IMPACT OF COLOR ON CHILDREN'S PLAY BEHAVIORS

By

Bridget Nicole Safferman

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

Environmental Design – Master of Arts

2015

ABSTRACT

IMPACT OF COLOR ON CHILDREN'S PLAY BEHAVIORS

By

Bridget Nicole Safferman

This research examines the effects of differently colored playground balls on the play behaviors of children between the ages of three and four. Color vision in human beings triggers certain physical and psychological responses that can influence behavioral changes; the goal of this observational study is to determine if these responses are strong enough to influence the type and durations of children's play. This observational study was conducted on children between the ages of 36 and 60 months old who were enrolled in a children's daycare and child development research facility. Results of this study produced trends that indicate that certain colors do have an impact on the level of activity in which children play, namely, that children exhibit a greater number of play behaviors on traditional playgrounds, but play longer on nature playgrounds. Additionally, trends suggested that red and yellow, warm colors, increase the number of active and low active play behaviors observed and blue, a cool color, increases the durations of play behaviors. This knowledge suggest that color could be a viable tool in designing play spaces to meet specific needs and promoting different play behaviors in children

Keywords: Color, Children's Play Behaviors, Children's Play Durations, Level of Activity

ACKNOWLEDGEMENTS

I would like to first thank the Michigan State University Child Development Lab teachers and staff for providing the location and students for this study, as well as the advice, insight and general interest in my work. I would also like to thank Dr. Trish Machemer, Associate Professor of the School of Planning, Design, and Construction, Michigan State University for chairing my committee and overseeing the entire process with patience, encouragement and practicality, as well as Dr. Claire Vallotton, Associate Professor of Human Development & Family Studies, Michigan State University and Dr. Eunsil Lee, Associate Professor of School of Planning, Design, and Construction, Michigan State University for their assistance both in the classroom and on my committee. Additionally, I would like to thank Dr. Scott Witter, Director of the School of Planning, Design, and Construction for his meaningful contribution at the defense presentation. Thank you as well to Yunsuk Dong for his help with the statistics in this study, and to my father, Steve Safferman for helping me outline the research and for the suggestion of using playground balls for the play objects. Finally, thank you to Michelle Kelly, PLA, Heath Wright, PLA, and everyone else at Upland Design, Ltd. for introducing me to playground design, and inspiring me to undertake this research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE – INTRODUCTION

The use of play in children's development and the study of color are two topics that have been heavily studied and provide valuable knowledge that is used by design professionals to create new places for human use (Curry and Gaines, 2001; Engelbrecht, 2003; Goldstein, 2012; Hart and Sheehan, 1986; Pellegrini and Smith, 1998). The goal of this study is to confirm a link between the color of children's play objects and their resulting play behaviors and to provide a foundation on which further investigation may be conducted.

Due to the lack of related study, extensive research will be required to fully understand the relationship between colors and play behaviors. Although a range of knowledge exists on these two subjects separately, there have been few attempts to assess the way in which color affects play. Once established, the relationship between color and play would be a useful tool in improving the ability of landscape architects and other professionals who work in the playground industry to best meet design and user criteria when creating and redesigning parks and play spaces.

Color studies are currently being applied in design in a number of different ways. There has been extensive research assessing the impact of color on recovery rates for the sick, office and classroom productivity, and consumer decision making. (Dijkstra and Pieterse, 2008; Kruczek and Zentall, 1988; Sherin, 2012) Other studies have identified the hormonal and emotional responses and the resulting physiological changes to viewing color which indicate the usefulness of color in influencing people's behaviors (Adler, 1999; Mahnke, 1996) Play is also a heavily researched topic with studies that have recorded the physical, mental, and emotional developmental benefits of play, evaluated the way children play in different settings, and

determined uniform definitions of play (King, 1979; Morgante, 2013; Ozdemir and Yilmaz, 2008; Smith and Vollstedt, 1985) Despite the significant findings in both of these areas and the potential benefits of combining the two bodies of knowledge to maximize the benefits of play spaces, little to no research has been conducted related color to children's play.

Purpose of Study

This study will establish a relationship between color and play behavior through the collection and analysis of observational data to examine the play behaviors of children on natural and traditional playgrounds when provided with differently colored playground balls. Of particular interest are the differences in the levels of activity observed for each color; that is, whether or not a particular color increases the number of occurrences and/or duration of active play. Also considered is the difference in ball use on nature playgrounds (which are composed predominately of elements found in nature) compared to traditional playgrounds (which are composed of highly structured, built elements) (Hart, 1986; Morgante, 2013; Ozdemir, 2008). This study is intended to serve as one of the first steps to understanding how color affects children's play behaviors with the expectation that further research will expand upon the results and increase the extent of the body of knowledge and its application in playground design.

Significance of Study

As obesity levels and other health concerns rise and children's lives are becoming more rigidly structured, children are spending less time outdoors at play despite its numerous health and developmental benefits (Almeida, Dowda, Pate, Sirarad, and Trost, 2004; Ueland, 1925). By better understanding how children play in different environments and how factors such as color influence their actions, efforts can be made to encourage positive behaviors and maximize the

benefits of children's play. This study is beneficial as it is one of the first conducted to determine a connection between color and play and will serve as a foundation for further research. Results from this study and resulting research will help landscape architects and other designers in the recreation industry create spaces that best meet the users' needs. Potential benefits of combining color and play knowledge include the ability to create more engaging and stimulating environments, encourage active or passive behaviors as the situation requires, increasing children's interest in play, and promoting social interaction.

CHAPTER TWO - LITERATURE REVIEW

Introduction

While the topics of color and children's play have each been widely studied independently, there has been little research that examines the effects color has on children's play. Therefore, in order to present an understanding of each topic that can be applied to determining a link between the use of color and the design of play areas for children, this literature review will cover three topics, namely, the biological effects of color, the psychological effects of color, and the definition of play.

How People See Color

All light is composed of a range of wavelengths that are translated into different colors and combinations of colors. Red light occupies the end of the spectrum with the longest wavelengths while violet light has the shortest wavelengths (Sherin, 2012). Color is the visual interpretation of the different wavelengths of white light. Structures in the eye known as rods and cones absorb different wavelengths of light and allow for color vision (Clarke, Corney, Lotto, and Purves, 2010; Mahnke, 1996; Sherin, 2012). The eye consists of three different types of cones each of which only absorbs specific wavelengths of light. These are short wavelengths, referred to as "blue light", medium wavelengths or "green light", and long wavelengths known as "red light". In addition to cones, one type of rod exists which absorbs wavelengths in the middle of the spectrum ranging from blue to yellow light (Clarke, 2010). Color vision for all animals is dependent of the structure of the eye and the types of rods and cones it contains. Species with the most types of cones are able to see the largest range of color. Trichromacy or the presence of all three types of cones, allows for one of the greatest ranges of color vision and

is rare in the animal kingdom. Humans, along with some primates, are among the few organisms who possess such an expansive range of color vision (Clarke, 2010). While the visible range of wavelengths, and therefore colors, are determined by the structure of the eye, the interpretation and perception of color itself occurs in the brain. When light waves are absorbed by a person's eyes it triggers the Hypothalamic Midbrain Region which controls the production and release of hormones (Adler, 1999; Mahnke, 1996). Depending upon the wavelengths of light absorbed and processed by the eye and brain, different hormones are released, triggering a variety of biological and psychological responses (Clarke, 2010).

Biological Effects of Color

Hormonal responses to color are the result of many generations of genetic evolution intended to increase an organism's chances of survival and reproduction and are therefore broadly consistent in all people (Engelbrecht, 2003). The color red raises the blood pressure, increases pulse and respiration, and has been reported to improve the sense of smell. Studies have also observed changes in motor skill activity and a tensing of muscles when people view the color red (Adler, 1999; Curry, 2011; Englebrecht, 2003). Considered the opposite of red, blue typically lowers the heart rate and blood pressure and slows breathing. The color blue has also been significantly linked to the senses and shown to increase sensitivity in vision, hearing and smell (Adler, 1999; Curry, 2011; Englebrecht, 2003). Yellow is the most luminous and visible color and is often negatively linked to eye strain, it also has positive effects on the chest and lungs, in some cases, easing breathing (Curry, 2011; Englebrecht, 2003). The color green is highly influential on the development of the vocal chords and speech skills and produces the least eye strain of all colors. Like blue it is considered restive and calming (Curry, 2011; Englebrecht, 2003). Orange and pink are both associated with a strong soothing effect due to the

slowing of the circulation and nervous systems associated with the color orange, and beneficial tonic effect of pink which reduces aggression (Curry, 2011, Englebrecht, 2003). Violet, has the least observable effects on the human body, however it seems to improve non-verbal functions and stimulates activity in the cerebellum region of the brain (Curry, 2011).

While the broad effects of color are well-known and similar between people, circumstances impact individual's reactions and create small inconsistencies that make it difficult to accurately predict the effects, if any, that a specific color will have on a person. The first complication in predicting the way color changes biological functions is the state of a person's body. Reactions will differ based on the level of development or deterioration of a person's eyes and brain which will affect how colors are actually seen. Humans can perceive color as early as one month old but have limited sensory capacities which limit their range of color vision. As the eye develops, the ability to see color increases and as the eye deteriorates due to aging, range of color vision decreases (Chang, Vemach, and Teller 2007). Most children develop full color vision around age fifteen. Adults experience optimal color vision between ages 20 and 30 before losing the most sensitivity around age 65 (Adler, 1999). As the eyes and brain develop, the ability to see shades of colors and distinguish more closely between colors evolves (Chang, 2007; Offenbach, 1980). The tone, or muteness of the color being observed can also have an effect on the degree to which a person responds to a color. (Curry, 2011). Bright, highly saturated colors are the easiest to see for all people. (Chang, 2007; Offenbach, 1980). These changes in vision and interpretation of color result in physical responses that are highly individualized.

All the reactions color creates in the body are temporary (Adler, 1999). A major tenant of color theory is the idea that the brain is constantly trying to achieve a state of equilibrium. Color

may provide an initial imbalance and create a biological response but the brain will eventually adjust to the change and mediate the response, negating the biological effects of the color after a period of time (Adler, 1999; Sherin, 2012).

Psychological Responses to Color

In addition to responding physically to color, people also have preferences for and associations with different colors. All people, regardless of age, race, gender, upbringing, culture, geographic location, and socio-economic standing associate similar meanings to color (Mahnke, 1996). When measuring reactions to colors children generally had stronger emotional response to all colors when compared to adults and indicated a preference for brighter shades (Agunga, 2001). These differences may be explained through other studies, children typically are more emotional in response to all things, not just color, and their preferences for bright colors could be a result of their ocular development and the ease with which brighter colors are seen (Agunga, Cole, Doneberg, and Rutledge, 2001; Chang, 2007).

While adults generally prefer more muted shades of color compared to children, most people have a bias against neutral tones; white, black, grey, and brown. Theses colors are most often associated with negative feelings (Curry, 2011). Colorless spaces, as neutral environments are sometimes called, can be harmful and stress inducing despite their widespread use for walls of hospitals, schools, and offices (Curry, 2011; Dijkstra, 2008; Kruczek, 1988). White, for example is often used in hospitals for its neutrality, lightness, and cleanliness but can create severe depression and tedium in patients (Curry, 2011; Dijkstra, 2008; Kruczek, 1988). When applied to walls in offices or classrooms it has a negative effect on worker productivity, efficiency and happiness (Curry, 2011; Dijkstra, 2008; Kruczek, 1988). These findings hold true for both adults and children (Curry, 2011; Dijkstra, 2008; Kruczek, 1988). Instead of using

neutral shades, experts recommend using a low-saturation green or blue as they are identified as the two colors that are most successful in reducing stress (Curry, 2011) (Dijkstra, 2008). Similar to the way under-stimulation occurs through the use of neutral colors, overly saturated colors, colors that are very high chroma, can reduce concentration levels, increase stress, and overstimulation from color can induce eye strain (Kruczek, 1988).

As is the case with biological responses to color, the same physical limitations of the eye and brain affect people's psychological responses in which their individual development determines their perception. Additionally, personality often plays a role in determining the emotional reactions created by color. People who are more extraverted require more stimulation in their lives and respond more positively to warm colors (red, orange, and yellow), brighter shades of colors and more combinations of colors (Curry, 2011; Kruczek, 1988; Mahnke, 1996). They often report feelings of boredom in less-stimulating environments (Curry, 2011; Kruczek, 1988; Mahnke, 1996). In contrast, introverts typically respond better to cool colors (green, blue, and purple), and are overwhelmed by highly stimulating environments (Curry, 2011; Kruczek, 1988; Mahnke, 1996). Despite these individual preferences for color, the under- or over-stimulation of any environment will eventually have negative effects on all people, though the brain's efforts to organize visual data and achieve equilibrium will allow most people to adjust to all but the most extreme environments (Curry, 2011; Sherin, 2012).

These physical and physiological characteristics of color affect every aspect of human life. Research has estimated that visual connections to the other senses within the brain are so strong that up to 80 percent of all sensory perception is defined by sight and therefore influenced by color (Sherin, 2012). It is therefore important to understand how color impacts people in different situations at work or leisure.

Play

Play is a complex behavior crucial to children's development, promoting children's long term health, increasing positive emotions, improving quality of life, and stimulating the development of physical, social, and mental skills (Goldstein, 2012). Despite the importance of play for children it is becoming a neglected aspect of their lives for a variety of reasons that include the increasing structure of children's lives, safety concerns, a decline in access to suitable play areas and the increase of technology in daily life (Eberle, 2014; Goldstein, 2012; Pellegrini and Smith, 1998; Ozdemir, 2008).

Defining Play

Defining play is crucial to successfully identifying and categorizing relevant behaviors in research. Play is complex and varied but several criteria have been established. In studies, adults and children have reported a typical group of behaviors when identifying instances of play (Jenvey and Turnbull, 2007; Smith, 1985). Common criteria include the voluntary nature of play, lack of goals of play, multidimensional and flexible nature, and positive emotional effect on participants (Eberle, 2014; Goldstein, 2012; King, 1979; Jenvey and Jenvey, 2002; Jenvey and Turnbull, 2007; Smith, 1985). Other criteria that are less defined but still common elements of play include an intimacy or absorption of the players, non-literal interpretation, and self-awareness (Brédikyté, Hakkarainen, Jakkula, and Munter, 2012; Jenvy and Jenvey, 2002; Jenvey and Turnbull, 2007). Some people argue that all criteria must be met to identify a behavior as play, yet others indicate only some of the criteria as being required (Eberle, 2014). Regardless,

there is agreement that play must be fun, when it loses this element it ceases to be play. (Eberle, 2014).

Among children, however, play is identified more simply than among adults. In its most basic definition, play is not work (King, 1979). For children the biggest determinate of play is free will and control; the freedom to choose when, how, and with whom to play and creating situations where the children have power over the situation and their environment (Anon, 1994; King, 1979). Many children associate this with the absence of an adult (Einarsdottir, 2014; Hernandez-Reif, Hudson, and Horton, 2012; Hill, Howard, and Jenvey, 2007). However, play can still be successfully associated with an adult when the adult is properly integrated into the situation and the child is competent and willing to communicate their play desires to adults (Brédikyté, 2012; Einarsdottir, 2014; Lindqvist, 2001). The number of other children present also has an effect on what children consider play. Pairs or groups of children are more likely to be identified as playing than a solitary child (Hill, 2007). These discrepancies between adults' and children's definitions is a product of perspective. Even though children do not understand the importance of play, they have a clear idea of what it is and become immersed in play activities (Hill, 2007; King, 1979). When designing play opportunities, it is important to consider the children's definitions to ensure appropriate play opportunities can be provided.

Play can be defined still further into several types that are characterized by different behaviors (Harris and Jalloul, 2013). Most commonly studied are physical activity and pretend/imaginative play. While each type of play has unique aspects, different types are often difficult to distinguish or are combined due to the flexible and changeable nature of children's play (Goldstein, 2012). Physical play is defined as play featuring vigorous activity or movement, and pretend play uses make-believe (Jenvey and Turnbull, 2007; Pellegrini, 1998). Physical

activity play can also be called active play and can be divided into subtypes that include gross-motor play referring to the muscle groups used, and rough-and-tumble play referring to play fighting (Jenvey and Turnbull, 2007; Pellegrini, 1998). Other categorical systems of play delineate social characteristics, observing whether children are alone or in groups. These include:

- Solitary where a child plays alone
- Onlooker where a child watches without participating
- Parallel where children play independently in proximity to each other
- Associative where two or more children play together, but have different goals
- Cooperative play where two or more children play together

(Goldstein, 2012; Hernandez-Reif, 2012).

Factors that Affect Play

A number of variables influence children's play, including the appropriateness of play materials and spatial relationships which impact type and duration of children's play. In terms of spatial organization, bigger is typically better. Smaller play areas often experience a conflict of use that severely limits the types and durations of play available to the children (McKendrick, 1999; Ozdemir, 2008). Additionally, providing a variety of different settings and materials in a single play space further increases the suitability of the site for play by creating areas that are suited for all types of play (Ozdemir, 2008). Green spaces, or areas that incorporate nature, have been identified as a crucial element to include in play environments. Their lack of structure, when used as a supplement to formalized play, increases creativity, complexity, and enthusiasm of children's play. In urban areas, green-space is the most commonly identified element children find lacking in play environments (Ozdemir, 2008). Using these findings, three types of play environments and structures can be identified. Traditional play environments are characterized by built play structures usually featuring swings, slides, and tunnels that are largely intended for a single-use. Contemporary play environments are characterized by more flexibility and are

defined by structures that offer multiple options for entry, exit, and linkage between spaces. Natural or adventure play spaces offer few man-made structures and promote children's creativity with movable components and elements that provide opportunities for many variations of play (Barbour, 1999). Traditional areas offer the greatest amount of active play, the fewest instances of unoccupied play, and the most interaction between children. However, these areas were used almost exclusively by children with a high level of physical fitness (Barbour, 1999; Hart, 1986). Children using contemporary play areas exhibited more types of play but played for shorter durations than those on natural or traditional structures. Researchers also saw more movement between areas of the contemporary play site and a greater variability of the physical fitness of children using these areas (Barour, 1999; Fikus and Luchs, 2013; Hart, 1986). Natural play areas produced the fewest changes in activity and the play was longer lasting and more complex and was also characterized as being more individualistic and solitary (Fikus, 2013). Although play spaces are rarely comprised of a single type of play environment, understanding the overall themes of each type of design helps adults understand the way children will use a space.

Understanding how and why children play is crucial not only for conducting research on the topic but also for designing new play spaces. Knowledge of these factors allows for safe and engaging playground design that also meets the developmental needs of the children using them. Applying color to these studies allows for further development of the aesthetics of the space, as well as presenting the opportunity to positively influence behavior.

Summary

By understanding the way people respond biologically and psychologically to color, and by determining the definitions of and factors that influence play, future experiments can be

designed that will determine the relationship between the two. Despite the large number of variables that affect people's reactions to colors, the biological reactions can be predicted. Likewise, how people respond to the calming and exciting influences of color is largely consistent. By applying these principles to the existing knowledge of how children play, a series of hypotheses can be developed.

Hypotheses

H1: A greater number of play behaviors for all levels of activity; active, low active, and passive, and for all colors of playground ball; red, yellow, and blue, will be observed on the traditional playground.

Traditional playgrounds, are typically less stimulating to children and produce shorter instances of play than those observed on other playground types (Fikus, 2013; Hart, 1986). In similar but separate studies conducted by Barour (1999), and McKendrick (1999), it was found that children utilizing play spaces that were not stimulating, displayed shorter attention spans and changed play activities frequently. Given these results, it can be assumed that the same trends will be observed on the traditional playgrounds used in this study.

H2: Longer play durations for all levels of activity; active, low active, and passive, and for all colors of playground balls; red, yellow, and blue, will be observed on the nature playground.

Referencing the definitions of play, control over and manipulation of the environment is a crucial component in engaging children in play (Eberle, 2014; Hill, 2007; Jenvey, 2002; Jenvey and Turnbull, 2007: Pellegrini, 1998). Nature playgrounds provide more opportunities for control and manipulation and their natural elements are thought to increase concentration,

producing the longer lasting play (Fikus, 2013). It can expected that the nature playground in this study will follow previously discovered trends.

H3: The color of the playground ball will significantly affect the number of observed play behaviors

H3.A: The greatest number of play behaviors for all levels of activity; active, low active, and passive, will be observed for the red playground balls

The exciting properties of red, resulting in raised blood pressure, pulse, and respiration and increased muscle tension combined with its high visibility as indicated by Adler (1999), Curry (2011), Engelbrecht (2003), and Mahnke (1996) stimulate movement suggesting that the red playground balls will elicit large amounts of activity but for short periods of time, creating the opportunity for a larger number of behaviors.

H3.B: The second greatest number of play behaviors for all levels of activity; active, low active, and passive will be observed for the yellow balls

Yellow is considered exciting due to its status as a warm color and is very luminous making it the most visible of all the colors (Curry, 2011; Mahnke, 1996). It has also been associated with the cardiopulmonary system, in some cases easing breathing. (Barour, 1999; Curry, 2011). Due to its ability to cause excitement it is expected that the yellow balls will encourage a large number of active behaviors, however its positive effect on the chest and lungs suggests that the play behaviors may last longer, resulting in fewer total activities.

H3C: The fewest number play behaviors for all levels of activity; active, low active, and passive will be observed for the blue balls

Blue is considered the most calming color and has been shown to decrease blood pressure, heart rate, and respiration (Adler 1999); Curry 2011; Engelbrecht 2003; Mahnke 1996). The calming influence of blue does not promote high levels of activity instead influencing bodily functions towards rest so it can be predicted that the blue balls will generate fewer play behaviors than the other colors.

H4: The color of the playground ball will have significant affect the durations of the observed play behaviors

H4.A: The longest durations of play behaviors for all levels of activity; active, low active, and passive, will be observed for the blue playground balls

As indicated by Adler (1999), Curry (2011), Engelbrecht (2003), and Mahnke (1996), the color blue creates a calming effect on the respiratory system. These physical responses are most often associated with resting actions and can be sustained for long periods of time enabling the children to maintain play behaviors for longer when using the blue balls compared to other colors.

H4.B: The second longest number of play behaviors for all levels of activity; active, low active, and passive will be observed for the yellow balls

Due to the influence of yellow on the chest and lungs, described by Barour (1999) and Curry (2011) it may be assumed that longer durations of play will be associated with the yellow ball. While the excitement attributed to the color yellow may increase the number of activities observed, it is predicted that the calming respiratory effects of the color will allow for longer sustention of what would normally be short-term behaviors.

H4C: The shortest durations for all levels of activity; active, low active, and passive will be observed for the red balls.

As indicated by Adler (1999), Curry (2011), Engelbrecht (2003), and Mahnke (1996) the responses associated with red lead to elevated pulse, blood pressure, levels of respiration, and increased muscle tension. These are typically short-term reactions that are difficult for the body to maintain for extended periods of time, therefore it is predicted that the red balls will generate the shortest durations of play.

CHAPTER THREE – METHODOLOGY

Research Design

This study was designed as a Quasi-experimental post-test in the form of a naturalistic observation. Repeated measurements of the manipulated elements, the playground balls, were taken within a group of existing subjects.

Research Site

Videos were recorded at the Michigan State University Child Development Lab in East Lansing, Michigan. The Child Development Lab (CDL) is operated by the Department of Human Development and Family Studies at Michigan State University and offers full-day and half-day preschool programs with enrollment open to the public. Curriculum is focused on play-based learning and high levels of cross-classroom interaction and social guidance. Additionally, the CDL is committed to supporting faculty and student research in child development and early childhood education.

Within the CDL facility, two different playgrounds were used for this experiment. Playground 2, referred to as the nature playground, is about 10,330 square feet and contains two sandpits, a wooden stage, a plastic play house, a large grassy area, a circular tricycle track, a bolder, several large deciduous trees, several deciduous bushes, a small garden, a storage shed, and a covered concrete pad with tables, cubbies, and a water fountain. Occasionally, a small sprinkler is also set up on the playground (Figures 1 -). This playground is located between two other playgrounds; Playground 1, which was not used for this study, for toddlers to the north; and the traditional playground to the west. Part of the west edge of nature playground is also bordered by the CDL's paved vehicular drop-off loop. To the east and south sides of the nature

playground are parking lots and the entire playground is surrounded by a black chain-link fence (Figures 1 - 6).

Figure 1: Nature playground at camera 2 (C2) facing east to south-east

Figure 2: Nature playground in the south-east corner facing west

Figure 3: Nature playground: storage shed and patio

Figure 4: Nature playground: at the south-west corner facing east

Figure 5: Nature playground: at the south-east corner of the storage shed facing south

Figure 6: Nature playground: at camera 1 (C1) and secondary camera looking north

Playground 3, referred to as the traditional playground, features a play structure designed for three through five year-olds, two small spring-riders (themed seats mounted on springs), a spinning net climber (a pyramidal net on a rotating base), a large teeter-totter, and a bucket spinner. On hot and sunny days the teachers also setup a small pavilion shade structure. This playground is approximately 3,780 square feet and is also surrounded by a black chain-link fence (Appendix B: Playground Images). The traditional playground is bordered by the nature

playground to the east, a parking lot to the south, Hillcrest Ave. to the west and the CDL's paved drop-off loop to the north. This playground is shaded and buffered by bushes and trees between the fence and the pavement on the north, south and west edges (Figures 7 - 8).

Figure 7: The traditional playground: at camera 1 (C1) facing east

Figure 8: The traditional playground: at primary camera 2 (P2) facing west to north

Participants

Subjects for this study consisted of the students in the three-year old and four-year old classes that were already established within the CDL. These two classes were selected for the study due to their age range. Children between the ages of three and five are typically identified as playing differently than children younger than three years and children between the ages of five and 12 and playground equipment manufacturers design structures and playground elements specifically for this age range. (Harris. 2013) Additionally, this age is typically when children

begin entering preschool programs (Almeida, 2004). Their increasingly rigid schedules, new educational and social situations, and mandatory recesses increase the importance of understanding how to design spaces best suited for their needs.

Student ages ranged between the ages of 36 – 60 months old and the students were assigned to classes independently of this study, by the staff of the CDL. The three-year old class had three to eleven children, dependent on daily attendance, and within the class, five of the students were female and six were male. This class was led by two teachers, both female, at least one of whom was on the playground with the children at all times. The four-year old class had seven to ten children, dependent on daily attendance, and within the class, four of the students were female and six were male. The teacher for the four-year old class was female and on the playground with the children at all times. She was sometimes assisted by one to two other teachers, both female. Because this study involved human subjects, approval from the Michigan State University Institutional Review Board (IRB) was obtained before the onset of the observations. The observer also obtained clearance from the State Police and the Department of Human Services before the onset of this study per the Child Development Lab requirements. Parents and/or guardians of the participants were provided the opportunity to deny consent to video record their children through implied consent forms distributed one week prior to the start of the study. From both classes, there were no students whose parents denied consent (Appendix A: Parental Implied Consent Form).

Materials

Materials for this study consisted of nine Champion Sports brand playground balls, 8.5” in diameter. Three balls were red in color, three were blue, and three were yellow (Figure 1: Examples of the red, yellow, and blue playground balls). For each session, three balls of the

same color were placed on the playground being used before the children arrived. For every session, the balls were placed in the same location so the children would always know their locations. Any play objects of any color, other than other balls, were permitted on the playground during the observations to allow for as normal as an environment as possible. The children were not told why the balls or observer were present and were not encouraged or discouraged to play with the balls by the teachers or observer.

Figure 9: Example of the red, yellow, and blue playground balls

Data Collection Procedures

Video recordings were collected and assessed for the sole purpose of this experiment. To record each session, digital cameras were located on the perimeter of the playground. Two cameras were used for all recordings; a Cannon HD Vixia HG20 and a Cannon Vixia HFM52 and were provided by the MSU School of Planning, Design and Construction. A third camera, a Samsung WB250F, was provide by the observer and was used on the nature playground in addition to the two other cameras where the larger size and uneven terrain required an additional camera to capture all of the activity. On the nature playground, camera 1 (C1) and camera 3 (C3) were mounted on the ledge located in the playground in the middle of the east edge. Camera 2 (C2) was located on the west edge of the playground on the fence by the north entry gate. The

observer (O) stood at C1 and C3 and adjusted the camera angles as needed to capture all behavior involving the playground balls. C2 remained stationary (Figure 2).

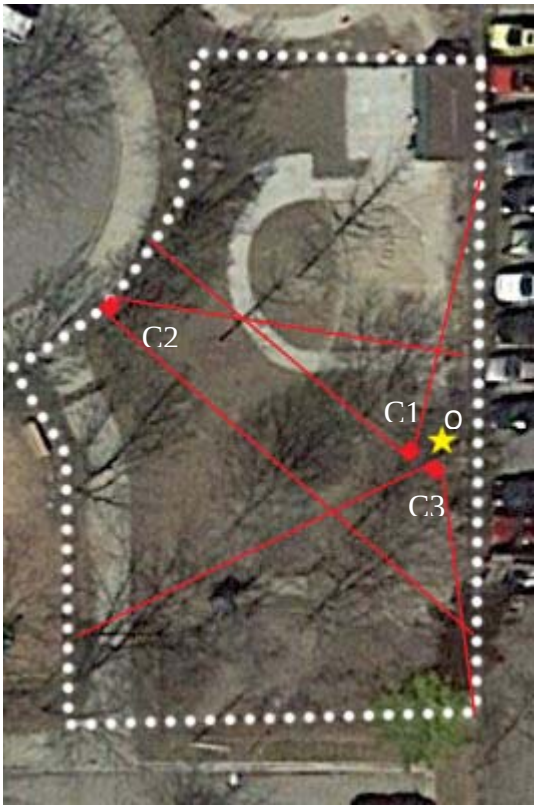

Figure 10: Camera locations on the nature playground

On The traditional playground, C1 was located in the north-west corner of the fence and the observer stood outside the playground at this camera to adjust the camera angle as needed. C2 was located in the south-east corner of the playground and remained stationary (Figure 3).

Figure 11: Camera locations on the traditional playground

Prior to the start of the observations, the observer, balls, and cameras were introduced to the playground so the children would acclimate to their presence. The observer began visiting the playgrounds four days before the start of the experiment, added the balls three days before the start, and the cameras one day before the start.

The existing schedule of each class was followed for this experiment with observations of the three year-old class occurring between 8:00 a.m. and 8:45 a.m. and observations of the four year-old class occurring between 8:00 a.m. and 8:45 a.m. On Mondays and Tuesdays, the three year-old class was scheduled on the nature playground, and the four year-old class was scheduled on the traditional playground. On Wednesdays and Thursdays, the four-year old class was scheduled on the nature playground, and the three year-old class was scheduled on the

traditional playground. Recording for this study began on May 28, 2015 and concluded on July 1, 2015 over a total of 18 days.

The color of the ball used for each observation was scheduled by the observer prior to the start of the study, in the rotation of blue, yellow, red, with both classes using the same color on the same day. This study was scheduled to give both classes an equal number of sessions on each playground resulting in each of the three colors being used the same number of times on each playground and at least twice on each day of the week (Table 1).

Monday	Tuesday	Wednesday	Thursday
			5/28/2015 BLUE BALL 3yr class = 3 4yr class = 2
6/1/2015 YELLOW BALL 3yr class = 2 4yr class = 3	6/2/2015 RED BALL 3yr class = 2 4yr class = 3	6/3/2015 BLUE BALL 3yr class = 3 4yr class = 2	6/4/2015 YELLOW BALL 3yr class = 3 4yr class = 2
6/8/2015 RED BALL ~~3yr class = 2~~ (rained out) 4yr class = 3	6/9/2015 BLUE BALL 3yr class = 2 4yr class = 3	6/10/2015 YELLOW BALL 3yr class = 3 4yr class = 2	6/11/2015 RED BALL 3yr class = 3 4yr class = 2
6/15/2015 *No Session	6/16/2015 BLUE BALL 3yr class = 2 4yr class = 3	6/17/2015 YELLOW BALL 3yr class = 3 4yr class = 2	6/18/2015 RED BALL ~~3yr class = 3~~ (rained out) 4yr class = 2
6/22/2015 BLUE BALL 3yr class = 2 4yr class = 3	6/23/2015 YELLOW BALL 3yr class = 2 4yr class = 3	6/24/2015 RED BALL 3yr class = 3 4yr class = 2	6/25/2015 *No Session (rained out)
6/29/2015 RED BALL 3yr class = 2 *Make-Up	6/30/2015 *Data Not Used	7/1/2015 RED BALL 3yr class = 3 *Make-Up	

Table 1: Observation Schedule

Coding

Video recordings were watched using Windows Media Viewer software and observational data was collected and coded in Microsoft Excel referencing an ethogram, (list of observable actions) of behaviors during the viewing. The ethogram was developed prior to the start of the study and consulted to identify the level of activity of each behavior that was

observed and is mutually exclusive and exhaustive. In addition to the behavior and a short identifying code for easier recording, the ethogram includes a detailed description of all the elements of the activity level that must be observed and a list of examples that were commonly seen for each behavior. The example list is not exhaustive (Table 1: Ethogram of active, low active, and passive behaviors).

Behavior	**Code**	**Description**	**Common Examples**
Active	A	Child is mobile using two or more of the gross muscle groups while having physical contact with the ball	
			Child walks or runs while holding or moving to or from the ball
			Child crawls while holding or moving to or from the ball Child kicks ball and chases after it
			Child places ball in play object and runs while spinning it
Low Active	L	Child is stationary using one of the gross muscle groups while having physical contact with the ball	Child stands and bounces ball against the ground or an object
			Child sits on the ball and bounces up and down
			Child sits on the ground and hits ball with hand or held object
			Child stands and kicks ball
Passive	P	Child is stationary and is not utilizing any of the gross muscle groups while having physical contact with the ball	
			Child stands and holds ball without moving their entire arms, legs, or torso

Table 2: Ethogram of active, low active, and passive play behaviors

Table 2 (cont'd)

			Child sits on ball without moving their entire arms, legs, or torso
Additional Notes: Only behaviors where the participant has contact at the onset, offset or during the action will be recorded. Play behaviors initiated by the teacher or another adult will not be recorded. The list of example behaviors is not exhaustive, other activities meeting the requirements of active, low active, or passive play must be recorded. All of the above behaviors may or may not incorporate fine muscle movements.			

Continuous coding was used for this study, recording only the behaviors in which one or more children or teachers had physical contact with a ball. A new behavior was recorded for each time contact with the ball was lost, activity level changed, the number of child and/or teacher interactions changed, and when the number of balls in use changed. Periods of time in which the balls were not in use were not coded, all time gaps between onset and offset behaviors indicated periods of time in which the balls were not in use. Additionally, behaviors in which the teacher used the ball, and behaviors initiated by the teacher were not included. Information recorded while viewing the data included:

- date
- weather
- day of the week
- playground number
- ball color
- total duration of the outside time

- age of class
- time of day
- number of children present
- number of teachers present
- start time of each behavior
- end time of each behavior
- behavior duration
- brief description of the behavior
- level of the activity (active, low active, or passive)
- total number of children interacting with the ball
- total number of adults interacting with the ball
- total number of balls being used
- child ID

The child ID's were anonymously assigned, in order of appearance on the playground during the first day of observation using the letters "B" for boy and "G" for girl followed by a number, for example, the first girl on the playground was identified as "G1", while the sixth boy was identified as "B6".

CHAPTER FOUR – RESULTS

As part of this naturalistic observational study, a total of 21 students from two separate classes were observed over 18 days consisting of a total of 18 hours, 27 minutes, and 23 seconds to collect data to determine the impact of the color of a playground ball on the level of activity of the children's play.

This study assessed the influence of color on play behaviors in terms of 1) the total number of active, low active, and passive behaviors on the nature playground compared to the traditional playground, 2) the duration of all active, low active, and passive behaviors on the nature playground compared to the traditional playground, 3) the number of active, low active, and passive behaviors observed for the red, yellow, and blue playground balls on both playgrounds; and 4) the durations of all active, low active, and passive behaviors observed for the red, yellow, and blue playground balls on both playgrounds.

Data pertaining to the number of behaviors observed was first normalized as a percentage of the number of specific level activity to the total number of activities. Normalization was inappropriate for assessing the total number of play behaviors for all combined activities and for the durations of the play behaviors because the durations of each type of play were not influenced by the total time spent on the playground each day. For all values, a margin of error was calculated using a confidence interval of 95%. (Table 3: Preliminary analysis)

Factors Assesed	Playground 2 (Natural Playground						Playground 3 (Traditional Playground)					
Average Number of Play Behaviors	27.7			22.2 Confidence Level (C.L.)			68			55.3 Confidence Level (C.L.)		
	Red		Yellow		Blue		Red		Yellow		Blue	
	22.6	14.9 C.L.	25.2	28.1 C.L.	35.2	25.0 C.L.	65.8	29.9 C.L.	37.4	28.9 C.L.	100.8	83.9 C.L.
Average Duration of Play Behaviors	25 seconds (sec)			7 sec (C.L.)			23 seconds (sec)			3 sec C.L.		
	Red		Yellow		Blue		Red		Yellow		Blue	
	28 sec	10 sec C.L.	17 sec	4 sec C.L.	30 sec	16 sec C.L	22 sec	6 sec C.L	21 sec	4 sec C.L.	24 sec	3 sec C.L.
Average Number of Play Behaviors	Red		Yellow		Blue		Red		Yellow		Blue	
Active	57.5%	22.1% C.L.	58.7%	10.9% C.L.	51.7%	9.9% C.L.	61.1%	8.2% C.L.	58.3%	8.6% C.L.	55.2%	6.8% C.L.
Low Active	26.5%	14.6% C.L.	28.6%	11.1% C.L.	24.4%	6.6% C.L.	26.4%	7.0% C.L.	21.4%	15.2% C.L.	13.7%	9.1% C.L.
Passive	15.9%	9.4% C.L.	12.7%	12.9% C.L.	23.9%	11.5% C.L.	12.5%	5.8% C.L.	20.3%	22.4% C.L.	21.2%	12.4% C.L.
Total	100.0%	N/A	100.0%	N/A	100.0%	N/A	100.0%	N/A	100.0%	N/A	100.0%	N/A
Average Duration of Play Behaviors	Red		Yellow		Blue		Red		Yellow		Blue	
Active	22 sec	6 sec C.L.	19 sec	6 sec C.L.	30 sec	25 sec C.L.	24 sec	10 sec C.L.	24 sec	6 sec C.L.	25 sec	4 sec C.L.
Low Active	48 sec	33 sec C.L.	11 sec	3 sec C.L.	22 sec	10 sec C.L.	18 sec	4 sec C.L.	18 sec	6 sec C.L.	24 sec	6 sec C.L.
Passive	14 sec	6 sec C.L.	17 sec	9 sec C.L.	36 sec	37 sec C.L.	17 sec	5 sec C.L.	16 sec	5 sec C.L.	25 sec	6 sec C.L.

Table 3: Preliminary analysis

Using the normalized data, an unpaired t-tests and Analysis of Variance (ANOVA) tests using SAS University Edition statistics software were conducted as appropriate

Variation in the Total Number of Active, Low Active and Passive Behaviors on Each Playground

An unpaired t-test was used to test H1: a greater number of play behaviors for all levels of activity; active, low active, and passive, and for all colors of playground ball; red, yellow, and blue, will be observed on the traditional playground. This test compares the means of two groups and was selected because the two groups, the nature and traditional playgrounds, are independent of each other and no additional variables were compared. In order to be considered significant, the P value must be lower than the standard of 0.05 which is standard for observational studies. Data for this test consisted of the total number of all levels of play behaviors (active, low active, and passive) observed on the nature playground and the total number of all levels of play behaviors (active, low active, and passive) observed on the traditional playground (Table 4: T-test results for the number of all play behaviors).

	Nature Playground	Traditional Playground
Mean	27.6667	68.0000
Variance	640.2381	3984.1430
Observations	15	15
Degree of Freedom	18	
t Stat	-2.2971	
P(T<=t) two-tail	0.0338	
t Critical two-tail	2.1009	

Table 4: T-test results for the number of all play behaviors

Results of the T-test indicate that there is a significant difference (P= 0.0338) between the number of behaviors observed on the nature playground compared to the traditional playground because the P value is less than 0.05.

Variation in the Durations of the Total Active, Low Active, and Passive Play Behavior Durations on each Playground

An unpaired t-test was used to test H2: Longer play durations for all levels of activity; active, low active, and passive, and for all colors of playground balls; red, yellow, and blue, will be observed on the nature playground. This test compares the means of two groups and was selected because the two groups, the nature and traditional playgrounds, are independent of each other and no additional variables were compared. In order to be considered significant, the P value must be lower than the standard of 0.05 which is standard for observational studies. Data for this test consisted of the total durations of all levels of play behaviors (active, low active, and passive) observed on the nature playground and the total durations of all levels of play behaviors (active, low active, and passive) observed on the traditional playground (Table 5: T-Test results for the duration of all play behaviors).

	Nature Playground	*Traditional Playground*
Mean (in seconds)	1043.0667	564.4667
Variance (in seconds)	319778.981	853189.3524
Observations	15	15
Degree of Freedom	23	
t Stat	-1.7115	
P(T<=t) two-tail	0.1004	
t Critical two-tail	2.0687	

Table 5: T-Test results for the duration of all play behaviors

Results of the T-test indicate that there is no significant difference (P= 0.1004) between the durations of behaviors observed on the nature playground compared to the traditional playground because the P value is less than 0.05.

Impact of the Color of the Ball on the Number of Active, Low Active, and Passive Behaviors on Each Playground

A two-factor Analysis of Variance or ANOVA test was used to test H3: The color of the playground ball will significantly affect the number of observed play behaviors. This test was used because it compares the mean differences between two groups that have been split on two independent factors. For the ANOVA test, results were assessed comparing the number of active, the number of low active, and the number of passive behaviors that were observed for red, yellow, and blue colored playground balls. In order for the results to be considered significant for this test, the calculated Pr value must be below 0.05 as is standard for observational studies. (Table 6: Anova results for the number of behaviors for the playground ball color and level of activity on both playgrounds).

Effect	Numerator Degree of Freedom (Num DF)	Denominator Degree of Freedom (Den DF)	F Value	Pr > F
Level of Activity	2	81	110.38	< 0.0001
Color	2	81	0	1.0000

Table 6: Anova results for the number of behaviors for the playground ball color and level of activity on both playgrounds

Results of this test returned a significant difference (Pr < 0.0001) between the number of active, low active, and passive behaviors when dependent on color because the Pr value was less than 0.05. Because significant differences were reported in this category, further tests must be

run to determine between which variables the difference occurred. The results for the difference in the color of the playground balls when dependent on the level of activity were insignificant (Pr = 1.0000) because the Pr value is greater than 0.05. Due to this insignificance, no further tests are needed for this category.

In order to determine which factors the significant difference occurs between, a sum of squares was conducted. This test determines the dispersion of the data points and indicates where the total variation that occurs in the results. For this test, the color of the ball was the independent variable and the level of activity was the dependent variable. In order for the difference between two factors to be considered significant, the Pr value must be below 0.05 as is standard for observational studies (Table 7: Sum of squares results for number of active, low active, and passive behaviors when dependent on ball color for both playgrounds).

	Level of Activity 1	Level of Activity 2	Estimate	Standard Error	Degree of Freedom	t Value	P r >|t|
Blue	Active	Low Active	0.363	0.0603	81	6.02	<.0001
Blue	Active	Passive	0.340	0.0603	81	5.64	<.0001
Blue	Low Active	Passive	-0.023	0.0603	81	-0.38	0.703
Red	Active	Low Active	0.455	0.0603	81	7.54	<.0001
Red	Active	Passive	0.559	0.0603	81	9.27	<.0001
Red	Low Active	Passive	0.104	0.0603	81	1.73	0.087
Yellow	Active	Low Active	0.468	0.0603	81	7.76	<.0001
Yellow	Active	Passive	0.496	0.0603	81	8.23	<.0001
Yellow	Low Active	Passive	0.028	0.0603	81	0.47	0.642

Table 7: Sum of squares results for number of active, low active, and passive behaviors when dependent on ball color for both playgrounds

Results of the sum of squares indicate that the differences between the number of active and low active behaviors observed ($Pr < 0.0001$) and between the number of active and passive behaviors observed ($Pr < 0.0001$) were significant for all the colors (red, yellow, and blue) because the Pr values were less than 0.05. The Pr values for the difference between the low active and passive behaviors for the blue balls ($Pr = 0.703$), the difference between the low active and passive behaviors for the red balls ($Pr = 0.087$), and the difference between the low active and passive behaviors for the yellow balls ($Pr = 0.642$) were all considered insignificant because the Pr value was greater than 0.05.

Impact of the Color of the Ball on the Durations of the Active, Low Active, and Passive Behaviors on Both Playgrounds

A two-factor Analysis of Variance or ANOVA test was used to test H4: The color of the playground ball will have significant affect the durations of the observed play behaviors. This test was used because it compares the mean differences between two groups that have been split on two independent factors. For the ANOVA test, results were assessed comparing the durations of the active, the durations of the low active, and the durations of the passive behaviors that were observed for red, yellow, and blue colored playground balls. In order for the results to be considered significant for this test, the calculated Pr value must be below 0.05 as is standard for observational studies. (Table 8: Anova results for the durations of the active, low active, and passive play behaviors associated with the playground ball color on both playgrounds).

Effect	Numerator Degree of Freedom (Num DF)	Denominator Degree of Freedom (Den DF)	F Value	Pr > F
Level of Activity	2	81	4.23	0.0179
Color	2	81	2.24	0.1130

Table 8: Anova results for the durations of the active, low active, and passive play behaviors associated with the playground ball color on both playgrounds

Results of this test returned a significant difference (Pr = 0.0179) between the number of active, low active, and passive behaviors when dependent on color because the Pr value was less than 0.05. Because significant differences were reported in this category, further tests must be run to determine between which variables the difference occurred. The results for the difference in the color of the playground balls when dependent on the level of activity were insignificant (Pr = 0.1130) because the Pr value is greater than 0.05. Due to this insignificance, no further tests are needed for this category.

In order to determine which factors the significant difference occurs between, a sum of squares was conducted. This test determines the dispersion of the data points and indicates where the total variation that occurs in the results. For this test, the color of the ball was the independent variable and the level of activity was the dependent variable. In order for the difference between two factors to be considered significant, the Pr value must be below 0.05 as is standard for observational studies (Table 9: Sum of squares results for the durations of the active, low active, and passive behaviors when dependent on ball color for both playgrounds).

	Color 1	Color 2	Estimate	Standard Error	Degree of Freedom	t Value	P r > |t|
Blue	Active	Low Active	545.5	241.29	81	2.26	0.0265
Blue	Active	Passive	361.4	241.29	81	1.5	0.1381
Blue	Low Active	Passive	-184.1	241.29	81	-0.76	0.4477
Red	Active	Low Active	196.3	241.29	81	0.81	0.4183
Red	Active	Passive	399.4	241.29	81	1.66	0.1017
Red	Low Active	Passive	203.1	241.29	81	0.84	0.4024
Yellow	Active	Low Active	295.3	241.29	81	1.22	0.2246
Yellow	Active	Passive	306.4	241.29	81	1.27	0.2078
Yellow	Low Active	Passive	11.1	241.29	81	0.05	0.9634

Table 9: Sum of squares results for the durations of the active, low active, and passive behaviors when dependent on ball color for both playgrounds

Results of the sum of squares indicate that the differences between the number of active and low active behaviors observed for the blue balls (Pr = 0.0265) was significant because the Pr values were less than 0.05. The Pr values for the difference between the active and the low active behaviors for the red and the yellow balls, and the between the active and passive behaviors and the low active and the passive behaviors for all the colored balls (red, yellow, and blue) were all considered insignificant because the Pr value was greater than 0.05.

CHAPTER FIVE – DISCUSSION

Although there was little statistical difference in the results of this study, indicated trends in the level of activity and durations of the children's play behaviors within and between the two different playgrounds, in addition to the statistically supported differences can be used to confirm or reject the hypotheses.

Variation in the Total Number of Active, Low Active and Passive Behaviors on Each Playground

Data from the observations revealed a significant difference in play between the two playgrounds (P = 0.0338) based on the results of the T-table test. The children played with the balls more frequently on the traditional playground, with an average of 68 total times, than on the nature playground, with an average of 27.7 total times (Figure 12: Average number of total play behaviors).

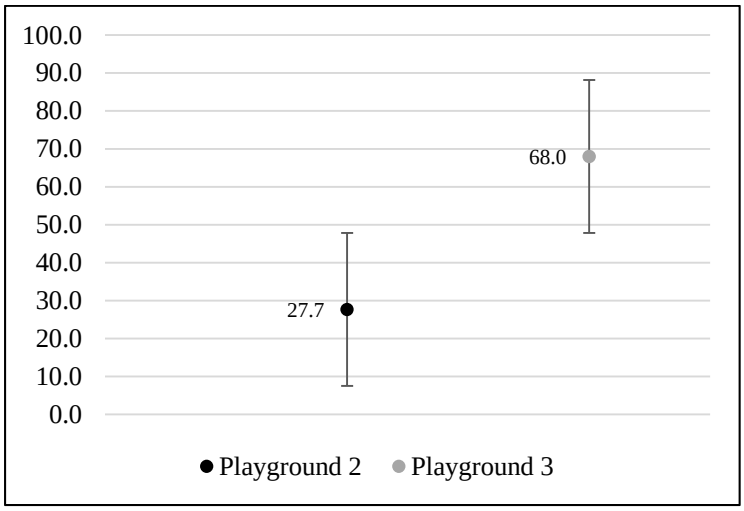

Figure 12: Average number of total active, low active, and passive play behaviors on the nature playground and the traditional playground

In addition to having significant statistical difference in the average number of total behaviors between the two playgrounds, the traditional playground typically had at least double the number play behaviors as the nature playground. The traditional playground also had a larger range in the number of observed behaviors over the course of the experiment.

These results support hypothesis H1 (A greater number of play behaviors for all levels of activity; active, low active, and passive, and for all colors of playground ball; red, yellow, and blue, will be observed on the traditional playground) and can be explained by referencing previous studies. Other research has assessed the way in which surroundings affect the way children play and have found that children required certain amounts of freedom and manipulation over their activities and environments (Eberle, 2014; Hill, 2007; Jenvey, 2002; Jenvey and Turnbull, 2007; Pellegrini, 1998). Nature playgrounds have been proven more capable of meeting these needs than traditional playgrounds. In this study, the differences in playgrounds likely impacted the way the children played with the balls; the nature playground was consistently the site of fewer instances of play with the playground balls. The traditional playground, featuring a variety of manufactured structures saw more play behaviors with the balls. Due to the characteristics that define play, it can be assumed that the children on the traditional playground were under-stimulated by their limited control of the environment and opportunities for creativity and utilized the balls more as a result. On the nature playground, more of the children's play requirements were being met and there was less desire to use the playground balls.

Variation in the Durations of the Total Active, Low Active, and Passive Play Behavior Durations on each Playground

While not a significant difference (P = 0.1004), the play durations on the nature playground, averaging 25 seconds, were slightly longer than the durations observed on the traditional playground which averaged 23 seconds (Figure 13: Average duration of total play behaviors).

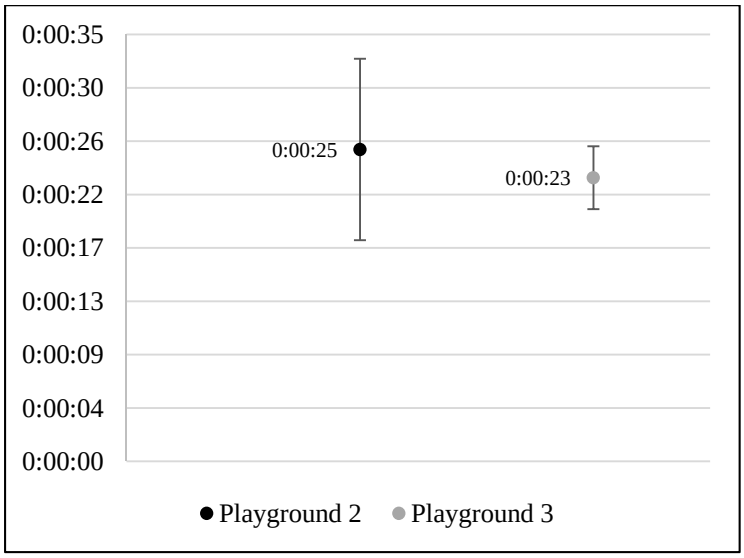

Figure 13: Average duration of total play behaviors

The results obtained in this study do not reveal a statistical difference or trend when comparing the durations of all active, low active, and passive behaviors between the two playgrounds. While the traditional playground did have a larger average duration of one second, it can be attributed to the unusually high durations that occurred in the beginning of the study, rather than a difference in play behaviors which rejects hypothesis H2 (Longer play durations for all levels of activity; active, low active, and passive, and for all colors of playground balls; red, yellow, and blue, will be observed on the nature playground).

Prior research suggests that children will play for longer durations on nature playgrounds, however this was not observed in this study (Fikus, 2013) This trend was probably not seen because this study focused on a single type of play object (the balls) rather than the entire play environment. The balls likely did not offer enough variety of play opportunities to keep the children engaged the same way a large space with multiple elements does.

Impact of the Color of the Ball on the Number of Active, Low Active, and Passive Behaviors on Each Playground

The results of this study did not return a significant difference in the amount of active, low active, and passive play between different colors on the playgrounds, however, there was a significant difference in the level of activities observed for each color ($P < 0.0001$) as indicated by the ANOVA with a 95% confidence interval. A sum of squares showed that for all the colors, a significant difference was observed between the active and low active, and the active and passive behaviors for all three colors ($Pr < 0.0001$). In addition to the statistically supported differences, observable trends for both the colors and the levels of activities were produced and can be used to assess the hypotheses.

On the nature playground, the yellow balls produced the greatest number of active behaviors, then the red, with the blue balls creating the fewest active behaviors. The red ball generated the greatest number of active behaviors on the traditional playground, with the yellow balls generating the second most and the blue, the fewest. On both playgrounds, the balls with the most instances of active play also had the largest margins of error, at 22.1% for red and 22.4% for yellow. The other colors on both playgrounds had much smaller margins of error, ranging between 6.8% and 10.9% (Figure 14: Average percentage of active play behaviors out of total play behaviors per color on the nature playground and the traditional playground).

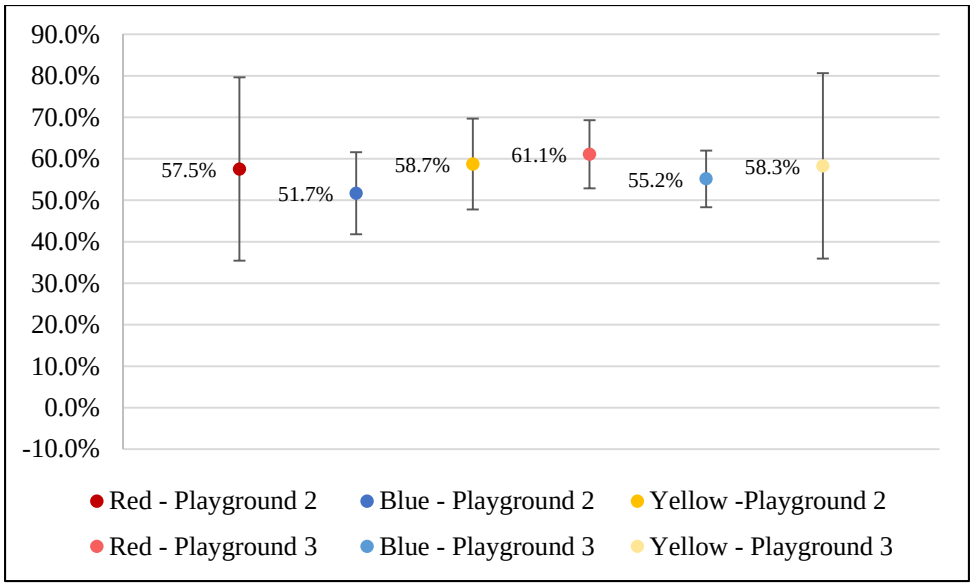

Figure 14: Average percentage of active play behaviors out of total play behaviors per color on the nature playground and the traditional playground

Low active play behaviors on the nature playground did not vary much by color, and had no statistical differences, but the yellow balls elicited the greatest number of low active behaviors. The red balls produced the second highest number of behaviors, and the blue, the least. A similar trend with no statistical difference was found on the traditional playground, where the blue balls had the fewest instances of low active play. However, on this playground, the red balls had more low active play than the yellow. The margins of error for the low active behaviors were generally larger than those of the active play, but had less standard deviation as all ranged between 6.6% and 15.2% (Figure 15: Average percentage of low active play behaviors out of total play behaviors per color on the nature playground and the traditional playground).

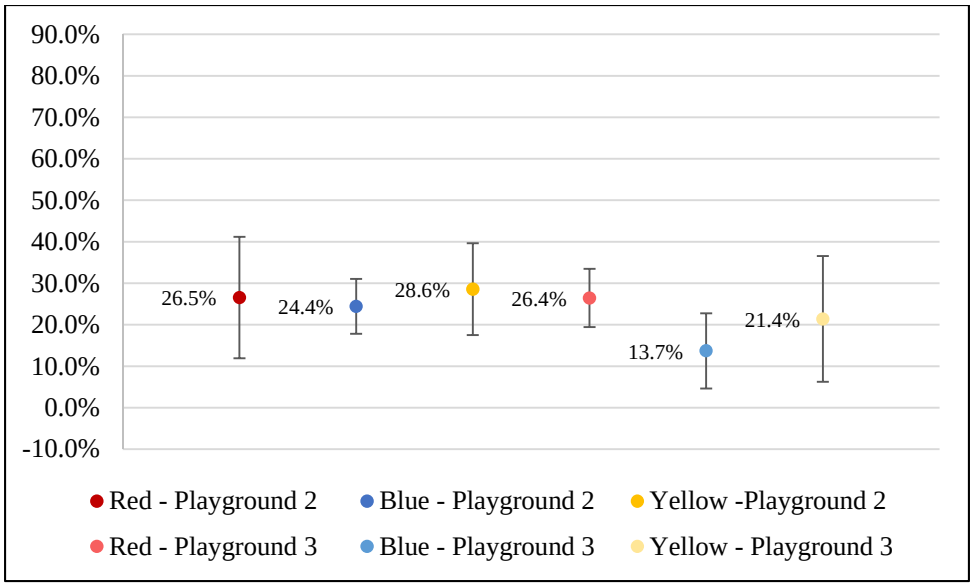

Figure 15: Average percentage of low active play behaviors out of total play behaviors per color on the nature playground and the traditional playground

While there was no statistical difference between any of the colors or playgrounds for passive play behaviors, the blue balls produced the greatest number of behaviors on both of the playgrounds. On the nature playground, the red balls had the most passive behaviors after blue, and the yellow balls had the least. The opposite was true on the traditional playground where the red balls created the fewest passive behaviors and the yellow had the second most. For the passive behaviors, the margins of error for the passive behaviors was similar to that of the low active behaviors. On both playgrounds, it was between 5.8% and 12.9% for all of the colors (Figure 16: Average percentage of passive play behaviors out of total play behaviors per color on the nature playground and the traditional playground).

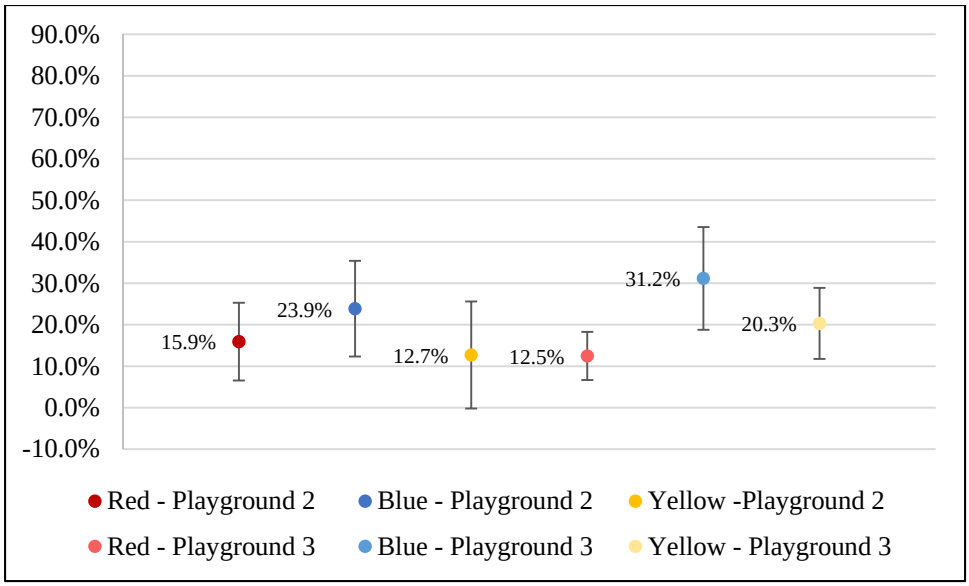

Figure 16: Average percentage of passive play behaviors out of total play behaviors per color on the nature playground and the traditional playground

Based on the results of this study, the color of the playground ball does have some effect on the level of activity of the resulting play behaviors. While results did vary slightly between the two playgrounds, the temperature of the color may have impacted the activity in more observable trends than the specific color did. In this observation, the red and the yellow balls, or the warm colored balls, generated higher percentages of active and low active behaviors while the blue balls were most often linked to passive play activities.

These results disprove hypotheses H3A, H3B, and H3C. In addition to none of these hypotheses being supported by statistical difference, each one can be further disproved by evaluating the observed trends. Because the greatest number of active and low active behaviors were seen in connection to either the red or yellow ball, rather than one over the other, and neither produced the most passive behaviors, hypotheses H3A, (The greatest number of play behaviors for all levels of activity; active, low active, and passive, will be observed for the red playground balls) and H3B (The second greatest number of play behaviors for all levels of

activity; active, low active, and passive will be observed for the yellow balls), are proved false. Additionally, the blue balls never produced the greatest number of active or low active behaviors, disproving H3C, (The fewest number play behaviors for all levels of activity; active, low active, and passive will be observed for the blue balls).

Knowing the physiological effects of these colors explains much of the behavior that was observed during this study. The red balls, with their connections to increased blood pressure, respiration, and pulse resulting in higher excitement levels, combined with the color's high visibility, created large numbers of active and low active behaviors and few passive behaviors. These physical changes described as "fight-or-flight" mechanisms are generated to promote movement as was seen with the red balls. The lack of passive behaviors associated with the red ball, further reinforces the influence of the physical reactions to red, which discourages non-active behaviors. It is these influences, particularly the association of red to the development and use of motor skills that led to a greater number low active behaviors where passive behaviors may have been equally appropriate, such as talking with other students and teachers. Additionally, there were multiple days on which the red balls failed to generate low active and passive behaviors which reinforces the assumption that red is best used as an instigator of activity.

Yellow, with its warm classification, and higher visibility than red, is also considered an exciting color. However, the color's link to the cardiopulmonary system, particularly the lungs, creates a unique circumstance in the number of play behaviors. For active and low active play behaviors, the yellow balls generated larger numbers of behaviors than they did for passive play. Similar to the red balls, the yellow balls failed to elicit any low active and passive behaviors in some sessions. This inability to create low active and passive behaviors indicates that yellow is

better suited to encourage active play, however the yellow balls did generate passive behaviors and had fewer instances of failing to elicit any of the behaviors. It could be that the conflicting impacts of the color; the excitement associated with its warmth and the relaxing responses to the chest, heart, and lungs, make it less effective in influencing any one type of play.

The blue balls were associated the least with active and low active behaviors and the most with passive behaviors. Additionally, there was not a single instance in which the blue balls failed to generate any level of play behavior. The color blue is considered the most calming and has been linked to the slowing of the heart rate and respiratory system, and the lowering of the body temperature, all of which are better suited for when the body is at rest and exhibiting minimal activity. The presence of the blue balls during low active behaviors may explain some of the instances in which the child stopped moving without being influenced by other factors. The ability of the blue balls to elicit at least one behavior of active, low active, and passive play during every play session may also be attributed to the color. Blue has been shown to increase concentration and may have kept the children's attention better than the warm colored balls despite its lower visibility.

When assessing the trends of each of the playgrounds, a general pattern can be found despite the differences in play. The data in this study indicates that the temperature of the color; warm or cool, may be more important to influencing behaviors than the impact of a single color. For both of the playgrounds used in this study, the warm colors, red and yellow, generated more active and low active play behaviors while the cool color, blue, generated the most passive behaviors. These responses are easily explained as red, and to a lesser extent, yellow are considered exciting colors while blue is considered calming. This is further reinforced by the knowledge of red and blue's inverse effects on blood pressure, respiration and heart rate which

red, the exciting color, increases, and blue, the calming color, decreases. The statistical differences which were observed between the number of active and low active behaviors, and the number of active and passive behaviors for all three colors are most likely not a response to the colors. Playground balls are designed to be used for active play therefore these play objects can be expected to produce the greatest number of active play behaviors for any color, this explains why similar results were seen for all three colors despite each colors differing impact.

Impact of the Color of the Ball on the Durations of the Active, Low Active, and Passive Behaviors on Both Playground

While data from this study did not produce significant differences for the durations of the red, yellow, and blue balls for dependent upon the active, low active, and passive play behaviors (Pr = 0.1130), it did indicate significant differences for the durations of the level of play behaviors dependent on the color (P = 0.0179). Observable trends in the durations of the different activity and the colored balls on both playgrounds, along with the statistically significant differences allow for the analysis of the hypothesis H4.

For active play behaviors on the nature playground, the blue balls generated the longest durations of play, followed by the red balls. Furthermore, the yellow balls had the fewest instances of active play. On the traditional playground, the blue balls had a slightly longer duration of active play than the other colors by one second. The red and yellow balls had the same average duration. The margins of error for the active play durations was within the range of six seconds to 10 seconds with the exception of the blue balls on the nature playground which had a margin of error of 25 seconds (Figure 17: Average durations of active play behaviors per color on the nature playground and the traditional playground).

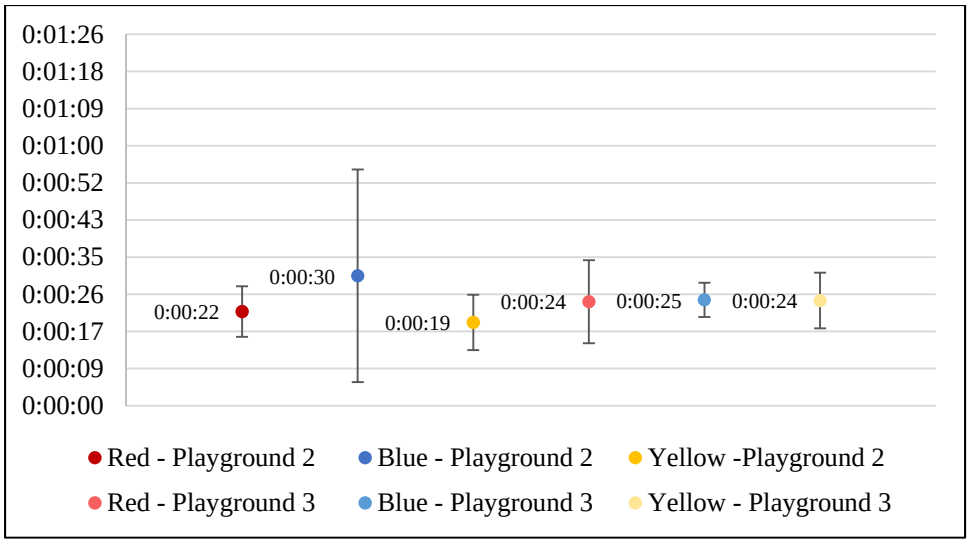

Figure 17: Average durations of active play behaviors per color on the nature playground and the traditional playground

On the nature playground, the longest low active durations were associated with the red balls, the second-longest with the blue balls, and the shortest with the yellow balls. The traditional playground, however showed similar trends to the active durations. For the low active play durations, the blue balls produced the longest behaviors and the red and yellow balls had the same average duration. Also similar to the active duration trends, the color ball with the longest durations, the red ball on the nature playground, had the largest margin of error at 33 seconds. The rest of the colors on both playgrounds had margins of error ranging between four seconds and ten seconds (Figure 18: Average durations of low active play behaviors per color on the nature playground and the traditional playground).

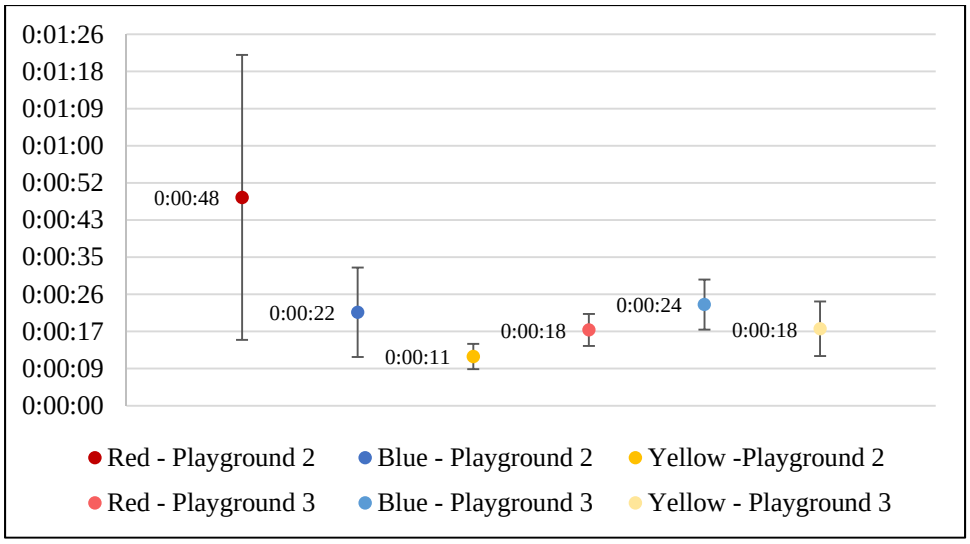

Figure 18: Average durations of low active play behaviors per color on the nature playground and the traditional playground

The passive durations on both the traditional and natural playgrounds followed similar trends to the active behaviors on both playgrounds and the low active durations on the traditional playground. On both the nature playground and the traditional playground, the blue balls produced the longest passive play durations. The yellow balls had the second-longest durations, and the red the shortest durations for the nature playground. On the traditional playground, the red balls had longer passive durations than the yellow balls. As was the case with the active durations, the blue balls on the nature playground had a larger margin of error than the other colored balls on both playgrounds. The margin of error for the blue balls on the nature playground was 37 seconds while the other margins of error were between 5 seconds and 9 seconds (Figure 19: Average durations of passive play behaviors per color on the nature playground and the traditional playground).

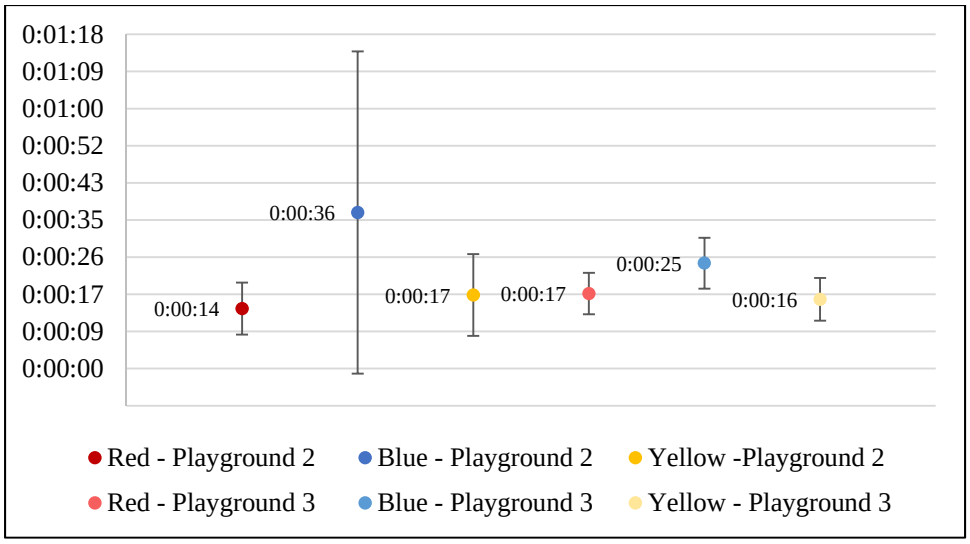

Figure 19: Average durations of passive play behaviors per color on the nature playground and the traditional playground

In addition to affecting the level of activity of children's play, this study indicated that the color of the playground ball may have an effect on the duration of the resulting play behaviors. As was the case with the number of behaviors, the temperature of the color follows a more observable trend. Unlike the number of behaviors, all three colors followed the same trend on both playgrounds where the blue balls generated the longest durations and the yellow and red balls generated the shortest

Despite the lack of statistical support, the trends observed in this study support hypothesis 4HA, (The longest durations of play behaviors for all levels of activity; active, low active, and passive, will be observed for the blue playground balls). Except of one instance, the blue balls consistently generated the longest durations of play for all activity levels, as hypothesis H4A suggests. The trends in these results disprove hypotheses H4B, H4C. In addition to neither of these hypotheses being supported by statistical difference, both can be further disproved by evaluating the observed trends. For the red and the yellow balls, neither consistently generated

longer durations of play than the other which makes both H4B, (The second longest number of play behaviors for all levels of activity; active, low active, and passive will be observed for the yellow balls, and H4C, (The shortest durations for all levels of activity; active, low active, and passive will be observed for the red balls) false.

For the red balls, durations of play for active, low active, and passive behaviors were the shortest or second shortest except on the nature playground where it generated the longest durations of low active behavior which can be attributed to an outlier. Due to the increased blood pressure, respiration, and pulse caused by the color red, which are associated with increased active behaviors, the low durations of play behaviors are easily explained. These responses to red do not promote passive behaviors and would also limit the time spent engaged in these behaviors. Conversely, although this color promotes higher levels of activities, these bodily conditions are also more tiring to maintain and are intended to function as short-term changes, therefore active behaviors would also be short in duration when associated with the red balls. An explanation for the long durations of the low active play is that the limited movement associated with them tires the body at a slower rate and allows for the longer durations.

The yellow balls consistently generated shorter durations of active, low active, and passive play than the blue balls and typically had similar times as the red balls. Additionally, the color yellow had relative consistency of the length of the play behaviors for each level of activity and usually had the smallest margin of error of all the colors. While the color yellow benefits the heart, lungs, and chest, this study indicates that the effects are similiar as with red balls in encouraging longer or shorter play behaviors due to its failures to generate low active and passive behaviors and consistently short durations.

The blue balls, with one exception, inspired the longest durations of play for the active, low active, and passive behaviors on both playgrounds. Additionally, while not statistically different, the blue balls typically had visibly longer durations than the red and yellow balls. The durations associated with the blue balls can be explained by the physical effects caused by the color. Due to the overall calming effect of the color blue; caused by the slowing of the heart rate, and respiratory system, the lowering of the body temperature all behaviors, despite level of activity, can be prolonged.

As was the case with the number of behaviors, the trends in determining duration of play is most pronounced when comparing warm and cool colors. For both of the playgrounds used in this study, the cool color, blue, generated the longest durations active, low active, and passive play behaviors while the warm colors, red and yellow, generated the least. Furthermore, the warm colors generated durations of play within zero to three seconds of each other on both playgrounds for active and passive behaviors. This can be attributed to the exciting effects of the warm colors and the similar durations between the two colors indicate less influence on the individual color over the color temperature. Additionally, the single statistically supported difference in the level of play, observed for the active and low active behaviors with the blue ball is probably not a result of the influence of the color. As was the case with the number of behaviors observed, the active intent of the ball as a play object was the most likely cause of this difference which is the opposite of what the blue balls would be expected to produce.

In summary, three general trends were observed in this study. First, children will play differently in different environments, typically exhibiting a greater number of behaviors that last for short durations on traditional playgrounds compared to the behaviors observed on nature playgrounds which are usually fewer in number and last for longer durations.

Second, color likely has some influence over the number of play behaviors that will be observed on any type of playground. The warm colors, red and yellow, were influential in encouraging active and low active play behaviors although neither consistently produced a greater number of behaviors than the other. The blue balls did consistently generate a greater number of behaviors than the other colors but only for passive behaviors.

Lastly, the durations of play behaviors on all types of playgrounds are also likely connected to color. While still not supported by statistical data, the blue balls typically generated the longest lasting durations of play although the difference between the blue balls and the other colors were minimal. As was the case when comparing the number of activities, the warm colored balls, (red and yellow) created similar responses, although the red balls had slightly longer durations compared to the yellow balls.

There are many reasons why these trends may have been observed. Hypotheses 1 and 2 and the relevant results of this study are strongly supported by prior research conducted by Barour (1999), Fikus (2013), Hart (1986), and McKendrick (1999), and the results specific to color may be explained by understanding the physical and psychological effects of color.

The red balls, with their connections to increased blood pressure, respiration, and pulse resulting in higher excitement levels, combined with the color's high visibility, created large numbers of active and low active behaviors and few passive behaviors. These physical changes described as "fight-or-flight" mechanisms are generated to promote movement as was seen with the red balls (Engelbrecht, 2003; Mahnke. 1996). The lack of passive behaviors associated with the red ball, further reinforces the influence of the physical reactions to red, which discourages non-active behaviors. It is these influences, particularly the association of red to the development and use of motor skills that led to a greater number low active behaviors where passive behaviors

may have been equally appropriate, such as talking with other students and teachers. Additionally, there were multiple days on which the red balls failed to generate low active and passive behaviors which reinforces the assumption that red is best used as an instigator of activity.

The blue balls, considered the opposite of red, typically were associated the least with active and low active behaviors and the most with passive behaviors. Additionally, there was not a single instance in which the blue balls failed to generate any level of play behavior. The color blue is considered the most calming and has been linked to the slowing of the heart rate and respiratory system, and the lowering of the body temperature, all of which are better suited for when the body is at rest and exhibiting minimal activity (Adler, 1999; Curry, 2011; Engelbrecht, 2003; Mahnke, 1996). The presence of the blue balls during low active behaviors may explain some of the instances in which the child stopped moving without being influenced by other factors. The ability of the blue balls to elicit at least one behavior of active, low active, and passive play during every play session may also be attributed to the color. Blue has been shown to increase concentration and may have kept the children's attention better than the warm colored balls despite its lower visibility.

Yellow, with its warm classification, and higher visibility than red, is also considered an exciting color. However, the color's link to the cardiopulmonary system, particularly the lungs, likely created a unique circumstance in the number of play behaviors generated (Barour, 1999, Curry, 2011). For active and low active play behaviors, the yellow balls generated larger numbers of behaviors than they did for passive play. Similar to the red balls, the yellow balls failed to elicit any low active and passive behaviors in some sessions. This inability to create low active and passive behaviors indicates that yellow is better suited to encourage active play,

however the yellow balls did generate passive behaviors and had fewer instances of failing to elicit any of the behaviors. It could be that the conflicting impacts of the color; the excitement associated with its warmth and the relaxing responses to the chest, heart, and lungs, make it less effective in influencing any one type of play.

Rather than support the hypotheses that one color will significantly affect the number or durations of observed play behaviors, this study suggests that the color temperature is more influential on behavior than a single color. Results indicated that the warm colored balls of red and yellow increase the number of active and low active play behaviors due to their exciting associations while the blue ball's calming influence generated larger numbers of passive behaviors. When measuring durations of play behaviors, longer durations were associated with the blue balls. The red and yellow balls produced equal or very similar durations to each other, however, the red ball typically had slightly longer durations.

Conclusion

Due to the changing demands in children's lives, outdoor play opportunities are becoming more limited with negative effects on children's health and development. This study was intended to confirm the link between the color of children's play objects and their resulting play behaviors and to provide a foundation on which further investigation may be conducted. Structured as a quasi-experimental, naturalistic observation using repeated measures within a group of existing subjects, this study used video recordings and an ethogram based coding system to collect data. Based on the results of this study, using specific colors when designing children's play spaces can influence their resulting play behaviors and help encourage desirable behaviors. This research has indicated and further reinforced the existing theory that a greater number of play behaviors will be observed on traditional over nature playgrounds and a trend

found that play durations will be longer on nature playgrounds. Although not statistically different in this study, trends among the total number of activates, the level of activity, and the durations of different play behaviors suggest practical applications of this research. Red and yellow likely encourage more active and low active behaviors while the color blue promotes passive activities. Color may also has the capacity to influence the duration of specific behaviors. The slight increase of behavior duration associated with the blue balls over the other colors indicates the potential for further development in this area. It is also possible that color temperature (warm or cool) is more influential than a single color. In summary, the results of this study suggest that color could be a viable tool in designing play spaces to meet specific needs and promoting different play behaviors in children and that further research is needed to gain a complete understanding of its affects.

Limitations

Due to the location of the study, the greatest limitation was the inability to control the multiple variables on the playground. In this experiment, none of these variables were controlled in an effort to keep the play environment as close to normal as possible for the children, however these variables may have influenced the results. For example, the children had access to other play objects of different colors which may have influenced their behaviors instead of or in addition to the color of the ball despite removing all other play balls from the site and keeping the color of the balls consistent during each observation session. Other variables which may have influenced the results include which children and teachers were present, the addition and removal of certain toys, and events outside the boundaries of the playground. Additionally, the presence of the observer and the video camera was at times a distraction for some of the students and altered their normal behaviors for short periods of time on multiple occasions. Lastly, the

presence and intervention in the children's play of the teachers on the playground limited a certain set of behaviors that were deemed unsafe or unkind.

Suggestions for Future Research

There are a number of questions and methods that could be utilized in future studies to expand the knowledge base in this area of research. Supporting research that would provide valuable knowledge for future studies would be experiments that assess the way in which combinations of two or more colors influence people's behaviors. This would be particularly useful when comparing color of similar tones, for example red and pink. Despite the visual similarities of these colors they have very different affects and there has been little to other color studies that would be useful would be more detailed investigations on the physical and psychological impacts of the color groups, that is warm, cool, and neutral colors. These studies, when applied to play would be extremely valuable as most playgrounds are designed with a color scheme of two or more colors.

Specific to this study, further testing and confirmation of these results on different types of playgrounds or play environments, the study of other colors and play objects, research on the impacts of combining different colors, and the application of the study to other age groups would be vital contributions to better understanding how color affects play behaviors. Comparing play behaviors over multiple times of day and testing a variety of different play objects would be particularly valuable in confirming or denying the universal effects of each color or color temperature. A supplemental survey of the participants could also be useful in helping distinguish between the impact of color preference and unconscious behaviors.

Implications

This study is the first step in better understanding how color influences the way children play and expanding this topic of knowledge to include larger play objects and structures to entire play spaces. Despite its limited scope, the results of this study can be applied to a number of different situations within the profession of landscape architecture and in related design fields. By better understanding the way in which color affects play, designers gain the opportunity to influence the way children use a space. Applying the appropriate color, or color temperature, may make a space more engaging, influence the amount of time children spend playing, and encourage appropriate behavior by contributing appropriate stimulation. Additionally, color may be used in a more specific context, applied selectively to specific elements to attract children to it or reinforce the intended level of activity. Utilizing color as an intentional design element allows planners and designers of children's built environment spaces to address specific needs and promote different play behaviors.

APPENDICES

APPENDIX A : PARENTAL IMPLIED CONSENT FORM

The Impact of Color on Children's Active Play Behavior

Bridget Safferman: Master of Environmental Design Student
Trish Machemer: Associate Professor
School of Planning, Design, and Construction, Michigan State University
517-763-7483, safferm1@msu.edu

Dear Parent or Guardian,

This letter is to inform you of an observation that is being conducted in your child's classroom to determine if there is a link between color and children's active play behavior. For this study, the researcher will be observing the children during their regular outside time over the course of approximately 1 month. During this observation, the researcher will be video recording the playground to determine instances of active play with colored playballs, and how long each instance of play lasts. The researcher will not be interacting with the children at any time

Your child's participation is greatly appreciated as the researcher attempts to better understand the impact that color has on play and encourage appropriate playground activities. Please note that there are no foreseeable risks associated with this study and privacy and confidentially will be ensured throughout the course of the experiment. No names or information pertaining to address or contact information will be collected. All recoded video data will be stored on a password protected computer during and after the experiment and will only be seen by the researchers.

Participation in the videotaped portion of this experiment is voluntary and can be revoked at any time without penalty to you or your child. Please note that this form only needs to be signed and returned if you wish to withdraw your consent for video recording.

If you have concerns or questions about this study, or on how to revoke your child's participation, please contact the researcher, Bridget Safferman at 517-763-7483, or at safferm1@msu.edu.

If you have questions or concerns about your child's role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 408 West Circle Drive, Olds Hall Room 207, MSU, East Lansing, MI 48824.

Thank you,

Bridget Safferman

Your signature below means that you **DO NOT** consent to be your child to be videotaped during this observation.

_____ _____

Signature Date

APPENDIX B: PLAYGROUND LOCATIONS

APPENDIX C: GLOSSARY OF TERMS

3-5 Year-old Structure	A play structure designed for use by children between the ages of 3 and 5 years old
Active Play	Play behaviors in which the participant is mobile and uses two or more of the gross muscle groups (arms, legs, and/or torso) while having deliberate physical contact with the ball
Continuous Coding	The process of recording data in which information is recorded by the changing of an event, rather than a consistent time interval
Cool Colors	The group of colors including green, blue, and purple that is generally considered calming
Ethogram	An inventory of the behaviors exhibited in an observation. Can include the behavior, an abbreviated code, a description of the behavior and examples
Level of Activity	Categorization of play behaviors based on the amount of movement and utilization of muscle groups observed
Low Active Play	Play behaviors in which the participant is stationary and uses one of the gross muscle groups (arms, legs or torso) while having deliberate physical contact with the ball
Nature Playground	A play space designed to promote natural play by using elements found in nature such as plants, water, sand, stone, and topography
Passive Play	Play behaviors in which the participant is stationary and is not utilizing any of the gross muscle groups while having deliberate physical contact with the ball

Physiological Response	The creation and release of hormones in the brain upon seeing color which effects bodily functions. Also referred to as physical responses
Play Object	An item located on the playground that is used during the children's play, these can be fixed items, moveable elements, and found objects
Play Structure	A built structure typically consisting of platforms of different heights, stairs, slides, and poles, among other features made of metal and/or plastic and intended for children's play
Psychological Response	The mental and emotional responses and associations formed upon seeing color
Traditional Playground	A play space composed of built elements, typically with a structure and several free-standing components such as a teeter-totter and swings, among other elements
Warm Colors	The group of colors including red, orange, and yellow that is generally considered exciting

BIBLIOGRAPHY

BIBLIOGRAPHY

Adler, L. Responding to Color. *University of Kentucky, College of Agriculture, Extention, 4*, 1-4. Retrieved June 14, 2014.

Agunga, A., Cole, S., Donenberg, N., & Rutledge, B. (2001). *Color Psychology: Children vs. Adults* (Master's thesis). 11DecemberRetrieved May 18, 2014

Andrade, E. B., Lee, C., & Palmer, S. (n.d.). How Emotions Influence Color Perception (Doctoral dissertation, University of California, Berkeley, Berkeley). Retrieved May 18, 2014.

Anon. How Children Use 'Play'. (1994, April). *The Education Digest, 59*(8), 1-4. Retrieved September 14, 2014.

Barbour, A. C. (1999). The Impact of Playground Design on the Play Behaviors of Children with Differing Levels of Physical Competence. *Early Childhood Research Quarterly*, *14*(1), 75-98. Retrieved October 14, 2014.

Bredikyte, M., Hakkarainen, P., Jakkula, K., & Munter, H. (2013). Adult Play Guidance and Children's Play Development in a Narrative Play-World. *European Early Childhood Education Research Journal*, *21*(2), 213-225. Retrieved October 9, 2014.

Chang, S., Teller, D. Y., & Zemach, I. (2007, May). Infant Color Vision: Prediction of Infant's Spontaneous Color Preferences. *Vision Research*, *47*(10), 1368-1381. Retrieved October 6, 2014.

Clarke, R., Corney, D., Lotto, R. B., & Purves, D. (2011). Seeing in Colour. *Optics and Laser Technology*, *43*, 261-269. Retrieved September 12, 2014.

Curry, Z. D., & Gaines, K. S. (2011). The Inclusive Classroom: The Effects of Color on Learning and Behavior. *Journal of Family & Consumer Sciences Education*, *29*(1), 46-57. Retrieved May 18, 2014.

Dijkstra, K., Pietserse, M. E., & Pruyn, A. H. (2008). Individual Differences in Reactions Towards Color in Simulated Healthcare Environments: The Role of Stimulus Screening Ability. *Journal of Environmental Psychology*, *28*, 268-277. Retrieved September 12, 2014.

Almeida, M., Pate, R. R., Trost, S. G., Almeida, M., & Sirard, J. R. (2004, June). Influences of Preschool Policies and Practicies on Children's Physical Activity. Journal of Community Health, 29(3), 183-196. Retrieved October 14, 2014.

Eberle, S. G. (2014). The Elements of Play: Toward a Philosophy and a Definition of Play. *American Journal of Play*, *6*(2), 214-233. Retrieved October 9, 2014.

Einarsdottir, J. (2005). We Can Decide What to Play! Children's Perception of Quality in an Icelandic Playschool. *Early Education and Development*, *16*(4), 469-488. Retrieved September 10, 2014.

Engelbrecht, K. (2003, June). The Impact of Color on Learning. *Perkins & Will*. Retrieved May 18, 2014.

Fikus, M., & Luchs, A. (2013). A Comparative Study of Active Play of Differently Designed Playgrounds. *Journal of Adventure Education and Outdoor Learning*, *13*(3), 206-222. Retrieved October 8, 2014.

Goldstein, J. (2012, February). Play in Children's Development, Health and Well-Being. *Toy Industries of Europe*, 1-44. Retrieved June 6, 2014.

Harris, P. L., & Jalloul, M. (2013). Running on Empty? Observing Casual Relationships of Play and Development. American Journal of Play, 6(1), 29-38. Retrieved September 14, 2014.

Hart, C. H., & Sheehan, R. (1986). Preschooler's Play Behavior in Outdoor Environments: Effects of Traditional and Contemporary Playgrounds. *American Educational Research Association*, *23*(4), 668-678. Retrieved October 14, 2014.

Hernandez-Reif, M., Horton, C., Hudson, C., Jeon, H., & Kendrick, A. (2012). Coding Group Behaviors in the Playground and the Effects of Teacher's Proximity on Preschool Children's Playground Behaviors. *Early Child Development and Care,182*(6), 37-41. Retrieved October 9, 2014.

Hill, C., Howard, J., & Jenvey, V. (2006). Children's Categorization of Play and Learning Based on Social Context. *Early Child Development and Care*, *176*(3-4), 379-393. Retrieved September 14, 2014.

Jenvey, V. B., & Turnbull, J. (2006). Criteria Used by Adults and Children to Categorize Subtypes of Play. *Early Child Development and Care*, *176*(5), 539-551. Retrieved September 14, 2014.

King, N. R. (1979, November). Play: The Kindergartner's Perspective. *The Elementary School Journal*, *80*(2), 80-87. Retrieved September 23, 2014.

Kruczek, T., & Zentall, S. S. (1988). The Attraction of Color for Active Attention-Problem Children. *Exceptional Children*, *54*(4), 357-362. Retrieved September 12, 2014.

Lindqvist, G. (2010, July 1). When Small Children Play: How Adults Dramatize and Children Create Meaning. *Early Years: An International Research Journal*, *21*(1), 7-14. Retrieved September 14, 2014.

Mahnke, F. H. (1996). *Color, Environment, and Human Response* (pp. 7-183). New York, NY: Van Nostrand Reinhold.Offenbach, S. I. (1980).

McKendrick, J. H. (1999). Playgrounds in the Built Environment. *Built Environment, 25*(1), 4-10. Retrieved August 10, 2014.

Morgante, J. D. (2013, April). Ecological Resources Affect Children's Play. Canadian Journal of Behavioral Science, 45(2), 115-123. Retrieved October 9, 2014.

Offenbach, S. I. (1980). Children's Perception of Munsell Colors. *The Journal of Psychology*, *104*, 43-51. Retrieved September 10, 2014.

Ozdemir, A., & Yilmaz, O. (2008). Assessment of Outdoor School Environments and Physical Activity in Ankara's Primary Schools. *Journal of Environmental Psychology, 28,* 287-300. Retrieved October 14, 2014.

Pellegrini, A. D., & Smith, P. K. (1998, June). Physical Activity Play: The Nature and Function of a Neglected Aspect of Play. *Child Development*, *69*(3), 577-598. Retrieved October 14, 2014.

Sherin, A. (2012). *Design Elements: Color Fundamentals (A Graphic Style Manual for Understanding How Color Affects Design)*. Beverly, MA: Rockport Publishers.

Smith, P. K., & Vollstedt, R. (1985, August). On Defining Play: An empirical Study of the Relationship Between Play and Various Play Criteria. *Child Development*, *56*(4), 1042-1050. Retrieved September 14, 2014

Ueland, E. (1925, September). Every - Child - Where and How He Plays. *American Academy of Political and Social Science*,*121*, 131-136. Retrieved September 14, 2014.