplishments with the targeted skills.
- ☐ Experimenter, child, and data collector return to the preschool.

Number of steps completed correctly:____________

Percentage of steps completed correctly:__________

Appendix G

Fluency Training Integrity Protocol

- ☐ Experimenter enthusiastically explains to the child, "Now that you can <skill> the right way, it's time to start time trials like in the Olympics!"

- ☐ Experimenter tells the child, "When I say go, I want you to <skill> as quickly as you can and do it right every time until I say stop. Ready? Go!" Experimenter starts the stop watch.

- ☐ If the child stops engaging in the target behavior, or begins to incorrectly complete the target behavior, the experimenter prompts the child to "Start again and do it the way we practiced last time."

- ☐ At the end of 20s the experimenter says, "Stop!" and records the number of skills executed.

- ☐ Once the child completes the fluency training for the first skill, then the experimenter enthusiastically praises the child and continues fluency training with the next skill in the target context.

- ☐ Once the child has completed 4-8 fluency training sessions for the day, the experimenter praises the child, and allows the child to place the fluency achievement stickers on his/her chart.

- ☐ Once the fluency criterion has been met, the experimenter provides a note to the child to take home and show his/her parents about the fluency accomplishments with the targeted skill.

- ☐ Experimenter, child, and data collector return to the preschool.

Number of steps completed correctly:____________

Percentage of steps completed correctly:__________

Appendix H
Accuracy Training Datasheet

Skill	Trial #	Prompting	# of repetitions	Correct?
		I V M PH	1 2 3	Y N

Skill	Trial #	Prompting	# of repetitions	Correct?
		I V M PH	1 2 3	Y N

Skill	Trial #	Prompting	# of repetitions	Correct?
		I V M PH	1 2 3	Y N

Skill	Trial #	Prompting	# of repetitions	Correct?
		I V M PH	1 2 3	Y N

Skill	Trial #	Prompting	# of repetitions	Correct?
		I V M PH	1 2 3	Y N

Skill	Trial #	Prompting	# of repetitions	Correct?
		I V M PH	1 2 3	Y N

Appendix I
Fluency Training Datasheet

Skill	Trial #	# of repetitions

Skill	Trial #	# of repetitions

Skill	Trial #	# of repetitions

Skill	Trial #	# of repetitions

Skill	Trial #	# of repetitions

Skill	Trial #	# of repetitions

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CURRICULUM VITAE

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EDUCATION

Doctor of Philosophy, School Psychology **2017 (Expected)**
Syracuse University (Full APA and NCATE Accredited, NASP approved): Syracuse, NY
Advisor: Brian Martens, Ph.D.
Dissertation: The effects of gross-motor fluency training on physical activity levels in young children

Master of Arts, Applied Behavior Analysis **May, 2012**
University of the Pacific, Psychology (Applied Behavior Analysis): Stockton, CA
Advisor: Matt Normand, Ph.D., BCBA-D
Thesis: Descriptive and experimental analyses of variables maintaining moderate-to-vigorous physical activity in preschool children

Bachelor of Arts, Psychology Major, French Major **May, 2006**
University of Victoria: Victoria, BC

PROFESSIONAL CERTIFICATION

Board Certified Behavior Analyst® (BCBA) Certificate #1-13-13092 **January, 2013**

LANGUAGES

Proficient in oral and written French.

PROFESSIONAL EXPERIENCE

Associate Director- *Behavioral Education for Children with Autism* **September 2016 - Present**
Implement and maintain standards as outlined on the Management Periodic Service Review (PSR); maintain on-going communication with Directors; maintain a productivity level of approximately 15% billable hours per week directly related to case management; supervise (including report review) and oversee the on-the-job training of instructional staff as well as supervisory staff; provide input and conduct annual staff evaluations; conduct client supervision/assessment; develop and manage research in coordination with supervisory staff to be presented at conferences; assist with community outreach as well as intake of new clients; foster and maintain professional relationships with others in the field; participate in marketing decisions and agency growth planning (e.g., intake of new clients, new

locations).

Psychology Intern- *Elmcrest Children's Center* **August 2015 – August 2016**
Conduct psychological diagnostic assessments and report findings in diagnostic meetings, behavior consultation, assessment, intervention, and progress monitoring in residential, school, respite, and individualized residential alternative settings for individuals ages 2–21 years, teacher and parent training, assist in monitoring ABA programs in a preschool setting for children ages 3-5 years.
Supervisors: Leah Phaneuf, Ph.D., BCBA-D, Licensed Psychologist, Patrick Casey, PhD., Licensed Psychologist.

Psychological Evaluator- *Elmcrest Children's Center* **August 2014 – August 2015**
Lead psychoeducational assessments on a multidisciplinary team and present results to the Committee on Special Preschool Education, conduct behavior consultation, assessment, intervention, progress monitoring, and parent training in a preschool setting for children ages 2–5 years.
Supervisor: Leah Phaneuf, Ph.D., BCBA-D, Licensed Psychologist.

Psychological Evaluator- *Gebbie Speech-Language Clinic* **October 2014 – August 2015**
Conduct psychoeducational assessments for children ages 2–5 years.
Supervisors: Lawrence Lewandowski, Ph.D., Licensed Psychologist, and Megan Leece, M.A., CCC-SLP.

Behavior Therapist- *CNY Medical Practice* **March 2013 – August 2014**
Provided behavior assessment, intervention, and parent training in a clinical setting for children ages 2–18 years.
Supervisors: Henry Roane, Ph.D., BCBA-D, Licensed Psychologist, and Nicole DeRosa, PsyD, BCBA-D, Licensed Psychologist.

Social Skills Training Assistant- *Syracuse University* **January 2013 – May 2013**
Assisted with 10-week, group-based cognitive-behavioral intervention designed to improve social functioning in children ages 6-13 years who are experiencing social difficulties (e.g., children with ASD, ADHD, anxiety).
Supervisor: Kevin Antshel, Ph.D., Licensed Psychologist.

Senior Trainer- *University of the Pacific* **August 2011 – June 2012**
Trained incoming graduate students in behavior analysis principles, data collection, and protocol.
Supervisors: Matthew Normand, Ph.D., BCBA-D, and Holly White, M.A., BCBA.

Senior Trainer- *Kavere Crisis Homes* **September 2010 – June 2012**
Trained board and care, and crisis home facility staff behavior principles and intervention strategies.
Supervisor: Holly White, M.A., BCBA.

Behavior Specialist- *Kavere Crisis Homes* **June 2010 – June 2012**
Provided behavior assessment, intervention, and consultation services for developmentally disabled children ages 7-18 years.
Supervisor: Holly White, M.A., BCBA.

Behavior Specialist- *Valley Mountain Regional Center* **October 2010 – June 2012**
Provided behavior assessment and intervention services for children ages 5-11 years, MR and ASD diagnoses.
Supervisors: Matthew Normand, Ph.D., BCBA-D, and Holly White, M.A., BCBA.

Behavior Specialist- *Stockton Unified School District* **September 2009 – June 2012**
Provided behavior assessment and intervention services for typically developing preschool children ages 3-5 years.
Supervisors: Matthew Normand, Ph.D., BCBA-D, and Holly White, M.A., BCBA

Independent Living Skills Coordinator- *Community Re-Entry Program* **July 2009 – July 2010**
Provided individual living skills training in an independent residential living facility for adults with mental health diagnoses.
Supervisor: Cris Clay, M.A.

Special Education Assistant- *Campus View Elementary School* **September 2008 – June 2009**
Provided behavior assessment and intervention services for children diagnosed with developmental disabilities.
Supervisor: Sara White, Ph.D., BCBA-D, Licensed Psychologist.

Special Education Assistant- *Christ Church Cathedral School* **September 2007 – June 2008**
Provided behavior assessment and intervention services for children diagnosed with developmental disabilities.
Supervisor: Sara White, Ph.D., BCBA-D, Licensed Psychologist.

Senior Behavior Program Manager- *Home-Based Behavior Intervention* **June 2007 – August 2009**
Provided Early Intensive Behavior Intervention (EIBI) for children diagnosed with developmental disabilities.
Supervisor: Sara White, Ph.D., BCBA-D, Licensed Psychologist.

Special Education Assistant- *Beacon Hill Montessori Preschool* **January 2007 – June 2007**
Provided behavior intervention services for a child diagnosed with ASD.
Supervisor: Sara White, Ph.D., BCBA-D, Licensed Psychologist.

Behavior Interventionist- *In-Home Behavior Intervention* **January 2005 – May 2007**
Provided Early Intensive Behavior Intervention (EIBI) for children diagnosed with developmental disabilities.
Supervisor: Sara White, Ph.D., BCBA-D, Licensed Psychologist.

RESEARCH EXPERIENCE

Senior Research Project Coordinator- *Syracuse University* **August 2013 – August 2015**
Physical activity, academic and behavioral assessments and interventions in school settings.
Supervisor: Brian Martens, Ph.D.

Research Assistant- *Syracuse University* **April 2013 – September 2013**
Academic assessments and interventions (e.g., performance feedback in writing) in school settings.
Supervisor: Tanya Eckert, Ph.D.

Research Assistant- *Syracuse University* **August 2012 – August 2013**
Academic and behavioral assessments, interventions, and teacher training in school settings.
Supervisor: Brian Martens, Ph.D.

Senior Research Project Coordinator- *University of the Pacific* **August 2010 – July 2012**
Obesity, physical activity, verbal behavior, food modeling, accurate response measurement, functional analyses and assessments in clinical and school settings.
Supervisor: Matthew Normand, Ph.D., BCBA-D

Undergraduate Research Supervisor- *University of the Pacific* **August 2010 – June 2012**
Supervision and training of undergraduate research assistants.
Supervisor: Matthew Normand, Ph.D., BCBA-D

Research Assistant- *University of the Pacific* **August 2009 – August 2010**
Obesity, physical activity, verbal behavior, food modeling, accurate response measurement, functional analyses and assessments in clinical and school settings.
Supervisor: Matthew Normand, Ph.D., BCBA-D

TEACHING EXPERIENCE

Guest speaker- *Syracuse University* **November 2015**
Prepared materials and provided guest lecture on Autism Spectrum Disorder and Applied Behavior Analysis to undergraduate students in a Pediatric Psychology course in the Psychology Department.

Guest speaker- *Syracuse University* **February 2015**
Prepared materials and provided guest lecture on behavior principles and systematic implementation of behavior management in clinic settings to graduate students in the Communication and Disorders Department.

Teaching Assistant- *Foundations of Human Behavior, Syracuse University* **Fall 2012 – Spring 2013**
Created lectures, provided interactive group activities, led discussions, graded quizzes and papers, maintained students' grades, held weekly office hours, and proctored exams for four recitations per week.
Supervisor: Tibor Palfai, Ph.D.

Teaching Assistant- *Behavior Change, University of the Pacific* **Spring 2011**
Created lectures, provided interactive group activities, led discussions, graded quizzes and papers, maintained students' grades, and held weekly office hours for one recitation section per week.
Supervisor: Carolynn Kohn, Ph.D., BCBA-D.

PRACTICUM EXPERIENCE

School-Psychologist Extern- *Elmcrest Children's Center* **August 2014 – August 2015**
Conduct behavior consultation, assessment, intervention, parent training, progress monitoring, and lead a project review of IEPs in a preschool setting for children ages 2–5 years.
Supervisors: Lawrence Lewandowski, Ph.D., Licensed Psychologist, and Leah Phaneuf, Ph.D., BCBA-D, Licensed Psychologist.

School-Based Intervention Team Consultant- *Bellevue Elementary School* **Spring 2014**
Served on a school-based intervention team to determine appropriate services for children experiencing behavioral difficulties.
Supervisors: Brian Martens, Ph.D., and Brienan Dubiel, Ed.S.

Psychoeducational Assessment Team Member- *Psychoeducational Clinic* **Summer 2013**
Served on a diagnostic team that conducted comprehensive evaluations for children with learning disabilities.
Supervisors: Michelle Storie, Ph.D., and Laura Spenceley, Ph.D.

Academic Intervention Specialist- *Salem Hyde Elementary School* **Spring 2013**
Assessed academic difficulties, developed and implemented interventions, conducted consultation with teachers, and monitored progress.
Supervisor: Seth Aldrich, Ph.D., Licensed Psychologist.

SERVICE EXPERIENCE

Professionalism Series Coordinator- *Syracuse University* **August 2013 – August 2015**
Coordinate the professionalism series that aims to enhance the professional development of graduate students in the school psychology department.

Student Affiliate to National Groups- *Syracuse University* **August 2012 – August 2015**
Disseminate information from National groups to graduate students in the school psychology department.

ABAI Student Program Representative- *University of the Pacific* **August 2011- June 2012**
Disseminated information from ABAI to graduate students in the Applied Behavior Analysis department and organized events at the annual conference.

PEER-REVIEWED PUBLICATIONS

Sullivan, W. E., Martens, B. K., **Morley, A. J.,** & John, S. J., (2017). Reducing transition latency and transition-related problem behavior in children by altering the motivating operations for task disengagement. *Psychology in the Schools, 54,* 404-420. doi:10.1002/pits.22008

Martens, B. K., Lambert, T. L., Sullivan, W. E., Magnuson, J. D., **Morley, A. J.,** Sallade, S. J., & Baxter, E. L. (2016). Choice in transition: Replication and extension to preschool children in a naturalistic setting. *Journal of the Experimental Analysis of Behavior, 105*, 307-321. doi: 10.1002/jeab.201

Larson, T. A., Normand, M. P., **Morley, A. J.,** & Hustyi, K. M. (2014). The role of the physical environment in promoting physical activity in children across different group compositions. *Behavior Modification, 38,* 837-851. doi: 10.1177/0145445514543466.

Larson, T. A., Normand, M. P., **Morley, A. J.,** & Miller, B. G. (2014). Further evaluation of a functional analysis of moderate-to-vigorous physical activity in young children. *Journal of Applied Behavior Analysis. 47,* 219-230. doi: 10.1002/jaba.127.

Larson, T. A., Normand, M. P., **Morley, A. J.,** & Miller, B. G. (2013). A functional analysis of moderate-to-vigorous physical activity in young children. *Journal of Applied Behavior Analysis, 46,* 199-207. doi: 10.1002/jaba.8

Hustyi, K. M., Normand, M. P., Larson, T. A., & **Morley, A. J.** (2012). The effect of outdoor activity context on physical activity in preschool children. *Journal of Applied Behavior Analysis, 45*, 401-405. doi: 10.1901/jaba.2012.45-401

Normand, M. P., Machado, M. A., Hustyi, K. M., & **Morley, A. J.** (2011). Infant sign training and functional analysis. *Journal of Applied Behavior Analysis, 44*, 305-314. doi: 10.1901/jaba.2012.45-401

PROFESSIONAL PRESENTATIONS

Morley, A.J., & Martens, B.K. (2017, May). *The effects of gross-motor fluency training on physical activity levels in young children.* Paper presented at the 42nd Annual Meeting of the Association for Behavior Analysis, International, Denver, CO.

Young, N.D., Martens, B.K., Mullane, M.P., Long, S.J., Sallade, S., Sullivan, W.E., **Morley, A.J.,** & Underberg, J.E. (2017, May). *Direct and generalized effects of a reading fluency intervention across different word overlap conditions.* Paper presented at the 42nd Annual Meeting of the Association for Behavior Analysis, International, Denver, CO.

Sullivan, W. E., Martens, B. K., **Morley, A. J., &** Long, S. J. (2016, February). *Facilitating transitions by briefly interrupting preferred activities.* Poster presented at the National Association of School Psychologists annual conference, New Orleans, LA.

Martens, B. K., Mullane, M. P., Sallade, S. J., Long, S., Sullivan, W. E., & **Morley, A. J.** (2016, February). *Gains in oral reading fluency across different word overlap conditions.* Poster presented at the National Association of School Psychologists annual conference, New Orleans, LA.

Novak, M., DeRosa, N. M., **Morley, A. J.**, Moolenschot, E., & Roane, H. S. (2015, October). *An evaluation of treatment outcomes for the reduction of motor stereotopy*. Poster presented at the 16th Annual Mid-American Association for Behavior Analysis, Kansas City, MO.

Morley, A. J., DeRosa, N. M., Novak, M., Moolenschot, E. L., & Roane, H. S. (2015, May). *An evaluation of treatment outcomes for the reduction of motor stereotopy*. Paper presented at the 41st Annual Meeting of the Association for Behavior Analysis, International, San Antonio, TX.

Bishop, J. R., Novak, M. D., Moolenschot E. L, **Morley, A. J**., DeRosa, N. M., & Roane, H. S. (2014, October). *A comparison of hands-down and response interruption and redirection (RIRD) for the treatment of motor stereotypy*. Paper presented at the 25th Annual Conference of the New York State Association for Behavior Analysis, Saratoga Springs, NY.

Moolenschot, E. L., DeRosa, N. M., Novak, M. D., **Morley, A. J.,** & Roane, H. S. (2014, October). *The use of programmatic research for evaluating functional communication outcomes.* Paper presented at the 25th Annual Conference of the New York State Association for Behavior Analysis, Saratoga Springs, NY.

Mullane, M. P., **Morley, A. J.**, Bishop, J., DeRosa, N. M., & Roane, H. S. (2014, October). *An evaluation of response cost and extinction on response allocation*. Poster presented at the 25th Annual Conference of the New York State Association for Behavior Analysis, Saratoga Springs, NY.

DeRosa, N. M., Roane, H. S., **Morley, A. J.,** & Sullivan, W. E. (2014, May). *The effects of varying duration of exposure to the establishing operation on functional communication training outcomes.* Paper presented at the 40th Annual Meeting of the Association for Behavior Analysis, International, Chicago, IL

Morley, A. J., Martens, B. K., Underberg, J. E., & Long, S. J. (2014, May). *Increasing moderate-to-vigorous physical activity in preschool children.* Poster presented at the 40th Annual Meeting of the Association for Behavior Analysis, International, Chicago, IL.

Hier, B. O., Eckert, T. L., Miller, L. A., **Morley, A. J**., Spielberger, S. L., & Malandrino, R. D. (2014, February). *Programming generality into a performance feedback writing intervention.* Poster presented at the National Association of School Psychologists annual conference, Washington, D.C.

Morley, A. J., Normand, M. P., & Larson, T. A. (2013, May). *Considerations for descriptive analyses of physical activity.* Paper presented at the 39th Annual Meeting of the Association for Behavior Analysis, International, Minneapolis, MN.

Larson, T. A., Normand, M. P., **Morley, A. J.,** & Miller, B. G. (2013, May). *A functional analysis of moderate-to-vigorous physical activity in young children*. Paper presented at the 39th Annual Meeting of the Association for Behavior Analysis, International, Minneapolis, MN.

Morley, A. J., Normand, M. P., & Larson, T. A. (2013, February). *Considerations for descriptive analyses of physical activity*. Paper presented at the 31st Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Larson, T. A., Normand, M. P., **Morley, A. J.,** & Miller, B. G. (2013, February). *A functional analysis of moderate-to-vigorous physical activity in young children*. Paper presented at the 31st Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Larson, T. A., **Morley, A. J.,** Miller, B. G., Galbraith, L. G., & Normand, M. P. (2013, February). *Free-living validation of the New Lifestyles® NL-2000TM pedometer and Fitbit® accelerometer with preschool-age children.* Paper presented at the 31st Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Larson, T. A., **Morley, A. J.,** Miller, B. G., Galbraith, L. G., & Normand, M. P. (2013, February). *Structured validation of the New Lifestyles® NL-2000TM pedometer and Fitbit® accelerometer with preschool-age children.* Paper presented at the 31st Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Morley, A. J., Normand, M. P., & Larson, T. A. (2012, May). *Descriptive and experimental analyses of variables maintaining moderate-to-vigorous physical activity in preschool children.* Paper presented at the 38th Annual Meeting of the Association for Behavior Analysis, International, Seattle, WA.

Silverman, K., Normand, M. P., VanHouten, R., & Volllmer, T. R. (2012, May). *The importance of innovative research in behavior analysis.* In **Morley, A.J.** (chair) panel discussion presented at the 38th Annual Meeting of the Association for Behavior Analysis, International, Seattle, WA.

Larson, T. A., **Morley, A. J.,** White, H. A., Sargent, E. R., & Pratt, L.A. (2012, April). *Functional communication training (FCT) protocol for access-maintained behavior in a clinical setting.* Poster presented at the 2nd Annual Meeting of the Association of Professional Behavior Analysts (APBA), Tampa, FL.

Schlinger, H. (2012, February). *Does ABA stand for autism and Behavior Analysis?* Invited Address introduced by **Morley, A. J.** at the 30th Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Morley, A. J., Normand, M. P., & Larson, T. A. (2012, February). *Descriptive and experimental analyses of variables maintaining moderate-to-vigorous physical activity in preschool children*. Paper presented at the 30th Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Larson, T. A., **Morley, A. J.,** White, H. A., Sargent, E. R., & Pratt, L.A. (2012, February). *Functional communication training (FCT) protocol for access-maintained behavior in a clinical setting.* Poster presented at the 30th Annual Meeting of the California Association for Behavior Analysis, Garden Grove, CA.

Hustyi, K. M., Normand, M. P., Larson, T. A., & **Morley, A. J.** (2011, May). *A functional analysis of physical activity in preschool children.* Paper presented at the 37th Annual Meeting of the Association for Behavior Analysis, International, Denver, CO.

Larson, T. A., Miller, B. G., **Morley, A. J.,** & Normand, M. P. (2011, May). *A Comparison of interval recording methods for measuring physical activity levels*. Paper presented at the 37th Annual Meeting of the Association for Behavior Analysis, International, Denver, CO.

Larson, T. A., Normand, M. P., **Morley, A. J.,** & Hustyi, K. M. (2011, April). *A functional analysis of physical activity in preschool children.* Poster presented at the Cambridge Center for Behavioral Studies: Applied Behavior Analysis: Evidence-based Solutions for Helping People conference, Fresno, CA.

Machado, M. A., Normand, M. P., **Morley, A. J.,** & Hustyi, K. M. (2011, April). *Infant sign training and functional analysis.* Poster presented at the Cambridge Center for Behavioral Studies: Applied Behavior Analysis: Evidence-based Solutions for Helping People conference, Fresno, CA.

Normand, M. P., Machado, M. A., Hustyi, K. M., **& Morley, A. J.** (2011, February). *Infant sign training and functional analysis*. Paper presented at the 29th Annual Meeting of the California Association for Behavior Analysis, Burlingame, CA.

Hustyi, K. M., Normand, M. P., Larson, T. A., & **Morley, A. J.** (2011, February). *Functional analysis of physical activity in preschool children.* Paper presented at the 29th Annual Meeting of the California Association for Behavior Analysis, Burlingame, CA.

Miller, B.G., Larson, T. A., **Morley, A. J.,** & Normand, M. P., (2011, February). *A comparison of interval recording methods for measuring physical activity levels*. Poster presented at the 29th Annual Meeting of the California Association for Behavior Analysis, Burlingame, CA.

Iwata, B. A. (2011, February). *The prevention of problem behavior*. Invited Address introduced by **Morley, A. J.** at the 29th Annual Meeting of the California Association for Behavior Analysis, Burlingame, CA.

Machado, M. A., Hustyi, K. M., **Morley, A. J.,** & Normand, M. P. (2010, May). *Infant sign training and functional analysis*. Poster presented at the 36th Annual Meeting of the Association for Behavior Analysis, International, San Antonio, TX.

Machado, M. A., Hustyi, K. M., **Morley, A. J.,** & Normand, M. P. (2010, February). *Infant sign training and functional analysis*. Poster presented at the 28th Annual Meeting of the California Association for Behavior Analysis, Irvine, CA.

MANUSCRIPTS IN PREPARATION

Morley, A. J., Normand, M. P., & Larson, T. A. (in prep). Descriptive and experimental analyses of variables maintaining moderate-to-vigorous physical activity in preschool children.

Larson, T. A., Miller, B. G., **Morley, A. J.,** & Normand, M. P. (in prep). A comparison of interval recording methods for measuring physical activity levels.

Larson, T. A., **Morley, A. J.,** Miller, B. G., Quan, P., & Normand, M. P. (in prep). Validation of the NEW-Lifestyles pedometer for use with young children.

HONORS AND AWARDS

Graduate Travel Award- ABAI Conference, *Syracuse University*	**2015**
Graduate Travel Award- ABAI Conference, *Syracuse University*	**2014**
Graduate Travel Award- ABAI Conference, *Syracuse University*	**2013**
Graduate Tuition Scholarship, *Syracuse University*	**2012-Present**
Who's Who Among Students in American Universities & Colleges, *University of the Pacific*	**2012**
Phi Kappa Phi, *University of the Pacific*	**2012**
Julie Vargas Award, *California Association for Behavior Analysis*	**2012**
Graduate Travel Award – ABAI Conference, *University of the Pacific*	**2012**
Martin T. Gipson Graduate Student Memorial Scholarship, *University of the Pacific*	**2011**
Graduate Travel Award – ABAI Conference, *University of the Pacific*	**2011**
Graduate Travel Award – ABAI Conference, *University of the Pacific*	**2010**
Graduate Tuition Scholarship, *University of the Pacific*	**2009-2012**

EDITORIAL ACTIVITIES

Ad Hoc Reviewer- *Journal of Behavioral Education*	**2015**
Ad Hoc Reviewer- *School Psychology Quarterly*	**2014**
Ad Hoc Reviewer- *Journal of Applied Behavior Analysis*	**2012- 2014**

PROFESSIONAL AFFILIATIONS

National Association of School Psychologists	**2013-Present**
Association for Behavior Analysis International	**2009-Present**
Phi Kappa Phi- National Honor Society for all academic disciplines	**2012-2013**
California Association for Behavior Analysis	**2009-2012, 2017**
British Columbia Association for Behavior Analysis	**2008-2009**

REFERENCES

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