OUTDOOR ENVIRONMENTS:
CHILDREN’S PHYSICAL ACTIVITY AND ACTIVE FREE PLAY

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CHILDREN'S PHYSICAL ACTIVITY AND ACTIVE FREE PLAY

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The present doctoral dissertation focused on the impact of outdoor environments on children's physical activity and active free play. Three studies investigate the environmental influences within children's microsystems: school gardens, adventure playgrounds, and conventional playgrounds, in order to systematically improve the *salutogenic* (health-promotive) design and effectiveness of built and natural environments to promote children's physical activity, health and well-being (Antonovsky, 1987, 1996).

First, *Children's physical activity while gardening: Development of a valid and reliable direct observation tool* (Chapter 2), the Physical Activity Research & Assessment tool for Garden ObservatioN (PARAGON), a direct observation tool was developed to operationalize children's physical activities, movement, and postures, while gardening at school. The study assessed the test-retest and inter-rater reliability of PARAGON as a measure of children's physical activity levels and movement in school gardens and assessed the validity of the physical activity codes. This valid and reliable direct observation tool may help to increase effectiveness of garden interventions that aim to improve children's health and well-being and can be used by community organizations to translate research into practice and practice into research.

The second study, *Children's physical activity in free-living outdoor environments (Chapter 3),* a within-subjects design exploring two playground types, (conventional and adventure) and their influence on children's physical activity, while outdoors. This study had two

purposes: a) to measure and compare children's physical activity, during active free play, in two playground types (conventional versus adventure), using two measures (accelerometry and direct observation); b) to explore the role of gender and playground types on physical activity. This study contributes to the literature exploring the physical environmental influences on children's physical activity, while engaging in outdoor, active free play, which will be important in the need to collect national data on children's active free play levels. In addition, this was the first study to look at adventure playgrounds effects on physical activity. And finally, the study filled a gap in out-of-school time (OST) research, exploring how the OST physical outdoor environments may promote children's physical activity.

The third study, *Adventure playgrounds and active free play: The role of environmental design in play behavior types, social interactions, and gender-inclusive space use (Chapter 4),* also utilized a within-subjects research design to examine the effects of playground type (adventure playground compared to conventional playground) and gender on three components of active free play: 1) play behavior types; 2) social interactions and; 3) gender-inclusive space use. Results showed that in the adventure playground, both boys and girls engaged in a greater variety of active free play behaviors, engaged in more time in pro-social interactions, and spent less time in conflict interactions than in the conventional playground. Though the conventional playground was hypothesized to be a more 'gendered space' compared to the adventure playground, playground type was found to have no effect on the third dependent variable, gender-inclusive space use. Though the history of adventure playgrounds is long to our knowledge, this is the first quasi-experimental study to examine the effects of an adventure playground on children's active free play components (play behavior types, social interactions, and gender-inclusive space use) compared to a conventional playground.

BIOGRAPHICAL SKETCH

Beth Myers was born and raised in Elkridge, Maryland, a small town outside of Baltimore, Maryland. She grew up in an old home steeped with generational history (the same home her great-great grandmother, great-grandmother, and grandmother once lived in). Influenced immensely by her mom, dad, older brother, and tight-knit extended family, Beth never imagined leaving her hometown – but decided to see if there was a life for her outside of Elkridge and attended James Madison University in Harrisonburg, Virginia. Alongside Beth's undergraduate degree in Kinesiology – Exercise Science, she spent much of college curious of how her education could be used to help others, leading her to join Teach For America and became a New York City public school teacher for three years. Inspired by fellow teachers and over 100 5th graders she taught at P.S. 28 Manhattan in Washington Heights, she distressingly decided to leave teaching and obtained a Masters of Public Health (MPH) at Temple University, in Philadelphia, Pennsylvania - committed to continuing her work linking health and schools. During her MPH, Beth was a research assistant at the Center for Obesity Research and Education as well as a teaching assistant and instructor of record.

Beth became interested in obtaining more research training and pursued a doctoral degree at Cornell University in Human Behavior and Design in the Department of Design and Environmental Analysis, with a desire to connect human movement, education, and public health through the theories of environmental psychology to promote children's health and well-being. Beth will continue her training and cultivate her curiosity as a National Institutes of Health Postdoctoral Fellow in Community Nutrition at Cornell University. She hopes that her teaching inspires and her research can be used for good.

In Memory of MeMaw

Thank you for loving the natural world & sharing the “breathtaking” view with me.

All My Love.

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CHAPTER 1

INTRODUCTION

Over the past four decades, childhood chronic diseases have been on the rise (Gortmaker, 1985; Perrin, Bloom, & Gortmaker, 2007). Early onset of chronic diseases such as obesity and asthma as well as chronic mental health issues and disorders such as ADHD and depression is alarming because of the likelihood that the trajectory of morbidity will continue throughout the life course leading to premature mortality (Elder & Rockwell, 1979; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997; Elder, 1998; Wethington, 2005). The rise in noncommunicable diseases may be contributing to the ever-increasing prevalence of both childhood and adulthood comorbidities (two or more chronic diseases) (Goodman & Whitaker, 2002), suggesting a sense of urgency to successfully identify environmental and policy strategies to promote healthy behavioral trajectories.

In response to the increasing prevalence of chronic diseases and in recognition of the varied contributing factors, in 2003, the public health field called for research on the role of the built environment on population health promotion and well-being (Jackson, 2003; Srinivasan, O'Fallon, & Dearry, 2003). Historically, *environmental health*, one of the core disciplines of public health, has primarily explored how environmental factors adversely affect health outcomes, while the discipline of *community health* has focused primarily on individual behavior change to promote health. The newly outlined priority within the public health discipline recognized a need to understand how and under what conditions environment and policy might *promote* population health. This call for research marked a historic shift in public health research, pedagogy, and practice in two ways: 1) the core discipline of environmental health broadened to include research and coursework regarding the influence of the built and natural environments as well as policy on population health and 2) state and local health departments began to implement practical interventions aimed to promote health, placed greater emphasis on the design and characteristics of the physical environment (Frumkin, 2001; Jackson, 2003). While the discipline of environmental psychology has longed recognized the beneficial influence of the built and natural environments on human behavior and health (Kaplan, 1973, 1983, 1995; Stokols, 1992; Kaplan & Peterson, 1993; Wells, 2000; Wells & Evans, 2003; Wells & Rollings, 2012), interdisciplinary research has burgeoned in the last decade and a half regarding the role of both the built environment (e.g., bike paths, greenways, rail-trails) and the natural environment (e.g., green space, wooded areas, protected park land) in promoting health (Cummins & Jackson, 2001; Jackson, Dannenberg, & Frumkin, 2013; Rahman, Cushing, & Jackson, 2011; Renalds, Smith, & Hale, 2010; Wells, Myers, & Henderson, 2014a; Wells, Myers, & Henderson, 2014b).

This doctoral dissertation contributes to the expanding interdisciplinary literature on environments and health promotion by exploring the impact of outdoor environments on children's physical activity (PA) and active free play. Three studies investigate the environmental influences within children's microsystems: school gardens, adventure playgrounds, and conventional playgrounds, in order to systematically improve the *salutogenic* (health-promotive) design and effectiveness of built and natural environments to promote children's physical activity, health and well-being (Antonovsky, 1987, 1996). The remainder of Chapter 1 will focus on the promise of environmental interventions to address three public health concerns affecting children, four theoretical frameworks that guide this dissertation, and a brief overview summarizing the topics of three dissertation papers to follow.

Public health concerns

This dissertation is motivated by three contemporary public health concerns, related to children: 1) physical inactivity; 2) decreased access to and availability of natural outdoor environments; and 3) gender disparities in PA and active free play, that may be linked to the design of outdoor environments.

1. *Burden of physical inactivity*

First, PA is decreasing among children, leading to a multitude of adverse mental and physical health outcomes (Gortmaker, 1985; Perrin, Bloom, & Gortmaker, 2007). Despite the health benefits of physical activity (Reiner, Niermann, Jekauc, & Woll, 2013), only 42% of school-aged children (aged 6 to 11) meet the recommended 60-minutes of moderate-to-vigorous physical activity, on most days (Troiano et al., 2008). Physical activity patterns track from childhood into adulthood (Gordon-Larsen, McMurray, & Popkin, 2000; Malina, 1996); active children tend to become active adults, while sedentary children will likely become sedentary adults. While the benefits of PA across the life course are well understood, the challenges to ensure that children obtain adequate levels of PA are related to ascertaining effective environmental and policy strategies to promote physical activity and accurately measuring the complexity of physical activities (especially among children) that make up the patterned behavior. Research focused on accurate measures of PA will likely contribute to the development of effective interventions.

However, there are difficulties in measuring physical activity, especially in children (Welk, Corbin, & Dale, 2000; Bailey et al., 1995). Accelerometry is an objective measure that has been found to accurately capture intensity of physical activity (Loprinzi & Cardinal, 2011) and moderate-to-vigorous PA (MVPA) is often used as a proxy for cardiovascular endurance (an indicator of overall physical health). However, especially as children grow and develop (Todd et al., 2008), it is important that PA measures capture the entirety of physical activities (i.e., including muscle-strengthening and bone-strengthening activities) so researchers can utilize accurate measures of children's various forms of physical activity to understand the clinical role of PA in reversing and curbing childhood chronic diseases.

2. *Access and availability to natural outdoor environments*

Second, children have limited opportunities to engage, explore, participate, and be adventurous in natural environments (Gleave, 2009; Hofferth, 2009; Larson, Green, & Cordell, 2011; Louv, 2008; Ladd, 1978). Active free play, is defined as children's spontaneous movement without direct supervision of adults, and has been linked to increases in moderate-to-vigorous physical activity, when compared to children moving during structured activities (National Physical Activity Plan Alliance, 2014). This unsupervised, child-directed active free play has concurrently diminished alongside children's access to natural environments (Hofferth, 2009). There are a variety of potential explanations for the decline of outdoor active free play including societal priorities in children's allocation of time spent indoors versus outdoors, especially at school, decreases in access and availability of natural spaces, and limited independent mobility or 'free-range' for children to move outdoors unaccompanied by an adult.

In school districts across the country, the hours children spend at school are increasing from six hours per day and 180 days per year toward 7.5 hours per day and 190 or more days per year (Patall, Cooper, & Allen, 2010) and mostly time is spent indoors (McMurrer, 2008). School grounds are underutilized as places to promote physical activity and increase opportunities for moving during the school day (Dyment & Bell, 2008). Moreover, in response to the 2011 federally mandated *Common Core Initiative,* state-level pressures to increase high-stakes testing in the United States, by both frequency and number of tests, as well as more grade-levels, (Common Core State Standards Initiative, 2012; Linn, 2002) schools have halted the emphasis on promoting physical activity in middle childhood (6 to 11 years old) during the school day and new emphasis is being placed on interventions during out-of-school time (Trost, Rosenkranz, & Dzewaltowski, 2008), which may provide a more practical solution to promote PA among school-aged children.

Over the past four decades, development of natural, wooded, wild, and open spaces (often spaces for outdoor active free play) have been considered a contributing factor to children's decreased outdoor time (Hofferth, 2009). Even when these natural outdoor spaces are available, independent mobility, defined as children moving outdoors unassisted by an adult, has decreased over time (Kyttä, 2004). Finally, boys have been shown to have a greater territorial range from their home in which they can freely move compared to girls (Kyttä, 2004) which may contribute to gender disparities in physical activity, affecting the health outcomes of girls and women over their life course.

3. *Gender disparities in physical activity and play*

Third, over the life course, girls and women are less physically active than boys and men. In middle childhood, between the ages of 6 and 11 years old, only 35% of girls met the physical activity recommendations of 60 minutes of moderate-to-vigorous physical activity, on most days, compared to 47% of boys and during adolescence, the gender disparities between boys' and girls' physical activity widens (Gortmaker et al., 2012). While physical activity levels decrease with age for both boys and girls, girls experience a steeper rate of decline over time than boys (Kimm et al., 2002). In addition to decreases in physical activity, girls have greater increases in sedentary bouts, or extended periods of no physical activity (Van Der Horst, Paw, Twisk, & Van Mechelen, 2007).

In the context of physical activity, the socially constructed concept of gender, developed throughout childhood, may underlie and contribute to the gender disparities seen over the life course and ultimately health disparities, in later life (Braveman & Barclay, 2009). Gender is not a static construct. Children and adults are constantly practicing gender and reinforcing it in actions, words, and in physical spaces (Martin, 2011; Martin & Ruble, 2010). Gender can be defined by social settings and structures and is reinforced through people, places, and behaviors (Moen & Chermack, 2005; Rossi & Association, 1985). If young children are situated in spaces and that reinforce gender roles and gender-role stereotyping, then they may begin to develop concepts that differential activities and ways of acting exist for girls compared to boys (Sarkin, McKenzie, & Sallis, 1997; Schmalz & Kerstetter, 2006).

Playgrounds have been considered 'gendered spaces' in which boys constrain girls in their physical activities (Azzarito & Hill, 2012; Clark, 2007; Karsten, 2003; Thorne, 1993). For example, boys often play ball sports, such as soccer or basketball, that take up large amounts of physical space. On the other hand, girls are often found playing in smaller groups, on the margins of the playground (Clark, 2007; Datta, 2008; Thorne, 1993). Therefore, the design of physical environments or 'microsystems' in which children spend a great deal of time in, may be contributing to the gender disparities in physical activity.

Research revealed that during play, natural elements were equally attractive to boys and girls, and may change the way children play with one another and move within a space (Moore, 1986; Anthamatten et al., 2011; Anggard, 2011). An ethnographic study among young Swedish children (ages 1 to 6 years old) considered the absence of gender-coding in natural outdoor playspaces and found that natural spaces may offer opportunities for gender equity during play (Anggard, 2011). However, to our knowledge, no empirical study has investigated the outdoor environment's role in *mitigating* gender disparities in children's physical activity, among older children (6 to 11 years old).

These three public health concerns -- children's physical inactivity; decreased access to and availability of natural outdoor environments; and gender disparities -- motivate this dissertation. We now turn to the theories that provide a foundation for this work.

Theoretical frameworks

Five theoretical frameworks guide this dissertation: a) bioecological model; b) theory of affordances; c) theory of loose parts; d) gender-schema theory; and e) behavior setting theory. Each of these theories is described below.

Bioecological model

Bronfenbrenner's bioecological model is a theoretical framework that considers human-environment interactions by investigating how varying levels of context surrounding the individual work to collectively influence human development. The microsystem is the context that is closest to a child and where children are interacting closely with individuals such as teachers, parents, and peers. Outdoor environments, such as school gardens, playgrounds, parks, and backyards, can be thought of as a micro-environment or microsystem (Bronfenbrenner, 1979; Bronfenbrenner, Morris, Damon, & Lerner, 1998; Bronfenbrenner & Morris, 2006). Children's reciprocal, long-standing, and frequent interactions with the physical environment, may be thought of as 'proximal processes' that create the greatest amount of influence on a child's development (Bronfenbrenner, 1979). For example, while children spend large amounts of time gardening or playing outdoors, the positive promotion of physical activity from peers, as well as the environmental characteristics in which the child is engaged with may greatly influence children's physical activity behaviors.

Theory of affordances

A central theoretical framework guiding the dissertation studies is the *Theory of Affordances* (Gibson, 1977, 1979). Gibson posits that there are perceived physical properties in the environment that encourage people to action. Objects in the environment are perceived, in terms of the object's possibilities for action, known as an *affordance*. These affordances or 'action possibilities' exist in the environment and can be objectively measured and lead people to act. In the context of outdoor play environments, affordances may motivate or 'afford' children to move and be physically active. For example, a tree may allow children to climb, a chair may afford someone to sit and rest, and shovel would provide an affordance for digging.

Theory of loose parts

In addition to affordances, the *theory of loose parts* (Nicholson, 1972) also contributes to the theoretical foundation of the studies (specifically Study 2 and Study 3). Loose parts can be thought of as affordances in the environment. Loose parts are any material or object that can be moved, carried, or manipulated by children. In natural environments, there are many loose parts that inherently exist (e.g. pieces of wood, leaves, rocks, etc.). Nicholson suggests that loose parts encourage children to change and manipulate their environment and consequently become more motivated to behave in a variety of ways. It is believed that fixed elements in outdoor play environments restrict children's ability to manipulate their environment and may discourage their movement (Blacksher & Lovasi, 2012).

Gender-schma theory

A fourth theory drawn upon in this dissertation is *gender schema theory* (Study 2 and Study 3). The gender-schema is a theoretical perspective on gender socialization, combining both social learning and cognitive-developmental approaches (Bem, 1981; Fagot, Rodgers, & Leinbach, 2000). Gender socialization can be defined as the learning of behaviors and attitudes that are considered appropriate for either boys or girls. Gender-schema theory suggests that children use gender as a way to organize their view of the world. Consequently, gender-role stereotypes, or the expectations that individuals will behave in certain ways because they are male or female, become reinforced through institutions that children spend time in, such as family, schools, peer groups, and media. These reinforcing institutions are thought of as 'agents of socialization' (Henslin & Nelson, 2000). Arguably the physical environment (especially microsystems) can influence children's development of gender and be seen as a socializing agent, in that physical spaces may contain components that are gender-coded and therefore may elicit specific gendered behaviors in physical activity and play (Boyle, Marshall, & Robeson, 2003).

Behavior setting theory

The idea that the physical environment exhibits certain properties that influence behavior, such as gender-coding, is suggested by Barker's behavior setting theory (Barker, 1965, 1968). Barker suggests that a behavior setting is a behavior-environment unit that has two interdependent properties: 1) specified time, place, and objects; and 2) attached standing patterns of behavior. In the context of outdoor play environments, there is a collection of specified behavior settings serving different functions (e.g. fixed play equipment, hard-surfaces, pathways, trees, etc.). Depending on children's gender-schema, these distinct behavior settings may be perceived differently, resulting in different patterns of physical activity.

Environmental psychology is the thread throughout all five theories. Throughout the three dissertation studies, multiple theories have been used to inform the research. In each theory, the relation of the environment (e.g. playgrounds) and behavior (e.g. physical activity) is central to how the theories either predict or explain the environmental influence on behavior.

Dissertation overview

Grounded in environmental psychology theories, the three dissertation studies combine the disciplines of human movement, public health, and education to investigate the influence of outdoor environments on children's physical activity and active free play. The chapters addressed the measurement of children's physical activity while gardening, the influence of playground design on children's physical activity in an outdoor free-living environment, and the effect of playground design on children's active free play behaviors, social interactions, and gender-inclusive space use.

First, *Children's physical activity while gardening: Development of a valid and reliable direct observation tool* (Chapter 2), the Physical Activity Research & Assessment tool for Garden ObservatioN (PARAGON), a direct observation tool was developed to operationalize children's physical activities, movement, and postures, while gardening at school (Myers & Wells, 2015)[1]. The study assessed the test-retest and inter-rater reliability of PARAGON as a measure of children's physical activity levels and movement in school gardens and assessed the validity of the physical activity codes. As more children become exposed to gardening through community and school programs, it will be important to systematically understand how and

[1] PARAGON was developed as part of the Wells, Myers, Henderson 2014b study and was used therein.

under what conditions gardening promotes children's physical activity. This valid and reliable direct observation tool may help to increase effectiveness of garden interventions that aim to improve children's health and well-being and can be used by community organizations to translate research into practice and practice into research.

The second study, *Children's physical activity in outdoor free-living environments (Chapter 3),* a within-subjects design exploring two playground types, (conventional and adventure) and their influence on children's physical activity, while outdoors. This study had two purposes: a) to measure and compare children's physical activity, during active free play, in two playground types (conventional versus adventure), using two measures (accelerometry and direct observation); b) to explore the role of gender and playground types on physical activity. This study contributes to the literature exploring the physical environmental influences on children's physical activity, while engaging in outdoor, active free play, which will be important in the need to collect national data on children's active free play levels. In addition, this was the first study to look at adventure playgrounds' effects on physical activity. And finally, the study filled a gap in out-of-school time (OST) research, exploring how the OST physical outdoor environments may promote children's physical activity.

The third study, *Adventure playgrounds and active free play: The role of environmental design in play behavior types, social interactions, and gender-inclusive space use (Chapter 4),* observed components of children's active free play, with two environmental psychology methods, direct observation and behavior mapping, to explore differences in children's active free play behaviors (overall and stratified by gender), social interactions (overall and stratified by gender) and gender-inclusive space use in an adventure playground compared to a conventional playground. Active free play is defined as child-directed, movements that result from children's innate need to be active, creative, and imaginative and is considered to be important to children's healthy development (National Physical Activity Plan Alliance, 2014). Researchers compared children's physical activity levels in structured play and unstructured play and found that children engaged in 25% more moderate-to-vigorous PA during unstructured play (active free play) than in structured play (organized activities) (Trost, Rosenkranz, & Dzewaltowski, 2008), suggesting that when children engage in self-directed play, they may more often choose higher intensity physical activities or engage in moderate-to-vigorous PA (MVPA) for longer bouts of time. Although active free play is recognized as a potential indicator for children's health (Burdette & Whitaker, 2005), population data on the amount of time children spend in active free play is unknown (National Physical Activity Plan Alliance, 2014), some studies have shown children's unstructured, free play time has diminished substantially between 1981 and 1997, while organized activities have increased six-fold (Doherty & Carlson, 2003). The third dissertation study aims to explore how the outdoor environment (conventional playground versus adventure playground) influences children's active free play behaviors, social interaction, and gender-inclusive space use.

Summary: Outdoor environments and children's physical activity and play

Environmental interventions hold promise for increasing children's health and well-being as effective strategies to increase children's PA and reduce gender disparities in PA and active free play (Pate, Pratt, Blair, & et al., 1995). While the school environment is considered an important aspect of the school health agenda and recognized as a potent context for health behavior intervention (CDC, 2011; Story, Nanney, & Schwartz, 2009), there is also increasing attention on intervening during out-of-school time (OST) (Trost, Rosenkranz, & Dzewaltowski, 2008) and considering the underutilized outdoor school environment as a place of intervention to promote children’s health (Dyment & Bell, 2008). The next three chapters investigate the environmental influences within children’s outdoor school environment (school gardens) and OST outdoor physical environments (adventure playgrounds and conventional playgrounds) to expand the literature on *salutogenic* design of children’s outdoor environments (Antonovsky, 1987, 1996).

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CHAPTER 2

CHILDREN'S PHYSICAL ACTIVITY WHILE GARDENING:

DEVELOPMENT OF A VALID AND RELIABLE DIRECT OBSERVATION TOOL

ABSTRACT

Background Gardens are a promising intervention to promote physical activity and foster health. However, because of the unique characteristics of gardening, no extant tool can capture physical activity (PA), postures, and motions that take place in a garden.

Methods The Physical Activity Research & Assessment tool for Garden ObservatioN (PARAGON) was developed to assess children's physical activity levels, tasks, postures, and motions, associations, and interactions while gardening. PARAGON uses momentary time sampling in which a trained observer watches a focal child for 15-seconds and then records behavior for 15-seconds. Sixty-five children (38 girls, 27 boys) at four elementary schools in New York State were observed over eight days. During the observation, children simultaneously wore GT3X+ accelerometers.

Results The overall inter-rater reliability was: 88 percent agreement and Ebel was .97. Percent agreement values for activity level (93%), garden tasks (93%), motions (80%), associations (95%), and interactions (91%) also met acceptable criteria. Validity was established by previously validated physical activity codes and by expected convergent validity with accelerometry.

Conclusions PARAGON is a valid and reliable observation tool for assessing children's physical activity in the context of gardening.

INTRODUCTION

School-aged children spend a substantial amount of their waking time at school (Hofferth & Sandberg, 2001). In school districts across the country, the hours children spend at school are increasing from six hours per day and 180 days per year toward 7.5 hours per day and 190 or more days per year (Patall, Cooper, & Allen, 2010). As a result of the school environment's direct impact on child development, schools are seen as an influential place for intervening in children's lives (CDC, 2011; Story, Nanney, & Schwartz, 2009). And, if the trend of increasing school days and school hours continues, then the school environment may become an even more important place of intervention.

Over the past three decades, schools have decreased opportunities for children to move and be physically active during the school day (Ebbeling, Pawlak, & Ludwig, 2002). From 2003 to 2008, time spent on math and English language arts has increased an average of 186 minutes per week while time spent in physical education classes has decreased by an average of 40 minutes per week (McMurrer, 2008). In addition to fewer opportunities for structured physical activity, outdoor recess time has also declined (Pellegrini & Smith, 1998; RWJF, 2011).

Concurrently, as in-school opportunities for physical activity have diminished, researchers have emphasized the need to promote health in schools, especially for low-income children (Basch, 2011). There has been an increase in programming to affect children's physical activity behaviors as well as efforts to implement environmental changes as a strategy to promote children's health (Wells, Myers, & Henderson, 2014a; Wells, Myers, & Henderson, 2014b; Anthamatten et al., 2011; Colabianchi, Maslow, & Swayampakala, 2011). One promising environmental intervention to promote children's health is the school garden (Wells, Myers, & Henderson, 2014a; Wells, Myers, & Henderson, 2014b; Christian, Evans, Nykjaer, Hancock, & Cade, 2014; Christian, Evans, Conner, Ransley, & Cade, 2012; Blair & Morris, 2009; Ozer, 2007). School gardens have garnered attention in the media and in communities of all sizes (Severson, 2010; Otterman, 2010). For example, New York City, the largest school system in the United States, educating nearly 1.1 million children, has proposed to build a school garden in every school by the year 2030 (Grow To Learn NYC, 2012). Non-profit organizations, such as FoodCorps, affiliated with the AmeriCorps program, have placed recent college graduates in schools to affect children's health by planting and maintaining school gardens (FoodCorps, 2012).

However, until recently (Wells, Myers, Henderson, 2014b)[1], the possible influence of school gardens on healthy eating has received considerable attention (McAleese & Rankin, 2007; Morris & Zidenberg-Cherr, 2002), the potential for school gardens to also affect children's physical activity has been underappreciated. School gardens may boost physical activity levels by increasing children's time outdoors, which has consistently been shown to be positively associated with physical activity levels (Sallis, Prochaska, & Taylor, 2000) and by promoting various physical movements and motions necessary to garden. Thereby, school gardens may help to displace sedentary behavior among children during the school day by providing time and space for active learning opportunities.

In recent years, new tools have been developed to systematically observe children's physical activity levels in a variety of contexts such as physical education classes, before, during, and after school, on playgrounds, and in community parks and recreational spaces (McKenzie, 2010). However, because of the unique characteristics of gardening, no extant observational tool is appropriate to capture children's physical movements, postures, and motions that take place in a garden. The uniqueness of gardening derives from the frequency of upper-extremity movements

[1] PARAGON was developed as part of the Wells, Myers, Henderson 2014b study and was used therein.

(e.g., digging with a trowel) and weight-bearing activities (e.g., carrying a bag of soil) (Welk, 2002) that occur in concert with activities involving moderate and vigorous PA. Accelerometry is a partial fit to capture garden activities but accelerometry's limited capacity to capture some muscle- and bone-strengthening physical activities common in gardening make it an imperfect measure of some aspects of gardening-based physical activity (i.e., certain types of MPA and VPA). Similarly, extant direct observation tools commonly used to observe physical activity (McKenzie, 2010; McKenzie et al., 1991) in various settings lack specific codes for the contextual characteristics of gardening. There is a need to develop a tool to directly measure children's physical activity in gardens.

The Physical Activity Research & Assessment tool for Garden ObservatioN (PARAGON) was developed to operationalize physical activities that take place while gardening in order to address three needs: 1) to fill the contextual gap in existing direct observation tools; 2) to capture the conditions of gardens as a unique environmental intervention to promote children's physical activity and movement and 3) to provide community organizations and researchers with a cost-effective tool to record and evaluate contextual characteristics of garden interventions as a strategy to promote physical activity. The availability of a valid and reliable tool to measure children's physical activity while gardening may facilitate the implementation, evaluation, and improvement of gardening as an environmental strategy to promote children's health.

The current study had three aims: a) to document the development of a systematic observation tool to quantify children's physical activity and movements while gardening b) to assess the test-retest and inter-rater reliability of PARAGON as a measure of children's physical activity levels and movement in school gardens; and c) to assess the validity of the physical activity codes of PARAGON.

METHODS

Observation instrument

PARAGON was developed to observe and record children's physical activity levels, gardening tasks, postures, social associations, and interactions while gardening. The tool was designed for a variety of settings in which children garden, including school gardens, community gardens, and home gardens. PARAGON uses a momentary time sampling technique in which a trained observer repeatedly observes a focal child for 15 seconds and then records the behavior during a 15-second recording interval.

Categories & codes

During each recording interval, the trained observer codes across five categories: physical activity level, garden tasks, garden motions, social associations, and interactions (Figure 2.1) using the recording form (Figure 2.2). For each interval, the observer chooses one of the *seven physical activity codes* (i.e., lying, sitting, standing, walking, vigorous, kneeling, or squatting) and one of the *nine garden tasks* (i.e., cleaning, carrying, digging, harvesting, watering, planting, weeding, resting / observing, or other (none garden related)). Taking into account the possible motions that are necessary to perform various gardening tasks, the observer chooses up to three of the *six garden motions* per interval (i.e., bending, gripping, stretching, lifting, pushing / pulling, or none). The *social context* of the garden is also observed and coded across two categories: social associations, and verbal as well as non-verbal interactions. The observer codes all that applied in regard to the *social associations* a child encounters while gardening (i.e., no others (completely alone), other children, other adults, parents or family members, and teachers). Finally, anytime during the 15-second observation period, the observer codes *verbal or non-verbal interactions* related to physical activity (promoting physical activity, inhibiting physical activity, or none).

Five of the seven physical activity codes have been previously validated (McKenzie et al., 1991; Rowe, Schuldheisz, & vanderMars, 1997) against heart-rate monitors and accelerometry. The other two physical activity codes (kneeling and squatting) as well as the garden task and garden motion codes were added based on observational studies with older adult gardeners (Park, Shoemaker, & Haub, 2008; Park & Shoemaker, 2009), to take into account the specific context of gardening. The garden motion codes also were adapted from ergonomic assessments measuring body postures and motions (Hignett & McAtamney, 2000; McAtamney & Corlett, 1993).

Category	Description
1.0 Activity Level 1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	Provides an estimate of the intensity of the child's physical activity. Codes 1 to 4, and& 6, 7 (lying down, sitting, standing, walking, kneeling, squatting) describe the body position of the child. Code 5 (vigorous) describes when child is expending more energy than during ordinary walking. (Code One)
2.0 Tasks C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing O. Other	Describes tasks related to activities a child might directly engage in, whether physical active or sedentary. (Code one)
3.0 Motions B. Bending G. Gripping S. Stretching/ Reaching L. Lifting P/P. Pushing/Pulling N. None	Identifies motions utilized while carrying out tasks. (Code maximum of three. NOTE: Only code "None" when child is not interacting with another object or within space)
4.0 Associations NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	Identifies persons in the child's environment at the end of the observation interval. (Code all that apply)
5.0 Interactions P. Promotes PA I. Inhibits PA N. None	Identifies teacher / adults verbal or nonverbal interactions to promote physical activity during the "observe" interval. (Code one)

Adapted from BEACHES Protocol

Figure 2.1 Categories, codes, and descriptions of PARAGON

Child's Name:	Gender: B / G	School Name:	Date:
Temperature: ________	Total Time (mins): ______	Total # of Students: ________	Total # of Adults: ________

*Interval	1.0 Activity Level (ONE)	2.0 Tasks (ONE)	3.0 Motions (THREE MAX)	4.0 Associations (All That Apply)	5.0 Interactions (ONE)
1	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
2	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
3	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
4	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
5	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
6	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
7	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
8	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
9	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
10	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
11	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
12	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
13	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
14	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
15	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
16	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
17	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
18	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
19	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
20	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
21	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
22	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
23	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
24	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
25	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
26	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
27	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
28	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
29	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
30	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
31	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N
32	1 2 3 4 5 6 7	Cl Ca D H $H^{2}O$ Pl We R O	B G S L P/P N	NO OC OA P T	P I N

*15 s observe/15 s record for 4 minutes per child (32 epochs = 16 observed mins)

Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	C. Cleaning Ca. Carrying D. Digging H. Harvesting $H^{2}O$. Watering Pl. Planting We. Weeding R. Resting/Observing O. Other	B. Bending G. Gripping S. Stretching L. Lifting P/P. Pushing/Pulling N. None	NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	P. Promotes PA I. Inhibits PA N. None

Physical Activity Research & Assessment tool for Garden ObservatioN **(PARAGON)** | **OBSERVER:**

Figure 2.2. Physical Activity Research Assessment tool for Garden ObservatioN (PARAGON) direct observation recording form

Observer training (20-25 total training hours)

Observer training comprises four training phases and one retraining phase (Figure 2.3.). Phase I: memorization of contextual categories and codes by studying list (see Figure 2.1.); Phase II: coding practice using still images; Phase III: coding practice using video and; Phase IV: field observation in garden; and Phase V: Retraining.

In Phase I, observers spent approximately two to four hours memorizing all categories and codes. Then the observers completed an assessment to ensure that 100% of the categories and codes were memorized. Phase II required the observers to practice coding by viewing still images. Observers watched a still image PowerPoint presentation (32 images) and completed three recording forms. Observers moved onto Phase III after they completed the three forms with 80-85% accuracy. Phase III also required the observers to continue practice coding, but by viewing a video of children gardening. As a result of the faster speed and more real-life scenarios, Phase III took observers about two to four hours to complete. During Phase II and Phase III, group meetings were held to discuss any discrepancies in coding and decisions were made regarding the criteria for coding to reach agreement on all code conventions. Once observers reached 85% - 90% inter-rater reliability in Phase III, they completed field observations (60 minutes) at a local school garden (Phase IV). During field observations, observers were observing the same children throughout the observation period. After a field observation, each epoch interval was examined to ensure all observers had correctly coded each category. For the field coding phase, inter-observer agreement criteria was set at >80% using interval-by-interval agreement for each category. Observers were considered "trained" when they reached the acceptable inter-observer agreement. Training across the four phases took a total of 20 to 25 hours total (about 3 to 4 weeks) for each observer to reach the acceptable inter-rater reliability (See Appendices A1-A37). Phase V, the retraining phase, was not used in the development of the measure, but would be employed as needed to retrain observers to ensure ongoing reliability.

PARAGON

Physical Activity Research & Assessment tool for Garden ObservatioN

PARAGON DIRECT OBSERVATION. A valid and reliable method by which trained observers objectively record children's physical activity (in a garden)

Tool: **PARAGON (P**hysical **A**ctivity **R**esearch & **A**ssessment tool for **G**arden **O**bservatio**N**)
Observation Time Period: 45 mins – 1 hour
Context: School Garden, Home Garden, or Community Garden.

TRAINING PHASES. In order to be prepared to collect direct observation data of children gardening, observers must successfully complete training Phases I through IV. Below, is a brief summary of the training phases.
[Phase V is retraining and continued training, as needed]

PHASE I. MEMORIZING CONTEXTUAL CODES (2 – 4 hours)
a. Memorize all PARAGON categories and codes
b. **Assessment:** Take "CODES" Assessment (100%) → Move on to Phase II

PHASE II. PRACTICE CODING - VIEW PPT STILL IMAGES (2 – 4 hours)
a. View the powerpoint still images and complete 3 recording forms
b. **Assessment:** Turn-in forms (to supervisor of training) to check reliability. Move on to Phase III when reach 80 - 85% correct.

PHASE III. PRACTICE CODING – VIEW VIDEO (4 hours)
a. View the video and complete 3 recording forms
b. **Assessment:** Turn-in forms to (to supervisor of training) to check reliability (move on to Phase IV when reach 80 - 85% correct).

PHASE IV. FIELD OBSERVATION + CODING (As many hours as necessary to reach 80 – 85%)
a. **Field observations –** schedule field observations of children gardening
b. Assessment: Turn-in forms (to supervisor of training) to check inter-rater reliability among partners (move on when reach 85% correct). **Once complete Phase IV with 80 – 85% reliability, ready to collect data in schools. NOTE:** If have not reached 80 - 85% correct – continue to **Phase V**.

PHASE V. RETRAINING / CONTINUED FIELD OBSERVATION
a. Use as needed to retrain or continue field observation until all observers reach 80-85% correct.
b. Assessment: Turn in forms to (to supervisor of training) to check reliability (move on when reach 85% correct). Once reached 80 - 85% - ready to collect data.

Figure 2.3. Training phases (I – IV) and retraining phase (V) of PARAGON

Settings & observation schedule

Data were collected at four elementary schools between May and June, 2012. Trained observers conducted direct observation in the school garden with children wearing tri-axial accelerometers (ActiGraph, GT3X+) on their right hip, on two consecutive days (total = eight days). The average observation period was 60 minutes. The average temperature was 68 degrees Fahrenheit.

Observation data were collected by eight trained observers (including the primary author). On each observation day, four children were observed by each observer. Over the eight days of observations, a total of 65 children were observed, with an average of 30 30-second epochs for each child, yielding an average of 15 total minutes of observation per child. Thirty second epochs were used to take into account children's sporadic physical activity levels (Bailey, et al., 1995). The institutional review board at the researchers' University approved the research protocol.

Reliability

To address the reliability of PARAGON as a measure of children's physical activity levels and movement in school gardens (aim b), reliability was measured in two ways: test-retest and inter-rater. To examine test-retest reliability, all seven observers watched a 16-minute video and independently coded 32 epochs. Two weeks later, all seven observers watched the video and repeated the coding for the same 32 epochs. Test-retest reliability was calculated for both the overall average and each of the five categories.

To establish inter-rater reliability, six field reliability checks were conducted in which two observers simultaneously observed and recorded activities of the same focal child, for 24 epochs. We calculated both percent agreement and Ebel because although percent agreement is a commonly used measure of reproducibility, it does not adjust for agreement expected by chance

(Hunt, 1986). Ebel's intraclass correlation takes chance agreement into account by considering both true variance and error variance (Ebel, 1951).

Validity

Concurrent validity is a type of criterion-related validity and is often used to validate a new test by establishing how well a specific measure correlates with a previously validated measure (Kerlinger, 2000; Ghiselli, Campbell, & Zedeck, 1981). In concurrent validity, the two measures can be for the same construct or for a slightly different but related construct. As mentioned earlier, five primary physical activity codes (lying, sitting, standing, walking, vigorous) used in PARAGON have been previously validated in studies using heart-rate monitors and accelerometers (McKenzie et al., 1991; Rowe, Schuldheisz, & vanderMars, 1997). For example, laboratory studies conducted with 19 young children ($r = .80$, $p<.01$) and 173 first through eighth graders ($r = .91$, $p<.01$), found that heart rate monitoring was highly correlated with physical activity codes. In field studies, among 56 third, fourth, and fifth graders, the five physical activity codes were also significantly correlated with average heart rate ($r = .61$) and with TriTrac accelerometers ($r = .61$) (Trost, Ward. Moorehead, Watson, Riner, & Burke, 1998).

ActiGraph GT3X+ tri-axial accelerometers were used in this study, as a criterion for concurrent validity. We expected strong correspondence between PARAGON and accelerometry for sedentary and light PA and given accelerometry's limitations capturing some types of more intense PA, less convergence between the two measures with respect to moderate and vigorous PA, with accelerometry yielding lower physical activity levels. Only physical activity levels were validated in this paper. The other categories of the PARAGON derived from previously used physical activity direct observation tools (McKenzie, 2010; McKenzie et al., 1991; Park, Shoemaker, & Haun, 2008; Park & Shoemaker, 2009) and ergonomic assessments (Hignett &

McAtamney, 2000; McAtamney & Corlett, 1993) are not examined here.

Field Validity.

The following steps were taken to validate PARAGON with accelerometry data, for each child. All children observed in the garden were concurrently wearing tri-axial accelerometers. First, time-stamped accelerometry data were matched with start and stop times for each observed child. Children's proportion of physical activity categories were calculated by summing the PARAGON activity codes for each 15-second interval observed (1 = lying, 2 = sitting & kneeling, 3 = standing & squatting, 4 = walking, 5 = vigorous). Second, paired t-tests were conducted to examine whether there is a difference between the PARAGON estimates of physical activity categories and the accelerometry categories (sedentary, light PA, moderate PA, vigorous PA, and MVPA). To provide additional insight regarding the correspondence of PARAGON observational data and accelerometry, interval-by-interval PARAGON activity codes were correlated with accelerometry data (using accelerometry categories based on Evenson cut-points) (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008). Evenson child-specific cut-points were chosen based on research exploring five independently developed ActiGraph cut-points (Freedson/Trost, Puyau, Treuth, Mattocks, and Evenson) (Trost, Loprinzi, Moore, & Pfeiffer, 2011). These five different cut-point recommendations were evaluated to determine the accuracy of classifying physical activity intensities. The study used indirect calorimetry as a criterion reference and found the Evenson (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008) and Freedson/Trost (Freedson, Pober & Janz, 2005; Trost, Way & Okely, 2006) cut-points had significantly better classification for all four PA intensities (sedentary, light PA, moderate PA, and vigorous PA) compared to Puyau, Treuth, and Mattocks (Puyau, Adolph, Vohra, & Butte, 2002; Trueth, et al., 2004; Mattocks, et al., 2007). Moreover, *only* the Evenson cut-points had acceptable classification accuracy for all four levels of PA intensities, *among children of all ages*. Therefore, it was recommended that researchers use Evenson ActiGraph cut-points, for children and adolescents (Trost, Loprinzi, Moore, & Pfeiffer, 2011). The Evenson cut-points for 30-second epochs[2] are based on activity counts per minute (CPM) and are the following: sedentary = 0 – 50 CPM; light =51 - 1147 CPM; moderate = 1148 – 2005 CPM; vigorous = 2006 and greater CPM.

RESULTS

The results of the three study Aims are presented below: (a) to document the development of PARAGON to quantify children's physical activity levels, movement, postures, and social associations while gardening; (b) to assess test-retest and inter-rater reliability of PARAGON; and (c) to assess PARAGON's concurrent validity.

Development of the Tool: Aim A.

This section summarizes Aim A, the descriptive statistics documenting the development of a systematic observation tool to quantify children's physical activity levels, movement postures, and social associations while gardening. Sixty-five children (27 boys, 38 girls) were observed outdoors during school gardening activities. Concurrently, all 65 children observed wore GT3X+ accelerometers.

Physical Activity Codes. Table 2.1. shows the percentage of time children spent, according to PARAGON, across the seven physical activity codes (lying, sitting, standing, walking, vigorous, kneeling, and squatting). The greatest proportion of garden time was spent standing (43.20%, ±25.07%). According to PARAGON, children walked approximately 10.68%, ±10.54% of the garden time and children were kneeling for 14.81, ±19.71% and squatting for 6.74%, ±11.75%.

[2] 30-s epochs are commonly used for children ages 6 to 11 years old, while 15-s epochs are used for younger children (1 to 5 years old).

Table 2.1. Mean Proportion of Time Spent in Overall Physical Activity, Garden Tasks, Garden Motions, Associations and Interactions While Gardening

	All Children (n=65)		Boys (n=27)		Girls (n=38)	
	Mean (%)	**SD**	**Mean (%)**	**SD**	**Mean (%)**	**SD**
PA Levels						
Lying	1.82	5.19	2.51	6.81	1.34	3.65
Sitting	22.92	28.59	15.60	20.00	28.12	32.65
Standing	43.20	25.07	42.77	20.53	43.50	28.12
Walking	10.68	10.54	13.91	12.05	8.38	8.78
Vigorous	1.46	3.63	1.72	4.63	1.27	2.77
Kneeling	14.81	19.71	18.25	19.37	12.37	19.84
Squatting	6.74	11.75	9.16	14.27	5.02	9.40
MVPA[a]	12.14	11.24	15.63	12.53	9.66	9.64
Garden Tasks						
Cleaning	1.03	2.59	0.54	1.97	1.38	2.93
Carrying	2.19	4.19	1.84	4.13	2.44	4.27
Digging	6.28	8.94	6.36	8.11	6.22	9.60
Harvesting	0.10	0.05	0.23	0.88	0.00	0.00
Watering	1.30	4.28	0.15	0.80	2.11	5.43
Planting	4.01	8.17	3.51	6.57	4.37	9.21
Weeding	0.90	3.85	1.89	5.68	0.22	1.35
Resting / Observing	69.98	25.22	70.20	26.99	69.82	24.25
Other	15.82	17.42	19.18	17.40	13.44	17.27
Garden Motions[b]						
Bending	24.18	18.72	23.20	20.84	24.87	17.32
Gripping	65.15	24.93	68.33	26.69	62.88	23.70
Stretching	39.38	33.91	37.34	33.92	40.83	34.29
Lifting	6.13	9.42	5.12	9.04	6.86	9.73
Pushing / Pulling	4.89	8.38	5.60	9.53	4.39	7.55
None	19.46	22.83	21.62	25.83	17.93	20.65
Social Associations						
No Other Children	1.93	4.41	1.89	3.54	1.96	4.99
Other Children	93.38	16.96	96.92	17.27	90.87	16.51
Other Adults	58.06	32.05	56.97	34.31	58.83	30.79
Parent / Family	0.00	0.00	0.00	0.00	0.00	0.00
Teachers	54.34	30.25	56.50	28.79	55.82	28.48
Interactions						
Promoting PA	9.38	11.88	8.98	14.72	9.66	9.58
Inhibiting PA	2.03	3.81	2.54	4.14	1.67	3.57
None	90.21	17.09	92.39	22.75	88.67	11.64

Contextual Variables. As described earlier, in addition to coding the seven physical activity levels, each 30-second epoch also included contextual variables. The contextual variables were garden tasks, garden motions, social associations, and interactions. These four contextual variables are explained below.

Garden Tasks. Among the nine garden tasks (i.e., cleaning, carrying, digging, harvesting, watering, planting, weeding, resting / observing, and other) the most prevalent was 'resting and / or observing' (69.98%, ±25.22%). For example, resting and observing were coded when a child was listening to his or her teacher's instructions or when the child was observing a plant. 'Other' was coded when a child was not performing any task related to gardening (15.82%, ±17.42%). Digging was observed 6.28%, ±8.94% of the time children were gardening.

Garden Motions. Among the six garden motions (i.e., bending, gripping, stretching, lifting, pushing / pulling, and none), gripping was the motion children engaged in most often, while gardening (65.15%, ±24.93%) followed by stretching (39.38%, ±33.91%), which consisted of any time the child was reaching with his or her upper-body. Children only spent approximately 6.13% lifting and 4.89% pushing and or pulling during the observed gardening time.

Social Associations. Social associations were coded to determine what people were involved with the child during the observed time in the garden. Approximately 93.38%, (±16.96%) of the observed time, there were other children (classmates) associated with the observed child. In addition, children were engaged with teachers 54.34% (±30.25%) of the time and with other adults 58.06% (±32.05%) of the time.

Interactions. Verbal and non-verbal interactions were coded in three ways: promoting physical activity, inhibiting physical activity, or none. Since all gardening took place in a context with other children, teachers, and other adults present, there was an opportunity to capture how often children's physical activity was promoted or inhibited while gardening. Examples of promoting cues are teachers saying, "Keep on digging!" or "Run over here and see what we found."

Verbal cues were easier for observers to hear, however, non-verbal promoting and inhibiting interactions were also taken into consideration. A non-verbal interaction would be coded if it was clear the behavior exhibited by a teacher, adult, or student had a direct impact on the physical movement of the observed child. Physical activity-promoting non-verbal interactions were examples such as a teacher bringing over a shovel to a child who was previously standing still. An inhibiting non-verbal interaction may be a child kicking dirt so it directly stopped the action of a classmate.

Teachers or adults were found promoting physical activity in the garden a total of 9.38% (±11.88%) of all observed time. Inhibiting interactions were phrases such as "stand still" or "put your tools down." Only 2.03%, ±3.81%) of the time, adults and teachers were found inhibiting children's physical activity while gardening. Most of the time (90.21%, ±17.09%) adults and teachers were neither promoting nor inhibiting physical activity.

Moderate-to-Vigorous Physical Activity.

The proportion of time children spent being sedentary, and engaged in light, and moderate-to-vigorous physical activity (MVPA) was also examined (Table 2.2.). Sedentary activity was defined as PARAGON codes of lying, sitting, kneeling. Light physical activity was defined as standing and squatting while moderate was walking, and vigorous was any activity expending more energy than walking. MVPA was defined as walking and vigorous.

The mean percentage (±SD%) of time spent in MVPA for all children while gardening was 12.14%, (±11.24%). Boys spent an average of 15.63%, (±12.53%) in MVPA while girls spent approximately 9.66%, (±9.64%) in MVPA. Typically, garden lessons were 60 minutes in duration; so, on average, children participated in approximately 7 minutes of MVPA during the one-hour lesson. Boys ($\bar{x}$ = 9 minutes) spent more minutes in MVPA than girls ($\bar{x}$ = 6 minutes). Children spent approximately 39.55%, (±27.56%) of their gardening time being sedentary. Girls were more sedentary than boys (41.82%, (±31.69%) and 36.35%, (±20.55%) respectively). Children engaged in light physical activity 49.94%, (±25.47%) of their time gardening. Boys and girls spent nearly the same amount of time in light PA (51.93%, (±17.37) for boys; 48.52%, (±30.09) for girls).

Table 2.2. Mean Proportion of Time Spent Sedentary and in Light and Moderate-Vigorous Physical Activity While Gardening At-School

	All Children n=65		**Boys n=27**		**Girls n=38**	
	Mean (%)	**SD**	**Mean (%)**	**SD**	**Mean (%)**	**SD**
PA Levels						
Sedentary	39.55	27.56	36.35	20.55	41.82	31.69
Light PA	49.94	25.47	51.93	17.37	48.52	30.09
MVPA	12.14	11.24	15.63	12.53	9.66	9.64

a. MVPA (moderate-to-vigorous physical activity)

Reliability: Aim B

The test-retest reliability was based on seven observer's overall averages across all five categories (r = .94). The test-retest reliability was also calculated for each of the five categories: activity (r = .97, tasks (r = .52), motions (r = .93), associations (r = .64), interactions (r = .90).

Inter-rater reliability also met acceptable levels. The overall percent agreement for PARAGON was 88% and Ebel was .97. Interval-by-interval agreement for each category was calculated (physical activity 93%, garden tasks 93%, garden motions 80%, social associations 95%, and interactions 91%).

Validation Data: Aim C

Table 2.3 shows the percentage of time spent in physical activity levels (sedentary, light, moderate, vigorous) measured by direct observation and by accelerometry. Paired t-test analyses indicated that the percentage of time children spent in sedentary and light physical activity levels were not significantly different, based on PARAGON (39.52%, 48.62%) versus accelerometry (44.12%, 52.47%) (t(64) =-1.48, *p*=.144; t(64) =-1.15, *p* =.255 for sedentary and light activity respectively). However, moderate physical activity, vigorous physical activity, and thus MVPA were found to be significantly different between PARAGON versus accelerometry measures (10.40%, 3.01%; 1.46%, 0.40%; 11.87%, 3.41%; respectively) (t(64)=5.91, *p*<.001 t(64)=2.79, *p*<.001; t(64)=7.16, *p*<.001 for moderate, vigorous, and MVPA respectively). As anticipated, more moderate, vigorous, and moderate-to-vigorous physical activity was detected by the PARAGON direct observation tool than by accelerometry.

Table 2.3. Percentage of Time Spent in Physical Activity Levels Measured by Time-Stamped Direct Observation and Accelerometry

	Direct Observation		**Accelerometry**		
	Mean (%)	**SD**	**Mean(%)**	**SD**	***p***
PA Levels					
Sedentary	39.52	27.09	44.12	25.09	.144
Light PA	48.62	25.39	52.47	23.17	.255
Moderate PA	10.40	10.21	3.01	4.84	< .001
Vigorous PA	1.46	3.64	0.40	1.46	.007**
MVPA[a]	11.87	10.97	3.41	5.71	< .001

a. MVPA (moderate-to-vigorous physical activity) **p<.01.

Sedentary *t*(64)=-1.478; LPA *t*(64)=-1.149. MPA *t*(64)=5.907. VPA *t*(64)=2.794. MVPA *t*(64)=7.159.

DISCUSSION

Interpretation

PARAGON is a reliable measure for observing children's physical activity in the garden. After extensive training, test-retest reliability and inter-rater reliability were established across all five categories of the direct observation tool. By following consistent training phases (memorization of codes, practice coding on still images and video, and field coding) individuals were able to learn the necessary procedures to become trained observers and collect data using this direct observation tool.

This direct observation tool is also a valid measure of physical activity levels while gardening and adds important contextual factors and systematically observes weight-bearing physical activities. While many weight-bearing activities, such as running or jumping, have been accurately captured by accelerometers (Garcia, Langenthal, Angulo-Barroso, & Gross, 2004), the weight-bearing nature of certain garden activities such as digging and lifting may be relatively imperceptible through accelerometry. In addition to being grounded by five previously validated physical activity codes (McKenzie et al., 1991; Rowe, Schuldheisz, & vanderMars, 1997), the validity of PARAGON was established by pairing time-stamped accelerometry with direct observation intervals.

As expected, there were no significant differences between sedentary behavior or light physical activity as measured by PARAGON and accelerometry. However, as anticipated, some divergence was found between direct observation and accelerometry for moderate and vigorous PA. PARAGON measured more moderate and vigorous PA (and MVPA) than did accelerometry. Much of the MVPA coded by directly observing may be attributed to weight-bearing garden activities such as vigorously digging or heavy lifting while walking and is consistent with prior evidence indicating accelerometry's limited capacity to capture certain types of MVPA (Garcia, Langenthal, Angulo-Barroso, & Gross, 2004).

Strengths

This is the first study to present a valid and reliable systematic observation method for the direct observation of physical activity while gardening. The method was developed to capture the unique characteristics of gardening physical activities that are not thoroughly captured by measures such as accelerometry. The PARAGON is a cost-effective direct observation tool that has the potential to be utilized by community organizations, researchers, and school systems. Objective measures of children's physical activity are increasingly important to inform social and environmental interventions to decrease children's sedentary behaviors and increase physical activity levels. However, objective measures, such as accelerometry, on a large scale, can be expensive.

PARAGON is practical and user-friendly for communities and schools. Providing a tool to systematically measure the impact of gardening on physical activity may enable programs to fund local initiatives to support children's health and well-being. Researchers, community organizations, teachers, and after-school staff can be trained to use the PARAGON to determine how and under what circumstances the garden intervention impacts children's physical activity.

Limitations

There currently is no true 'gold standard' against which to compare the PARAGON direct observation tool. While accelerometry is an objective measure, it is imperfect due to its limitations as noted previously. Having children wear heart-rate monitors or measuring oxygen consumption (VO_2), while gardening, may be a way to further validate this tool.

Another limitation of this study concerns generalizability. The observations were conducted among fourth and fifth graders at low-income, public elementary schools within New York State and may not generalize to other age groups or contexts. In addition, the children were part of a larger study and therefore the size and type of gardens were similar across schools, with little variability.

Implications

Given the increase in the number of gardens planted as a strategy to improve children's health there may be opportunities for evaluative studies measuring physical activity and gardening. Teachers and school staff members who build a school garden can determine under what conditions children engage in the most physical activity (e.g., student-to-teacher ratios, specific tasks, weather conditions, lesson types, etc.). For example, the most prevalent garden task observed was 'resting and / observing' (69.98%, ±25.22%). This could be a result of large student-to-teacher ratios (mean = 20:1) and relatively small garden bed sizes. Perhaps smaller class sizes or larger garden beds would yield greater physical activity levels.

Future research

As more children become exposed to gardening through community and school gardening programs, it will be important to systematically understand how and under what conditions gardening improves children's physical health. Future applied research might investigate various aspects of the connection between gardening and children's health. For example, PARAGON could be employed to study gardening and fitness components (beyond body composition); the ergonomics of gardening to assess garden tool design to ensure children are gardening safely and not susceptible to injury. In addition PARAGON would be further developed and validated for use with age groups beyond childhood.

The CDC recommends three days per week of time spent in bone-bearing, or strength-based activities (as part of the 60 minutes a day of physical activity) (CDC, 2011). Because gardening engages the total body, the PARAGON could be used in future research to determine how and under what conditions gardening may affect other important, and often understudied, components of children's fitness, such as muscular strength, muscular endurance, and flexibility.

In addition to measuring children's physical activity, the PARAGON also systematically codes gardening postures and motions. These posture codes, such as 'bending', 'gripping', 'lifting', etc. may be used in studies to assess the ergonomics of children gardening. Studies investigating the ergonomics of gardening among older adults have been conducted (Park, Shoemaker, & Haub, 2008; Park & Shoemaker, 2009) and have been important to assess the potential postural risks associated with gardening. No study has investigated the ergonomics of children's gardening and such a study may help to determine the optimal environmental design of gardens (and tools) by taking into account such things as the height of garden beds, tool design, and frequency of tasks and movements.

The development of the valid and reliable direct observation tool for measuring children's physical activity while gardening may help to inform gardening interventions that aim to improve children's health and well-being. Gardening is an activity that can carry from childhood throughout the life course and may be a strategy to promote healthy habits in childhood and beyond.

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CHAPTER 3

CHILDREN'S PHYSICAL ACTIVITY IN OUTDOOR FREE-LIVING ENVIRONMENTS

ABSTRACT

Objective. This within-subjects study examines the effects of playground type (adventure playground versus conventional playground) on children's physical activity (PA) levels.

Methods. Data were collected over twelve 60-minute observation periods (six in the adventure playground and six in the conventional playground) over six weeks in 2014. The sample was 40 children, 19 boys and 21 girls, from a Central New York summer camp program. The children ranged from kindergarten to third grade (aged 5 to 10 years old). Children's physical activity levels were measured in two ways: accelerometry and direct observation.

Results. The effect of playground type on PA levels differed by measure. Accelerometry and direct observation tell different stories. Accelerometry data indicated that children were *more active* (more time in VPA and MVPA and less time in light PA) *in the conventional playground* than in the adventure playground. However direct observation indicated the opposite; that children were *more active* (more time in MPA and MVPA and less time in sedentary*) in the adventure playground* than in the conventional playground. Accelerometers may underestimate children's moderate physical activity, in both settings, while direct observation appeared to overestimate children's sedentary behaviors in the conventional playground, and may not have accurately measured short burst of children's vigorous PA.

Conclusions. During active free play outdoors, using only one measure for children's physical activity may not be sufficient. More research may be needed to determine the most effective ways to measure PA and the varied movements children spontaneously and continually perform in outdoor free-living environments (e.g. playgrounds).

INTRODUCTION

Over the life course, physical activity (PA) is beneficial to human health and well-being and has shown to be a protective factor against chronic diseases such as cardiovascular disease, obesity, and diabetes (Reiner, Niermann, Jekauc, & Woll, 2013). People who are physically active show fewer depressive symptoms, take less medication, and recover faster from illness, leading to a higher quality of life (Cardon et al., 2007; Paluska & Schwenk, 2000). Moderate and vigorous physical activity in childhood and adolescence is linked to greater bone mineral density, known to protect against the adult onset of osteoporosis (Boreham & Riddoch, 2001; Fletcher et al., 1996; Pate, Pratt, Blair, & et al., 1995). However, despite the health benefits of physical activity (Reiner, Niermann, Jekauc, & Woll, 2013), only 42% of school-aged children (aged 6 to 11) meet the recommended 60-minutes of moderate-to-vigorous physical activity, on most days (Troiano et al., 2008). Decreasing levels of PA among children has been shown to adversely affect mental and physical health outcomes (Gortmaker, 1985; Perrin, Bloom, & Gortmaker, 2007) and disproportionately affect low income and ethnic minority children (Whitt-Glover et al., 2009).

Environmental justice and physical activity

Given the disproportionate health burden of physical inactivity among low income and ethnic minority children, an environmental justice framework has recently been considered a useful tool for eliminating health disparities and inadequate levels of PA. The first wave of the environmental justice movement was concerned with the disproportionate burden of adverse health outcomes posed by environmental hazards and toxins (e.g. air and water pollution, land fills, chemical dump sites) disempowered communities were forced to withstand (Bullard, 1994; Taylor, Floyd, Whitt-Glover, & Brooks, 2007; Taylor, Poston, Jones, & Kraft, 2006). However, as there has been increased focus on the role of environments for health promotion is emerging, especially to influence PA behavior change (Perdue, et al., 2003; Pate, 1995) a 'second wave' of the environmental justice movement has been developing and posits that differential levels of PA among low income and ethnic minority children compared to higher income, white children, may be a result of an unequal distribution in the number and quality of environmental amenities (e.g. parks and playgrounds) to promote PA (Bullard, 1994; Taylor et al., 2007; Taylor et al., 2006; Cutts, Darby, Boone, & Brewis, 2009). Out-of-school time (OST) environments may provide significant reach and a promising place of intervention to promote children's PA, especially among low-income and ethnic minority children.

Out-of-school time: Promising place of intervention

Out-of-school time (OST) environments are considered to be influential places to intervene to promote children's PA, health and well-being, (Trost, Rosenkranz, & Dzewaltowski, 2008). Over the past decade in the United States, children's participation in OST programs (specifically afterschool from 3pm to 6pm) has steadily increased from 6.5 million children (11%) in 2004 to 10.2 million children (18%) in 2014 (Afterschool Alliance, 2014). Participation in OST programs was about 2% greater among low income children compared to high income children while the demand to participate in OST programs (if they were available) was 16% greater among low income children (50%) compared to high income children (34%) (Afterschool Alliance, 2014). African-American and Hispanic children were two times more likely to participate in an OST program compared to White children; about 29% of Hispanic, 24% of African-American participated in OST programs compared to 12% of white children. The demand to participate in OST programs, self reported by parents and families, was also higher among Hispanic (57%) and African-American (60%) children compared to only a 35% demand among white children (Afterschool Alliance, 2014). Therefore, as a result of the large number of low income and ethnic minority children participating in OST programs as well as the steady increase in the demand for such programs, the OST environment presents a unique opportunity to reduce health disparities through increasing programs and places for children to be physically active.

While OST programs to influence PA have been frequently studied, the focus has been on programmatic features (Gortmaker et al., 1999; Choudhry et al., 2011; Story et al., 2003; Beets, Beighle, Erwin, & Huberty, 2009; Dzewaltowski et al., 2010) with little research investigating the design of the physical environment of OST (Borradaile et al., 2009; Coleman, Geller, Rosenkranz, & Dzewaltowski, 2008). The inclusion of the physical environment's role in OST (specifically the role of the outdoor OST environment) may be potent strategy to promote PA and decrease disparities in PA. Time outdoors has been consistently positively associated with children's PA (Sallis, Prochaska, & Taylor, 2000). Children's physical activity is triggered by spending time outdoors, in part because outdoor environments typically contain more natural elements that provide greater complexity and maneuverable materials (loose parts) – which all synergistically provide children with more challenging and engaging opportunities to move (Gallahue & Ozmun, 1995; Nicholson, 1972). Outdoor environments may also provide children with a greater number of affordances (Gibson, 1977, 1979), such as trees, shrubbery, and varied topography, thereby encouraging children's movement (Boldemann et al., 2011).

Affordance theory and 'loose parts'

The central theoretical framework guiding this study is the theory of affordances (Gibson, 1977, 1979). Gibson posits that there are perceived physical properties in the environment that encourage people to act. Objects in the environment are perceived, in terms of the object's possibilities for action, known as an *affordance*. These affordances or 'action possibilities' exist in the environment, can be objectively measured, and lead people to action. In the context of outdoor play environments, affordances may motivate or 'afford' children to move and be physically active.

In addition to affordances, the theory of loose parts (Nicholson, 1972) will also be used to guide the study. Nicholson suggests that loose parts encourage children to change and manipulate their environment and consequently become more motivated to behave in a variety of ways. It is believed that fixed elements in outdoor play environments restrict children's ability to manipulate their environment and may discourage their movement (Blacksher & Lovasi, 2012). One study, with a small sample of twelve participants, found an increase in children's PA during outdoor time at school when loose parts were incorporated into recess time (Bundy et al., 2009). Figure 3.1. below shows examples of fixed play equipment in a conventional playground and loose parts in an adventure playground. Loose parts are integral to adventure playgrounds and can be thought of as affordances in the environment. Loose parts are any material or object that can be moved, carried, or manipulated by children. In natural environments, there are many loose parts that exist (e.g. pieces of wood, leaves, rocks, etc.).

Figure 3.1. Example of fixed-parts in a conventional playground (top photo) and loose-parts in an adventure playground (bottom photo)

Adventure playgrounds as OST environments

Adventure playgrounds may hold promise as an outdoor OST environmental strategy to promote PA and decrease disparities in PA by providing children with greater time outdoors, with natural elements and loose parts. Near the end of World War II, in 1943, a Danish landscape architect, Carl Theodor Sorenson, implemented his conceptualization of an ideal play environment for children, called "junk playgrounds", where children could use any kind of found materials to construct their own outdoor environment (Sorenson, 1931). After World War II, in 1946, the "junk playground" model was brought from Denmark to England by Lady Allen of Hurtwood, when she changed the name to "adventure playgrounds" (Allen of Hurtwood, 1968; Sorenson, 1931). As a direct result of the aftermath of WWII, Western European children reacted to the trauma of war by creating self-directed outdoor play environments or "adventure playgrounds", often located in recent bombsites and vacant lots, equipped with maneuverable materials or "loose parts" leftover from war (e.g. scrap metal, tires, and wood) (Benjamin, 1974), and by integrating many natural elements (e.g. trees, grass and shrubbery, dirt, and varied topography).

Within the context of OST and health disparities, investigating the influences of the design of playgrounds (adventure vs. conventional) on children's PA levels is important for three reasons. First, natural elements in outdoor play environments are associated with more PA among young children (aged 3 to 5) (Boldemann, 2011; Boldemann et al., 2006; Mårtensson et al., 2009; Fjortoft & Sageie, 2000; Cosco, Moore & Islam, 2010). Natural elements may be considered a kind of 'loose part' in that their purpose can be more imagined than fixed (Norman, 1990; Bundy et al., 2009; Gibson, 1977; 1979). Evidence suggests that young children (aged 3 to 5) with greater exposure to natural elements in their childcare outdoor play environments were more physically active, acquired more advanced motor coordination and balance compared to children who attended conventional childcare centers with fixed play equipment and limited exposure to natural elements (Boldemann, 2011; Boldemann et al., 2006; Mårtensson et al., 2009; Fjortoft & Sageie, 2000; Cosco, Moore & Islam, 2010). With the exception of the pioneering study transforming a school playground into a natural landscape or 'Environmental Schoolyard' (Moore & Wong, 1997) that was conducted in the United States among children (aged 6 to 11) the majority of studies investigating natural outdoor play environments and children's PA, focus primarily on childcare centers for young children (aged 3 to 5) (Boldemann, 2011; Boldemann et al., 2006; Mårtensson et al., 2009; Fjortoft & Sageie, 2000; Cosco, Moore & Islam, 2010) or school-aged children outside the United States. (Dyment, Bell, & Lucas, 2009; Dymnet & Reid, 2010). An adventure playground consisting of many natural elements and loose parts provides a promising environment and will fill a gap in evidence regarding the effects of nature and loose parts on physical activity, among children in middle childhood (aged 6 to 11).

Second, low-income and ethnic minority children have less exposure to natural outdoor play environments than their higher income children and white peers (Strife & Downey, 2009). Environmental inequalities such as limited accessibility to and availability of outdoor play environments among low-income, ethnic minority children may be contributing to the lower levels of PA (Strife & Downey, 2009). Studies show that low-income children are less likely to visit local parks and playgrounds and live further away from accessible outdoor play environments than higher-income children (Babey, Hastert, & Brown, 2007; Gordon-Larsen, 2006). However, insufficient evidence exists of the relationship between playgrounds and children's physical activity (Grow et al., 2008), especially among low-income, ethnic and racial minority children (Cradock et al., 2005). Studying the PA levels in an adventure playground, among low-income, ethnic minority children is needed to begin to identify potent intervention strategies to promote PA levels during out-of-school time.

Finally, although OST environments are considered to be influential places to intervene to promote children's PA, health and well-being, the study of OST environments and children's PA is lacking (Trost et al., 2008). The growing emphasis on creating healthy OST to affect positive health behavior changes in children and youth may be linked to the current educational climate of high-stakes testing which has decreased PA opportunities during at-school time (Linn, 2002; Jarrett, 2015). Decreasing recess time and physical education occurs most often in low-income schools and disproportionately affects African-American and Hispanic children, the very children who are the lowest performing academically and have the highest rates of obesity and chronic diseases (King & Sallis, 2009; Robert Wood Johnson Foundation, 2012). Studying the physical OST environment may help to inform salutogenic environmental design interventions to promote children's health and well-being, especially among low-income and ethnic minority children.

Current study

Few studies have considered how the environmental design of OST environments may promote children's physical activity in middle childhood. The present study aimed to measure children's physical activity, in two outdoor free-living environments (adventure playground and conventional playground). The current study examines the main effects of playground type (adventure versus conventional) on children's physical activity levels, measured by accelerometry and direct observation (sedentary and physical activity levels: light (LPA), moderate (MPA), vigorous (VPA), and moderate-to-vigorous (MVPA) (research questions 1a and 1b) and whether the playground type and PA relation differed by PA measure (research question 2). The main effects of gender on children's physical activity levels, measured by accelerometry and by direct observation, are also examined (research questions 3a and 3b) as well as whether gender and PA relation differed by PA measure (research question 4). Finally, the interaction effect of playground type and gender on physical activity is explored (research questions 5a and 5b).

METHODS

Participants and setting

The sample was 40 children from a Central New York summer camp program. Of the 40 school-aged children, 19 boys and 21 girls participated in the study. The children ranged from kindergarten to third grade (aged 5 to 10 years old). Children's active free play behaviors, social interactions, and gender-inclusive space use, were observed in two playground types: 1) a conventional playground and 2) an adventure playground. The conventional playground consisted primarily of metal and plastic fixed play structures while the adventure playground was mostly natural, with many loose parts.

Study design

In this within-subjects study design, the effect of two playgrounds on children's active free play behaviors, social interactions, and gender-inclusive space use were investigated. Data were collected over twelve 60-minute observational periods (six in the adventure playground and six in the conventional playground). Demographic data (e.g. gender, age, height and weight) were also collected and analyzed.

Constructs and measures: Independent variables

Playground type was used to operationalize the differing environmental characteristics of the outdoor environments. The two playgrounds types, conventional playgrounds and adventure playgrounds are described below:

1. Conventional Playground. The conventional playground was 17,621.50 square feet (Figure 3.2). The conventional playground consisted of asphalt, which included painted lines for two basketball hoops and a colorfully painted portion of the asphalt provided a path for games such as hop-scotch and four-square. In a third of the space, a large, multi-component fixed play structure (made of plastic and fiberglass) provided children with opportunities to climb, jump, run, and slide. In the center of the play space, there was a newly constructed fixed play structure, consisting of interconnecting climbing ropes. A few trees and spots of grass lined the perimeter and a vegetable garden was present along the far-end of the playground, next to the fence. Several basketballs and soccer balls were also provided during outdoor time (i.e. loose parts).

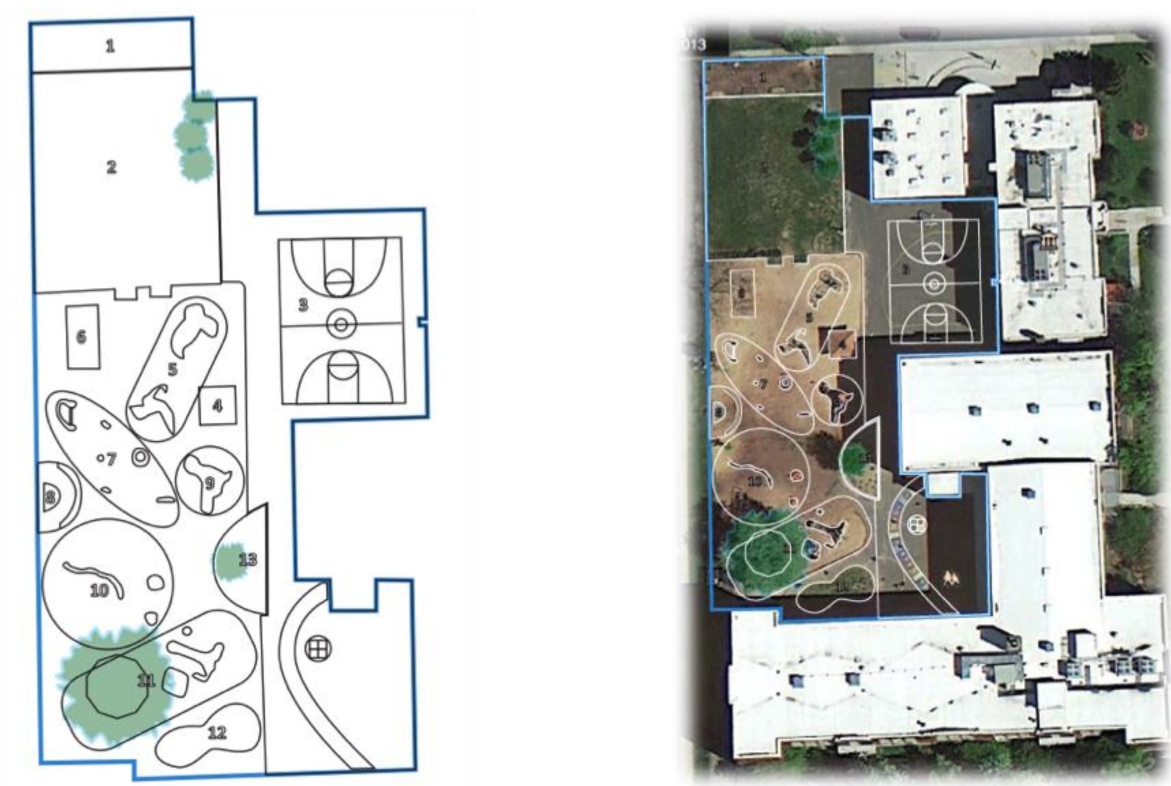


Figure 3.2. Map and aerial view of conventional playground (17,621.50ft^2)

2. Adventure Playground. The adventure playground was 12,444.12 square feet (Figure 3.3.). The adventure playground consisted almost equally of grass, dirt, hay, and wood-chips. About a third of the space was shaded by one large sycamore tree, used for climbing. In addition, children attached ropes and cloth to the lower branches for swinging. Hay piles had been spread out in the space, directly below and adjacent to the tree. In the center of the space, there were varying levels of mulch, grass mounds, and dirt piles. Adjacent to the dirt piles, were several over-sized tree stumps. A large winding tunnel, made of willow branches, provided a space to run through and hide in. Finally, a small shed stocked with numerous tools and supplies was made available to children for digging and additional loose-parts for playing.

Figure 3.3. Map and aerial view of adventure playground (12,444.12ft^2)

Construct and measures: Dependent variables

Physical Activity: Accelerometry.

Accelerometry, a validated objective measure of physical activity, was used to assess children's playground physical activity. In use with children, Actigraph accelerometer data are highly correlated with energy expenditure (r=.86, .87), oxygen consumption (r=.86, .87), heart rate (r=.77, .77) and treadmill speed (r=.90, .89) (Freedson & Miller, 2000; Trost et al., 1998). To account for children's sporadic physical activity patterns 30-second epochs were used (Bailey et al., 1995). All accelerometer data will be downloaded and scored using ActiLife6 software. To determine physical activity intensity levels (sedentary, light PA, moderate PA, vigorous PA, and MVPA) child-specific cut-points were used (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008; Stewart G Trost, Loprinzi, Moore, & Pfeiffer, 2011). Evenson child-specific cut-points were chosen based on research exploring five independently developed ActiGraph cut-points (Freedson/Trost, Puyau, Treuth, Mattocks, and Evenson) (Trost, Loprinzi, Moore, & Pfeiffer, 2011). These five different cut-point recommendations were evaluated to determine the accuracy of classifying physical activity intensities. The study used indirect calorimetry as a criterion reference and found the Evenson (Evenson et al., 2008) and Freedson/Trost (Freedson, Pober & Janz, 2005; Trost, Way & Okely, 2006) cut-points had significantly better classification for all four PA intensities (sedentary, light PA, moderate PA, and vigorous PA) compared to Puyau, Treuth, and Mattocks (Puyau, Adolph, Vohra, & Butte, 2002; Trueth, Schmitz, Catellier, 2004; Mattocks, Leary, Ness, et al, 2007). Moreover, *only* the Evenson cut-points had acceptable classification accuracy for all four levels of PA intensities, *among children of all ages*. Therefore, it was recommended that researchers should use Evenson ActiGraph cut-points, for children and adolescents (Stewart G Trost et al., 2011). The Evenson cut-points for 30-second epochs are based on activity counts per minute (CPM) and were determined to be the following: sedentary = 0 – 50 CPM; light =51 - 1147 CPM; moderate = 1148 – 2005 CPM; vigorous = 2006 and greater CPM.

Physical Activity: Direct Observation.

The System for Observing Children's Activity and Relationships During Play (SOCARP) (Ridgers, Stratton, & McKenzie, 2010) was previously developed to directly observe children's physical activity, social group sizes, play behavior types, social associations, and social interactions, during play. Estimated energy expenditure rates from SOCARP and mean accelerometer counts were significantly correlated ($r = .67$, $p < .01$) and percent agreement for all four categories met acceptable criteria (88% to 90%) (Ridgers et al., 2010). During each interval, the trained observers code across the five categories, and used a momentary time-sampling technique in which two trained observers repeatedly observed a focal child for 15 seconds and then recorded the behavior during a 15-second recording interval. For the present study, physical activity levels were used as outcome measures.

Demographic Variables. Gender, age, body-mass index (BMI) measured by height and weight, were also be measured, collected, and analyzed (CDC, 2000).

Procedure

In July and August 2014, children's physical activity levels were objectively measured by accelerometry and direct observation on six occasions for an average of 61 minutes each time, in each setting. Trained research assistants followed accelerometry protocols and conduct two observations per week, using SOCARP, for six weeks (one weekly observation in adventure playground and one weekly observation in conventional playground).

Analytic Strategy

Accelerometry data collected from both playgrounds were downloaded and scored using ActiGraph ActiLife 6 Software. Five variables were created from the data to represent the four levels of physical activity (sedentary, LPA, MPA, VPA) and MVPA was computed by summing MPA and VPA. Direct observation data were input into Microsoft Excel and six variables were used in analysis (percentage of time spent lying, sitting, standing, walking, vigorous, and MVPA). Paired Sample t-tests were conducted using IBM SPSS Statistics for Windows (IBM Corp., Version 21) to determine if there were statistically significant differences between the means of each of the five variable-pairs (Research Questions 1a and 1b). Independent samples t-tests examined how the main effects of both playground type and gender differed by measurement (Research Questions 2 and 4). Regression models examined the main effects of gender on PA levels (Research Questions 3a and 3b) and the gender and playground interaction effect on PA levels (Research Questions 5a and 5b).

Research questions

Main effects of playground type on physical activity

1a: How do PA levels, measured by accelerometry, compare in an adventure playground to those in a conventional playground?

1b: How do PA levels, measured by direct observation, compare in an adventure playground to those in a conventional playground?

Interaction of playground type and measure on PA level.

2: How does the playground type and PA relation differ by measure (accelerometry vs direct observation)?

Main effects of gender on physical activity

3a: How do PA levels, measured by accelerometry, differ among boys and girls?

3b: How do PA levels, measured by direct observation, differ among boys and girls?

Interaction of gender and measure on PA level

4: How does the gender and PA relation differ by measure (accelerometry vs direct observation)?

Gender and playground type interaction effect on physical activity

5a: Does the effect of playground type on physical activity, measured by accelerometry, differ by gender?

5b: Does the effect of playground type on physical activity, measured by direct observation, differ by gender?

RESULTS

Of the 40 participating children, 19 were girls and 21 were boys (see Table 3.1.). The mean age was 6.4 years old (SD =1.26) and range was 5 to 10 years old. Of the 40 children, 29 (72.5%) were minority, non-white and 11 (27.5%) were white. Height and weight measurements were objectively measured and used to calculate body mass index (BMI) using the Center for Disease Control BMI calculation for children (CDC, 2000). Of the 37 out of 40 children whose parents and families gave informed consent, 2.7% were underweight, 78.4% were normal weight, 10.8% overweight, and 8.1% were obese.

Table 3.1. Participant Characteristics (n=40)

	Boys n=21	**Girls n=19**	**All n=40**
	n (%)	**n (%)**	**n (%)**
Age			
5 years old	5 (24)	6 (32)	11 (28)
6 years old	10 (48)	4 (21)	14 (35)
7 years old	3 (14)	2 (11)	5 (13)
8 years old	2 (10)	7 (37)	9 (23)
9 years old	0 (0)	0 (0)	0 (0)
10 years old	1 (5)	0 (0)	1 (3)
Race/Ethnicity			
Non-Minority (White)	5 (24)	6 (32)	11 (28)
Minority (Non-White)	16 (76)	13 (68)	29 (73)
Body Mass Index (BMI)[a]			
Underweight	1 (6)	0 (0)	1 (3)
Normal weight	14 (78)	15 (79)	29 (78)
Overweight	2 (11)	2 (11)	4 (11)
Obese	1 (6)	2 (11)	3 (8)

a. Body Mass Index (BMI): excluded 3 boys (2 non-minority, 1 minority) whose parents / families declined height & weight measurements (n=37).

First, the results of the research questions that examined the influence of playground type (adventure compared to conventional) on children's physical activity levels (measured by accelerometry and direct observation) are presented.

Main effects of playground type on physical activity

Research Question 1a: How do PA levels, measured by accelerometry, compare in an adventure playground to those in a conventional playground?

For each of the two playground types, adventure and conventional, sedentary behavior and physical activity levels (light, moderate, vigorous, and MVPA) were objectively measured using accelerometers. Results in Table 3.2. shows the mean proportion of time spent in each PA level, measured by accelerometry, in both conventional and adventure playgrounds.

Sedentary behavior

There was no significant difference in the time children spent in sedentary behavior in the conventional playground compared to the adventure playground ($p=.080$). In the conventional play environment, on average, children spent 8.90%, (SD = 5.81%) in sedentary behavior compared to in the adventure play environment, where children spent 10.58%, (SD = 6.80%).

Light physical activity (LPA)

Children spent a greater proportion of time in LPA in the adventure playground than the conventional playground ($p<.001$). While children spent a large percentage of time in the conventional playground engaged in light PA, $\overline{x}$ = 33.55%, (SD = 10.21%), even more time was spent in LPA in the adventure playground, $\overline{x}$ = 43.31%, (SD = 11.78%).

Moderate physical activity (MPA)

According to the accelerometry data, there was no significant difference in time spent in MPA in the adventure playground compared to the conventional playground ($p=.061$). Children engaged in moderate PA for about 21% of the time, $\overline{x}$ = 20.96%, (SD = 4.35%), in the conventional playground and engaged in moderate PA for only about 23% of the time, $\overline{x}$ = 23.07%, (SD = 5.57%), while in the adventure playground.

Vigorous physical activity (VPA)

Children spent greater proportions of time in VPA in the conventional playground compared to the adventure playground (p<.001). In the adventure playground, children spent about 23% of the time in vigorous physical activity, $\overline{x}$ = 23.04%, (SD = 11.58%). However, in the conventional playground children were engaged in even more vigorous physical activity, $\overline{x}$ = 36.60%, (SD =13.97%).

Moderate-to-vigorous physical activity (MVPA)

Children also spent a greater proportion of time in MVPA in the conventional playground compared to the adventure playground (p<.001). Combining both moderate and vigorous activity, in the adventure playground, children spent about 46% of their time in MVPA, $\overline{x}$ = 46.11%, (SD = 14.59%). However, the greatest amount of MVPA took place in the conventional playground $\overline{x}$ = 57.55%, (SD = 14.11%).

Table 3.2. Children's mean proportion of time spent across physical activity levels, by environment type, measured by accelerometry (n=40)

	Conventional Play Environment		Adventure Play Environment			
	Mean %	(sd)	Mean %	(sd)	Mean Difference (conv.–adv.)	p-value
Physical Activity Level						
Sedentary	8.90	(5.81)	10.58	(6.80)	- 1.68	.080
Light PA	33.55	(10.21)	43.31	(11.78)	- 9.76	<.001***
Moderate PA	20.96	(4.35)	23.07	(5.57)	- 2.11	.061
Vigorous PA	36.60	(13.97)	23.04	(11.58)	+ 13.56	<.001***
MVPA	57.55	(14.11)	46.11	(14.59)	+ 11.44	<.001***

a. MVPA (moderate-to-vigorous physical activity = walking + vigorous) ***p < .001.

Research Question 1b: How do PA levels, measured by direct observation, compare in an adventure playground to those in a conventional playground?

Here we address the same research question, but now using direct observation, rather than accelerometry to measure PA (lying, sitting, standing, walking, vigorous). Results in Table 3.3. show the proportion of time spent across the five physical activity levels, in both conventional and adventure playgrounds.

Sedentary behavior (lying and sitting)

In both playground types, children spent very little time in sedentary behaviors of lying and sitting. There was no significant difference in the amount of time children spent lying down in the conventional play environment, $\overline{x}$ = 0.02%, (SD = 8.00%), compared to in the adventure playground, $\overline{x}$ = 0.03%, (SD = 1.46%) (p=.146). There was a significant difference in the amount of time children spent sitting. In the conventional playground, 18.13%, (SD = 16.36%) of the time was spent sitting compared to only 5.17%, (SD = 11.90%) in the adventure playground (p<.001).

Light physical activity (standing)

In both play environments, children spent about a third of their time standing or LPA, subsequently there was no significant difference in the amount of time spent standing between the two playgrounds (p=.513). In the conventional playground, children spent, on average, 35% of time in LPA, $\overline{x}$ = 35.44%, (SD = 21.24%). Children in the adventure playground, spent about the same amount of time in LPA, $\overline{x}$ = 33.11%, (SD = 16.21%).

Moderate physical activity (walking)

In the adventure playground, children spent a significantly greater proportion of their time in MPA (walking) compared to the conventional playground (p <.001). In the adventure playground, children spent on average, about 37% of their time in MPA, $\overline{x}$ = 37.52%, (SD = 14.01).

Whereas in the conventional playground, children spent less time in MPA, $\overline{x}$ = 25.39%, (SD = 12.33%).

Vigorous physical activity

According to the direct observation data, children spent similar time in vigorous PA in both play environments (p=.106). In the adventure playground, children spent, on average, 24% of time in VPA, $\overline{x}$ = 23.89%, (SD = 18.12%) compared to in the conventional playground, $\overline{x}$ = 18.70%, (SD = 17.71%).

Moderate-to-vigorous physical activity (MVPA)

MVPA was computed by combining the proportion of time children were observed walking and being vigorously active. There was no significant difference in the amount of time spent in MVPA between the two environment types, p=.069.. In the adventure playground, children spent about 61% in MVPA, $\overline{x}$ = 61.41%, (SD = 17.61%) compared to the conventional playground, $\overline{x}$ = 44.09%, (SD = 22.48%).

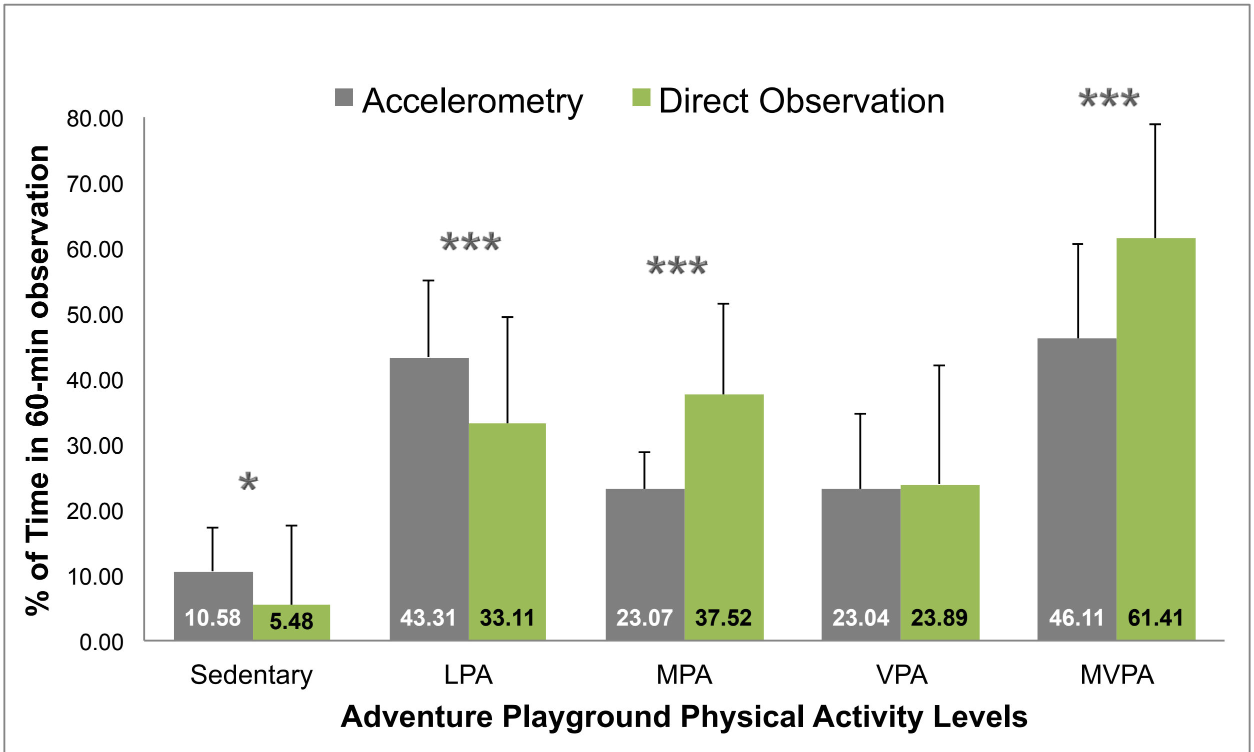
Table 3.3. Children's mean proportion of time spent across physical activity levels, by environment type, measured by direct observation (n=40)

	Conventional Playground		Adventure Playground			
	Mean %	(sd)	Mean %	(sd)	Mean difference (conv.-adv.)	p-value
Physical Activity Level						
Lying	.024	(8.00)	.031	(1.46)	+ 1.93	.146
Sitting	18.13	(16.36)	5.17	(11.90)	+ 12.96	<.001***
Standing	35.44	(21.24)	33.11	(16.21)	+ 2.33	.513
Walking	25.39	(12.33)	37.52	(14.01)	- 12.13	<.001***
Vigorous	18.70	(17.71)	23.89	(18.12)	- 5.19	.106
MVPA[a]	44.09	(22.48)	61.41	(17.61)	- 17.32	<.001***

a. MVPA (moderate-to-vigorous physical activity = walking + vigorous) ***p < .001.

Research Question 2: How do PA levels by playground type differ by measures (accelerometry vs direct observation)?

Research question 2 compares the differences in physical activity levels (sedentary, LPA, MPA, VPA, MVPA), measured by accelerometry and direct observation, for each of the two playground types, adventure and conventional. Figure 3.3 shows mean proportion of time spent in each PA level, measured by accelerometry and direct observation, in the adventure playground. Figure 3.4. shows the mean proportion of time spent in each PA level, measured by accelerometry and direct observation, in the conventional playground.



*p < .05. **p < .01. ***p < .001

Figure 3.4. Proportion of time spent across physical activity levels in an adventure playground, (60-minute observation period) by measurement type (accelerometry vs direct observation)[1]

[1] Paired sample *t*-tests were conducted to determine statistically significant differences between PA levels and PA measures, in an adventure playground (sedentary p=.026; LPA p<.001; MPA p<.001; VPA p=.731; MVPA p<.001).

Adventure playground physical activity levels by measure

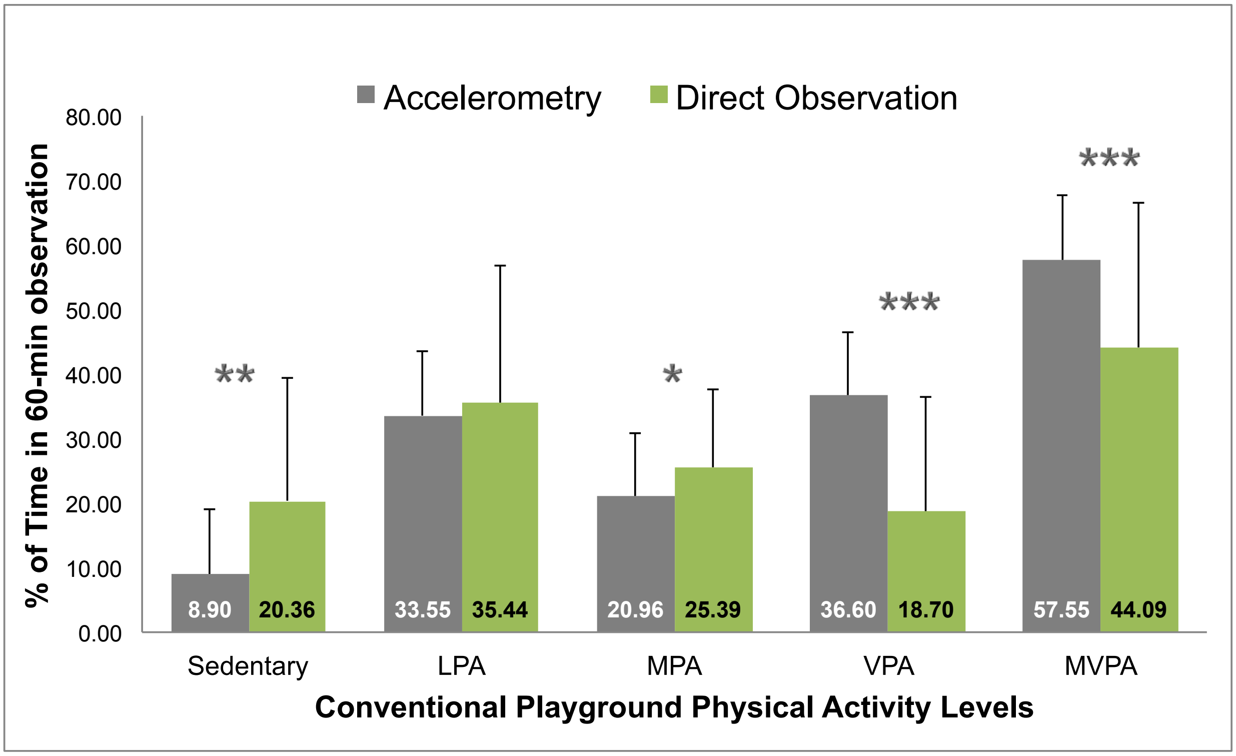
According to the results in Figure 3.4, in the adventure playground, accelerometers indicated that children spent significantly more time in sedentary behavior (p=.026) and LPA (p<.001) than direct observation. Accelerometers measured that children spent about 11% of the time in sedentary behaviors, $\bar{x}$ = 10.58%, (SD = 6.80%) compared to direct observation, $\bar{x}$ = 5.48%, (SD = 12.00%). In the adventure playground, accelerometry also indicated that children spent about 43% of their time in LPA, $\bar{x}$ = 43.31%, (SD = 11.78%) compared to direct observation, $\bar{x}$ = 33.11%, (SD = 16.21%).

However, Figure 3.4 also shows, in the adventure playground, direct observation indicated children spent significantly more time in MPA (p<.001) and MVPA (p<.001) compared to accelerometry. Direct observation measurement indicated that children spent about 38% of the time in moderate physical activity, $\bar{x}$ = 37.52%, (SD = 14.01%) compared to accelerometry, $\bar{x}$ = 23.07%, (SD = 5.57%). In the adventure playground, direct observation also measured children spent about 62% of their time in MVPA, $\bar{x}$ = 61.41%, (SD = 17.61%) compared to accelerometry, $\bar{x}$ = 46.11%, (SD = 14.59%). In the adventure playground, children spent about the same amount of time in VPA, measured by accelerometry, $\bar{x}$ = 23.04%, (SD = 11.58%) and direct observation, $\bar{x}$ = 23.89%, (SD = 18.12%), p=.731.

Conventional playground physical activity levels by measure

According to the results in Figure 3.5, in the conventional playground, accelerometers indicated that children spent significantly less time in sedentary behavior (p=.001) and MPA (p=.041) than direct observation. Accelerometers measured that children spent about 9% of the time in sedentary behaviors, $\bar{x}$ = 8.90%, (SD = 5.81%) compared to direct observation, $\bar{x}$ = 20.36%, (SD = 19.13%). In the conventional playground, accelerometry also indicated that children spent about 21% of their time in MPA, $\bar{x}$ = 20.96%, (SD = 4.35%) compared to direct observation, $\bar{x}$ = 25.11%, (SD = 12.33%).

Figure 3.5 also shows, in the conventional playground, direct observation indicated children spent significantly less time in VPA ($p<.001$) and MVPA ($p<.001$) compared to accelerometry. Direct observation indicated that children spent about 38% of the time in vigorous physical activity, $\bar{x}$ = 18.70%, (SD = 17.71%) compared to accelerometry, $\bar{x}$ = 36.60%, (SD = 13.97%). In the conventional playground, direct observation indicated children spent about 44% of their time in MVPA, $\bar{x}$ = 44.09%, (SD = 22.48%) compared to accelerometry, $\bar{x}$ = 57.55%, (SD = 14.11%). In the conventional playground, children spent about the same amount of time in LPA, indicated by accelerometry, $\bar{x}$ = 33.55%, (SD = 10.21%) and direct observation, $\bar{x}$ = 35.44%, (SD = 21.24%), p=.568.



*p < .05. **p < .01. ***p < .001

Figure 3.5. Proportion of time spent across physical activity levels in a conventional playground, (60-minute observation period) by measurement type (accelerometry vs direct observation)[2]

[2] Paired sample *t*-tests were conducted to determine statistically significant differences between PA levels and PA measures, in a conventional playground (sedentary p=.001; LPA p=.568; MPA p=.041; VPA p<.001; MVPA p<.001).

Next, the results of the research questions that examined the influence of gender (boys and girls) on physical activity levels (indicated by accelerometry and direct observation) are presented below.

Main effects of gender on physical activity

Research Question 3a: How do PA levels, measured by accelerometry, differ among boys and girls?

For both boys and girls, physical activity levels (sedentary, light, moderate, vigorous, and MVPA) were objectively measured using accelerometers. Results in Table 3.4. shows the mean proportion of time spent in each PA level, measured by accelerometry, by gender.

Sedentary behavior

Girls spent a greater proportion of time in in sedentary behavior compared to boys ($p<.001$). Girls, on average, spent 12.43%, (SD = 7.22%) in sedentary behavior compared to boys who, on average, spent 7.30%, (SD = 4.19%) of their time in sedentary behavior.

Light physical activity (LPA)

There was no significant difference in time spent in LPA among girls compared to boys ($p=.883$). Boys and girls both spent about 38% of their time in LPA, while playing outdoors. Boys spent about $\overline{x}$ = 38.24%, (SD = 13.58%), in LPA and girls engaged in similar percentage of time in LPA, $\overline{x}$ = 38.64%, (SD = 10.16%).

Moderate physical activity (MPA)

There was also no significant difference in time spent in MPA among boys compared to girls ($p=.553$). Boys spent about 22% of their time engaged in moderate PA, $\overline{x}$ = 22.34%, (SD = 5.02%), and girls also engaged in moderate PA for about 22% of the time, $\overline{x}$ = 21.66%, (SD = 5.19%).

Vigorous physical activity (VPA)

There was also no significant difference in time spent in VPA among boys compared to girls (p=.135). Boys spent about 32% of their time engaged in vigorous PA, $\overline{x}$ = 32.12%, (SD = 15.47%). Girls engaged in vigorous PA for about 28% of time, $\overline{x}$ = 27.27%, (SD = 12.98%).

Moderate-to-vigorous physical activity (MVPA)

Boys and girls also spent a similar proportion of time in MVPA in the outdoor playgrounds (p=.109). Combining both moderate and vigorous activity, boys spent about 55% of their time in MVPA, $\overline{x}$ = 54.46%, (SD = 15.90%). Girls spent about 49% their time in MVPA, $\overline{x}$ = 48.93%, (SD = 14.44%).

Table 3.4. Children's mean proportion of time spent across physical activity levels, by gender, measured by accelerometry (n=40)

	Boys (n=21)		Girls (n=19)			
	Mean %	(sd)	Mean %	(sd)	Mean difference (boys – girls)	p-value
Physical Activity Level						
Sedentary	7.30	(4.19)	12.43	(7.22)	- 5.13	<.001***
Light PA	38.24	(13.58)	38.64	(10.16)	- 0.40	.883
Moderate PA	22.34	(5.02)	21.66	(5.19)	+ 0.68	.553
Vigorous PA	32.12	(15.47)	27.27	(12.98)	+ 4.85	.135
MVPA[a]	54.46	(15.90)	48.93	(14.44)	+ 5.53	.109

a. MVPA (moderate-to-vigorous physical activity = walking + vigorous) *p < .05. **p < .01. ***p<.001.

Research Question 3b: How do PA levels measured by direct observation, differ among boys and girls?

Here we address the same research question, but now using direct observation, rather than accelerometry to measure PA (lying, sitting, standing, walking, vigorous). Results in Table 3.5 show the proportion of time spent across the five physical activity levels, in both boys and girls.

Sedentary behavior (lying and sitting)

Boys and girls spent very little time in sedentary behaviors of lying and sitting. There was no significant difference in the amount of time boys spent lying down in the conventional play environment, $\overline{x}$ = 2.13%, (SD = 7.87%), compared to girls, $\overline{x}$ = 0.33%, (SD = 1.14%) (p=.149). There was also no significant difference in the amount of time boys and girls spent sitting. Boys spent about 12.43%, (SD = 16.52%) of the time sitting compared to girls who were observed sitting for about 10.78%, (SD = 14.77%) (p=.642).

Table 3.5. Children's mean proportion of time spent across physical activity levels, by gender, measured by direct observation (n=40)

	Boys (n=21)		Girls (n=19)			
	Mean %	(sd)	Mean %	(sd)	Mean difference (boys – girls)	p-value
Physical Activity Level						
Lying	2.13	(7.87)	0.33	(1.14)	+ 1.80	.149
Sitting	12.43	(16.52)	10.78	(14.77)	+ 1.65	.642
Standing	28.25	(17.81)	40.95	(17.81)	- 12.70	.002**
Walking	31.88	(12.66)	30.98	(16.39)	+ 0.90	.786
Vigorous	25.31	(20.66)	16.85	(13.41)	+ 8.46	.032*
MVPA[a]	57.20	(21.79)	47.83	(21.17)	+ 9.37	.055

a. MVPA (moderate-to-vigorous physical activity = walking + vigorous) *p < .05. **p < .01.

Light physical activity (standing)

However, girls spent a significantly greater proportion of time in LPA (standing) compared to boys (p=.002). Boys spent about a third of the time in LPA, $\bar{x}$ = 28.25%, (SD = 17.81%) while girls spent, on average, almost 40% of their time in LPA, $\bar{x}$ = 40.95%, (SD = 17.81%).

Moderate physical activity (walking)

Boys and girls spent about a third of their time in MPA (walking) (p=.786). Boys spent about 32% of their time engaged in moderate PA, $\bar{x}$ = 31.88%, (SD = 12.66%). Girls also engaged in moderate PA for about 31% of the time, $\bar{x}$ = 30.98%, (SD = 16.39%).

Vigorous physical activity

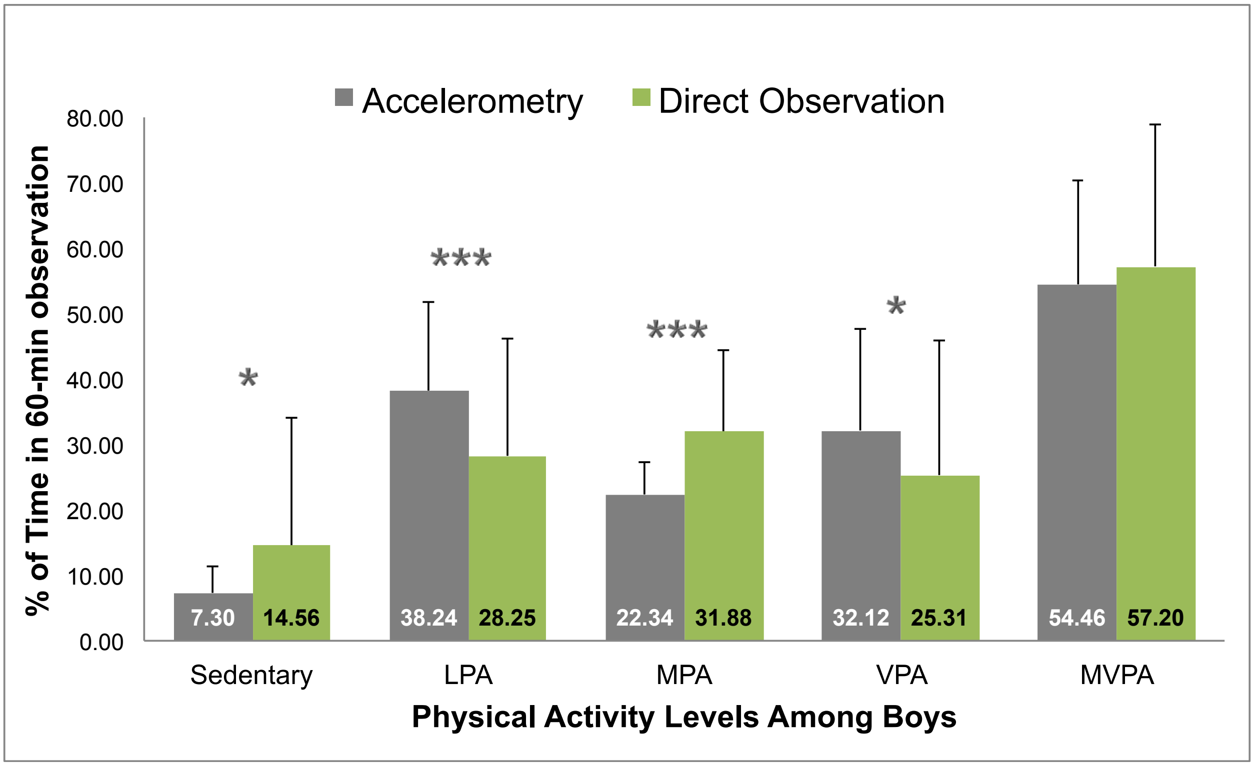
Boys spent significantly more time in vigorous PA than girls (p=.032). Boys spent, on average, 25% of time in VPA, $\bar{x}$ = 25.31%, (SD = 20.66%) compared girls, $\bar{x}$ = 16.85%, (SD = 13.41%).

Moderate-to-vigorous physical activity (MVPA)

MVPA was computed by combining the proportion of time children were observed walking (MPA) and being vigorously active (VPA). There was no significant difference in the amount of time spent in MVPA between boys and girls, p=.055. Boys spent about 57% in MVPA, $\bar{x}$ = 57.20%, (SD = 21.79%) compared to girls, $\bar{x}$ = 47.83%, (SD = 21.17%).

Research Question 4: How does the gender and PA relation differ by measures (accelerometry vs direct observation)?

Research question 4 compares the differences in physical activity levels (sedentary, light, moderate, vigorous, and MVPA), measured by accelerometry and direct observation, among boys and girls. Figure Xc shows the mean proportion of time spent in each PA level, among boys, measured by accelerometry and direct observation. Figure 3.6 shows the mean proportion of time spent in each PA level, among girls, measured by accelerometry and direct observation.



*p < .05. **p < .01. ***p < .001

Figure 3.6. Proportion of time spent across physical activity levels among boys, (60-minute observation period) by measurement type (accelerometry vs direct observation)[3]

Boys' physical activity levels by measure

According to the results in Figure 3.6, accelerometers indicated that boys spent significantly more time in LPA (p<.001) and VPA (p=.013) than direct observation. Accelerometers indicated that boys spent about 38% of the time in light PA, $\bar{x}$ = 38.24%, (SD = 13.58%) compared to direct observation, $\bar{x}$ = 28.25%, (SD = 17.81%). The accelerometry measure also indicated that boys spent about 32%

3 Paired sample *t*-tests were conducted to determine statistically significant differences between PA levels and PA measures, among boys (sedentary p=.024; LPA p<.001; MPA p<.001; VPA p=.013; MVPA p=.380).

of their time in VPA, $\overline{x}$ = 32.12%, (SD = 15.47%) compared to direct observation, $\overline{x}$ = 25.31%, (SD = 20.66%).

However, Figure 3.6. shows, among boys, direct observation indicated boys spent significantly more time in sedentary behavior (p=.024) and MPA (p<.001) compared to accelerometry. Direct observation measured that boys spent about 15% of the time in sedentary behavior, $\overline{x}$ = 14.56%, (SD = 19.51%) compared to accelerometry, $\overline{x}$ = 7.30%, (SD = 4.19%). Direct observation also indicated that boys spent about 32% of time in MPA, $\overline{x}$ = 31.88%, (SD = 12.66%) compared to accelerometry, $\overline{x}$ = 22.34%, (SD = 5.02%). Boys spent about the same amount of time in MVPA, measured by accelerometry, $\overline{x}$ = 54.46%, (SD = 15.90%) and direct observation, $\overline{x}$ = 57.20%, (SD = 21.79%), p=.380.

Girls' physical activity levels by measure

According to the results in Figure 3.7., direct observation indicated that girls spent significantly more time in MPA (p=.002) than by accelerometry. Direct observation indicated that girls spent about 31% of the time in moderate physical activity, $\overline{x}$ = 30.98%, (SD = 16.39%) compared to accelerometry, $\overline{x}$ = 21.66%, (SD = 5.19%). However, accelerometers indicated that girls spent significantly more time in VPA than direct observation (p=.001). Accelerometers indicated that children spent about 27% of the time in vigorous physical activity, $\overline{x}$ = 27.27%, (SD = 12.98%) compared to direct observation, $\overline{x}$ = 16.85%, (SD = 13.41%).

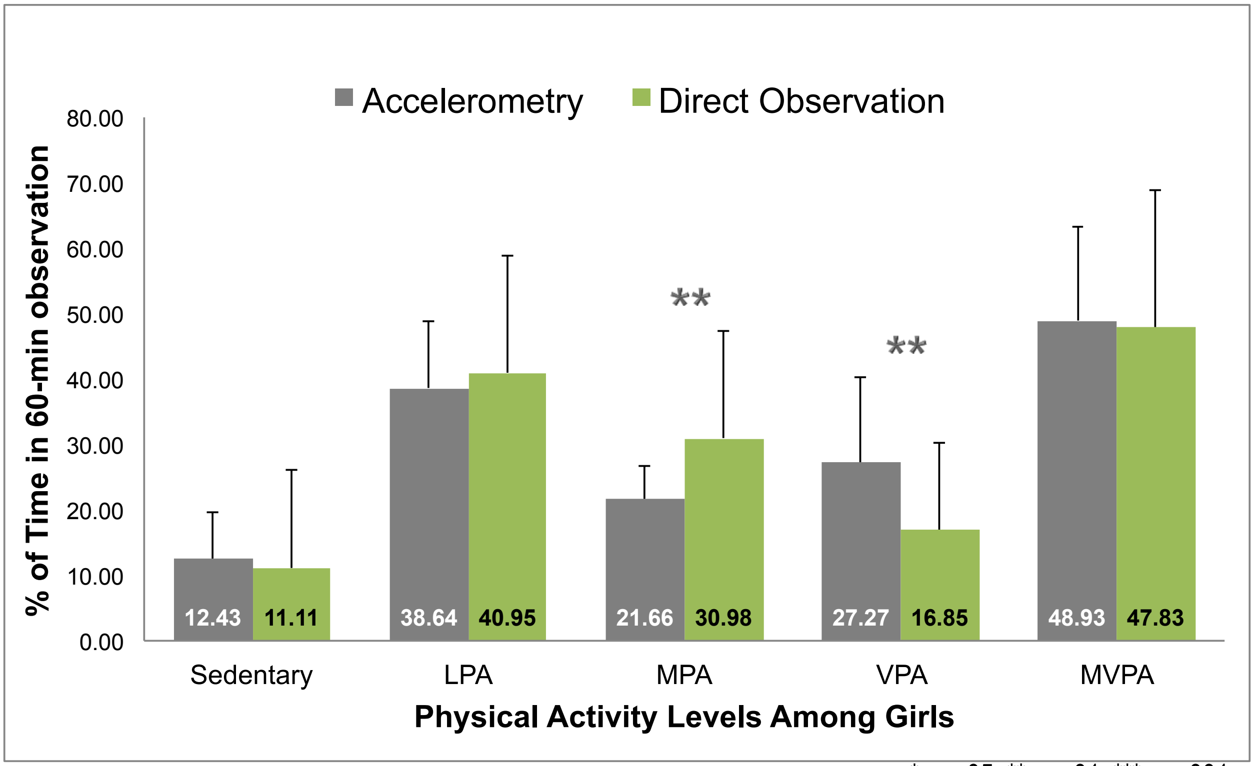


Figure 3.7. Proportion of time spent across physical activity levels among girls, (60-minute observation period) by measurement type (accelerometry vs direct observation)[4]

Figure 3.7 also shows girls spent about the same amount of time in sedentary behavior, indicated by accelerometry, $\overline{x}$ = 12.43%, (SD = 7.22%) and direct observation, $\overline{x}$ = 11.11%, (SD = 15.14%), p=.641. Girls also spent an equal amount of time in LPA, indicated by accelerometry, $\overline{x}$ = 38.64%, (SD = 10.16%) and direct observation, $\overline{x}$ = 40.95%, (SD = 17.81%), p=.488. Finally, similar to boys, girls were found to spend about the same amount of time in MVPA, indicated by accelerometry, $\overline{x}$ = 48.93%, (SD = 14.44%) and direct observation, $\overline{x}$ = 47.83%, (SD = 21.17%), p=.787.

[4] Paired sample *t*-tests were conducted to determine statistically significant differences between PA levels and PA measures, among girls (sedentary p=.641; LPA p=.488; MPA p=.002; VPA p=.001; MVPA p=.787).

Interaction of Gender and playground type on physical activity

The next set of research questions examined the gender and playground type interaction effects on PA level.

Research Question 5a: Does the effect of playground type on physical activity, measured by accelerometry, differ by gender?

Research question 5a explored the interaction of playground type and gender on physical activity, measured by accelerometry. Analyses show a significant interaction effect of playground type and gender on *light PA* (p=.016). As shown in Figure 3.8, gender moderates the impact of playground type on children's light PA. The link between playground type and LPA is stronger among girls than boys. However, according to the results, there were no playground type by gender interaction effects on *sedentary behavior* (p=.125), *MPA* (p=.157), or *VPA* (p=.070) or MVPA (p=.220).

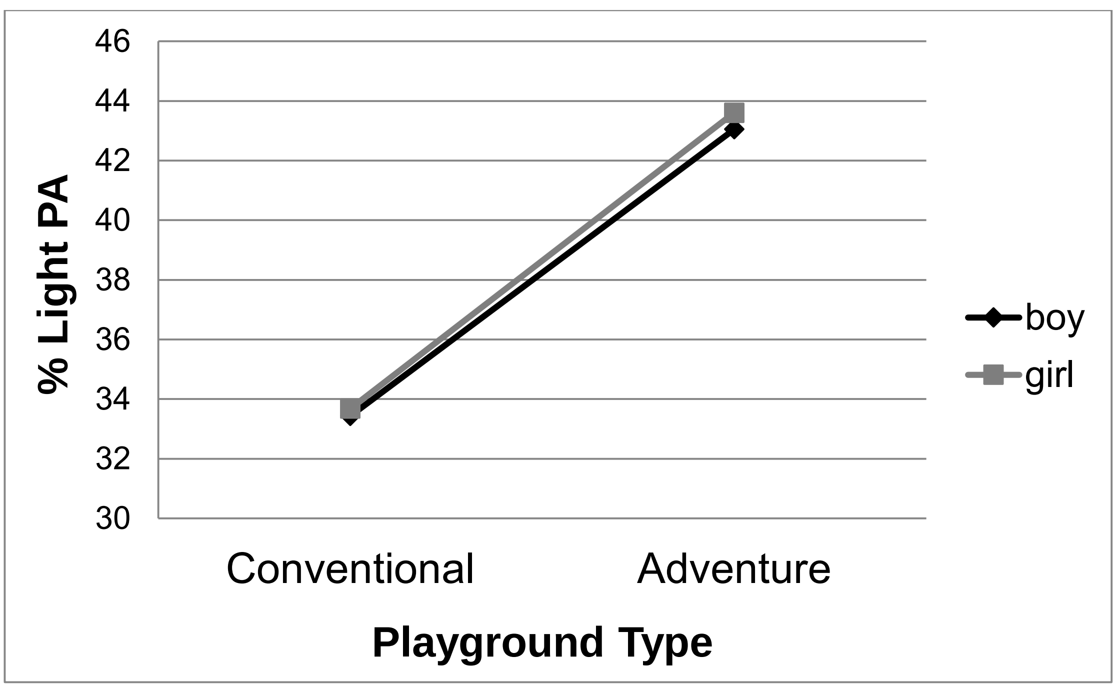


Figure 3.8. Gender by playground interaction effect on percent of light PA, during a 60-minute observation (measured by accelerometry) *p*=.016

Research Question 5b: Does the effect of playground type on physical activity, measured by direct observation, differ by gender?

Research question 5b explored the interaction of playground type and gender on physical activity, measured by direct observation. Analyses show a significant interaction effect of playground type and gender on *sitting* (p=.032), *standing* (p=.003), *walking,* (p=.003), *vigorous* (p=.001), *and MVPA* (p<.001). However, there were no playground type by gender interaction effects on *lying* (p=.871).

As shown in Figures 3.9 through 3.13, gender moderates the impact of playground type on children's percentage of time spent *sitting*, *standing*, *walking*, *vigorous*, and *MVPA*. The link between playground type and *sitting* was stronger among boys than among girls (Figure 3.9). The link between playground type and *standing* was stronger among girls than boys (Figure 3.10). While there was little difference between boys' percentage of time spent standing in the conventional playground compared to the adventure playground, girls spent even less time standing than boys in the adventure playground compared to the conventional playground. Among girls, there was also a more dramatic contrast between adventure and conventional playground compared to boys (Figure 3.11). Girls also showed a greater difference in the percentage of time spent in vigorous PA between the conventional playground and the adventure playground (Figure 3.12.) and MVPA (Figure 3.13.) compared to boys.

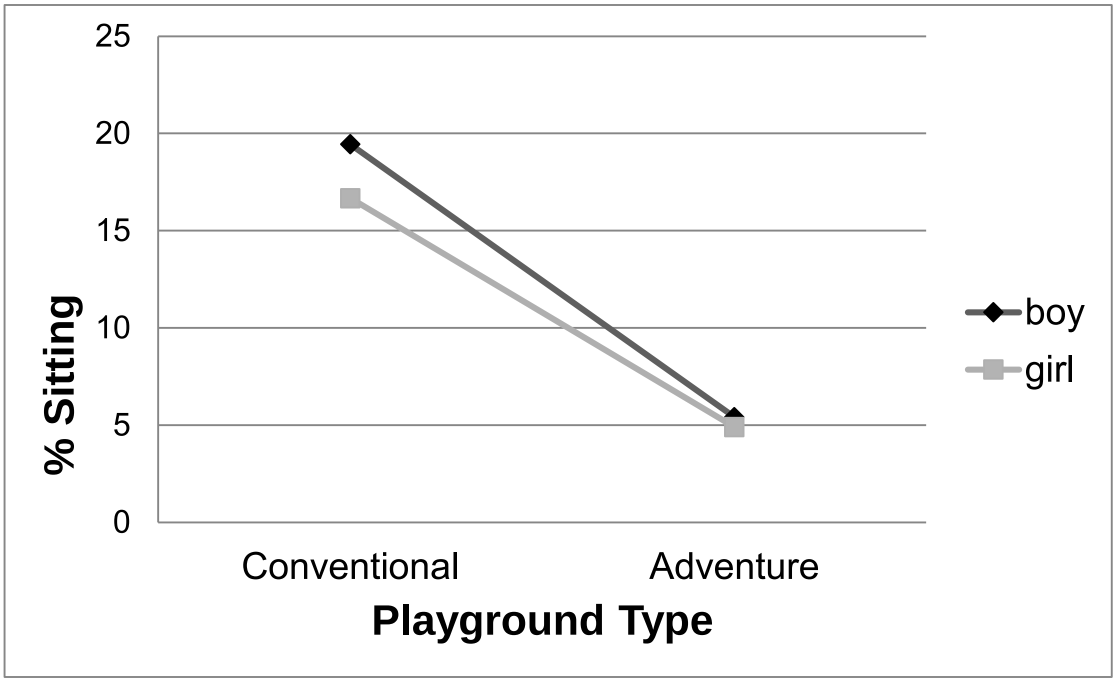


Figure 3.9. Gender by playground interaction effect on percent sitting, during a 60-minute observation (measured by direct observation) p=.032

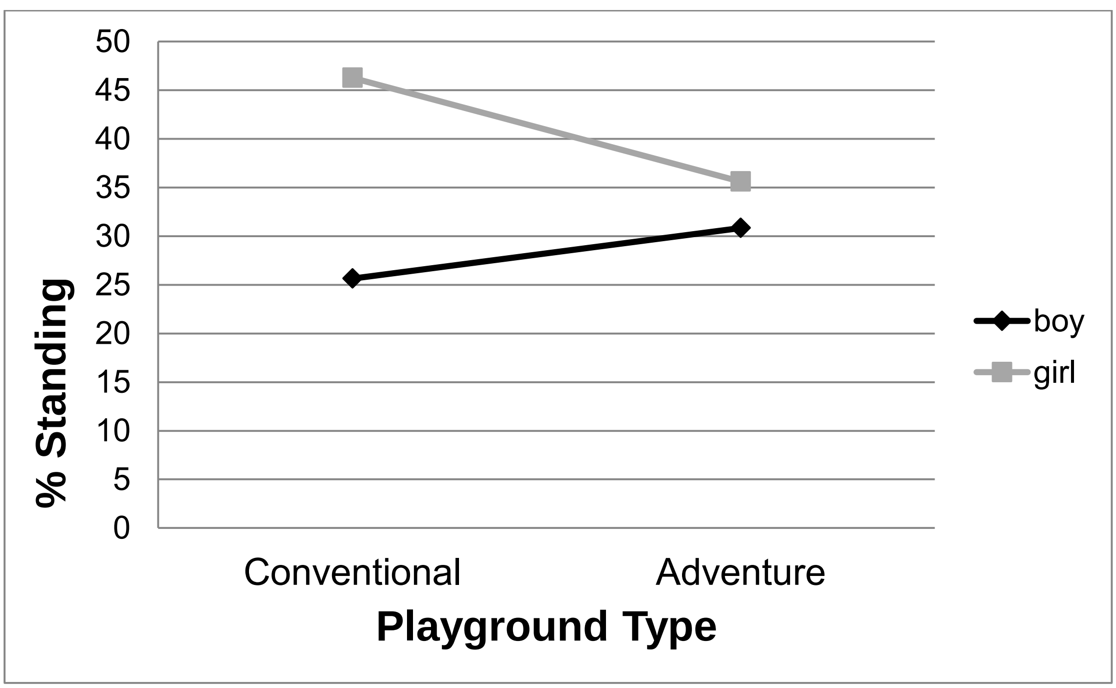


Figure 3.10. Gender by playground interaction effect on percent standing, during a 60-minute observation (measured by direct observation) p=.003

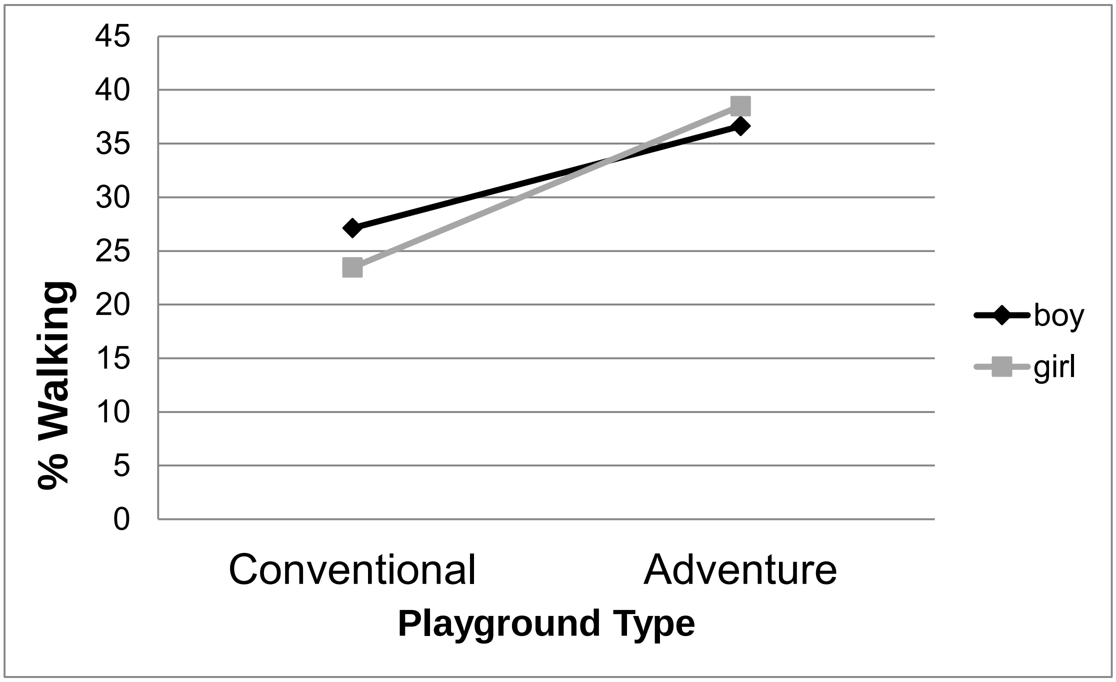


Figure 3.11. Gender by playground interaction effect on percent walking, during a 60-minute observation (measured by direct observation) *p*=.003

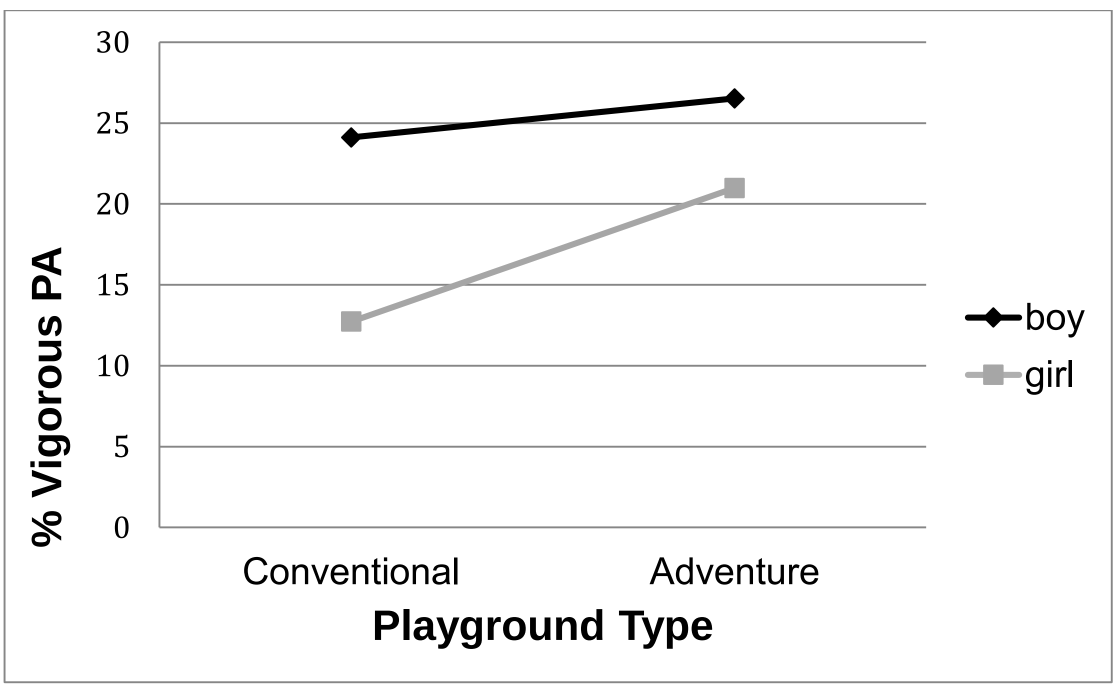


Figure 3.12. Gender by playground interaction effect on percent vigorous, during a 60-minute observation (measured by direct observation) *p*=.001

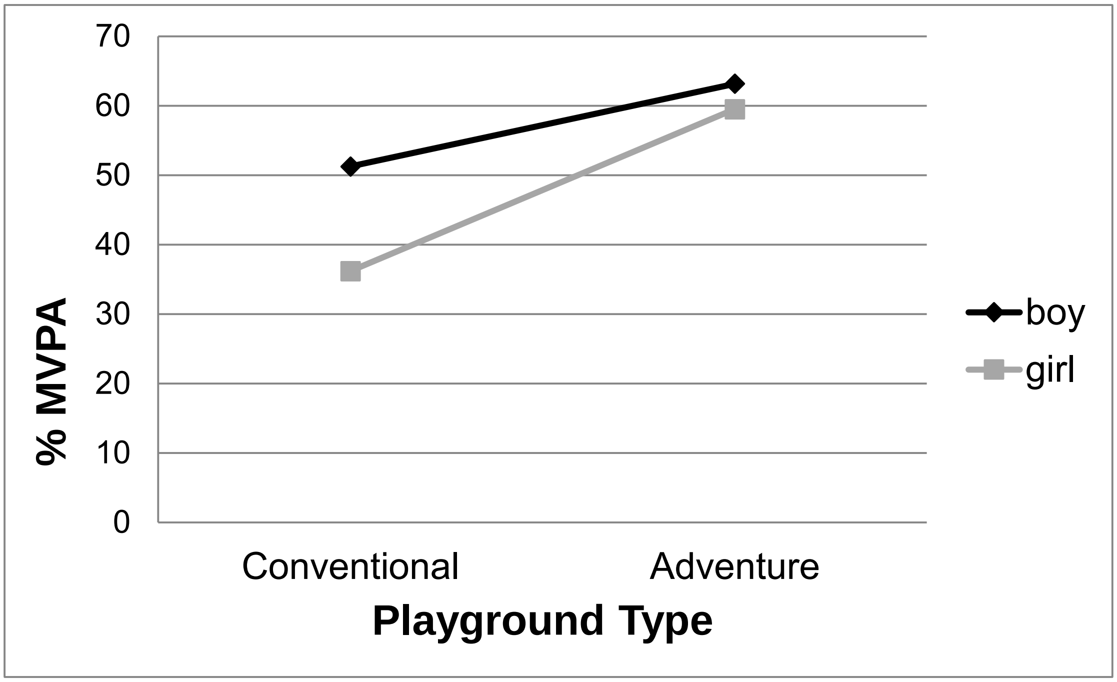


Figure 3.13. Gender by playground interaction effect on percent MVPA, during a 60-minute observation (measured by direct observation) $p<.001$

DISCUSSION

Purpose

The present study had two purposes: 1) to compare children's physical activity, during active free play, in two playgrounds (adventure versus conventional), using two measures (accelerometry and direct observation); and 2) to explore the role of gender on physical activity.

Findings and interpretations

The first purpose was to understand how different outdoor playground designs (adventure versus conventional) might influence children's physical activity and how this comparison might differ when utilizing two measures of physical activity (accelerometry and direct observation). Results indicated that the effect of playground type on PA levels differed by measure; accelerometry and direct observation tell different stories. Therefore, using only one measure of children's physical activity during outdoor active free play may not have sufficiently told the more nuanced story of children's physical activity levels outdoors. Accelerometry data indicated that children were *more active* (more time in VPA and MVPA and less time in light PA) *in the conventional playground* than in the adventure playground. However direct observation indicated the opposite; that children were *more active* (more time in MPA and MVPA and less time sedentary*) in the adventure playground* than in the conventional playground. Accelerometers may have underestimated children's moderate physical activity in both settings; direct observation appeared to overestimate children's sedentary behaviors.

Our findings are similar to prior research showing a lack of convergence when using two measures of PA (Prince, Adamo, Hamel, Hardt, Connor Gorber, & Tremblay, 2008). In this large systematic review of PA agreement among various types of PA assessments (e.g., self-report, direct observation, accelerometry), among adults, the findings suggested no clear pattern between the various measures. In other words, some self-report measures reported higher levels than direct measures of PA, while at other times the self-report PA measures were lower than direct measures. A lack of convergence has also been cited comparing accelerometry and direct observation for MPA, VPA and MVPA among children (Myers & Wells, 2015) and young children (Kahan, Nicaise, & Reuben, 2013; Kelly, Reilly, Fairweather, Barrie, Grant, & Paton, 2004). More research may be need in order to understand the most effective ways to measure PA and the varied movements that children spontaneously and continually perform in outdoor free-living environments (e.g. playgrounds).

The second purpose of this study was to consider how gender influences physical activity levels during outdoor active free play, regardless of playground type. According to accelerometry data, girls were more sedentary than boys, however there were no gender differences found in sedentary behavior as measured by direct observation. In addition, while direct observation indicated that boys were more often engaged in vigorous PA than girls, both measures indicated that there were no significant differences among boys and girls time spent in MVPA. This finding – no gender difference in MVPA - differs greatly from the many studies indicating boys are more physically active than girls (Sallis, et al., 1999; Trost, et al., 2002; Trost et al., 1996; Troiano, 2008; Whitt-Glover, et al., 2009). Therefore, the overall lack of gender disparities in physical activity levels suggests that perhaps when children move outdoors, there are fewer disparities in PA than prior research suggests. It could also be possible that the sample size was too small to detect significant differences.

Strengths

To our knowledge, this is the first quasi-experimental study examining the effects of an adventure playground compared to a conventional playground on children's physical activity levels. The within-subjects study design ensures strong internal validity by reducing error variance associated with individual differences. By conducting a within-subjects study, and having the same children freely playing outdoors in both playground designs: a conventional playground, with mostly fixed equipment components (e.g. slides, monkey bars, rope climbs) and an adventure playground, with many loose-parts and natural elements (e.g. trees, grass, dirt mounds), one can be quite certain that the conclusions made are the result of the independent variable, playground type affecting children's physical activity (as opposed to some alternative explanation such as 'selection bias').

Selection bias was a threat in a previous observational study that employed a between-subjects design to examine children's play on different playground designs (traditional, contemporary, and adventure playgrounds) (Hayward, Rothenberg, & Beasley, 1974). In that study, researchers observed different children, playing in three different settings and found that children spent more time in and preferred the adventure playground compared to the other two playground types. Though PA was not an outcome measure, the differences observed in the dependent variables of space use and preference may have been due to systematic differences among the children, as opposed to differences between playground types. Thus when comparing different children, internal validity may be weaker (in that the differences one sees may be a result of cofounding variables, not necessarily the independent variable). The current study is able to more confidently state that differential levels of physical activity, seen among the same children, resulted by the effects of playground design.

A second strength of the study is the use of two objective measures to capture physical activity levels (direct observation and accelerometry). In other between-subject studies conducted in the United States and abroad, specifically investigating the role of a natural environment on physical activity among young children (aged 3 to 5) not only were these studies also confined by having to compare different children attending different childcare settings but they also relied only on one measure of physical activity (either direct observation or accelerometry) (Boldemann, 2011; Cosco, Moore, & Islam, 2010; Boldemann et al., 2006; Mårtensson et al., 2009; Fjortoft & Sageie, 2000). As shown in the present study, the effect of playground type on PA levels differed by measure, suggesting that children's physical activity, during outdoor active free play, may be more nuanced and perhaps more difficult to measure than previously considered.

Limitations

This study is not without limitations. While the use of a quasi-experiment using within-subjects design to reduce error variance and strengthen internal validity was a key strength of this study, a primary limitation of a within-subjects research design is the possibility of 'carry-over effects,' in this case, from one play environment to another. Carry-over effects are a potential threat to internal validity and this limitation is often why researchers choose between-subjects study designs. Since children played in both settings, it is possible that the experience of playing, for example, in the conventional playground could influence children's play and movement in the adventure playground, and vice versa, thus decreasing the certainty that the independent variable (i.e. playground type) affected PA. To account for this potential limitation, and not having any evidence to help plan for which order the children should play in the playgrounds, a consistent pattern was used throughout the study. For example, conventional playground observation and data collection days took place first (day 1), followed by a visit to the adventure playground (day 2), a visit to the conventional playground (day 3), and finally play in the adventure playground (day 4) (This pattern was completed three times over the six-week period for a total of six observation days in each setting). Even with this data collection pattern, without further investigation, such as a qualitative study to ask children questions that may elicit some possibilities of carry-over, or an experimental study that explores the carry-over effects from one playground to another, the carry-over effects in this study remain unknown.

Even though a within-subjects study design allows for smaller sample sizes, another potential limitation of this study may be low statistical power due to a modest sample size (n = 40). This may lead to a threat to statistical validity such as increased risk of a Type II error (false negative or “miss”) occurring. The sample size may be too small for the analysis to detect a statistically significant difference, even if there is one. This may be especially true for the research questions involving the gender by playground type interactions.

Finally, there may also be a threat to external validity. The findings from this study of one adventure playground in one Upstate New York community may not generalize to *all* adventure playgrounds. Similar findings from the sample of New York children may not generalize to children in other parts of New York, in other states, or other countries, due to varying demographic and cultural differences.

Implications and conclusions

The two measures used in the study (accelerometry and direct observation) to examine the effects of playground type on PA levels - told different stories. If only accelerometry was used, the conclusions would be that children were more active in the conventional playground than in the adventure playground. However, concurrently using direct observation shed light on perhaps a more nuanced story of children’s physical activities and movements during outdoor free play. Perhaps two measures to capture children’s various physical activites, while outdoors, is needed to begin to understand how unstructured, active free play can contribute to children’s health and well-being (National Physical Activity Plan, 2014).

There is acknowledgment within the field of public health and physical activity research, that accelerometers are accurate in measuring physical activities such as, running and jumping (Loprinzi & Cardinal, 2011). However, there is also evidence that accelerometers cannot capture all types of physical activities, especially muscle-strengthening and bone-strengthening activities, as well as other movements, such as balancing (Garcia, Langenthal, Angulo-Barroso, & Gross, 2004; Welk, 2002). These varied types of physical activities may be more present among children, particularly during outdoor active free play. While the 'gold standard' of measuring children's energy expenditure, due to physical activity in free-living environments, is doubly labeled water (DLW), it is rarely used as accelerometry is the preferred tool, especially to analyze population data, patterned PA behavior, and longitudinal data (Plasqui & Westerterp, 2007; Loprinzi & Cardinal, 2011). However, before beginning to determine a guideline on how much or how often children should spend engaged in active free play or 'unstructured' physical activity, there may be a need for more research to accurately measure the many physical activities children engage in during outdoor play. It may be that a combination of accelerometry and direct observation may yield the most accurate measurement of children's PA during outdoor active free play.

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CHAPTER 4

ADVENTURE PLAYGROUNDS AND ACTIVE FREE PLAY: THE ROLE OF ENVIRONMENTAL DESIGN IN PLAY BEHAVIOR TYPES, SOCIAL INTERACTIONS, AND GENDER-INCLUSIVE SPACE USE

ABSTRACT

Objective. This within-subjects study examines the effects of playground type (adventure playground versus conventional playground) and gender on three components of active free play: 1) play behavior types; 2) social interactions and; 3) gender-inclusive space use.

Methods. Data were collected over twelve 60-minute observation periods (six in the adventure playground and six in the conventional playground) over a six-week period in summer 2014. The sample was 40 children, 19 boys and 21 girls, from a Central New York summer camp program. The children ranged from kindergarten to third grade (aged 5 to 10 years old). Children's active free play behaviors, social interactions, and gender-inclusive space use, were observed using direct observation and behavior mapping methods, in two playground types (adventure playground and conventional playground).

Results. In the adventure playground, both boys and girls engaged in a greater variety of active free play behaviors, engaged in more time in pro-social interactions, and spent less time in conflict interactions than in the conventional playground. Additionally, boys and girls both spent less time in 'non-play' activities in the adventure playground, but for girls, the contrast between the adventure playground and the conventional playground was more pronounced than for boys. Finally, playground type was found to have no effect on the third dependent variable, gender-inclusive space use.

Conclusions. Adventure playgrounds may foster greater variety of play behaviors, more positive social interactions, and greater participation among girls during outdoor active free play, contributing positively to daily PA, among boys and girls.

"From a design viewpoint, the possibility of stimulating wilderness or creating environments… which contain some risk-taking elements should be a challenge to the planner and landscape architect who would go beyond conventional playground settings and design places with possibilities for adventure…"
-Florence C. Ladd, 1977
(p. 447 in Humanscape, Environments for People)

INTRODUCTION

All children have a right to play – according to United Nations (UN) Article 31 developed in 1979 with the International Play Association (Unicef, 1989). In the past three decades, since the inception of the UN's declaration that all children have the right to rest and leisure activities as well as the right to be involved in cultural and artistic activities (Unicef, 1989; Davey & Lundy, 2011), there has been a significant decline in the amount of time children spend freely playing, especially outdoors (Rivkin, 1995; Hofferth, 2009; Hofferth & Sandberg, 2001). Increased time spent at school, structured activities, and use of technology, are all been considered contributing factors to the decline in outdoor free play (Larson & Verma, 1999; Hofferth, 2009; Hofferth & Sandberg, 2001). Concurrent with the decline in outdoor free play, childhood chronic diseases and disorders such as obesity, depression, type II diabetes, and ADHD have been rising steadily, suggesting that decreases in outdoor free play may be associated with adverse health outcomes in childhood (Gortmaker, 1985; Gortmaker et al., 2012).

Active free play, especially outdoors, is associated with healthy child development (Ginsburg, 2007) and may be especially important for children living in poverty (Milteer & Ginsburg, 2012). Opportunities for play account for a substantial proportion of the total amount of physical activity (PA) achieved by children, particularly during middle childhood (ages 6 to 11) (National Physical Activity Plan Alliance, 2014). PA and movement in the form of active free play can counter the development of chronic diseases, in childhood and later adulthood (Gortmaker, 1985; Perrin, Bloom, & Gortmaker, 2007). Play behaviors can be an indicator of children's health, well-being, and development (Ashish et al., 2015; Pellegrini, 1985). However, gender differences in play have been observed and these disparities in play may influence the healthy development of boys and girls (Pellegrini, Dupuis, & Smith, 2007).

Gender differences in play behaviors

In the context of active free play, the socially constructed concept of gender, developed throughout childhood, may underlie and contribute to the gender disparities in physical activity and play seen over the life course as well as, ultimately, to health disparities, in later life (Braveman & Barclay, 2009).

Gender is not a static construct. Children and adults are constantly "practicing" gender and reinforcing it in actions, words, and in physical spaces (B. Martin, 2011; C. L. Martin & Ruble, 2010). Two-year old children have been found to be aware of and practice gender roles (Boyle, Marshall, & Robeson, 2003; B. Martin, 2011). Playgrounds have been considered 'gendered spaces' in which boys constrain girls in their physical activities and play (Azzarito & Hill, 2012; Karsten, 2003; Thorne, 1993). For example, boys often play games with rules and play ball sports, such as soccer or basketball, that take up large amounts of physical space. On the other hand, girls are often found playing in smaller groups, on the margins of the playground (Clark, 2007; Datta, 2008; Thorne, 1993). Boys have also been found to spend more time in more vigorous activities during functional play (Hughes, 2009) and spend greater time in constructive play than girls (Pellegrini & Perlmutter, 1989). Girls have been found to spend greater proportions of their time playing 'make-believe' or in dramatic play (Pellegrini & Bjorkland, 2004).

Gendered spaces and gender-inclusive space use

Gender can be defined and reinforced by social settings and structures, and through people, places, and behaviors (Moen & Chermack, 2005; Rossi, 1985). Recent research identified ways that institutions, such as schools, may be reinforcing gender-role stereotypes through gendered play spaces (Clark, 2007; Datta, 2008; Karsten, 2003). Consequently, schools and other 'microsystems' in which children spend a great deal of time may be contributing to the gender disparities in physical activity and play (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 1989).

The environmental quality of the playground has also been investigated in the context of gendered spaces. Several studies have found that when children play as a group, boys and girls are equally attracted to natural elements in play spaces. Moreover, when more natural elements are present, there is an increase in the gender-mix of children, as they play (Änggård, 2011; Anthamatten et al., 2014; Anthamatten et al., 2011; Moore, 1986a), which may help to improve children's overall physical competence (Barbour, 1999).

"Borderwork"

The term "Borderwork" was coined in Barrie Thorne's qualitative study as a participant observer in schools to understand children's gendered active free play (Thorne, 1993). Borderwork implies that the distinction between boys' and girls' play and play behaviors are upheld. Thorne believed that while children often played in sex-segregated groupings, boys and girls were found exploring the gender boundaries. On the playground, she observed children partaking in cross-sex interactions that resulted in the affirmation of preexisting physical gender boundaries. She found that boys control more space than girls and often boys are found trying to take-over girls' spaces. In addition, when girls attempted to 'invade' boys' spaces, they were often turned away. This need for girls to be included on a playground has been sited in other studies. When girls, even as young as 3, try to engage in physical play with boys, they are often told that they are not allowed to play (Azzarito & Hill, 2012). Thorne believed that Borderwork shows that boys' and girls' spaces are not equal and that both sexes work hard on keeping these two gender worlds separate (Datta, 2008; Karsten, 2003; Martin, 2011).

The overt exclusion of girls in active free play is an example of how children reinforce what type of play is appropriate for boys and girls (Martin, 2011; Thorne, 1993). Being excluded from play may be the first direct experience girls have with the concept of 'constrained choice'. Constrained choice is the idea that while it may appear as if girls and women have equal opportunities to participate in various physical activities and play experiences, there may be sociocultural contexts that are acting upon their choices (Rieker & Bird, 2005). Experiencing 'constrained choice' in the context of active free play may be connected to the gender differences seen in physical activity and play behaviors that affect the trajectory of children's health outcomes in later life.

Environmental design may matter

Designing play spaces that afford gender inclusivity may help children's healthy development. Most of the studies mentioned above involve observing children playing more conventional playgrounds (Barbour, 1999; Anthamatten, Brink, Lampe, Greenwood, Kingston, & Nigg, 2011) and a few studies have been conducted in natural environments, but among young children not those in middle childhood (Boldemann, 2011; Boldemann et al., 2006; Mårtensson et al., 2009; Fjortoft & Sageie, 2000). Research suggests that playgrounds that children participate in building themselves may better meet their developmental needs and promote healthy development (Sanoff, 2000). Adventure playgrounds are examples of a child-led playground design, where children plan, design, build, and reconstruct their own play environment. Responding to children's loss of outdoor free play

(Rosin, 2014; Rivkin, 1995), adventure playgrounds, first implemented in America around the 1960s and 1970s, have recently regained attention, within the current interest in providing greater opportunities for children to experience 'risk' and increase their unstructured play opportunities. While the history of adventure playgrounds is long (first developed in Denmark in 1943), research is lacking on how adventure playgrounds influence children's play (Hayward, Rothenberg, & Beasley, 1974)

Adventure playgrounds: A brief history

A Danish landscape architect, Carl Theodor Sorenson, envisioned an ideal design of an outdoor play environment for children where they would be encouraged to use any kind of found materials to construct their own outdoor environment (Sorenson, 1931). In 1943, in Copenhagen, Denmark, Sorenson witnessed his conceptualization implemented in the form of what he called "*Skrammellegepladsen"* or "junk playground". The concept that children could plan, design, and manipulate their own outdoor play environments, inspired Lady Allen of Hurtwood, a child advocate from London, to visit the "junk playground" in Copenhagen and later, in 1946, brought the novel idea to England, changing the name to "adventure playground" (See Figure 4.1.) (Allen of Hurtwood, 1968; Sorenson, 1931).

Western European children reacted to the trauma of World War II by creating “adventure playgrounds”, often located in recent bombsites and vacant lots, equipped with maneuverable materials “loose parts” leftover from war (e.g. scrap metal, tires, and wood) (Benjamin, 1974), as well as integrating many natural elements (e.g. trees, grass and shrubbery, dirt, and varied topography). Today, in Europe, there are about 1,000 adventure playgrounds in use. In contrast, the United States has only four adventure playgrounds, currently in use (Figure 4.2.: Huntington Beach, California; Figure 4.3.: Berkeley, California; Figure 4.4.: Ithaca, New York; and Figure 4.5.: Mercer Island, Washington), though others are currently in the planning phase.

Figure 4.1. Lady Allen Hurtwood’s essay,
“Why Not Use Our Bomb Sites Like This?” 1946.

Figure 4.2 Adventure Playground, Huntington Beach, California: 1970 - present

Figure 4.3 Adventure Playground, Berkeley, California: 1979 - present

Figure 4.4 Hands-On-Nature Anarchy Zone, Ithaca, New York: 2011 - present

Figure 4.5 Deane's Children's Park, Mercer Island, Washington: 2014 - present

Environmental psychology and adventure playgrounds

Despite the long history of adventure playgrounds, especially in Western Europe, there is a relative dearth of empirical evidence regarding the influence of adventure playgrounds on children's play behaviors and developmental domains (physical, cognitive, social, and emotional) (Ward, 1961; Marcus, 1970; Marcus & Moore, 1976; Moore, 2014). In 1974, during the height of the adventure playground movement in North America, Hayward, Rothenberg, and Beasley conducted an observational study comparing children's playground use and play behaviors in three playground design types: *traditional (i.e. metal swings and slides), contemporary (i.e. interconnected play components made of various materials such as wood and plastic)*, and *adventure (i.e. loose parts)*. The rationale for the observational study was to consider the role of the physical environment in children's play, through "intensive observation" to understand what children were doing across different settings. According to the authors, all environmental psychologists, planning for children's play spaces seemed to be based more on intuition than on systematic empirical evidence:

> *"In considering play spaces available to school-age children…there emerged a variety of intentions and traditions of play. It appeared that all planned play spaces embodied untested assumptions about the users, the nature of the activity and the interaction of the physical environment and children's play" (Hayward, Rothenberg, & Beasley, pg 133, 1974)*

To rigorously measure children's play in different settings, Hayward and colleagues (1974) employed a variety of environmental psychology methods: behavior mapping, behavior settings' records, (Ittelson et al., 1970; Barker & Wright, 1963) as well as interviews. Behavior mapping was used to investigate patterns of equipment use, and behavior settings' records determined children's flow, duration, and content of play behavior. Finally, individual interviews were conducted to understand how children chose the playground.

According to Hayward and colleagues' (1974) findings, children entered the playground with caretakers most often in the traditional playground (60% of the observed time) followed by about 41% of the time in the contemporary playground. Conversely, children observed playing in the adventure playground entered the playground alone or with peers, with no adults present, 96.7% of the observed time. In addition to children coming alone to play in the adventure playground, results also showed that a greater proportion of children in the adventure playground lived in the neighborhood (97%) compared to 46% in the traditional playground and 41% in the contemporary playground. Additionally, on average, children stayed playing in the adventure playground for 75 minutes, substantially longer than the contemporary playground (32 minutes) and traditional playground (21 minutes). In summary, children observed playing in the adventure playground, had the longest length of stays, chose to be there without the care of an adult, came almost every day of the week, and children consistently named the adventure playground as their favorite place. In both the traditional and contemporary playgrounds, children had shorter lengths of stay, rarely came alone, and perhaps because they were not from the neighborhood, visited infrequently (Hayward et al., 1974). Greater use and preference for the adventure playground may speak to the design and space better meeting children's developmental needs; or, alternatively could be due to the novelty of the adventure playground.

The Hayward, Rothenberg, and Beasley observational study was the first empirical study to provide insights regarding differential playground design and children's time spent, playground use, and preference. However, there is a threat to internal validity. Because the study compared different children in three playground designs, the findings may be a result of fundamental differences among the groups of children that may or may not have to do with the design of the playgrounds. In other words, selection bias may decrease the certainty that the playground type influenced the time spent, playground use, and preference among children. The current study will attempt to address the issue by strengthening internal validity.

Theoretical framework

The three theories central to the current study are: 1) the bioecological model (Bronfenbrenner, 1979; Bronfenbrenner, Morris, Damon, & Lerner, 1998); 2) gender-schema theory (Bem, 1981) and 3) behavior setting theory (Barker, 1965, 1968). The combination of these three theories helps to explain how outdoor play environments may influence gender differences in play behavior types, social interactions, and gender-inclusive space utilization, during active free play. The three theories are described below.

The **bioecological model** is a theoretical framework that considers the human-environment interaction by investigating the varying levels of context surrounding the individual, working to collectively influence human development. The *microsystem* is the context that is closest to a child and where children are interacting closely with individuals such as teachers, parents, and peers. Outdoor play environments, such as playgrounds, parks, and backyards, can be thought of as a micro-environment or a microsystem (Bronfenbrenner, 1979; Bronfenbrenner et al., 1998). Children's reciprocal, long-standing, and frequent interactions with these physical environments and social interactions that take place within them (e.g. child-teacher, child-parent, or child-child interactions), are 'proximal processes' that according to the bioecological model, can create the greatest influence on a child's development.

Gender-schema theory is a theoretical perspective on gender socialization, combining both social learning and cognitive-developmental approaches (Bem, 1981; Fagot, Rodgers, & Leinbach, 2000). Gender socialization can be defined as the learning of behaviors and attitudes that are considered appropriate for either boys or girls. Gender-schema theory posits that children use gender as a way to organize their view of the world. Consequently, gender-role stereotypes, or the expectations that individuals will behave in certain ways because they are girls or boys, become reinforced through institutions that children spend time in, such as family, schools, peer groups, and media. These reinforcing institutions are thought of as 'agents of socialization' (Henslin & Nelson, 2000). Arguably the physical environment can be seen as a socializing agent, in that physical spaces may contain components that are gender-coded and therefore may elicit specific gendered behaviors.

The idea that the physical environment exhibits certain properties that influence behavior is supported by Barker's **behavior setting theory** (1965)**.** Barker suggests that a behavior setting is a behavior-environment unit that has two interdependent properties: 1) specified time, place, and objects; and 2) attached standing patterns of behavior. In the context of outdoor play environments, there is a collection of specified behavior settings serving different functions (e.g. fixed play equipment, hard-surfaces, pathways, trees, etc.) (Barker, 1965, 1968). Depending on children's gender-schema, these distinct behavior settings may be perceived differently, resulting in different patterns of physical activity.

The current study is the first within-subjects study to consider how adventure playgrounds may influence children's active free play. Investigating the design of playgrounds and their role in promoting a variety of play behavior types, social interactions, and gender-inclusive space use, among children in middle childhood, especially among low-income minority children, warrants study for three reasons. First, conventional playgrounds may be 'gendered spaces' and constrain children's play behavior choices (Moen & Chermack, 2005; Rossi, 1985). Second, connecting the physical environment and positive social interactions or 'prosocialness' may be beneficial for children's healthy development (Caprara, Barbaranelli, Pastorelli, Bandura & Zimbardo, 2000).

Finally, when natural elements are present in outdoor play environments, there has been an increase in the gender-mix or gender-inclusion of children, as they play (Änggård, 2011; Moore, 1986a), which may promote children's health and wellbeing. In the next section, we will elaborate on these three reasons for studying the role of adventure playgrounds in children's active free play. In the next section, we will elaborate on these three reasons.

Environmental design and play behavior types

First, conventional playgrounds may contribute to gender-stereotypes in children's play behavior types, social interactions, and gender-inclusive space use. Recent research has identified the ways institutions and public places, may be reinforcing gender-role stereotypes through gendered play (Clark, 2007; Datta, 2008; Karsten, 2003). Gender can be defined by social settings and structures and is reinforced through people, places, and behaviors (Moen & Chermack, 2005; Rossi, 1985). If children are situated in gendered spaces that reinforce gender roles and gender-role stereotyping, then they will begin to develop concepts that differential activities and ways of acting exist for girls and boys (Sarkin et al., 1997; Schmalz & Kerstetter, 2006). Determining how the physical environment may promote a variety of play behaviors among both girls and boys will help to inform the design of outdoor play spaces to promote physical activity and children's health.

Environmental design & pro-social interactions

Second, early positive social interactions or prosocialness has been found to promote healthy development in later life (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000) while anti-social or conflict interactions show no association to later development of academic skills. Therefore, fostering environments for children to engage in pro-social interactions may be more beneficial for healthy development than eliminating conflict (Antonovsky, 1987, 1996). The Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo study provided a longitudinal account of how prosocial interactions in third grade were more indicative of healthy development ten years later, in eighth grade. However, the study neglected the potential role of the physical environment on positive social interactions. This study will investigate the role of the physical environment on social interactions.

Environmental design & gender-inclusive space use

Third, when natural elements are present in outdoor play environments, there has been an increase in the gender-mix or gender-inclusion of children, as they play (Änggård, 2011; Moore, 1986a). Girls have been shown to prefer natural features of schoolyards and consequently had higher levels of physical activity, after a renovation to increase green elements (Dyment, Bell, & Lucas, 2009; Dyment & Reid, 2011; Moore, 1986a). Recent studies have explored the effects of renovated outdoor schoolyard environments on children's physical activity, however these studies do not explicitly investigate the role of natural elements in physical activity (Anthamatten et al., 2014; Anthamatten et al., 2011; Colabianchi, Maslow, & Swayampakala, 2011). Outdoor play environments that promote inclusive play among girls and boys is important to investigate, as more inclusive play may increase physical activity levels for girls as well as support a greater variety of play among boys.

The current study aims to investigate play behavior types, social interactions, and gender-inclusive space use, during active free play in a conventional playground compared to an adventure playground. This study will fill a critical conceptual gap and contribute to future environmental salutogenic design interventions to promote children's play and ultimately, their health and well-being.

The current study examines the main effects of playground type (adventure compared to conventional) and gender on three components of active free play: 1) play behavior types; 2) social interactions and; 3) gender-inclusive space use. In addition, the interaction effects of playground type and gender relation on the amount of time spent in various types of play behaviors and social interactions were explored.

METHODS

Participants and setting

The sample was 40 children from a Central New York summer camp program. Of the 40 school-aged children, 19 boys and 21 girls participated in the study. The children ranged from kindergarten to third grade (aged 5 to 10 years old). Children's active free play behaviors, social interactions, and gender-inclusive space use, were observed in two playground types: 1) a conventional playground and 2) an adventure playground. The conventional playground consisted primarily of metal and plastic fixed play structures while the adventure playground was mostly natural, with many loose parts.

Study design

In this within-subjects study design, the effect of two playgrounds on children's active free play behaviors, social interactions, and gender-inclusive space use were investigated. Data were collected over twelve 60-minute observational periods (six in the adventure playground and six in the conventional playground). Demographic data (e.g. gender, age, height and weight) were also collected and analyzed.

Constructs and measures: Independent variables

Playground Type. The two playgrounds studied were conventional and adventure playgrounds.

1. Conventional Playground. The conventional playground was 17,621.50 square feet (Figure 4.6.). The conventional playground consisted of asphalt, which included painted lines for two basketball hoops and a colorfully painted portion of the asphalt provided a path for games

such as hop-scotch and four-square. In a third of the space, a large, multi-component fixed play structure (made of plastic and fiberglass) provided children with opportunities to climb, jump, run, and slide. In the center of the play space, there was a newly constructed fixed play structure, consisting of interconnecting climbing ropes. A few trees and spots of grass line the perimeter and a vegetable garden was present along the far-end of the playground, next to the fence. During outdoor time, several basketballs and soccer balls were provided for play. Within this space, 13 behavior settings were predetermined by the researchers and were used during the behavior mapping protocol (Table 4.1.). Images of the conventional playground map and 13 play behavior settings are displayed in below in Figures 4.7. – 4.10.

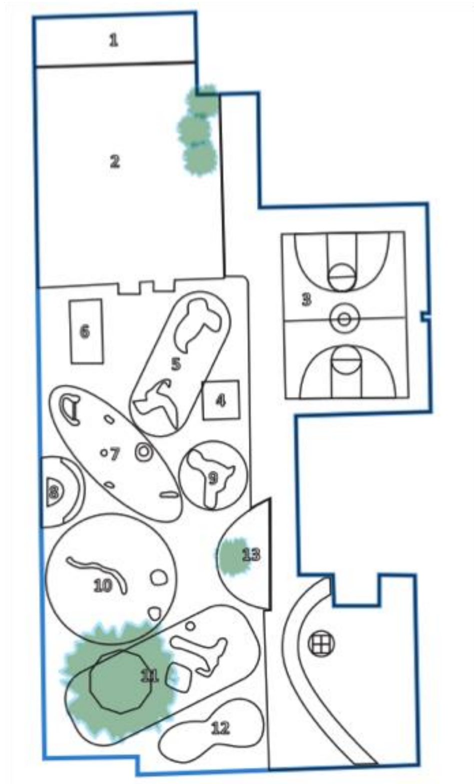

Figure 4.6. Map and aerial view of conventional playground (Total area = 17,621.50ft^2)

Table 4.1. Conventional Playground Behavior Settings and Size (ft^2)

Behavior Settings (C1-C13)	Size (ft^2)
C1. Garden	1644.27 ft^2
C2. Meadow	4637.00 ft^2
C3. Asphalt	3606.50 ft^2
C4. Umbrella Deck	253.26 ft^2
C5. Spider Jungles	1111.61 ft^2
C6. Soft Swings	881.41 ft^2
C7. Balance Zone	790.58 ft^2
C8. Stage	255.35 ft^2
C9. Big Slide	722.97 ft^2
C10. Hard swing area	804.25 ft^2
C11. Little slide	1275.28 ft^2
C12. Grassy knoll	989.80 ft^2
C13. Half moon	649.22 ft^2

Total Area: 17621.50 ft^2

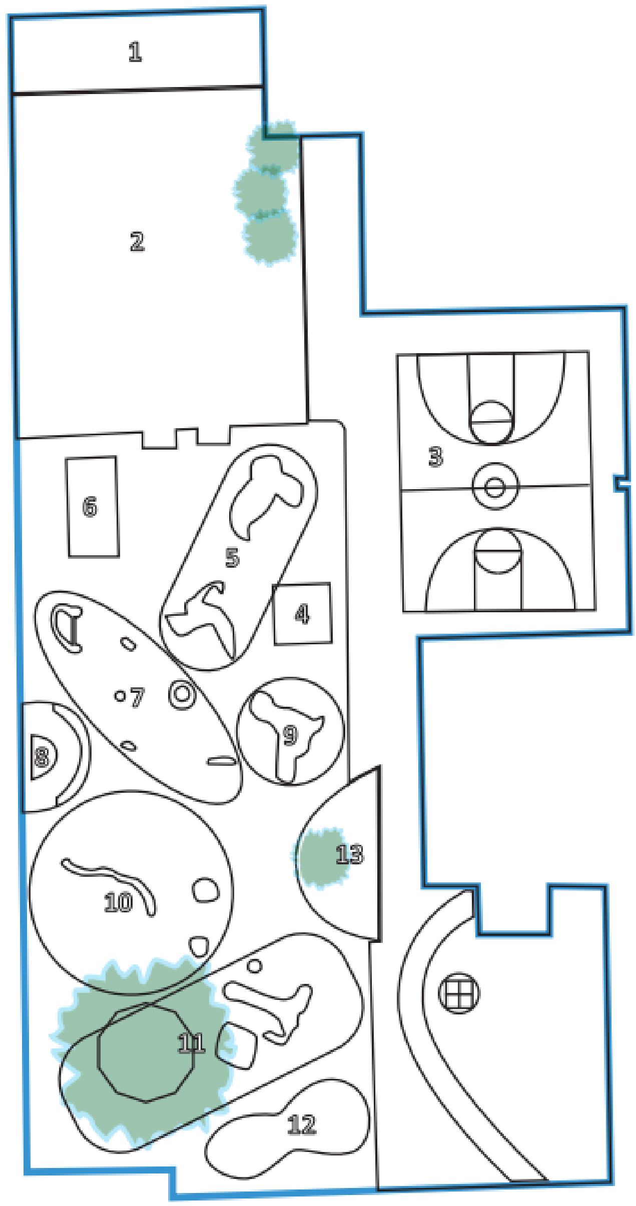

Figure 4.7. Conventional playground behavior settings (C1-C4)

Figure 4.8. Conventional playground behavior settings (C5-C7)

Figure 4.9. Conventional playground behavior settings (C8-C11)

Figure 4.10. Conventional playground behavior settings (C12-C13)

2. Adventure Playground. The adventure playground was 12,444.12 square feet (Figure 4.11.). The adventure playground consisted almost equally of grass, dirt, hay, and wood-chips. About a third of the space was shaded by one large sycamore tree, used for climbing. In addition, children attached ropes and cloth to the lower branches for swinging. Hay piles had been spread out in the space, directly below and adjacent to the tree. In the center of the space, there were varying levels of mulch, grass mounds, and dirt piles. Adjacent to the dirt piles, were several over-sized tree stumps. A large winding tunnel, made of willow branches, provided a space to run through and hide in. Finally, a small shed stocked with numerous tools and supplies was made available to children for digging and additional loose-parts for playing. Within this space, 13 behavior settings were also predetermined by the researchers and used during the behavior mapping protocol (See Table 4.2.). Images of the adventure playground map and 13 play behavior settings are displayed below in Figures 4.13. – 4.15.

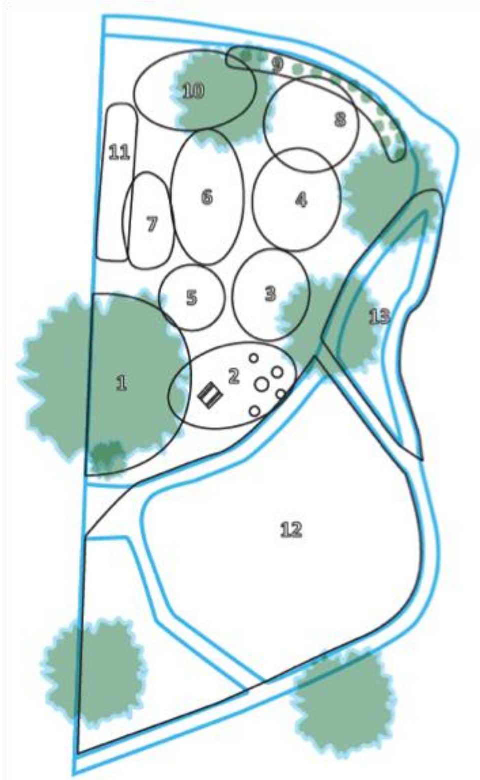

Figure 4.11. Map and aerial view of adventure playground (Total area = 12,444.12ft^2)

Table 4.2. Adventure Playground Behavior Settings and Size (ft^2)

Behavior Settings (A1-A13)	Size (ft^2)	Total Area: 12444.12 ft^2
A1. Sycamore tree	1256.64 ft^2	
A2. Stump seating	611.83 ft^2	
A3. Tunnel mound	439.91 ft^2	
A4. Digging mound	439.91 ft^2	
A5. The circle	157.48 ft^2	
A6. Transition space	778.54 ft^2	
A7. Mulch mound	283.53 ft^2	
A8. Mud pit	796.23 ft^2	
A9. Apple dome	42.86 ft^2	
A10. The shade	1008.85 ft^2	
A11. Willow tunnel	393.96 ft^2	
A12. Meadow	4727.04 ft^2	
A13. Meadow (cont.)	1507.34 ft^2	

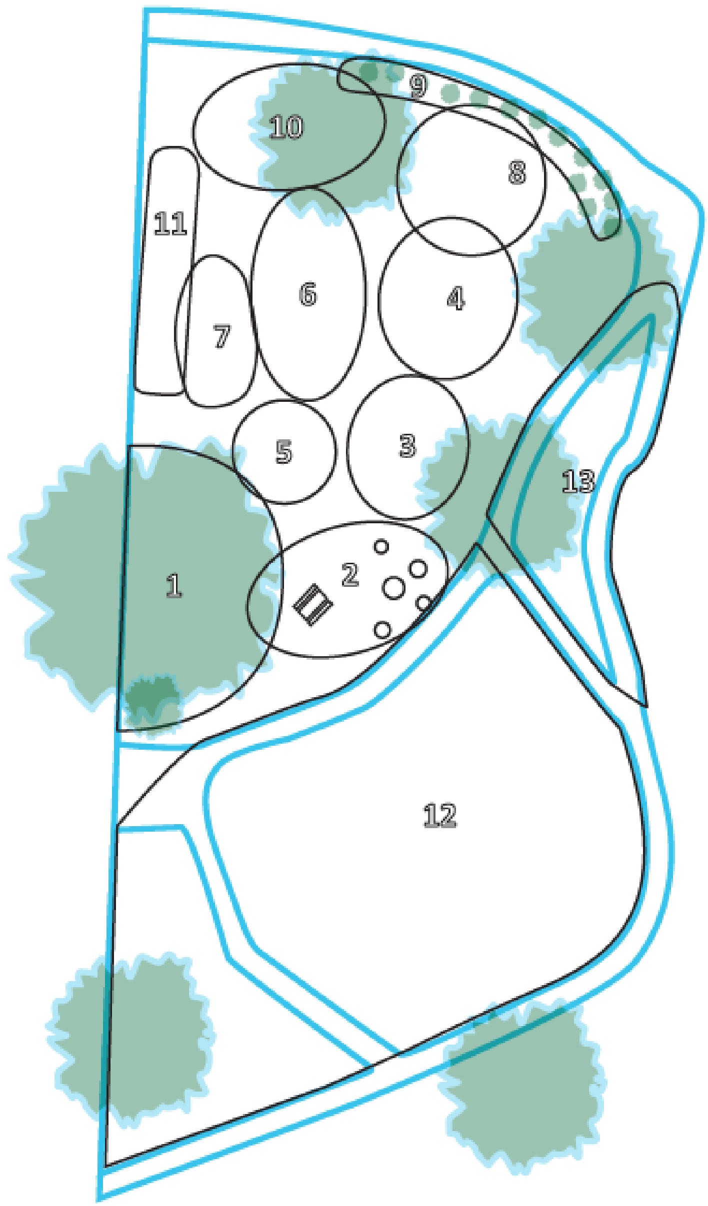

Figure 4.12. Adventure playground behavior settings (A1-A4)

Figure 4.13. Adventure playground behavior settings (A5-A7)

Figure 4.14. Adventure playground behavior settings (A8-A11)

Figure 4.15. Adventure playground behavior settings (A12-A13)

Constructs and measures: Dependent variables

Play behaviors & social contextual factors: Direct observation

The System for Observing Children's Activity and Relationships During Play (SOCARP) (Ridgers, Stratton, & McKenzie, 2010) was used to directly observe children's physical activity, social group sizes, play behavior types, social associations, and social interactions, during play. Construct validity data indicated that estimated energy expenditure rates from SOCARP and mean accelerometer counts were significantly correlated ($r = .67$, $p < .01$) and percent agreement for all four categories met acceptable criteria (88% to 90%) (Ridgers et al., 2010). In this study during each 30 second interval, the trained observer coded across the five categories, using a momentary time-sampling in which a trained observer repeatedly observes a focal child for 15 seconds and then recorded the behavior during a 15-second recording interval. Play behavior types and social interactions are the outcomes of interest in this study.

Play behavior types: Direct observation

Five types of play behaviors were recorded: *dramatic, constructive, functional, games-with-rules*, and *non-play*. Using the SOCARP protocol (Ridgers et al., 2010), each of these play behavior types was directly observed during ~60 minute observation period and coded once per interval. *Dramatic* play or 'fantasy' play was defined when children were actively involved in 'make-believe' and took on roles by acting out imaginative environments and scenarios. In *dramatic* play, children may be imagining that a play component is actually a sinking boat or an airplane they can fly. *Constructive* play was observed to be any play when children were purposefully working towards accomplishing a goal by engaging with objects to build, collect, and design. *Constructive* play usually had an element of declaring a goal the child had in mind "I'm going to keep digging this hole. Go over there and get that bucket and pour water into it, okay?"

Functional play was defined as any gross motor movement, often displayed by engaging with objects or play structures, with the goal being movement itself (e.g. running, skipping, hopping, jumping, climbing, spinning). *Games-with-rules* usually occurred with balls, clear order, and usually a 'winner' and clear verbalized goals. *Non-play* was coded when children were observing or standing around and not moving in anyway that appeared to be play.

Social interactions: Direct observation

Anytime during the 15-second observation period, the observer codes 'pro-social' (verbal or physical), 'conflict' (verbal or physical), and 'no interaction'. Pro-social interactions were verbal and physical positive interactions between children. For example, asking a child to work together on digging a hole, using encouraging words as children played, or physically helping another student climb a tree. Conflict interactions often were verbal disagreements, name-calling, or physically pushing another child. It was possible, in one interval, that an observation could be both 'pro-social' and 'conflict'. These observations were recoded as 'other'.

Space utilization: Behavior mapping

Behavior mapping is an objective approach to concurrently observe behaviors, physical environmental characteristics, and spatial patterning of movements (Zeisel, 2006). Behavior mapping is commonly used in environmental psychology research to understand how the built and natural environments relate to behavior and has also been used to investigate how natural play environments influence young children's physical activity levels and play behaviors (Cosco, Moore, & Islam, 2010). In this study, a map of the adventure playground and the conventional playground were developed and used to record locations of children's movements. Over the 60-minute observation, the researcher spent one minute in each behavior setting, and went from behavior setting 1 to behavior setting 13. In each behavior setting, each child present was marked on the map and coded across the direct observation categories. For the purposes of this study, gender was also recorded. Four behavior maps were created in each 60-minute observation period.

Gender-inclusive space use: Behavior mapping

Gender-inclusive space use was defined as having both genders present at the same time, in the observed behavior setting. For example, during an observation interval, if there were only boys in the behavior setting, then that interval would be coded as 'no gender-mix'. However, if both boys and girls were climbing in a tree, while the trained researcher was observing, the interval would be coded as 'yes, gender-mix'. Finally, if one child was playing alone, without any other children playing in the behavior setting, the code was defined as 'alone'.

Demographic variables Gender, age, race / ethnicity, and body-mass index (BMI) calculated based on measured by height and weight, and environmental characteristics such as area, adjacencies, and environmental features were also be measured, collected, and analyzed.

Procedure

In July and August 2014, 40 children's play behaviors and social interactions were directly observed six times for an average of 61 minutes, in each setting using SOCARP (19 boys and 21 girls) and children's ages ranged 5 to 10 years old. Trained research assistants conducted two observation sessions per week for six weeks (one observation session in adventure playground and one in conventional playground) and one trained researcher followed the behavior mapping protocol to conduct three observations per group over three weeks (one observation in adventure playground and one observation in conventional playground). During the observation period, the researcher spent one minute in each behavior setting, and went from behavior setting 1 to behavior setting 13. Researchers were able to identify individual children present in each behavior setting and were specifically marked on the map and coded across the direct observation categories, eliminated occurrences of double counting children. Four behavior maps were created in each 60-minute observation period.

Research Questions (See Figure 4.16. and Figure 4.17.)

The research questions, articulated below address three main outcome variables: 1) play behavior types; 2) social interactions and; 3) gender-inclusive space use.

1. Play behavior types (Figure 4.16.)

Research Question 1a: Is there a main effect of playground type (adventure versus conventional) on children's play behavior types (dramatic, constructive, functional, games-with-rules, and non-play)?

Research Question 1b: Is there a main effect of gender on children's play behavior types (dramatic, constructive, functional, games-with-rules, and non-play)?

Research Question 1c: Does the effect of playground type (adventure versus conventional) on patterns of play behaviors differ by gender?

If interactions are statistically significant, then the simple effects will be further explored:

Research Question 1d: Do girls' play behavior types differ in an adventure playground versus a conventional playground?; Do boys' play behavior types differ in an adventure playground versus a conventional playground?

Research Question 1e: Do play behavior types in an adventure playground differ among boys and among girls?; Do play behavior types in a conventional playground differ among boys and among girls?

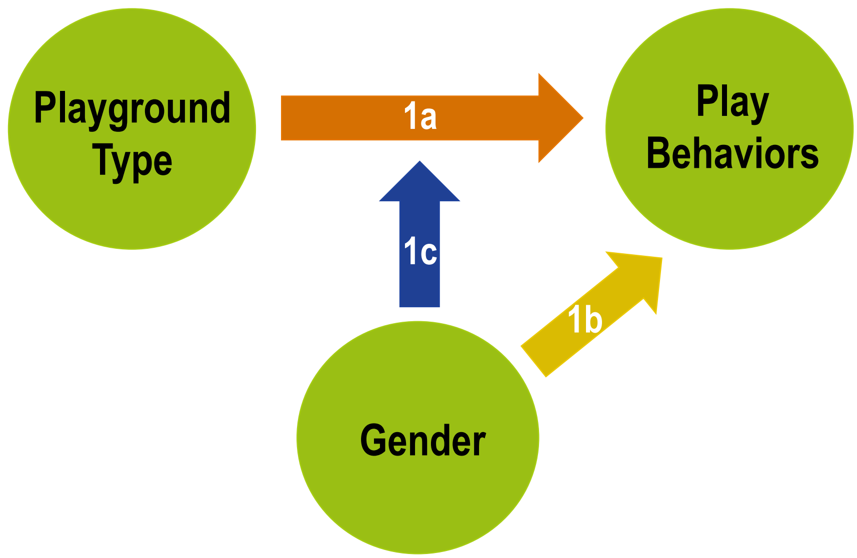

Figure 4.16. Main effect of playground type (1a); main effect of gender (1b); interaction of playground type by gender (1c) on play behaviors.

2. Social interactions (Figure 4.17.)

Research Question 2a. Is there a main effect of playground type (adventure versus conventional) on children's social interactions (pro-social, conflict, no interactions, other)?

Research Question 2b: Is there a main effect of gender on children's social interactions (pro-social, conflict, no interactions, other)?

Research Question 2c: Does the effect of playground type (adventure versus conventional) on social interactions differ by gender?

If interactions are significant, then the simple effects will be further explored:

Research Question 2d: Do girls' social interactions, differ in an adventure playground versus a conventional playground?; Do boys' social interactions differ in an adventure playground versus a conventional playground?

Research Question 2e: Do social interactions in an adventure playground, differ between boys and girls?; Do social interactions in a conventional playground, differ between boys and girls?

3. Gender-inclusive space use

Research Question 3: Where do children spend their time during active free play?

Research Question 4: Is there a main effect of playground type on *gender-inclusive space use?*

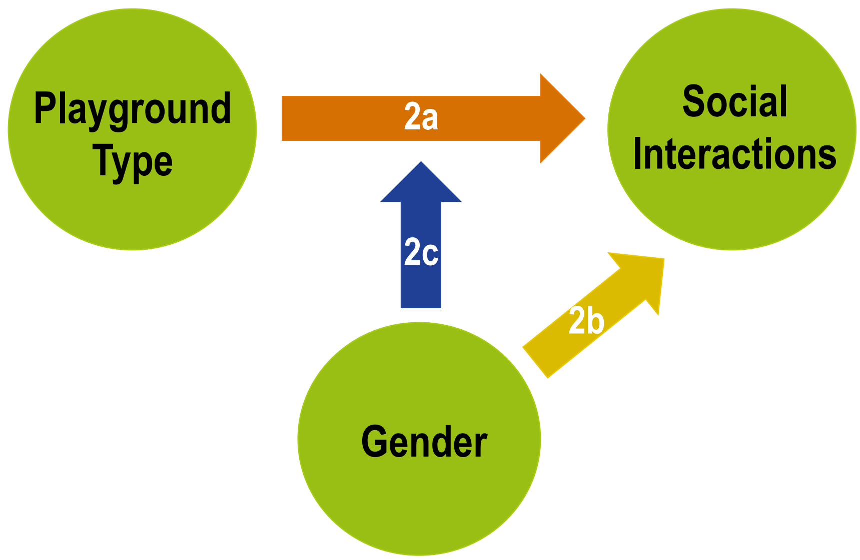

Figure 4.17. Main effect of playground type (1a); main effect of gender (1b); interaction of playground type by gender (1c) on social interactions.

Analytic Strategy

Direct observation data were input into Microsoft Excel and six variables were used in analysis (percentage of time spent lying, sitting, standing, walking, vigorous, and MVPA). Independent samples t-tests were conducted using IBM SPSS Statistics for Windows (IBM Corp., Version 21) to examined how the main effects of playground type and gender on physical activity (Research Question 1a and 1b) and social interactions (Research Question 2a and 2b). Regression models explored the interaction effects of playground type by gender on both PA and social interactions (Research Questions 1c and 1d). Descriptive analyses explored children's percentage of time spent and gender-inclusive space use, across behavior settings within the conventional playground and adventure playground (Research Question 3). Finally, independent samples t-tests explored the main effects of playground type on gender-inclusive space use (Research Question 4).

RESULTS

Of the 40 participating children, 19 were girls and 21 were boys (see Table 4.3.). The mean age was 6.4 years old (SD =1.26) and range was 5 to 10 years old. Of the 40 children, 29 (72.5%) were minority, non-white and 11 (27.5%) were white. Height and weight measurements were objectively measured and used to calculate body mass index (BMI) using the Center for Disease Control BMI calculation for children (CDC, 2000). Of the 37 out of 40 children whose parents and families gave informed consent, 2.7% were underweight, 78.4% were normal weight, 10.8% overweight, and 8.1% were obese.

Table 4.3. Participant Characteristics (n=40)

	Boys n=21	Girls n=19	All n=40
	n (%)	**n (%)**	**n (%)**
Age			
5 years old	5 (24)	6 (32)	11 (28)
6 years old	10 (48)	4 (21)	14 (35)
7 years old	3 (14)	2 (11)	5 (13)
8 years old	2 (10)	7 (37)	9 (23)
9 years old	0 (0)	0 (0)	0 (0)
10 years old	1 (5)	0 (0)	1 (3)
Race/Ethnicity			
Non-Minority (White)	5 (24)	6 (32)	11 (28)
Minority (Non-White)	16 (76)	13 (68)	29 (73)
Body Mass Index (BMI)[a]			
Underweight	1 (6)	0 (0)	1 (3)
Normal weight	14 (78)	15 (79)	29 (78)
Overweight	2 (11)	2 (11)	4 (11)
Obese	1 (6)	2 (11)	3 (8)

a. Body Mass Index (BMI): excluded 3 boys (2 non-minority, 1 minority) whose parents / families declined height & weight measurements (n=37).

The results of the research questions that examined the influence of playground type (adventure compared to conventional) on three components of active free play: 1. play behavior types; 2. social interactions; and 3; gender-inclusive space use, are presented below.

Play Behavior Types

Three research questions are explored related to the first component of active free play, *play behavior types*. Five types of play behaviors were directly observed and recorded one time per observation interval: dramatic, constructive, functional, games with rules, and non-play. First, the main effect of playground type on play behavior types was explored (Research Question 1a). Next, the main effect of gender on play behavior types was investigated (Research Question 1b). Then, the interaction of playground type and gender on play behavior types was examined (Research Question 1c). Finally, for significant interactions, simple effects will be explored (Research Questions 1d and 1e):

Research Question 1a: How do children's play behaviors types (dramatic, constructive, functional, games with rules, and non-play) in an adventure playground compare to those in a conventional playground?

First, the main effect of playground type on the five play behavior types was explored. The results, shown in Table 4.4., indicate that in the adventure playground, children were engaged in dramatic play about 30% of the time, $\overline{x}$ = 29.81%, (SD = 25.06%) compared to about 10% of the time spent in dramatic play in the conventional playground, $\overline{x}$ = 9.69%, SD = 12.60%, $p<.001$. More time was spent in constructive play in the adventure playground compared to the conventional playground ($\overline{x}$ = 25.96%, (SD = 23.96%) and $\overline{x}$ = 0.07%, (SD = 3.52%) respectively, $p<.001$). In the adventure playground, there were no observations of children playing games-with-rules (0.00%) however, in the conventional playground, children spent about 16.56% (SD = 17.22%) of the time playing games-with-rules ($p<.001$). Additionally, in the adventure playground, children spent less than 10% in non-play, $\overline{x}$ = 9.04%, (SD = 11.79%) compared to the conventional playground, where non-play was observed about 30% of the time, $\overline{x}$ = 28.41% (SD

= 20.76%), p<.001. Children spent about the same amount of time in functional play in both playground types (adventure playground, $\overline{x}$ = 35.20%, (SD = 26.22%) and conventional playground, $\overline{x}$ = 44.27%, (SD = 21.24%)), p=.109.

Table 4.4. Children's mean proportion of time spent across play behavior types, by playground type, measured by direct observation (n=40)

Playground Type

	Conventional Playground		Adventure Playground			
	Mean %	(sd)	Mean %	(sd)	Mean difference	p-value
Play Behavior Type						
Dramatic	9.69	(12.60)	29.81	(25.06)	- 20.12	<.001***
Constructive	0.07	(3.52)	25.96	(23.26)	- 25.23	<.001***
Functional	44.27	(21.24)	35.20	(26.22)	+ 9.07	.109
Games w/ Rules	16.56	(17.22)	0.00	(0.00)	+ 16.59	<.001***
Non-Play	28.41	(20.76)	9.04	(11.79)	+ 19.37	<.001***

***p < .001.

Research Question 1b: Is there a main effect of gender on children's play behavior types (dramatic, constructive, functional, games-with-rules, and non-play)?

Next, the main effect of gender on play behavior types was investigated. Results shown in Table 4.5., indicate that there was a main effect of gender on constructive play ($p=.048$). Boys were observed participating in constructive play for a greater percentage of time compared to girls ($\overline{x}$ = 16.79%, (SD = 23.24%) and $\overline{x}$ = 9.53%, (SD = 17.34%), respectively). There were no significant differences in the remaining play behavior type between boys and girls (Dramatic, $p=.113$; Functional, $p=.731$; Games-with-Rules, $p=.336$; Non-Play, $p=.731$).

Table 4.5. Children's mean proportion of time spent across play behavior types, by gender, measured by direct observation (n=40)

All Children (n=40)

	Boys (n = 21)		Girls (n = 19)			
	Mean %	(sd)	Mean %	(sd)	Mean difference	p-value
Play Behavior Type						
Dramatic	16.37	(19.33)	23.47	(24.64)	- 7.10	.113
Constructive	16.79	(23.24)	9.53	(17.34)	+ 7.26	.048*
Functional	38.87	(24.08)	40.69	(24.49)	- 1.82	.731
Games w/ Rules	9.55	(15.30)	6.91	(14.08)	+ 2.64	.336
Non-Play	18.12	(22.47)	19.40	(22.47)	-1.28	.731

*p < .05.

Research Question 1c: Does the effect of playground type (adventure versus conventional) on patterns of play behaviors differ by gender?

The third research question explored the interaction of playground type and gender on play behavior types. Analyses show a significant interaction effect of playground type and gender on *functional* play (p=.041) and *non-play* (p=.032). As shown in Figure 4.18., playground type moderates the impact of gender on children's functional play. The link between playground type and functional play is stronger among boys than girls. Playing in an adventure playground decreases the amount of time boys spend in functional play, while girls spend about the same amount of time in functional play, in both the conventional and adventure playgrounds.

Additionally, as shown in Figure 4.19., gender moderates the impact of playground type on non-play. The link between playground type and non-play is stronger among girls than boys. Playing in an adventure playground decreases the proportion of time spent in non-play, especially among girls. However, according to the results, there were no playground type by gender interaction effects on *dramatic* play (p=.987), *constructive* play (p=.109), or *games-with-rules* (p=.336).

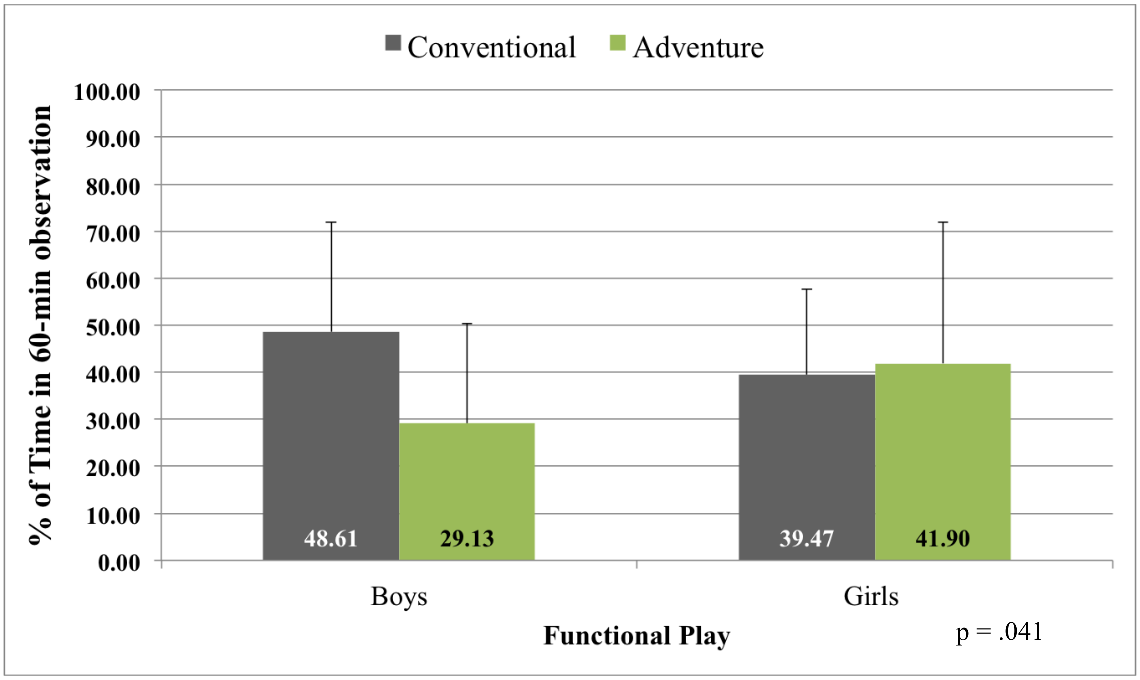

Figure 4.18. Children's mean proportion of time spent in functional play, by gender & playground type (n=40)

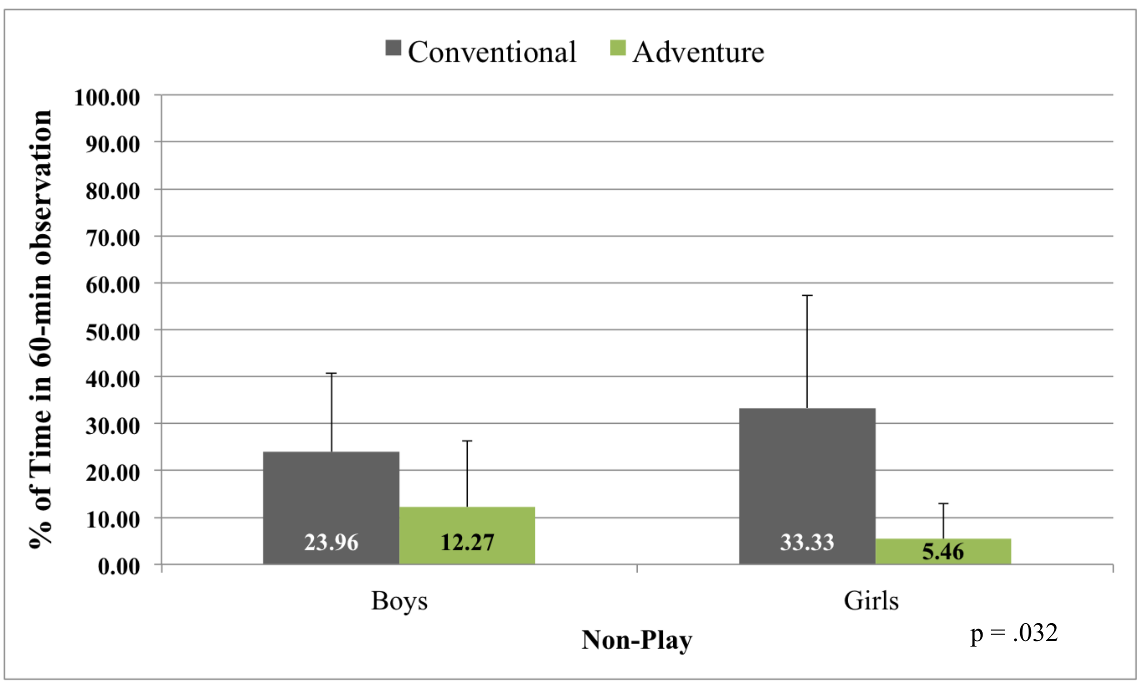

Figure 4.19. Children's mean proportion of time spent in non-play, by gender & playground type (n=40)

Research Question 1d: Do girls' play behavior types differ in an adventure playground versus a conventional playground?; Do boys' play behavior types differ in an adventure playground versus a conventional playground?

Given the statistically significant playground type and gender interaction effect on functional play ($p=.041$) and non-play ($p=.032$), the results in Table 4.6. explored the simple effects of playground type for both functional play and non-play within gender. Boys observed in the conventional playground spent a greater percentage of time in functional play, $\overline{x}$ = 48.61%, (SD = 23.29%), compared to in the adventure playground, $\overline{x}$ = 29.13%, (SD = 21.16%), $p=.025$. In the conventional playground, boys spent a significantly greater proportion of their time in non-play ($\overline{x}$ = 23.96%, (SD = 16.81%)), compared to the adventure playground, $\overline{x}$ = 12.27%, (SD = 14.04%) compared $p=.029$.

Table 4.6. also shows the percentage of time spent in play behaviors (functional play and non-play) among girls in the adventure playground compared to the conventional playgrounds. Unlike the boys, girls spent about the same amount of time in functional play, $\overline{x}$ = 41.90%, (SD = 30.02%) in the adventure playground compared to the conventional playground, $\overline{x}$ = 39.47%, (SD = 18.13%), $p=.759$. However, similar to the boys, in the adventure playground, girls spent significantly less time in non-play, $\overline{x}$ = 5.46%, (SD = 7.51%) compared to the conventional playground, $\overline{x}$ = 33.33%, (SD = 23.90%), $p<.001$.

Table 4.6. Simple effects of playground type on mean proportion of time spent across play behavior types (functional play and non-play), within each gender, measured by direct observation (n=40)

	Boys n = 21			Girls n = 19		
	Conventional Playground	Adventure Playground		Conventional Playground	Adventure Playground	
	Mean % (sd)	Mean % (sd)	p	Mean % (sd)	Mean % (sd)	p
Play Behavior Type						
Functional	48.61 (23.29)	29.13 (21.16)	.025*	39.47 (18.13)	41.90 (30.02)	.759
Non-Play	23.96 (16.81)	12.27 (14.04)	.029*	33.33 (23.90)	5.46 (7.51)	<.001***

*p < .05. ***p < .001.

Research Question 1e: Do play behavior types in an adventure playground differ among boys and girls?; Do play behavior types in a conventional playground differ among boys and girls?

The results in Table 4.7. show the second set of simple effects (within gender) for both functional play (p=.041) and non-play (p=.032). According to the results in Table 4.7., within the conventional playground, there were no significant differences in the mean proportion of time spent in functional play among boys and girls (p=.177) or time spent in non-play among boys and girls (p=.156). Finally, within the adventure playground, there were also no significant differences in the mean proportion of time spent in functional play among boys versus girls (p=.131) or time spent in non-play among boys versus girls (p=.062).

Table 4.7. Simple effects of gender on mean proportion of time spent across play behavior types (functional play and non-play), within each playground type, measured by direct observation (n=40)

	Conventional Playground			Adventure Playground		
	Boys n = 21	Girls n = 19		Boys n = 21	Girls n = 19	
	Mean % (sd)	Mean % (sd)	p	Mean % (sd)	Mean % (sd)	p
Play Behavior Type						
Functional	48.61 (23.29)	39.47 (18.13)	.177	29.13 (21.16)	41.90 (30.02)	.133
Non-Play	23.96 (16.81)	33.33 (23.90)	.156	12.27 (14.04)	5.46 (7.51)	.062

Social Interactions

The following three research questions are related to the second aspect of active free play, *social interactions*. First, the main effect of playground type on social interactions was explored (Research Question 2a). Then, the main effect gender on social interactions was investigated (Research Question 2b). Finally, the interaction of playground type and gender on social interactions was assessed (Research Question 2c). Social interactions were measured by direct observation, anytime during the 15-second observation interval and the observer coded 'pro-social' (verbal or physical), 'conflict' (verbal or physical), or 'no interaction'. It was possible, in one interval, that an observation could be both 'pro-social' and 'conflict'. These observations were recoded as 'other', and occurred about 2% of the time in both playground types (conventional: 1.67%; adventure: 2.01%).

Research Question 2a: Is there a main effect of playground type (adventure versus conventional) on children's social interactions (pro-social, conflict, no interactions, other)?

Main effects of playground type on social interactions were examined by coding verbal and physical pro-social and conflict oriented social interactions, for each child observed, as well as times when no social interaction took place. According to results shown in Table 4.8., in the conventional playground, children spent a greater proportion of time in no social interaction compared to the adventure playground (p=.003). In the conventional playground, children spent about 40% of their time in no social interactions, $\overline{x}$ = 40.31%, (SD = 26.59%), compared to the adventure playground, where children spent about 25% of their time in no social interactions, $\overline{x}$ = 24.50%, (SD = 21.56%). In both playground types, children spent the greater proportion of their time in pro-social interactions. However, in the adventure playground, a greater proportion of time was spent in pro-social interactions (70.73%) compared to the conventional playground (50.81%), p<.001. Conversely, in the conventional playground, there was a greater proportion of time spent in conflict interactions, $\overline{x}$ = 7.21%, (SD = 11.44%), compared to the adventure playground, $\overline{x}$ = 2.76%, (SD = 5.81%), p=.024. Finally, there was no difference in the percentage of time children spent in 'other' social interactions (pro-social and conflict coding in the same interval), in the two playgrounds (p=.658).

Table 4.8. Children's mean proportion of time spent across social interactions, by playground type, measured by direct observation (n=40)

Playground Type

	Conventional Playground		Adventure Playground			
	Mean %	(sd)	Mean %	(sd)	Mean difference	p-value
Social Interactions						
None	40.31	(26.59)	24.50	(21.56)	+ 15.81	.003**
Pro-Social	50.81	(27.53)	70.73	(22.25)	- 19.92	<.001***
Conflict	7.21	(11.44)	2.76	(5.81)	+ 4.45	.024*
Other	1.67	(3.10)	2.01	(4.71)	- 0.34	.658

*p < .05. **p < .01. ***p < .001.

Research Question 2b: Is there a main effect of gender on children's social interactions (pro-social, conflict, no interactions, other)?

Next, the main effect of gender on social interactions was investigated. Results shown in Table 4.9., indicate that girls spent a significantly greater proportion of their time in conflict interactions $\overline{x}$ = 7.24%, (SD = 12.09%) compared to the percentage of time boys spent in conflict interactions $\overline{x}$ = 2.95%, (SD = 5.04%), p=.048. Boys and girls both spent about 30% of their time in no social interactions, p=.611 and the majority of their time in pro-social interactions, though the difference was not significant (p=.713). Finally, there was no difference in the amount of time boys and girls spent in 'other' social interactions (pro-social and conflict coding in the same interval), p=.337.

Table 4.9. Children's mean proportion of time spent across social interactions by gender, measured by direct observation (n=40)

	All Children (n=40)					
	Boys (n = 21)		Girls (n = 19)			
	Mean %	(sd)	Mean %	(sd)	Mean difference	p-value
Social Interactions						
None	33.79	(22.30)	30.88	(28.55)	+ 2.91	.611
Pro-Social	61.84	(23.14)	59.58	(30.65)	+ 2.26	.713
Conflict	2.95	(5.04)	7.24	(12.09)	- 4.27	.048*
Other	1.41	(2.51)	2.30	(5.12)	- 0.89	.337

*p < .05.

Research Question 2c: Does the effect of playground type (adventure versus conventional) on social interactions differ by gender?

The third research question, pertaining to the active free play component, social interactions, explored the interaction of playground type and gender on social interactions. According to the results, there were no significant differences in social interactions between boys and girls (None: $p=.090$; Pro-Social: $p=.061$; Conflict: $p=.220$; Other: $p=.204$). Since there were no significant interaction effects of playground type and gender on social interactions, simple effects of gender within playground type and simple effects of playground type within gender were not explored.

Gender-inclusive space use: Behavior mapping

Research Question 3: Where do children spend their time during active free play?

Behavior mapping was used as an objective approach to observe where boys and girls were located throughout the conventional playground (Figure 4.20.) and adventure playground (Figure 4.21.). Descriptive analyses explored children's percentage of time spent and gender-inclusive space use, across behavior settings within the conventional playground (Table 4.10.) and adventure playground (Table 4.11.). The percentage of time spent and gender-inclusive space use in the behavior settings are described below.

In the conventional playground, children spent most of the observed time (24.03%) in the 'little slide' behavior setting, in which 61.29% of the time the space was utilized inclusively among boys and girls. The next most used space in the conventional playground was the 'asphalt' area (16.28%), however, 85% of the time mostly boys were using the space, with no girls present. Both the 'balance zone' and the 'half moon' areas were utilized less than 15% of the observed time with gender-inclusive space use of 68.42% and 82.35%, respectively. However, boys or girls did not utilize the ‘stage’ area and the ‘garden’ during the observation period. The remaining seven behavior settings were utilized for less than 10% of the time.

In the adventure playground, children spent most of the observed time (26.03%) in the ‘sycamore tree’ behavior setting, and about half the observed time (47.37%) the space was utilized inclusively among boys and girls. The next most used space in the conventional playground was the ‘digging mound’ area (19.18%). Again, about half the observed time (53.57%) boys and girls were observed using the space inclusively. Finally, the ‘mud pit’ was used 15.07% of the observed time and had the greatest percentage of gender-inclusive space use among all behavior settings of the adventure playground (68.18%). However, boys and girls did not utilize the ‘willow tunnel’ area and spent very little time (0.68%) on the ‘tunnel mound’ during the observation period. The remaining eight behavior settings were used less than 10% of the time.

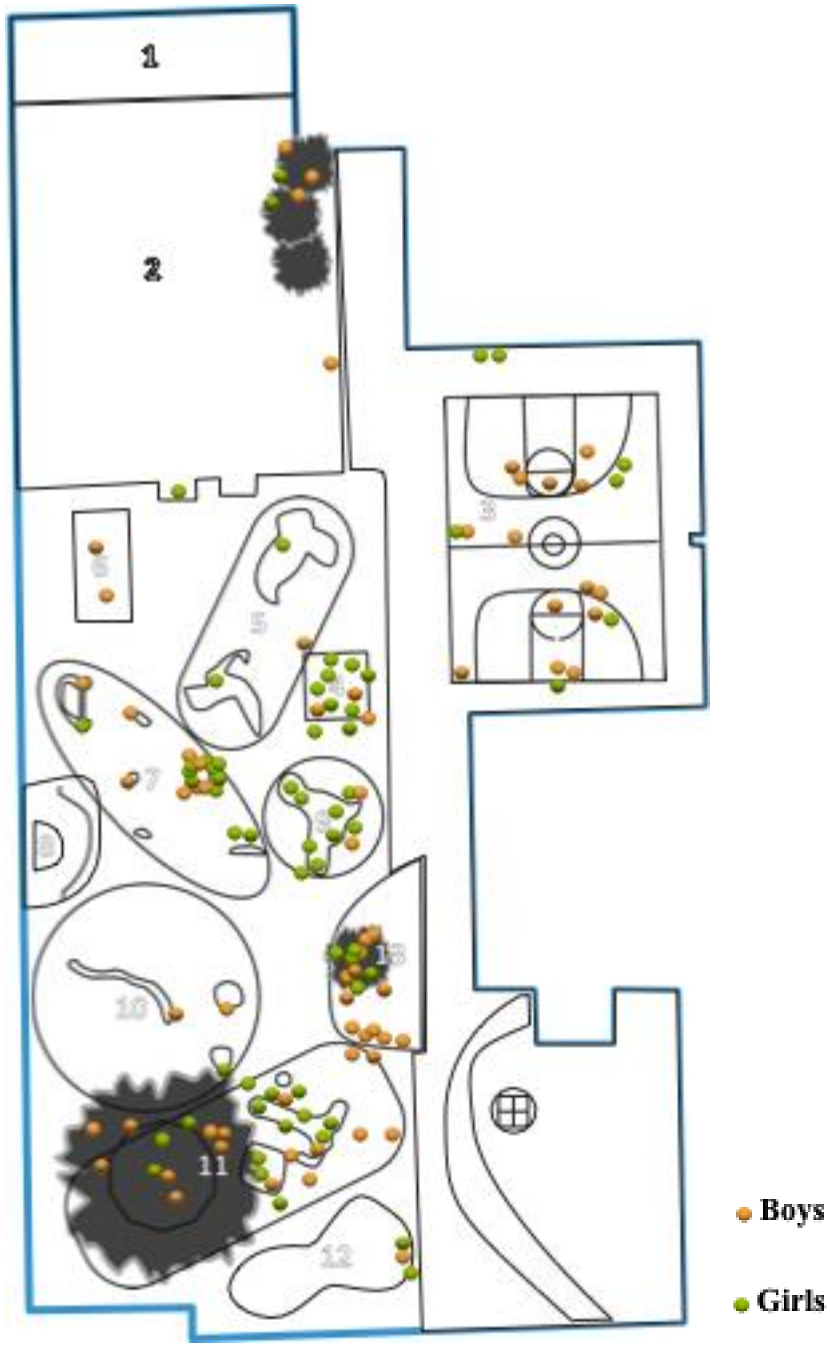

Figure 4.20. Gender-inclusive space use in a conventional playground, measured by behavior mapping

Table 4.10. Gender-inclusive space use during active free play by behavior settings: Conventional playground (n=13 behavior settings)

	Alone	**No Gender Inclusion**	**Gender Inclusion**	**Percentage of Time Spent**
Behavior Settings: Conventional Playground[a]				
C1. Garden	0.00%	0.00%	0.00%	**0.00%**
C2. Meadow	28.57%	0.00%	71.43%	**5.43%**
C3. Asphalt	4.76%	85.71%	9.52%	**16.28%**
C4. Umbrella Deck	0.00%	91.67%	8.33%	**9.30%**
C5. Spider Jungles	33.33%	0.00%	66.67%	**2.33%**
C6. Soft Swings	50.00%	50.00%	0.00%	**1.55%**
C7. Balance Zone	10.53%	21.05%	68.42%	**14.73%**
C8. Stage	0.00%	0.00%	0.00%	**0.00%**
C9. Big Slide	27.27%	18.18%	54.55%	**8.53%**
C10. Hard swing area	66.67%	0.00%	33.33%	**2.33%**
C11. Little slide	3.23%	35.48%	61.29%	**24.03%**
C12. Grassy knoll	0.00%	0.00%	100.00%	**2.33%**
C13. Half moon	5.88%	11.76%	82.35%	**13.18%**

a. Total observation epochs in conventional playground: n=129.

Figure 4.21. Gender-inclusive space use in an adventure playground, measured by behavior mapping.

Table 4.11. Gender-inclusive space use during active free play by behavior settings: Adventure playground (n=146 observations; n=13 behavior settings)

	Alone	No Gender Inclusion	Gender Inclusion	Percentage of Time Spent
Behavior Settings: Adventure Playground[a]				
A1. Sycamore tree	2.63%	50.00%	47.37%	**26.03%**
A2. Stump seating	66.67%	0.00%	33.33%	**2.05%**
A3. Tunnel mound	100.00%	0.00%	0.00%	**0.68%**
A4. Digging mound	10.71%	35.71%	53.57%	**19.18%**
A5. The circle	0.00%	100.00%	0.00%	**2.05%**
A6. Transition space	0.00%	21.43%	78.57%	**9.59%**
A7. Mulch mound	100.00%	0.00%	0.00%	**1.37%**
A8. Mud pit	9.09%	22.73%	68.18%	**15.07%**
A9. Apple dome	8.33%	50.00%	41.67%	**8.22%**
A10. The shade	18.18%	63.64%	18.18%	**7.53%**
A11. Willow tunnel	0.00%	0.00%	0.00%	**0.00%**
A12. Meadow	0.00%	50.00%	50.00%	**4.11%**
A13. Meadow cont.	0.00%	33.33%	66.67%	**4.11%**

a. Total observation epochs in adventure playground: n=146.

Research Question 4: Is there a main effect of playground type on gender-inclusive space use?

Gender-inclusive space use was defined as having both genders present at the same time in the observed behavior setting. Results regarding the main effect of playground type on gender-inclusive space use are shown in Table 4.12.. In both the adventure playground and conventional playground, children were observed playing alone about the same amount of the time (24.31% and 17.77%, respectively), p=.596. In addition, there was no significant difference between the two playground types in the percentage of time children were playing with no gender inclusion (either all girls or all boys at one time), p=.489. In the adventure playground, children were observed playing in same-sex groups about 32.85% of the time compared to 24.15% of the time in the conventional playground. Finally, in both environments, about 40% of the time, children were observed playing with other genders (35.23% in the adventure playground and 42.69% in the conventional playground), p=.563.

Table 4.12. Gender-inclusive space use during active free play, in a conventional playground compared to an adventure playground, measured by behavior mapping[a]

	Conventional Playground[b] (n=13 behavior settings)	**Adventure Playground[c] (n=13 behavior settings)**	
	Mean % (sd)	Mean % (sd)	p-value
Gender-Inclusive Space Use			
Alone	17.77 (21.86)	24.31 (38.09)	.596
No Gender Inclusion	24.15 (32.80)	32.85 (30.17)	.489
Gender Inclusion	42.69 (35.57)	35.23 (28.90)	.563

a. Total observation epochs in both spaces: n=275. b. Total observation epochs in conventional: n=129. c. Total observation epochs in adventure: n=146.

DISCUSSION

Purpose

This study aimed to investigate the influence of environmental design (two playground types: adventure versus conventional) on children's time spent in play behavior types (functional, constructive, dramatic, games-with-rules, and non-play), proportion of time spent in social interactions (prosocial and conflict), and gender-inclusive space use, during outdoor active free play.

Findings and interpretations

First, the results indicated that children engaged in a greater variety of play behavior types in the adventure playground compared to the conventional playground. Specifically, in the adventure playground, children engaged in more dramatic play (+20%) and in more constructive play (+25%) compared to the conventional playground. In the adventure playground, children also spent no time playing games-with-rules, compared to the conventional playground, in which children spent about 17% of the time playing games-with-rules. Consistent with the theory of loose parts and affordance theory, the adventure playground contained a greater amount of natural elements and loose parts which may help to explain the greater variety of play behavior types exhibited by children in the adventure playground.

In the context of reducing PA gender disparities, an important finding is that the link between playground type and 'non-play' is stronger among girls than boys. Both boys and girls spent less time in 'non-play' activities in the adventure playground than in the conventional playground, but for girls, the contrast between the adventure playground and the conventional playground was more pronounced than for boys. Framed within the gender-schema theory and previous literature on the potential gender-coding of physical environments, the characteristics of conventional outdoor environments including fixed equipment, large open spaces, and asphalt for organized games and ball sports may lead girls to perceive conventionally-designed playgrounds as places where they do not ‘belong’ (Thorne, 1993; B. Martin, 2011; C. L. Martin & Ruble, 2010; Azzarito & Hill, 2012; Karsten, 2003: Becker, 1976). The adventure playground, hypothesized to be less of a gendered space as a result of the greater proportion of natural elements and loose parts, may have been more engaging for girls. Therefore girls spent a greater proportion of their time in a variety of play behaviors, instead of in non-play, which may increase girls’ participation in outdoor active free play, contributing to their daily PA.

As opposed to recent literature and increasing societal views concerned with the increase in children ‘bullying’ or being aggressive during unstructured play time (Hymel & Swearer, 2015), this study found that in fact, in both environments, children spent a great deal of time in pro-social interactions. In the adventure playground compared to the conventional playground, children spent more time interacting with one another and their interactions were more likely to be in the form of positive social interactions (+~20%). Even with the small proportion of time spent in conflict interactions among children (7.24% of the time in the conventional playground and 2.76% of the time in the adventure playground), in the conventional playground, children were observed to be in conflicting interactions for significantly more time than in the adventure playground. This suggests that unstructured, outdoor active free playtime may encourage positive interaction among children, especially in adventure playgrounds. Fostering pro-social interactions versus decreasing conflict have been found to be a significant factor in predicting children’s later-life positive academic outcomes (Caprara, Barbaranelli, Pastorelli, Bandura & Zimbardo, 2000) and children spending time in adventure playground may increase their experiences of prosocialness.

Though children, especially girls, engaged in less non-play in the adventure playground, there was no pattern determined in gender-inclusive space use in either environment. In other words, unlike previous research that concluded boys took up a greater amount of physical space resulting in girls being marginalized to the edges of the playground (Thorne, 1993), girls and boys were found to be playing equally in all behavior settings.

Strengths

Though the history of adventure playgrounds is long (Ward, 1961; Marcus, 1970; Marcus & Moore, 1976; Moore, 2014), to our knowledge, this is the first empirical research study (within-subjects study) to examine the effects of an adventure playground on children's active free play components (play behavior types, social interactions, and gender-inclusive space use) compared to a conventional playground. There are two fundamental advantages of utilizing a within-subjects study design: 1. power (fewer subjects needed) and 2. reduction in error variance associated with individual differences.

The within-subjects study design ensures strong internal validity by reducing error variance associated with individual differences. By conducting a within-subjects study, and having the same children freely playing outdoors in both playground designs: a conventional playground, with mostly fixed equipment components (e.g. slides, monkey bars, rope climbs) and an adventure playground, with many loose-parts and natural elements (e.g. trees, grass, dirt mounds), internal validity was strong. Therefore, one can be more certain that the conclusions made are the result of the independent variable, playground type affecting children's physical activity (as opposed to some alternative explanation such as 'selection bias').

Limitations

This study is not without limitations. While the use of a quasi-experimental, within-subjects design to reduce error variance and strengthen internal validity was a key strength of this study, a primary limitation of a within-subjects research design is the possibility of 'carry-over effects,' in this case, from one play environment to another. Carry-over effects can be defined as the participation in one condition (e.g. playing in the adventure playground) may affect the performance (i.e. behavior) in other conditions (e.g. the conventional playground). One potential 'carry-over' is children playing in the adventure playground, spending more time in dramatic play. Then, when they go to play in the conventional playground, there is a potential 'carry-over' of dramatic play from the adventure playground to the conventional playground. Therefore, carry-over effects present a possible limitation because it may introduce an alternative explanation or confounding variable that changes the independent variable (e.g. playground type).

To account for this potential limitation or 'carry-over effect' a consistent pattern was used throughout the study. For example, conventional playground observation and data collection days took place first (day 1), followed by a visit to the adventure playground (day 2), a visit to the conventional playground (day 3), and finally play in the adventure playground (day 4) (This pattern was completed three times over the six-week period for a total of six observation days in each setting). Even with this data collection pattern, without further investigation, such as a qualitative study to ask children questions that may elicit some possibilities of carry-over, or an experimental study that explores the carry-over effects from one playground to another, the carry-over effects in this study remain unknown.

Even though a within-subjects study design allows for smaller sample sizes, another potential limitation of this study may be low statistical power due to a modest sample size (n= 40). This may lead to a threat to statistical validity such as increased risk of a Type II error (false negative or "miss") occurring. The sample size may be too small for the analysis to detect a statistically significant difference, even if there is one. This may be especially true for the research questions involving the gender by playground type interactions.

Finally, there may also be a threat to external validity. The findings from this study of one adventure playground in one Upstate New York community may not generalize to *all* adventure playgrounds. Similar findings from the sample of New York children may not generalize to children in other parts of New York, in other states, or other countries, due to varying demographic and cultural differences.

Implications and conclusions

Low income and ethnic minority populations are disproportionately burdened by poor physical and mental health outcomes, across the life course. The evidence from this study can be used to guide and inform the design process toward salutogenic evidence-based design of the spaces in which children spend a great deal of time. Additionally, when research evidence is utilized in the design process it will also be important to follow-up on the hypotheses of the design to understand how children are indeed moving and interacting within the space (Zeisel, 2006).

> *"In considering play spaces available to school-age children…there emerged a variety of intentions and traditions of play. It appeared that all planned play spaces embodied untested assumptions about the users, the nature of the activity and the interaction of the physical environment and children's play" (Hayward, Rothenberg, & Beasley, pg. 133, 1974)*

Considering early research on adventure playgrounds, future research on these “planned play spaces” may begin to test some assumptions and hypotheses about how the design of outdoor play spaces may influence children’s behavior and use of space, asking questions such as: How can outdoor play spaces foster children’s healthy development? And are there environmental characteristics that may be more ‘salutogenic’ than others?

As more adventure playgrounds emerge throughout the United States, process evaluations will be necessary to understand what works and what does not work. High maintenance costs, low staff involvement, and loss of temporary land-agreements were conjectured to previously contribute to the end of many adventure playgrounds started in the United States from the 1950s to the 1980s (Steller, 2014; Moore, 1974; Moore, 1986b; Moore, 2014) therefore, identifying the enablers and barriers to designing, using, and sustaining a ‘successful’ adventure playground will need to be systematically researched. As a result of the inherent need for community involvement as a key factor in sustaining adventure playgrounds, a community-based participatory research design likely will be an appropriate tool to gain insight into how adventure playgrounds influence healthy child development.

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CHAPTER 5

CONCLUSION

Play is a right for all children (Unicef, 1989). Active free play, especially outdoors, is associated with healthy child development (Ginsburg, 2007) and may be especially important for children living in poverty, given low-income children's disproportionate health burden (Milteer & Ginsburg, 2012). Over the past four decades, the downward trend of children's time outdoors, contact with nature, and engagement in active free play (Gleave, 2009; Larson, Green, & Cordell, 2011; Louv, 2008; Ladd, 1978; Larson & Verma, 1999; Hofferth, 2009; Hofferth & Sandberg, 2001; Rivkin, 1995) can be linked to federal, state, and local policies (e.g. increased school-time, standardized testing mandates) (Patall, Cooper, & Allen, 2010; Linn, 2002), environmental factors (e.g. changes in land-use resulting in decreases in natural areas, especially within low-income communities) (Bullard, 1994; Taylor, Floyd, Whitt-Glover, & Brooks, 2007; Taylor, Poston, Jones, & Kraft, 2006), and social conditions (e.g. parental fear, decreases in independent mobility) (Kyttä, 2004; Rosin, 2014; Davey & Lundy, 2011) that have coincided with the increase in childhood chronic diseases (Gortmaker, 1985; Gortmaker et al., 2012). United States national organizations are beginning to take notice of the collective decline in children's time outdoors, contact with nature, and engagement in active free play and are calling for environmental interventions to promote children's health and well-being (National Physical Activity Plan Alliance, 2014; RWJF, 2007; Jackson, 2003; Srinivasan, O'Fallon, & Dearry, 2003).

Summary

The three studies that comprise this dissertation explored the influence of outdoor environments on children's physical activity and three aspects of active free play (play behavior types; social interactions; and gender-inclusive space use). Chapter 2 developed the Physical

Activity Research & Assessment tool for Garden ObservatioN (PARAGON), the first validated and reliable direct observation tool to operationalize physical activity, postures, motions, social associations, and interactions that take place while gardening. Chapter 3 examined the effects of playground type (adventure versus conventional) on children's physical activity level and compared two measurements of physical activity (accelerometry and direct observation). Chapter 4 further explored the effects of playground type (adventure versus conventional) on children's free play behavior types and social interactions and examined gender-inclusive space use.

Together, these three studies investigated three childhood microsystems: school gardens, adventure playgrounds, and conventional playgrounds, and examined the influence on children's physical activity and active free play. The collective aim of the studies was to generate information that may help inform evidence-based design to improve the design and effectiveness of environmental interventions to promote children's health and well-being.

Chapter 2: Children's physical activity while gardening: Development of a valid and reliable direct observation tool

The Physical Activity Research & Assessment tool for Garden ObservatioN (PARAGON) was developed to operationalize physical activities that take place while gardening in order to address three needs: 1) to fill the contextual gap in existing direct observation tools; 2) to capture the conditions of gardens as a unique environmental intervention to promote children's physical activity and movement and 3) to provide community organizations and researchers with a cost-effective tool to record and evaluate characteristics of garden interventions as a strategy to promote physical activity.

This is the first study to present a valid and reliable systematic observation method for the direct observation of physical activity while gardening. The PARAGON is a cost-effective direct observation tool that has the potential to be utilized by community organizations, researchers, and school systems. Objective measures of children's physical activity are increasingly important to inform social and environmental interventions to decrease children's sedentary behaviors and increase physical activity levels. However, objective measures, such as accelerometry, on a large scale, can be expensive. PARAGON is practical and user-friendly for communities and schools and may help to inform the design and effectiveness of school gardens.

Chapter 3: Children's physical activity in outdoor free-living environments

While chapter 2 developed and validated a direct observation tool for physical activity while gardening, chapter 3 further explored the measurement of children's PA. A within-subjects research design was used to examine the effects of playground type (adventure compared to conventional) on children's PA levels (measured by accelerometry and direct observation). The results indicated that the effect of playground type on PA levels differed by measure. Accelerometry and direct observation told different stories. It may be that accelerometers underestimate children's moderate physical activity, in both settings, while direct observation appeared to overestimate children's sedentary behaviors in the conventional playground, and may not have accurately measured short burst of children's vigorous PA.

As mentioned previously, there is a desire to measure children's frequency and duration spent engaged in active free play, in an effort to provide a national guideline to improve health and well-being (National Physical Activity Plan, 2014). However, before determining a guideline regarding how much or how often children should spend engaged in active free play or 'unstructured' physical activity, there may be a need for more research to accurately measure the many physical activities children engage in during outdoor play. It may be that a combination of accelerometry and direct observation yield the most accurate and thorough measurement of children's PA during outdoor active free play.

Chapter 4: Adventure playgrounds and active free play: The role of environmental design in play behavior types, social interactions, and gender-inclusive space use

Chapter 4 also utilized a within-subjects research design to examine the effects of playground type (adventure playground compared to conventional playground) and gender on three components of active free play: 1) play behavior types; 2) social interactions and; 3) gender-inclusive space use. Results showed that in the adventure playground, both boys and girls engaged in a greater variety of active free play behaviors, engaged in more time in pro-social interactions, and spent less time in conflict interactions than in the conventional playground. Though the conventional playground was hypothesized to be a more 'gendered space' compared to the adventure playground, playground type was found to have no effect on the third dependent variable, gender-inclusive space use. Though the history of adventure playgrounds is long (Sorenson, 1931; Hayward, Rothenberg, & Beasley, 1974; Becker, 1976), to our knowledge, this is the first quasi-experimental study to examine the effects of an adventure playground on children's active free play components (play behavior types, social interactions, and gender-inclusive space use) compared to a conventional playground.

Collective strengths

The three dissertation studies collectively contribute to the research literature on children's outdoor environments and physical activity in three ways. First, PARAGON (Chapter 2) filled a gap in the literature by providing the first valid and reliable direct observation tool to measure children's physical activity while gardening. In combination with (Chapter 3) which was the first empirical study to measure children's PA in an adventure playground, these two studies contribute to the physical activity measurement literature and further consider measurement challenges within children's varied physical activities, especially during outdoor active free play, which is currently lacking and needed (National Physical Activity Plan, 2014).

Second, the within-subjects research design (Chapter 2 and Chapter 3), to our knowledge, were the first quasi-experimental study examining the effects of an adventure playground compared to conventional playground on children's physical activity and active free play. The strong internal validity of the within-subjects design makes more certain that the differences seen among the dependent variables (physical activity and active free play) were the result of the independent variable (playground type) and are not attributable to a confounding variable. Therefore, these studies substantially add to the literature on how outdoor environments affect children's health behaviors.

Finally, all three studies examine the influence of outdoor microenvironments on low-income and ethnicity minority children. In the context of the 'second wave' of the environmental justice movement, a greater focus is on creating enabling environments for health promotion (Bullard, 1994; Taylor et al., 2007; Taylor et al., 2006; Cutts, Darby, Boone, & Brewis, 2009), especially to affect PA behavior change (Sallis, Owen, Fisher, 2008; Pate et al., 1995). Given the disproportionate health burden of physical inactivity among low income and ethnicity minority children, designing and systematically researching salutogenic environments (benefitting low income and ethnic minority children) should be a priority.

Collective implications

Results from these studies have implications for the role of design in promoting population health. By providing designers, researchers, and community organizations tools (Chapter 2, PARAGON) environmental interventions taking place in communities and throughout school districts can be evaluated and help communities evaluate their own impact. In addition, the results of studies such as those presented in Chapter 3 and Chapter 4 can be summarized in the form of research briefs and be given to policy-makers, teachers, designers, and researchers interested and connected to children's outdoor environments. Through sharing tools and research evidence with stakeholders, design-research connections can be made to systematically improve the design and effectiveness of children's outdoor environments for the promotion of health and well-being.

The idea of school gardens as environments to promote health and well-being is not new. Similarly, in the United States, adventure playgrounds have been recently unearthed and toted as an optimal outdoor play environment for children, especially in middle childhood (Moore, 2014; Rosin, 2014). However, in past decades, both school gardens and adventure playground initiatives came and went, without systematic evidence answering questions such as: What components worked or did not work? Whom did the environments benefit? Why did these environmental interventions disappear? In order for the results of the current studies to have an impact on children's outdoor environments and ultimately on health and well-being, the results need to be translated into practice and then evaluated to see what works and what does not work.

Unexpected findings

There were several unexpected findings in the three studies. In study 2, while the two measures used to assess PA (accelerometry and direct observation) were expected to diverge somewhat, (perhaps in moderate PA and vigorous PA), it was not hypothesized that the two measures would tell opposite stories. In fact, accelerometry data indicated that children were more active in the conventional playground, while direct observation data indicated that children were more active in the adventure playground. In study 3, an unexpected finding was the lack of significance regarding the main effect of gender on physical activity and on the three components of active free play. Previous research has consistently shown disparities between boys' and girls' PA, wherein boys usually are more active than girls (Trost, et al. 2008; Gortmaker et al., 2012). However, in this study, there were no main effects of gender on PA, or on active free play behaviors (except for boys exhibiting greater percentage of constructive play compared to girls). Also in study 3 there was no clear pattern of gendered space use in either of the two playgrounds, assessed by behavior mapping and direct observation. Due to the lack of random selection, it may be that these particular children did not have expected disparities across PA and active free play components; or the sample size may not have been too small to compare differences between boys and girls.

Future research directions: Connecting translational research & design

Social scientists and designers interested in how the natural and built environments impacts human health and well-being may be able to participate in and inform translational research. Translational research is broadly defined as research that links scientific findings to practices that improve human health and well-being (Wethington & Dunifon, 2012). Translational research was initiated and applied within biomedical research to improve the treatment of disease though recently, social and behavioral scientists have begun to utilize and inform practices of translational research (Wethington & Dunifon, 2012). In the social and behavioral sciences, the research-to-practice gap is predominately studied by looking at how evidence-based programs go from efficacy trials to effectiveness trials, then to implementation, adaptation, and finally become disseminated and scaled-up for populations and communities. Previous public health research studying health behavior change has focused on evidence-based *programs* influencing individual behavior (Gortmaker et al., 1999; Choudhry et al., 2011; Story et al., 2003; Beets, Beighle, Erwin, & Huberty, 2009; Dzewaltowski et al., 2010) but there is a great potential for how evidence-based environmental *design* can influence human health and well-being (Jackson, 2003; Srinivasan, O'Fallon, & Dearry, 2003; Borradaile et al., 2009; Coleman, Geller, Rosenkranz, & Dzewaltowski, 2008).

In need of a systematic approach: Evidence-based 'salutogenic' design

There is a lack of systematic approaches to link research to practice within the research agenda of environments and health, especially with respect to children's outdoor environments. Often, environmental design occurs without being informed by research and often without any evaluation after people begin to use the designed spaces. This lack of a design-research connection allows for many environmental changes to take place without being informed by evidence or evaluated and therefore cannot help to inform subsequent designs.

Evidence-Based Design or EBD is the use of data and research evidence to inform the design process. While EBD has the potential to influence all designs, it has been most successful in healthcare. Designs of hospitals, computer interfaces, waiting rooms, etc., have all been researched to understand how the built environment affects human health and well-being. The surge of EBD in healthcare may be the result of economic and political climates that make it "worth" studying. However, the EBD taking place in the healthcare systems may provide a platform for researchers and designers of outdoor environments to learn from and improve upon so that research can be used for designing outdoor environments and improving future designs of outdoor environments to influence health.

Design-process cycle (Zeisel, 2006)

There are many opportunities for researchers to participate and collaborate with designers in the day-to-day design process (Zeisel, 2006). In the design process proposed by Zeisel there are three phrases during which researcher and designers ought to collaborate: 1) Programming Research; 2) Design Review and; 3) Post-Occupancy Evaluation. **Figure 5.1.** below shows the design-process cycle.

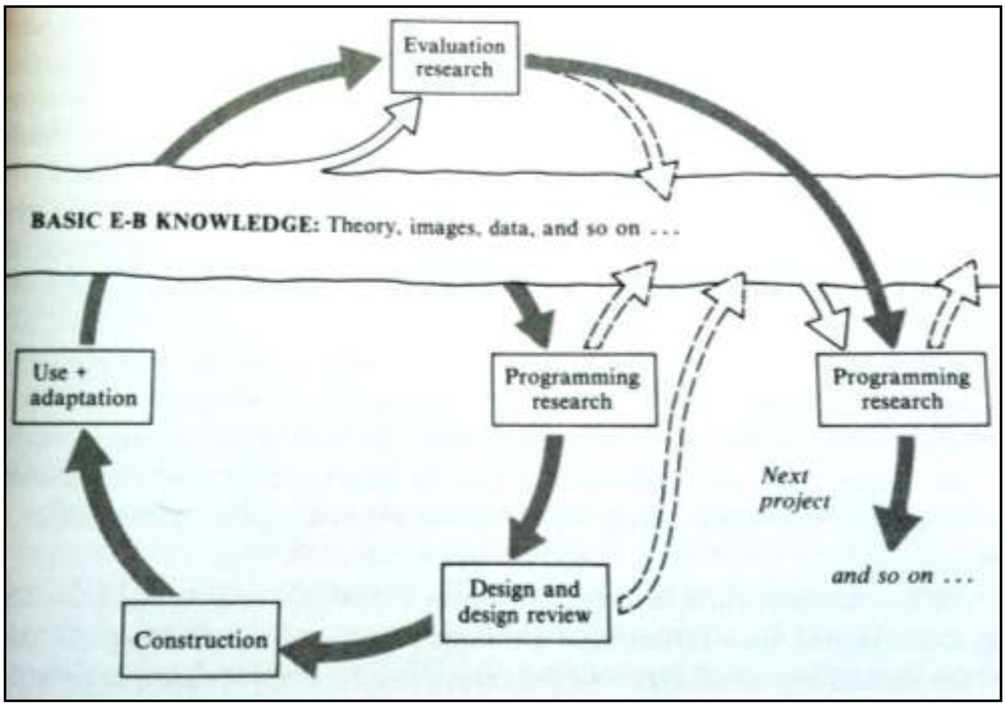

Figure 5.1. Design-Process Cycle (Zeisel, 2006, page 51)

Limitations of the design-process incorporating research

The design-process cycle occurs with or without researchers, everyday in the lives of designers. The three parts of the design-process cycle mentioned above (Programming, Design Review, and POEs) are referred to as "occasions for research / design collaborations" in the design-process, implying that it is a possibility for researchers and designers to connect but that it is not a necessary part of the design-process. One limitation of the design-process is that design is often carried out through construction, use, and adaptation, without being informed by research and collecting no evidence of how people use space.

Environmental interventions alone may not change behavior; improving environmental quality does not always yield people to use the space (Cohen, Golinelli, Williamson, Sehgal, Marsh, & McKenzie, 2009). There may need to be research into how evidence-based *programs* can work alongside evidence-based *design* interventions to make a positive change to human health and well-being. For example, a new schoolyard may incorporate elements known to promote physical activity, such as a school garden or loose parts, but if no programming or opportunities to use the space exist, the potential benefits of the space are negligible. For example, to study how the introduction of loose parts in an outdoor schoolyard may influence children’s physical activity, a feasible research design may be *‘removed-treatment with pre- and post-tests’*. If the sample population of children being studied would remain the same, (ie no control group) the removed treatment aspect of this research design would improve the internal validity of the study as compared to using a one-group pre- and post-test design.

Removed-treatment design with pre- and post-tests: $O_1 \;\; X \;\; O_2 \;\; O_3 \;\; \cancel{X} \;\; O_4$.

A local school may be interested in answering the following question: does the inclusion of loose parts into the schoolyard increase children’s physical activity during recess time? In the research design diagram above ‘O_1’, demonstrates the pre-test and the time at which PA data could be collected to see how much PA children are engaging in on the playground at baseline. Then, ‘X’ would be the intervention or the introduction of loose parts into the playground during recess. Two post-tests would be administered after the intervention (O_2 and O_3). Then, the ‘$\cancel{X}$’ symbolizes the removal of the intervention or loose parts from the playground. Finally, a third post-test would be conducted 'O_4'. In this design, and this specific example, with the removal of loose parts intervention, PA at O_1 and at PA O_4 should be relatively close and less than both PA at O_2 and PA at O_3.

Design & transformative opportunity

Design is action and has the power to transform political, environmental, and social conditions acting upon the decline of children's time spent freely playing outdoors, in nature – which can improve children's health and well-being. A critical next step is to incorporate research into the components of the design process. Evidence-based design has the potential to play a prominent role in translational research: social science to be used for public good (Wethington & Dunifon, 2012).

Modern philosopher and politician Roberto Unger on 'good' social science:

> To associate the explanation of what exists with the imagination of transformative opportunity. Not some horizon of ultimate possibles but **the real possible** which is always the adjacent possible; every social situation is surrounded by a penumbra of transformative opportunity. And then, the vocation of social science is to help us understand how we came to be in this present situation, in such a fashion that our understanding of our circumstance, rather than putting us to sleep and inducing this fatalistic superstition, awakens us to the imagination of the adjacent possible.
> – *Roberto Unger, (*Social Science Space, interview transcript p. 5)

Humans are continually revising their political, environmental, and social contexts – humans design their environments and these designed environments subsequently affect people. Transformative opportunities for researchers interested in salutogenic evidence-based design, may be able to take advantage of *naturalistic experiments* or the practical and constant research-design opportunities showing-up in everyday life, representing the ways that humans adapt to their environments. Considering children's outdoor environments, the 'real possible' must take into account the political, environmental, and social contexts surrounding children's right to play, freely outdoors. Social science research tapped into the political, environmental, and social situations surrounding a ‘problem’, may be able to translate research into practice, thereby allowing for the ‘real-possible’ designs of salutogenic environments to promote children’s health and well-being.

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CHAPTER 2

APPENDIX A

PARAGON TRAINING BUNDLE

PARAGON

Physical Activity Research & Assessment tool for Garden ObservatioN

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Description. The Physical Activity Research & Assessment tool for Garden ObservatioN (PARAGON) was developed to measure children's physical activity levels, tasks, postures, and motions, associations, and interactions while gardening. PARAGON uses momentary time sampling in which a trained observer repeatedly watches a focal child for 15-seconds and then records behavior for 15-seconds.

Purpose. The tool was designed for a variety of settings in which children garden, including school gardens, community gardens, and home gardens.

Categories & Codes. During each recording interval, the trained observer codes across five categories:
1) physical activity level; 2) garden tasks; 3) garden motions; 4) social associations; and 5) interactions.

For each 15-second observation interval, the observer chooses one of the *seven physical activity codes* (i.e., lying, sitting, standing, walking, vigorous, kneeling, or squatting) and one of the *nine garden tasks* (i.e., cleaning, carrying, digging, harvesting, watering, planting, weeding, resting / observing, or other [none garden related]). Taking into account the possible motions that are necessary to perform various gardening tasks, the observer chooses up to three of the *six garden motions* per interval (i.e., bending, gripping, stretching, lifting, pushing / pulling, or none). The *social context* of the garden is also observed and coded across two categories: social associations, and verbal / non-verbal interactions. The observer codes all that apply in regard to the *social associations* a child encounters while gardening (i.e., no others (completely alone), other children, other adults, parents or family members, and teachers). Finally, anytime during the 15-second observation interval, the observer codes *verbal or non-verbal interactions* related to physical activity (promoting physical activity, inhibiting physical activity, or none).

Scoring.

1. For each of the 5 categories, sum across each child and divide by total observed epochs.
Physical activity levels: count number of times lying, sitting, standing, walking, vigorous, kneeling, or squatting. Divide each code by total epochs = % lying, % sitting, etc. Repeat for garden tasks, motions, social associations and interactions.

2. Unit of Analysis - Child and observation period specific descriptives.
Gender, school, temperature, total # of students, and total # of adults

Reference:

Myers, B.M. & Wells, N.M. (2015) Children's physical activity while gardening: Development of a valid and reliable direct observation tool. *Journal of Physical Activity and Health. 12(4). 522-528.*

Child's Name: Gender: B / G School Name: Date:

Temperature: ________ Total Time (mins): ______ Total # of Students: ________ Total # of Adults: ________

*Interval	1.0 Activity Level (ONE)	2.0 Tasks (ONE)	3.0 Motions (THREE MAX)	4.0 Associations (All That Apply)	5.0 Interactions (ONE)
1	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
2	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
3	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
4	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
5	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
6	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
7	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
8	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
9	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
10	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
11	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
12	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
13	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
14	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
15	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
16	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
17	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
18	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
19	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
20	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
21	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
22	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
23	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
24	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
25	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
26	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
27	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
28	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
29	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
30	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
31	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
32	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
*15 s observe/15 s record for 4 minutes per child (32 epochs = 16 observed mins)					
Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing O. Other	B. Bending G. Gripping S. Stretching L. Lifting P/P. Pushing/Pulling N. None	NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	P. Promotes PA I. Inhibits PA N. None

Physical Activity Research & Assessment tool for Garden ObservatioN **(PARAGON)** **OBSERVER:** ___________

Category	Description
1.0 Activity Level 1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	Provides an estimate of the intensity of the child's physical activity. Codes 1 to 4 & 6 and 7 (lying down, sitting, standing, walking, kneeling, squatting) describe the body position of the child. Code 5 (vigorous) describes when child is expending more energy than during ordinary walking. (Code One)
2.0 Tasks C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing O. Other	Describes tasks related to activities a child might directly engage in, whether physical active or sedentary. (Code one)
3.0 Motions B. Bending G. Gripping S. Stretching / Reaching L. Lifting P/P. Pushing/Pulling N. None	Identifies motions utilized while carrying out tasks. (Code maximum of three. NOTE: Only code "None" when child is not interacting with another object or with space)
4.0 Associations NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	Identifies persons in the child's environment at the end of the observation interval. (Code all that apply)
5.0 Interactions P. Promotes PA I. Inhibits PA N. None	Identifies teacher / adults verbal or nonverbal interactions to promote physical activity during the "observe" interval. (Code one)

Adapted from BEACHES Protocol

PARAGON

Physical Activity Research & Assessment tool for Garden ObservatioN

PARAGON DIRECT OBSERVATION. A valid and reliable method by which trained observers objectively record children's physical activity (in a garden)

Tool: **PARAGON (P**hysical **A**ctivity **R**esearch & **A**ssessment tool for **G**arden **O**bservatio**N**)
Observation Time Period: 45 mins – 1 hour
Context: School Garden

TRAINING PHASES. In order to be prepared to collect direct observation data of children gardening, observers must successfully complete Phase I through Phase IV.
[Phase V is retraining and continued training, as needed]

PHASE I. MEMORIZING CONTEXTUAL CODES (2 – 4 hours)

a. Memorize all PARAGON categories and codes
b. **Assessment:** Take "CODES" Assessment (100%) → Move on to Phase II

PHASE II. PRACTICE CODING - VIEW PPT STILL IMAGES (2 – 4 hours)

a. View the ppt still images and complete 3 recording forms
b. **Assessment:** Turn-in forms (to supervisor of training) to check reliability. Move on to Phase III when reach 80 - 85% correct.

PHASE III. PRACTICE CODING – VIEW VIDEO (4 hours)

a. View the video and complete 3 recording forms
b. **Assessment:** Turn-in forms to (to supervisor of training) to check reliability (move on to Phase IV when reach 80 - 85% correct).

PHASE IV. FIELD OBSERVATION + CODING (As many hours as necessary to reach 80 – 85%)

a. **Field observations –** schedule field observations of children gardening
b. **Assessment:** Turn-in forms to (to supervisor of training) to check inter-rater reliability (move on when reach 85% correct). **Once complete Phase IV with 80 – 85% reliability, ready to collect data in schools. NOTE:** If have not reached 80 - 85% correct – continue to **Phase V**.

PHASE V. RETRAINING / CONTINUED FIELD OBSERVATION

a. Use as needed to retrain or continue field observation until all observers reach 80-85% correct.
b. **Assessment:** Turn in forms to (to supervisor of training) to check reliability (move on when reach 85% correct). Once reached 80 - 85% - ready to collect data.

NAME ________________________ DATE _________

PHASE Ib. CODES ASSESSMENT FORM

*Interval	1.0 ___________ (____) # choose?	2.0 _____________ (____) # choose?	3.0 __________ (___________) # choose?	4.0 ____________ (___________) # choose?	5.0 __________ (____) # choose?
1	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R O	B G S L P/P N	NO OC OA P T	P I N
	1 = 2 = 3 = 4 = 5 = 6 = 7 =	Cl = Ca = D = H = H^2O = Pl = We = R = O =	B = G = S = L = P/P = N =	NO = OC = OA = P = T =	P = I = N =

How many seconds do you observe? _____
How many seconds do you take to record? _____
How many minutes do you observe per child (before moving onto the next child?) _____

School Garden Research

Direct Observation Training

This exercise is intended to acclimate observers to the PARAGON Direct Observation.

PHASE II. PRACTICE CODING - VIEW STILL IMAGES (2 - 4 HOURS)

There will be a series of slides beginning with a 15-second observation period, where the trainee is to view and decide which activity level, task, motions, associals, and interactions occur for a focal child. This will transition to a 15-second "coding" slide. Using the PARAGON direct observation form (Phase IIb), code your observations from the previous slide. A third slide will apperar for 15 seconds, revealing a "check" for your observations (see right).

This three-part process will repeat until the training process finsihes.

Code Check will be in the format:

X, X, X, X, X, Where each x, (or multiple x x x, for which more than one code applies), will correspond to a code column (i.e. "1.0 Activity Level," etc.)

For example, if 1.0 Activity Level is coded as 1: Lying down, 2.0 Tasks as Cl: Cleaning, 3.0 Motions as B: Bending and G: gripping, 4.0 Associations as NO: No others, and 5.0 Interactions as P: Promotes PA, then the Code Check would read:

1, Cl, B G, NO, P

The goals is to achieve 80% accuracy or higher to move onto Phase III.

CLICK TO BEGIN

Observe:

A8

CODE NOW

A9

CHECK:

1, R, S, NO, N

A10

Observe:

A11

CODE NOW

A12

CHECK:

7, D, B G S, OC, P

A13

Observe:

A14

CODE NOW

A15

CHECK:

3, H20, G L S, OC, P

A16

Observe:

A17

CODE NOW

A18

CHECK:

4, Ca, G L, OC, OA, P

A19

END

NAME: ______________________________ # OF ERRORS: ______ % CORRECT: ___ / 80 = _____%

PHASE IIb. PRACTICE CODING ASSESSMENT - AFTER VIEWING PPT STILL IMAGES (2 – 4 hours) pg 1

*Interval	1.0 Activity Level (ONE) (1)	2.0 Tasks (ONE) (1)	3.0 Motions (THREE MAX) (1)	4.0 Associations (All That Apply) (1)	5.0 Interactions (ONE) (1)	Errors (1 - 5)
1	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
1A						
2	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
2A						
3	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
3A						
4	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
4A						
5	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
5A						
6	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
6A						
7	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
7A						
8	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
8A						
9	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
9A						
10	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
10A						
11	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
11A						
12	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
12A						
13	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
13A						
14	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
14A						
15	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
15A						
16	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
16A						
*15 s observe/15 s record for 4 minutes per child (32 epochs = 16 observed mins)						
Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing	B. Bending G. Gripping S. Stretching L. Lifting P/P. Pushing/Pulling	NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	P. Promotes PA I. Inhibits PA N. None	

NAME: ______________________________ # OF ERRORS: ______ % CORRECT: ___ / 80 = _____%

PHASE IIb. PRACTICE CODING ASSESSMENT - AFTER VIEWING PPT STILL IMAGES (2 – 4 hours) pg 2

*Interval	1.0 Activity Level (ONE) (1)	2.0 Tasks (ONE) (1)	3.0 Motions (All That Apply) (1)	4.0 Associations (All That Apply) (1)	5.0 Interactions (ONE) (1)	Errors (1 - 5)
17	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
17A						
18	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
18A						
19	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
19A						
20	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
20A						
21	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
21A						
22	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
22A						
23	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
23A						
24	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
24A						
25	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
25A						
26	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
26A						
27	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
27A						
28	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
28A						
29	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
29A						
30	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
30A						
31	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
31A						
32	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
32A						
*15 s observe/15 s record for 4 minutes per child (32 epochs = 16 observed mins)						
Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing	B. Bending G. Gripping S. Stretching L. Lifting P/P. Pushing/Pulling	NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	P. Promotes PA I. Inhibits PA N. None	

School Garden Research

Direct Observation Training

This exercise is intended to acclimate observers to the **PARAGON direct observation.**
PHASE III Video

There will be a series of slides beginning with a 15 second "observation" period, where the trainee is to view and decide which activity level, task, motions, associations, and interactions occur for a focal child. This will transition to a 15 second "coding" slide. Using the PARAGON direct observation form, code your observations from the previous slide. A third slide will appear for 15 seconds, revealing a "check" for your observations (see right). This three-part process will repeat until the training program finishes.

The goal is to achieve 80% accuracy or higher for preparation for the field.

Code Check will be in the format:

X, X, X, X, X, Where each x, (or multiple x x x, for which more than one code applies), will correspond to a code column (i.e. "1.0 Activity Level," etc.)

For example, if 1.0 Activity Level is coded as 1: Lying down, 2.0 Tasks as Cl: Cleaning, 3.0 Motions as B: Bending and G: gripping, 4.0 Associations as NO: No others, and 5.0 Interactions as P: Promotes PA, then the Code Check would read:

1, Cl, B G, NO, P

CLICK TO BEGIN

A24

CODE NOW

A25

CHECK:

6, R, G S, P, P

A26

A27

CODE NOW

A28

CHECK:

6, H, G S L, P, N

A29

A30

CODE NOW

A31

CHECK:

4, Ca, G, P, P

A32

A33

CODE NOW

A34

CHECK:

3, H, G, P, N

A35

END

NAME: ______________________________ # OF ERRORS: % CORRECT: ___ / 80 = _____ %

PHASE IIIb. PRACTICE CODING ASSESSMENT - AFTER VIEWING VIDEO (2 – 4 hours) pg 1 of 2

*Interval	1.0 Activity Level (ONE) (1)	2.0 Tasks (ONE) (1)	3.0 Motions (THREE MAX) (1)	4.0 Associations (All That Apply) (1)	5.0 Interactions (ONE) (1)	Errors (1 - 5)
1	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
1A						
2	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
2A						
3	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
3A						
4	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
4A						
5	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
5A						
6	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
6A						
7	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
7A						
8	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
8A						
9	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
9A						
10	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
10A						
11	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
11A						
12	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
12A						
13	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
13A						
14	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
14A						
15	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
15A						
16	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
16A						
*15 s observe/15 s record for 4 minutes per child (32 epochs = 16 observed mins)						
Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing	B. Bending G. Gripping S. Stretching L. Lifting P/P. Pushing/Pulling	NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	P. Promotes PA I. Inhibits PA N. None	

NAME: ______________________________ # OF ERRORS: ______ % CORRECT: ___ / 80 = _____ %

PHASE IIIb. PRACTICE CODING ASSESSMENT - AFTER VIEWING VIDEO (2 – 4 hours) pg 2 of 2

*Interval	1.0 Activity Level (ONE) (1)	2.0 Tasks (ONE) (1)	3.0 Motions (All That Apply) (1)	4.0 Associations (All That Apply) (1)	5.0 Interactions (ONE) (1)	Errors (1 - 5)
17	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
17A						
18	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
18A						
19	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
19A						
20	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
20A						
21	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
21A						
22	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
22A						
23	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
23A						
24	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
24A						
25	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
25A						
26	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
26A						
27	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
27A						
28	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
28A						
29	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
29A						
30	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
30A						
31	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
31A						
32	1 2 3 4 5 6 7	Cl Ca D H H^2O Pl We R	B G S L P/P	NO OC OA P T	P I N	
32A						
*15 s observe/15 s record for 4 minutes per child (32 epochs = 16 observed mins)						
Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous 6. Kneeling 7. Squatting	C. Cleaning Ca. Carrying D. Digging H. Harvesting H^2O. Watering Pl. Planting We. Weeding R. Resting/Observing	B. Bending G. Gripping S. Stretching L. Lifting P/P. Pushing/Pulling	NO. No others OC. Other child OA. Other adult P. Parent/Family T. Teacher	P. Promotes PA I. Inhibits PA N. None	

CHAPTERS 3 & 4

APPENDIX B

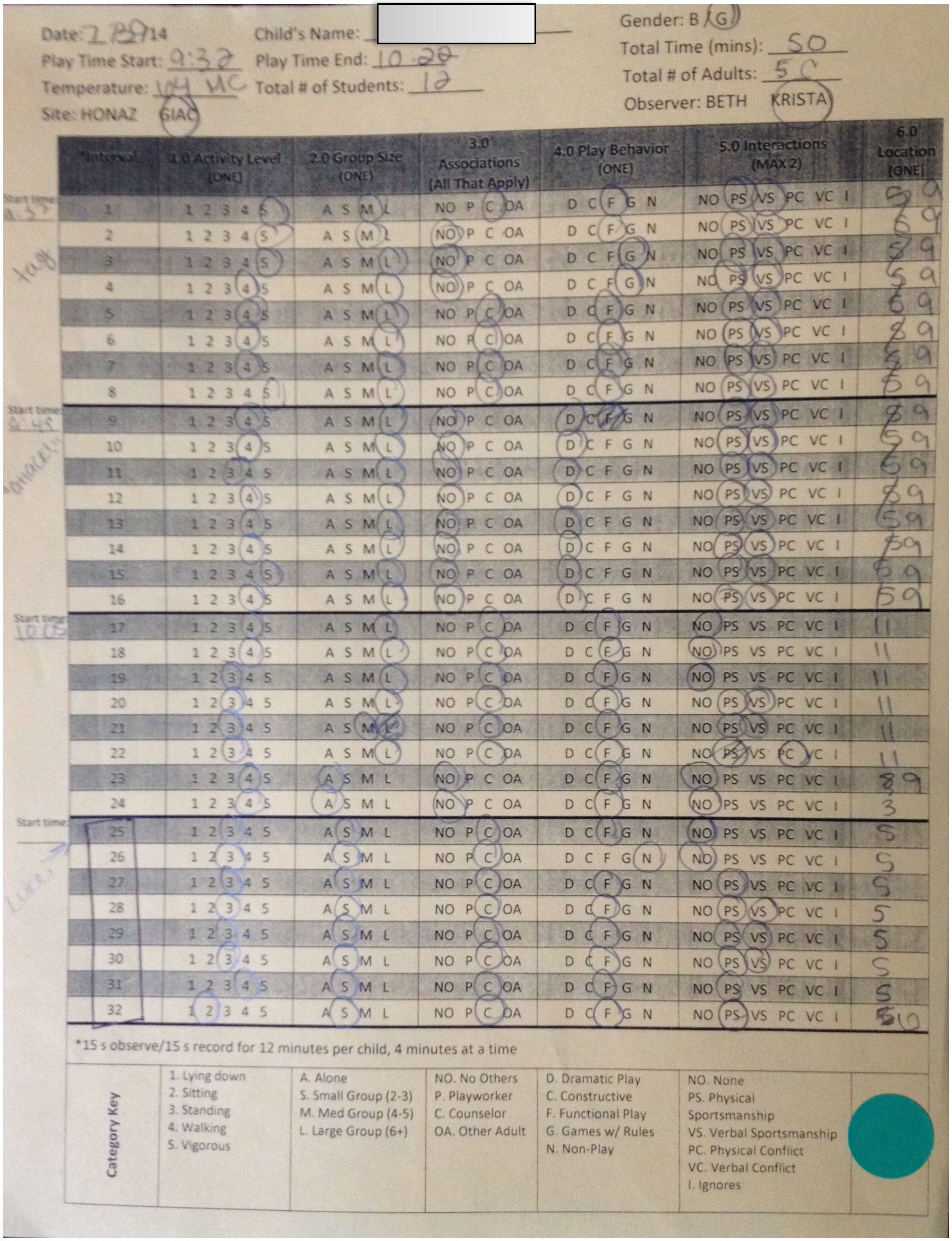
DIRECT OBSERVATION, PHYSICAL ACTIVITY, & ACTIVE FREE PLAY

SAMPLE DATA COLLECTION FORMS

Date: __/__/14
Child's Name: ____________________
Gender: B / G
Play Time Start: ________
Play Time End: ________
Total Time (mins): ________
Temp/Condition: ________
Total # of Students: ________
Adults (P+C+OA=T): __+__+__=___
Site: HONAZ GIAC
Observer: BETH KRISTA

	*Interval	1.0 Activity Level (ONE)	2.0 Group Size (ONE)	3.0 Associations (All That Apply)	4.0 Play Behavior (ONE)	5.0 Interactions (MAX 2)	6.0 Location (ONE)
Start time: ____	1	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	2	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	3	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	4	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	5	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	6	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	7	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	8	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
Start time: ____	9	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	10	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	11	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	12	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	13	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	14	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	15	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	16	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
Start time: ____	17	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	18	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	19	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	20	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	21	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	22	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	23	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	24	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
Start time: ____	25	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	26	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	27	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	28	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	29	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	30	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	31	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
End time: ____	32	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	*15 s observe/15 s record for 12 minutes per child, 4 minutes at a time						
	Category Key	1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous	A. Alone S. Small Group (2-3) M. Med Group (4-5) L. Large Group (6+)	NO. No Others P. Playworker C. Counselor OA. Other Adult	D. Dramatic Play C. Constructive F. Functional Play G. Games w/ Rules N. Non-Play	NO. None PS. Physical Sportsmanship VS. Verbal Sportsmanship PC. Physical Conflict VC. Verbal Conflict I. Ignores	

Direct Observation Recording Form (blank)



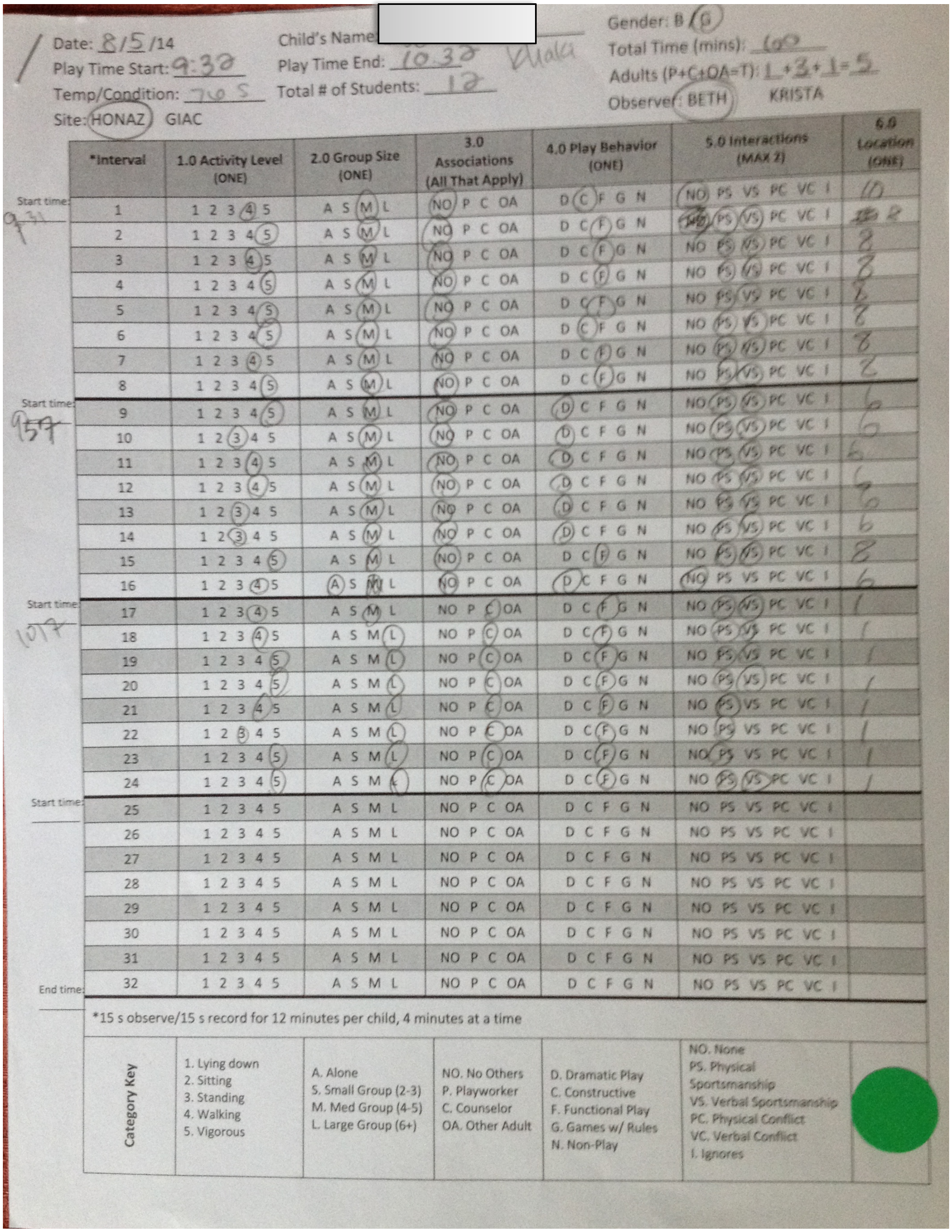
Date: 2 18 14 | Child's Name: [redacted] | Gender: B / G
Play Time Start: 9:32 | Play Time End: 10:20 | Total Time (mins): 50
Temperature: 64 MC | Total # of Students: 12 | Total # of Adults: 5C
Site: HONAZ GIAC | Observer: BETH KRISTA

*Interval	1.0 Activity Level (ONE)	2.0 Group Size (ONE)	3.0 Associations (All That Apply)	4.0 Play Behavior (ONE)	5.0 Interactions (MAX 2)	6.0 Location (ONE)
Start time 9:32 1	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
2	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
3	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
4	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
5	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	69
6	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	89
7	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
8	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
Start time 9:45 9	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	89
10	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
11	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
12	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	89
13	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
14	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
15	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	69
16	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	59
Start time 10:05 17	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	11
18	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	11
19	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	11
20	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	11
21	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	11
22	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	11
23	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	89
24	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	3
Start time 25	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
26	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
27	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
28	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
29	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
30	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
31	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5
32	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	5 10

*15 s observe/15 s record for 12 minutes per child, 4 minutes at a time

Category Key					
1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous	A. Alone S. Small Group (2-3) M. Med Group (4-5) L. Large Group (6+)	NO. No Others P. Playworker C. Counselor OA. Other Adult	D. Dramatic Play C. Constructive F. Functional Play G. Games w/ Rules N. Non-Play	NO. None PS. Physical Sportsmanship VS. Verbal Sportsmanship PC. Physical Conflict VC. Verbal Conflict I. Ignores	

Direct Observation Recording Form (Conventional Playground)


Date: 8/5/14
Play Time Start: 9:32
Temp/Condition: 70 S
Site: HONAZ GIAC

Child's Name [redacted]
Play Time End: 10:32
Total # of Students: 12

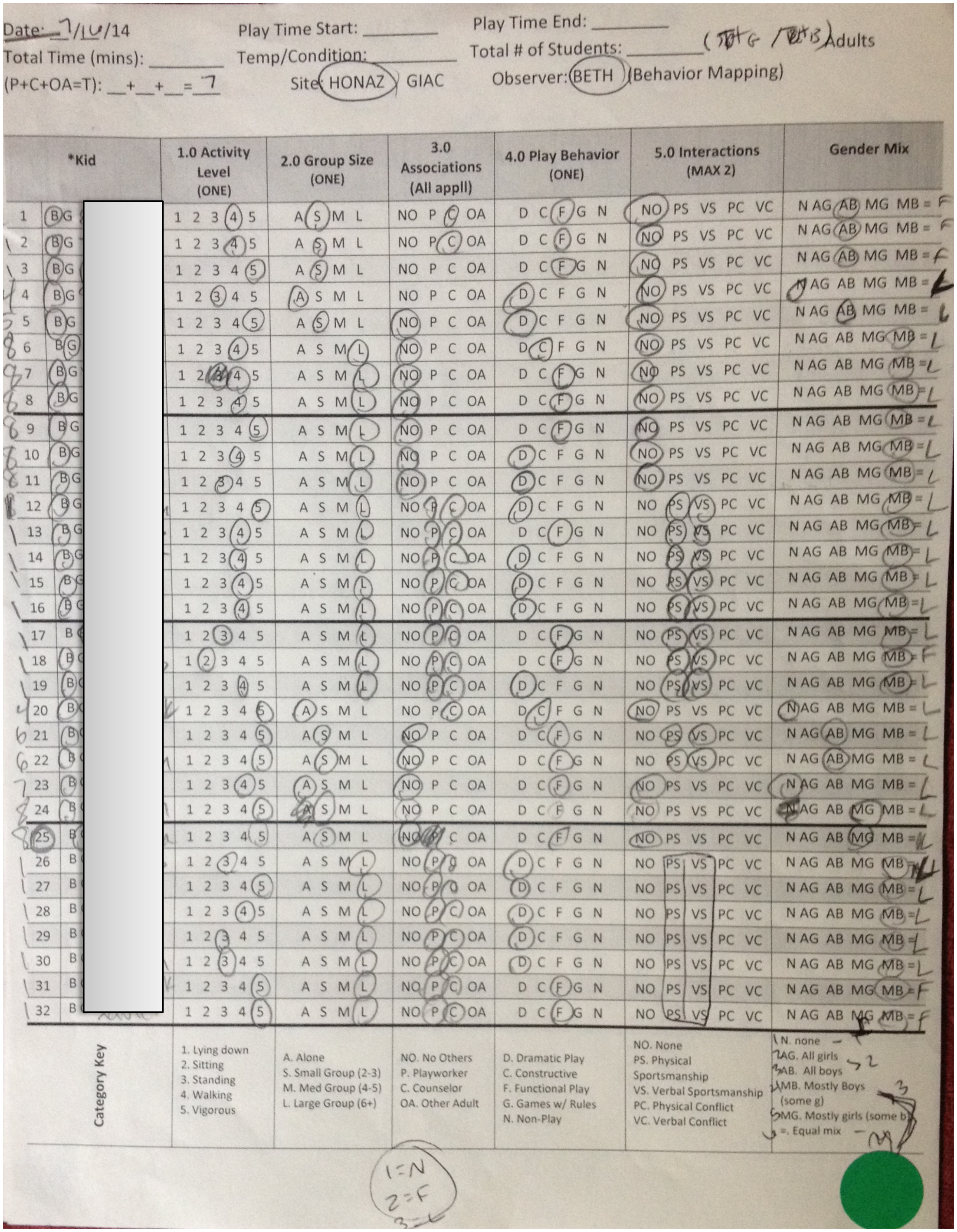
Gender: B / G
Total Time (mins): 60
Adults (P+C+OA=T): 1+3+1=5
Observer: BETH KRISTA

	*Interval	1.0 Activity Level (ONE)	2.0 Group Size (ONE)	3.0 Associations (All That Apply)	4.0 Play Behavior (ONE)	5.0 Interactions (MAX 2)	6.0 Location (ONE)
Start time: 9:31	1	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	10
	2	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	3	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	4	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	5	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	6	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	7	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	8	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
Start time: 9:57	9	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
	10	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
	11	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
	12	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
	13	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
	14	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
	15	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	8
	16	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	6
Start time: 10:17	17	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	18	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	19	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	20	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	21	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	22	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	23	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
	24	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	1
Start time:	25	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	26	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	27	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	28	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	29	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	30	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
	31	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	
End time:	32	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC I	

*15 s observe/15 s record for 12 minutes per child, 4 minutes at a time

Category Key					
1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous	A. Alone S. Small Group (2-3) M. Med Group (4-5) L. Large Group (6+)	NO. No Others P. Playworker C. Counselor OA. Other Adult	D. Dramatic Play C. Constructive F. Functional Play G. Games w/ Rules N. Non-Play	NO. None PS. Physical Sportsmanship VS. Verbal Sportsmanship PC. Physical Conflict VC. Verbal Conflict I. Ignores	

Direct Observation Recording Form (Adventure Playground)



Date: 7/10/14 Play Time Start: ________ Play Time End: ________

Total Time (mins): ________ Temp/Condition: ________ Total # of Students: ________ (G / B) Adults

(P+C+OA=T): __+__+__=7 Site: HONAZ GIAC Observer: BETH (Behavior Mapping)

*Kid			1.0 Activity Level (ONE)	2.0 Group Size (ONE)	3.0 Associations (All appl)	4.0 Play Behavior (ONE)	5.0 Interactions (MAX 2)	Gender Mix
1	B G	[redacted]	1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = F
2	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = F
3	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = F
4	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
5	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
6	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
7	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
8	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
9	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
10	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
11	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
12	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
13	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
14	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
15	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
16	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
17	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
18	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = F
19	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
20	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
21	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
22	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
23	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
24	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
25	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
26	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
27	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
28	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
29	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
30	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = L
31	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = F
32	B G		1 2 3 4 5	A S M L	NO P C OA	D C F G N	NO PS VS PC VC	N AG AB MG MB = F
Category Key			1. Lying down 2. Sitting 3. Standing 4. Walking 5. Vigorous	A. Alone S. Small Group (2-3) M. Med Group (4-5) L. Large Group (6+)	NO. No Others P. Playworker C. Counselor OA. Other Adult	D. Dramatic Play C. Constructive F. Functional Play G. Games w/ Rules N. Non-Play	NO. None PS. Physical Sportsmanship VS. Verbal Sportsmanship PC. Physical Conflict VC. Verbal Conflict	N. none AG. All girls AB. All boys MB. Mostly Boys (some g) MG. Mostly girls (some b) =. Equal mix

1=N
2=F
3=L

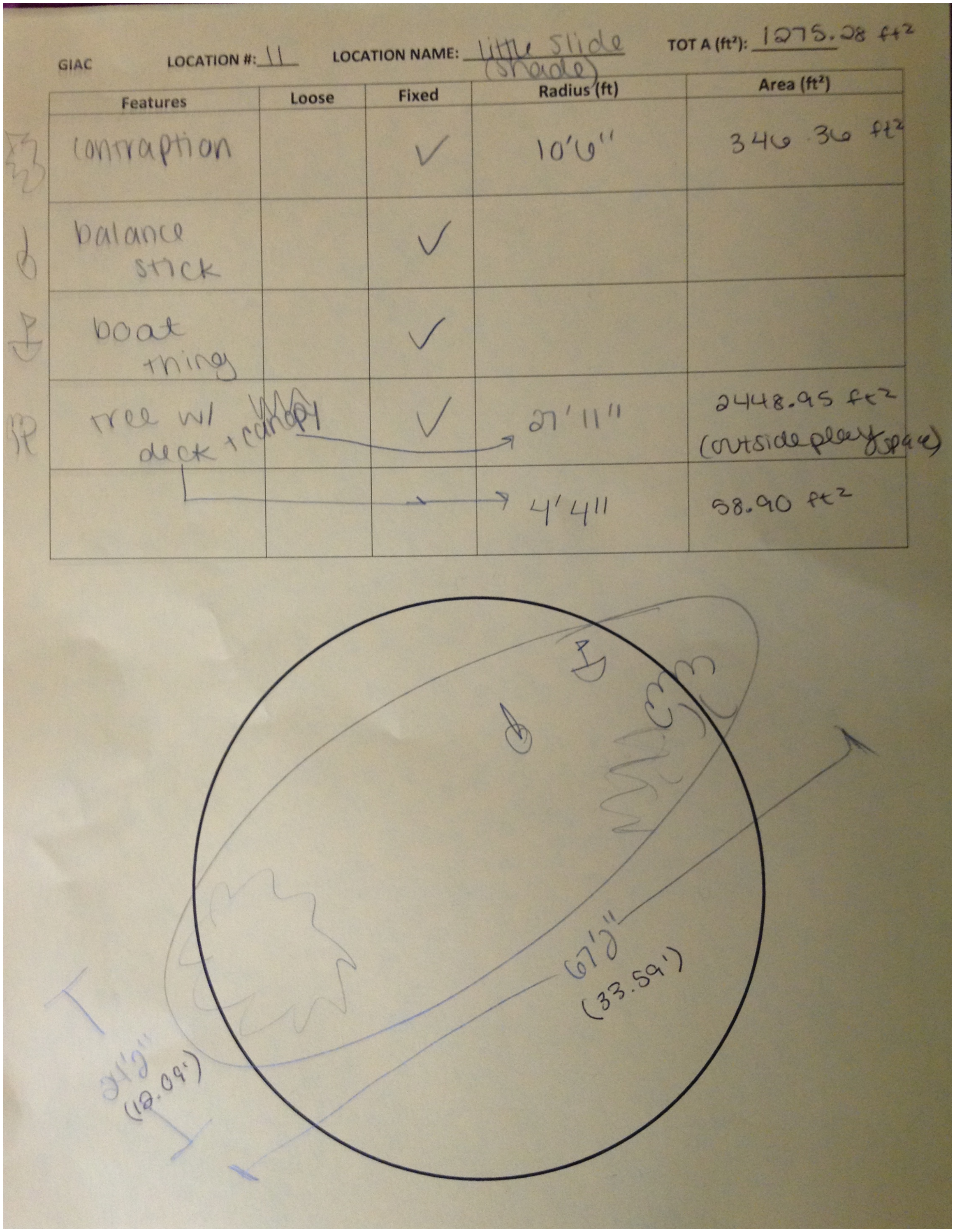
Behavior Mapping Recording Form

CHAPTER 4

APPENDIX C

BEHAVIOR MAPPING AND ACTIVE FREE PLAY

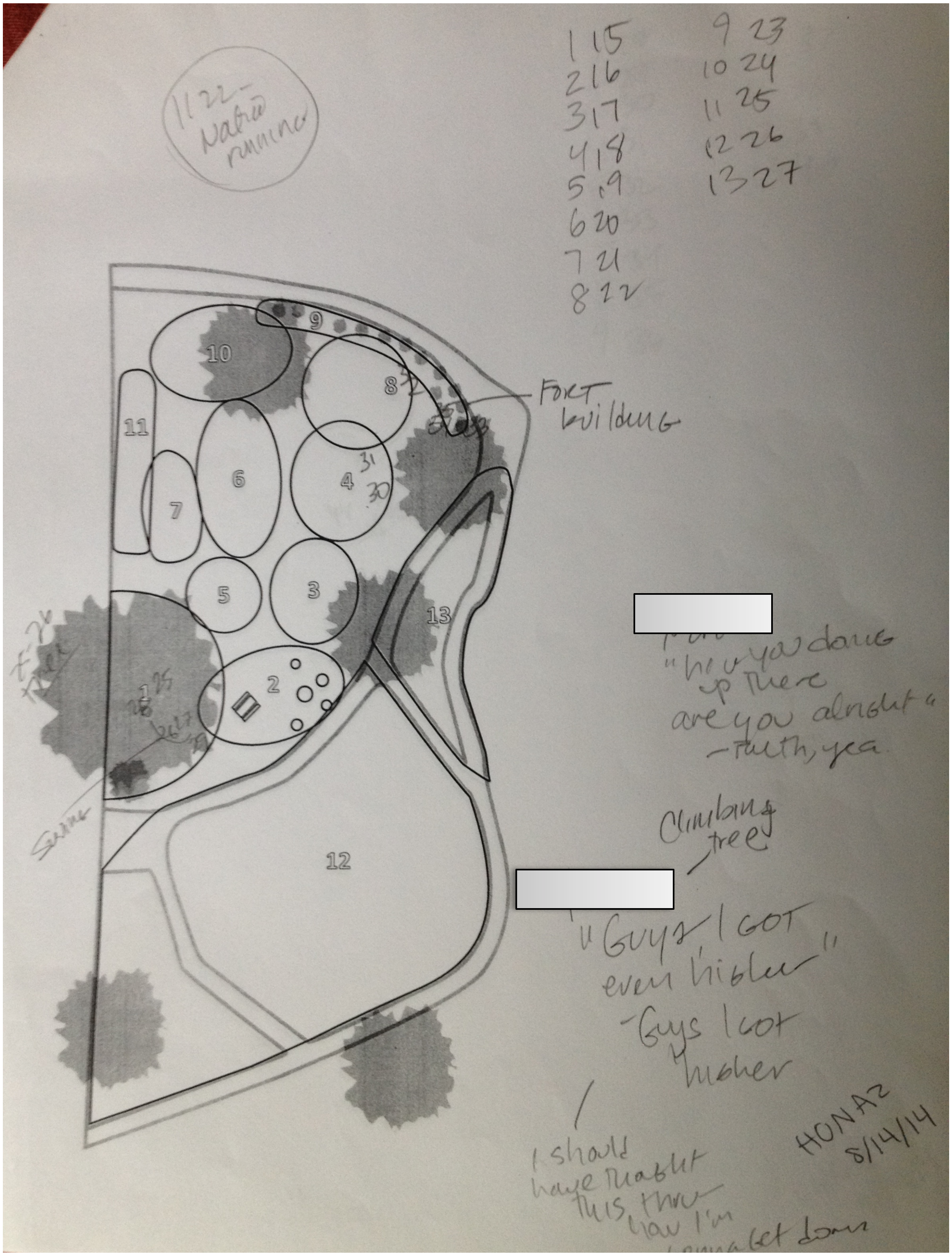
SAMPLE BEHAVIOR SETTING & BEHAVIOR MAPPING FORMS



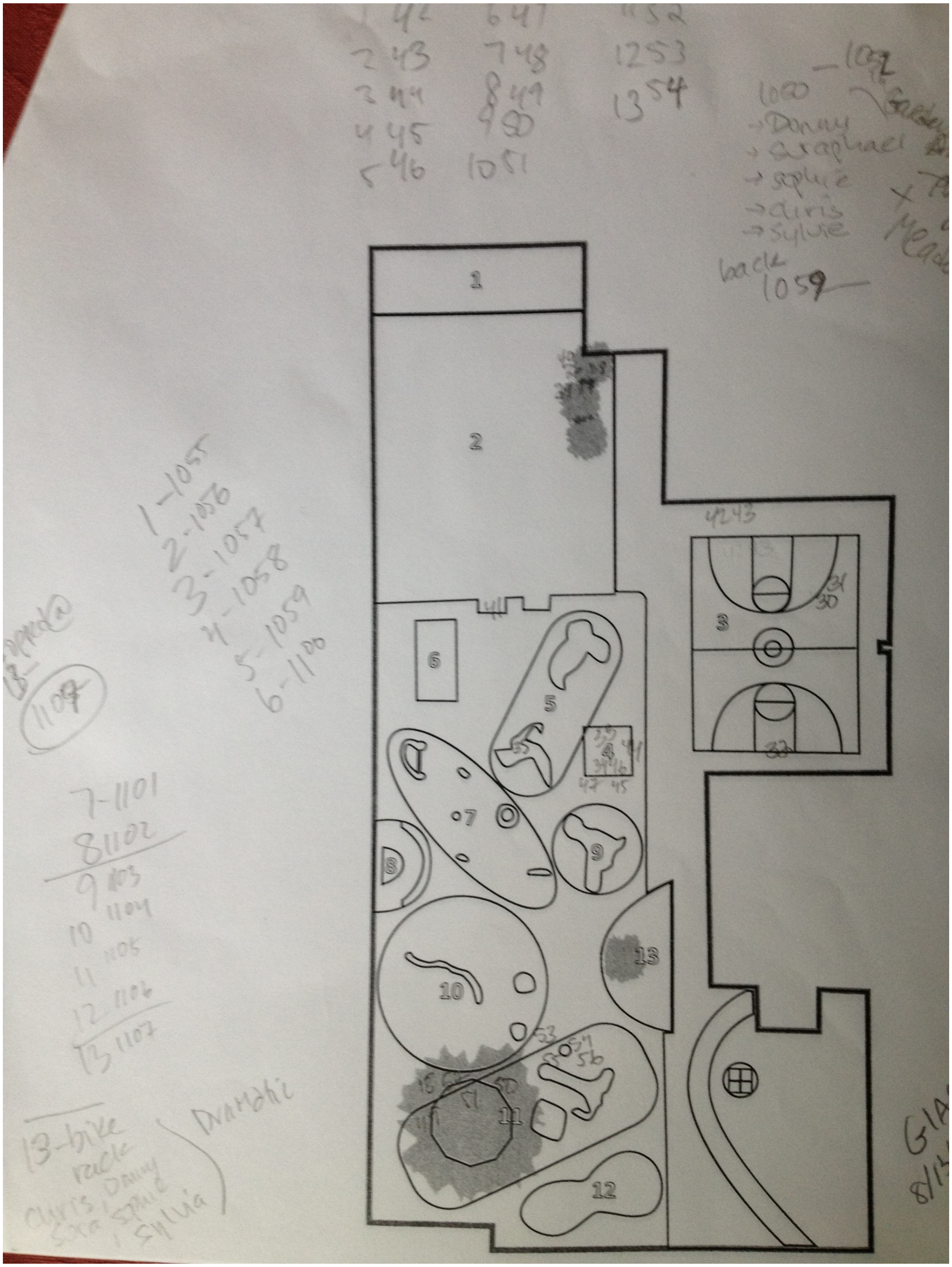
GIAC LOCATION #: 11 LOCATION NAME: little slide (shade) TOT A (ft²): 1275.28 ft²

Features	Loose	Fixed	Radius (ft)	Area (ft²)
contraption		✓	10'6"	346.36 ft²
balance stick		✓		
boat thing		✓		
tree w/ deck + canopy		✓	27'11"	2448.95 ft² (outside play space)
			4'4"	58.90 ft²

Behavior Setting Location Sheet



Behavior Mapping (Adventure Playground)



Behavior Mapping (Conventional Playground)