ASSOCIATIONS OF NATURE-BASED OUTDOOR PLAYGROUND EXPERIENCES WITH PRESCHOOL AGED CHILDREN'S SUSTAINED ATTENTION

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A THESIS

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

Child Development- Master of Science

2016

ABSTRACT

ASSOCIATIONS OF NATURE-BASED OUTDOOR PLAYGROUND EXPERIENCES WITH PRESCHOOL AGED CHILDREN'S SUSTAINED ATTENTION

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The purpose of this study was to examine the association between preschool-aged children's exposure to a nature-based outdoor playground with a facilitation of nature-based activities and their sustained attention abilities. Using the Attention Restoration Theory as a theoretical framework, this study employed single group pretest-posttest design to measure children's sustained attention abilities before and after engaging in outdoor play on a nature-based playground with nature-based activities facilitated by teachers. The sample size was comprised of the 17 children, between the ages of 3 and 4 years, enrolled in the two preschool classrooms participating in the summer program at a child development laboratory in the Midwest, and two teachers. Descriptive statistics and paired t-tests were utilized to test the hypothesis that children perform with higher sustained attention after participating in nature-based activities. Results yielded no significant results when comparing pre and post sustained attention, operationalized as omission and commission errors in response to target stimuli in the Picture Deletion Test for Preschoolers task. However, overall errors decreased from pre to post examination. Unexpectedly, more participation in the nature-based activities was associated with greater sustained attention errors. Results of this pilot study suggest that structured and semi-structured nature-based activities may not yield the same benefits as unstructured experiences in nature. Implications for teachers training and curriculum planning are discussed.

There are so many wonderful people I'd like to dedicate this thesis to. First off, thank you to my family for always being by my side, supporting me through schooling and pushing me to succeed. Second, I dedicate this paper to my loving boyfriend, Dan. You've been a huge support and I could never thank you enough for your love and support through my schooling experience. This journey wouldn't have been what is now without you by my side. Third, I dedicate this paper to my deceased grandfather. We both had a love for the outdoors and I loved our conversations over coffee as I spilled my heart out about my research interests with nature-based classrooms. It was tragic to lose him while I collected data for this paper, something I knew he'd be eager to hear about. Lastly, thank you to my committee for providing support through my program, and especially thank you to Dr. Brophy-Herb. There are not enough words I can say to express my gratitude for all that you've done for me and all the experiences you've given me to help prepare for life after graduate school. You have been one of the best academic mentors I've had and I will never forget just how special you are to me!

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KEY TO ABBREVIATIONS

ART Attention Restoration Theory

PDTP-R Picture Deletion Test for Preschoolers-Revised

ECERS-R Early Childhood Environmental Rating Scale-Revised

CBCL Child Behavior Check List

ADD Attention Deficit Disorder

ADHD Attention-Deficit/Hyperactivity Disorder

CDL Child Development Laboratories

Chapter 1: Introduction

The purpose of this introductory chapter is to provide a brief overview of the rationale for the study, the study purposes, the conceptual model and study research questions. An in-depth review of the literature is provided in Chapter 2. Methods are described in Chapter 3. Results are provided in Chapter 4, and Chapter 5 is comprised of the study discussion and conclusions.

Children's Attention

Attentional abilities, particularly sustained attention, are important to concurrent and later development in early childhood (Bennett-Murphy, Laurie-Rose, Brinkman & McNamara, 2007; Choudhury & Gorman, 2000; Reck & Hund, 2011). Attention, the ability to maintain focus on a given stimuli, develops rapidly in early childhood, beginning with growth in infancy (Petersen & Posner, 2012). With younger children, sustained attention is often measured as omission and commission errors in relation to attending to target stimuli (Corkum & Burne, 1995). Respectively, these include failing to respond to a target stimuli and responding to nontarget stimuli. Much research has focused on how parenting (Belsky, Pasco Fearon & Bell, 2007) and maturation of executive functioning are linked closely with attentional abilities (Posner & Petersen, 1990). However, high quality early childhood educational environments also reflect key developmental contexts for young children. Classroom quality refers to structural and process elements such as classroom activities, classroom interactions, language and reasoning, personal care routines, space and furnishings, and program structure (Cassidy et al., 2005). The ways in which teachers construct the environment, including experiences offered in the outdoor environment, are thought to affect sustained attention (DiCarlo, Baumgartner, Ota & Geary, 2016). In fact, a wide body of research has examined links between the quality of preschool environments and children's development, including their attentional abilities (Peisner-Feinberg

et al., 2001). However, the vast majority of this work has focused on indoor rather than outdoor early childhood environments. Newly emerging work in early childhood development and education has emphasized the role of nature-exposure to enhance children's attention abilities (Schutte, Torquati & Beattie, 2017), with increasing attention focused on planning for outdoor activities just as teachers plan for indoor activities. This new body of work is driven largely by theories positing that exposure to nature enhances attention, likely through associated decreases in stress, including stress on cognitive resources.

Theoretical Framework

The Attention Restoration Theory (ART) posits that there are particular environments that are supportive of attention capabilities through the environments' characteristics that allow attention capabilities to rest and replenish (Berman, Jonides, & Kaplan, 2008; Kaplan, 1995). The terms rest and replenish are unique to ART and reflect the supposition that exposure to nature places fewer demands on attention systems (e.g., the anterior and posterior attention systems that integrate focusing and shifting attention to and from stimuli) which allows other cognitive functions, such as working memory and executive functioning, to function properly without cognitive strain. Thus, "top-down functions" are not overly taxed and allowed to rest. Top-down refers to attentional processes that focus on aspects of stimuli that align with prior knowledge. For example, if a child is looking for all the green balls in a bowl, top-down attentional processes mean that the child is applying prior knowledge of color to focus attention on green balls. The sudden appearance of a red ball may draw the child's attention away. Most sustained attention task elicit top-down attentional processing. Certainly, the natural environment elicits attention and the use of cognitive resources resulting in attention. However, ART suggests that attending in a natural environment requires far fewer cognitive resources than does attending

in urban environments where stimuli such as lights, noises and motion are intense. Although complex, the stimuli in natural environments are thought to be less jarring. Nature promotes bottom-up attentional processes (i.e., attentional processes informed by sensory information about the stimuli, such as noticing the texture of leaves) without overstimulating which aids in the rest and replenish of top-down functions. As such, we would expect exposure to nature to allow for more optimal top-down processing.

Nature and Early Childhood

The early childhood field has begun to understand the importance of environmental contexts, specifically nature-based environments, with regard to how such experiences in nature-based environments are associated with outcomes for children. Louv (2008) reports that nature exposure is important and that children who do not receive nature exposure suffer from nature-deficit disorder, which leads to diminished senses and attentional problems. Some outcomes of exposure to nature include perceived decreased stress (Wells & Evans, 2003) and psychological restoration (e.g., perception that exposure to nature helps you feel better psychologically and physically; Berto, Pasini & Barbiero, 2015). Many of the outcomes of studies that examine nature-based environments for children focus on attention abilities as being the biggest gain (Schutte et al., 2017; Wells, 2000).

Despite a promising body of research, we know little about how the sustained attention of preschoolers is influenced by the nature-based outdoor playgrounds in early childhood educational contexts. With more than 12 million children under the age of 5 years in full time early education settings (Laughlin, 2013), there is need to integrate existing research into early educational contexts. Studies that use the ART and nature-based environments focus mainly on older children (Hartig & Staats, 2006; Hartig et al., 2011) and samples of children with attention

deficit disorder (ADD) and attention-deficit/hyperactivity disorder (ADHD) as benefiting from nature exposure (Taylor, Kuo, & Sullivan, 2001; Taylor & Kuo, 2009). Considering that ADHD is an attentional related disorder, it is not surprising the research has focused on samples of non-normative children. Minimal studies focus on the role of nature-based environments promoting attentional capabilities in normative samples. Schutte and colleagues (2017) examined executive functioning and attention in children 4 to 8 years old, and found that children exposed to natural environments performed better on attentional control tasks as compared to children in urban environments. However, more research on how exposure to nature may benefit children's attentional skills is needed, given the importance of sustained attention skills to children's school readiness (Razza, Martin & Brooks-Gunn, 2010). Interestingly, current research suggests that even brief exposure to nature, such as a 20-minute walk, is sufficient for young children to benefit from nature, including increased attention abilities (Taylor & Kuo, 2009). Such findings suggest that teachers' incorporation of even brief nature-based experiences in early childhood educational contexts could yield important benefits for young children.

Study Purpose

Given the afore mentioned gaps in the extant literature, the purpose of this study is to examine relations between the provision of nature-based, outdoor activities and children's sustained attention. As articulated in the conceptual model (see Figure 1), I hypothesized that sustained attention abilities are promoted in nature-based environments. Per Corkum and Byrne (1995), sustained attention was operationalized as children's performance in focusing on target stimuli. I hypothesized that children would perform with fewer omission errors (able to focus on target stimuli) and fewer commission scores (responses to nontargets) after participating in nature-based outdoor playground activities during outdoor play time. I chose to conduct the

study using nature-based activities rather than exposure to nature via playground time for three reasons. First, the children spend time outdoors as part of the early childhood curriculum and have done so all school year. Thus, it would have been impossible to detect any effects of nature exposure on outcomes. Second, the center had already begun the process of making their outdoor playground into a nature-based outdoor playground by adding nature-based materials and changing the structure of the playground. I had intended to embellish the playground with additional natural materials but this plan was underway without my knowledge and I was not aware of the laboratories' plans when I presented my thesis ideas to the laboratory administration and research committee. Thus, activities for the current study were created and designed to scaffold the nature-based concept the center already had in motion. Finally, studies have suggested that teachers have little knowledge about how to plan for authentic, child-centered nature-based activities outdoors (Ernst, 2014; McClintic & Petty, 2015). Hence, examining the associations between children's use of planned nature-based activities in the outdoor environment provides valuable information on potential associations with sustained attention but could also have much needed practical implications for teacher training.

The conceptual and operational definitions for the study are provided in Table 1. As additional descriptive information, information on the overall classroom quality and teachers' ratings of children's behaviors were collected. As previously noted, classroom quality is associated with children's developmental outcomes. Likewise, skills such as sustained attention as associated with children's behavioral competencies (Aebi, Metzke & Steinhausen, 2010; DuPaul, McGoey, Eckert, & VanBrakle, 2001). Hence, collecting descriptive information on both classroom quality and child behavior provided important contextual, descriptive information for the study. Conceptually, these characteristics were considered control variables,

although it was not possible to statistically include these data formally in analyses due to the study's small sample. Similarly, as I have noted briefly, it is likely that children's nature-based experiences promote children's sustained attention through nature's effects of less stress on cognitive attention systems. It is not possible in the course of this study to assess brain activity in that fashion. Thus, the conceptual model does not depict that path.

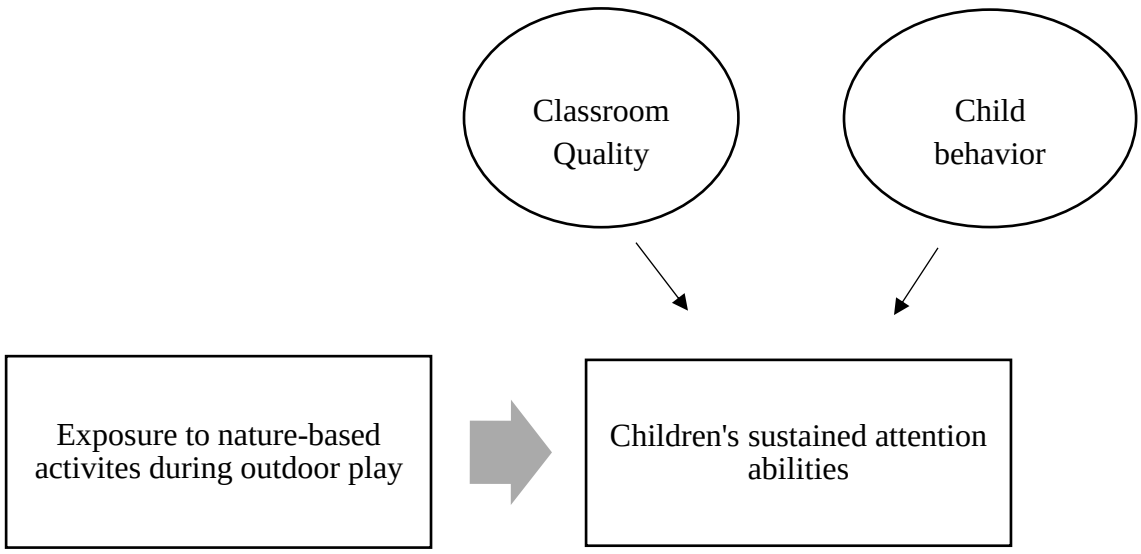

Figure 1. Conceptual Model. This model illustrates the hypothesized relationship between children exposure to nature-based activities on a nature-based outdoor playground and attention abilities.

Table 1. Conceptual and Operational Definitions of Study Variables

Concept	Conceptualized	Operationalized
Nature-based outdoor playground	Nature-based environment that allows access to nature-based materials through outdoor space and play.	Nature-based materials (as seen in Patti Bailie's Natureness of a program scale) in a sensory rich outdoor environment with garden/quiet areas, natural objects such as logs, sticks and rock, sand and soil for digging, logs for balancing and hills and open space. Additionally, per the Nature Explore program, one of three certification requirements show that outdoor play spaces should have an entry feature, open area for large motor activities, climbing/crawling area, messy materials area, building area, nature art area, music and movement area, garden area, gathering area and storage area. (See Appendix A).
Nature-based outdoor playground activity	An activity facilitated by teachers that involves nature exploration for preschoolers that occurs during outdoor play.	Taken from a workshop presented at a regional early childhood education conference, these activities were designed and implemented by Rachel Larimore and staff at the nature preschool at the Chippewa Nature Center in Midland, MI. See Appendix B for lesson plans of each activity.
Children's attention abilities	The ability to focus attention on a target stimulus in the presence on distractor stimuli with low omission and low commission. Omission is the failure to respond to a target and commission is responsiveness to nontargets.	Sustained Attention: Picture Deletion Test for Preschoolers-Revised (PDTP-R; Corkum & Byrne, 1995; Palmer, Miller, & Robinson, 2013).
Classroom quality	The overall global quality of the classroom environment that includes structural and process elements such as classroom activities, classroom interactions, language and reasoning, personal care routines, space and furnishings, and program structure.	Early Childhood Environment Rating Scale Revised (ECERS-R; Harms, Clifford, & Cryer, 1998)
Child behavior	Teacher rated report of problem behaviors of preschool aged children.	Child Behavior Check List (CBCL 1.5/5; Achenbach & Rescorla, 2000).

Research Question

1. Do children perform with fewer omission and commission errors on attention tasks after participation in nature-based outdoor playground activities?

Hypothesis 1a: Children's lower omission scores on attention tasks will be associated with their participation in nature-based activities outdoors for a week.

Hypothesis 1b: Children's lower commission scores on attention tasks will be associated with their participation in nature-based activities outdoors for a week.

Note that I have not stated directional hypotheses as this pilot study does not employ a control condition. That being said, the literature strongly suggests directionality and thus one-tailed tests were also explored and utilized in the final analyses.

Chapter 2: Literature Review

This chapter presents a literature review focusing on attention in early childhood. It begins with a discussion of how attention is defined, how attention develops, and how attentional abilities are important to children's development, specifically sustained attention. Next, I examine how attentional abilities develop, particularly in the contexts of early childhood environments, specifically nature-based environments. As I will explain, contemporary research is examining the ways in which exposure to nature promotes children's attentional abilities. I will discuss the ART (Attention Restoration Theory) as the theoretical framework for the study. This will lead to a discussion on the importance of outdoor play and nature-based classrooms as providing opportunities for children to gain exposure to nature.

Attention

Attention capabilities in children are key to successful growth and development (McClelland et al., 2013; Stipek & Valentino, 2015). In particular, sustained attention is important for later positive outcomes, such as inhibitory control and social competence (Bennett-Murphy, et al., 2007; Reck & Hund, 2011). Below is a discussion on attention development through the beginning stages of life and how attention is related to various outcomes in early childhood.

Attention is defined as the ability to shift, orient and maintain focus on stimulus and events (Posner & Petersen, 1990). Posner and Petersen (1990) first highlighted three functions of attention, including sensory orientation, detection and alertness, which detail the cognitive functions and neural activity involved in attending. Since their original work, others, namely Tomlin and Villa (1994) have adapted Posner and Petersen's brain based model for more applied purposes. Although they applied the model to language acquisition, the applications of their

work are amenable to the current study. Specifically, they describe the first function, alertness, as readiness to receive stimuli. Interestingly, speed of sensory information receipt is an aspect of alertness such that rapid receipt of information may result in less optimal alertness. As I will discuss further, one of the arguments put forth in the Attention Restoration Theory is that the stimuli available in nature occurs at a less frenetic pace, in most cases, than perhaps the rapid presentation of stimuli in urban environments, for example.

The second function in the attention system is orientation, which refers to the system's tendencies to direct attention resources to certain stimuli at the exclusion of other stimuli unless additional effort is made. This directly aligns with the idea of top-down and bottom-up attentional processing, more fully described later in this chapter. Attention orientation may occur differently in nature-based environments, where less of an effort might be needed to direct attention resources a la bottom-up processing, as compared to non-natural environments which might require more resource-heavy, top-down processing. The third function of the attention system is detection that describes the point at which certain stimuli or information is selected for attentional processing. Typical sustained attention tasks, for example, rely on this point of detection at which the child may commit cognitive and neural resources to focusing on a specific informational aspect of the stimuli (such as color, size, or shape).

This study focuses particularly on sustained attention which can be defined as the ability to focus continuously on a given stimuli (Fuentes, 2004; Posner & Petersen, 1990) and includes the ability to have accurate responses over time (Robertson & O'Connell, 2010). This study specifically operationalizes sustained attention as the ability to focus attention on a target without omission (failing to respond to targets) and commission (responding to nontargets) errors.

Understanding definitions of attention and sustained attention leads to a discussion of the developmental trajectory of attention in early childhood.

Attention in early childhood. Attention capabilities are evident in early infancy and develop rapidly throughout toddlerhood and preschool. Infants are born with selective attention (Ruff & Rothbart, 2001; Sheesh, Rothbart, Posner, White, & Fraundorf, 2008). By six months of age, orienting becomes fully functional in infants and is shown through their eye movements as infants begin to intentionally attend to stimuli, and sustained attention begins to develop. As infants grow into toddlerhood, the executive control system matures and this changes the function of attention. Attention in early childhood is more focused on planned play with objects and overlaps broadly with executive function (Posner & Petersen, 1990). This suggests that attention in preschoolers is a complex process that has much overlap with the components of executive functioning: working memory, cognitive flexibility and inhibitory control.

Associations among attention and other outcomes. Broadly, early attention skills are linked to later positive outcomes, underscoring the need to study this skill in children. Attention abilities in early childhood predict children's academic skills, specifically reading and math skills through elementary school years (Duncan et al., 2007; Rudasill, Gallagher & White, 2010; Stipek & Valentino, 2015). Specifically, sustained attention abilities have been linked with social competency (Bennett-Murphy, et al., 2007), inhibitory control (Reck & Hund, 2011) and early cognitive competency (Choudhury & Gorman, 2000). Attention span at age 4 also predicts college completion at age 25 (McClelland et al., 2013).

Both home and school environments influence children's attention abilities and, under optimal circumstances, provide children many opportunities to develop attention abilities. Home environments are influential on children's development and children enter preschool

environments with skills, including attentional and regulatory skills, which influence their preschool experiences. Likewise, early childhood educational environments also reflect key developmental contexts, given that 12 million children under the age of five are enrolled in early childhood education (Laughlin, 2013). This study focuses on sustained attention demonstrated in the early childhood environment with an eye toward better understanding how teachers can support skill development, given the large numbers of children spending considerable time each week in early childhood environments.

Attention Restoration Theory

The theoretical framework for this study employs the Attention Restoration Theory, hereafter known as ART, which states that particular environments are supportive of attention capabilities through the environments' ability to allow attention capabilities to rest and replenish (Berman et al., 2008; Kaplan, 1995). "Capability" is thought of in terms of maximum potential for attentional skills. The ART extends work from James (1962) who highlighted two types of attention, involuntary attention, which is virtually effortless and related to bottom-up processing, and voluntary attention, which requires effort and is related to top-down processing. Engaging in sustained attention involves multiple systems. The anterior and posterior attention systems in the brain regulate the receipt of input from stimuli and the corresponding behavior to shift toward or away from the stimuli. Shifting toward or away from stimuli also involves other cognitive functions including inhibition and working memory (Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001). Thus, when attentional systems are overly taxed, a broad array of cognitive functions are compromised, resulting in poor, dysregulated attention. The ART highlights the importance of the environment to an individual's attention potential. Nature-based environments, compared to urban environments, are theorized by the ART to be the most supportive of

attention capabilities (Hartig & Staats, 2006) because natural stimuli are less taxing and require less effort on the attention system, allowing "top-down" attentional processes to rest. This means that other functions that rely on attention systems will function more optimally. As I discussed earlier, attention functions (alertness, orientation and detection) may operate more optimally in nature-based environments. Top-down processes rely on the cognitive processing of information already stored in the brain and are thought to be more taxing or require more effort than bottom-up processing or involuntary attention (James, 1962; Kaplan & Berman, 2010). Bottom-up attentional processing refers to the intake of new information entering the brain via sensory input (e.g., the color, shape, texture, smell, sound of objects in the environment). In short, ART argues that the "artificial" stimuli common in urban environments, such as media stimuli and traffic noises, for example, tend to invoke top-down processes, which are more taxing and require more effort on the brain. Natural stimuli, however, such as the crunch of leaves underfoot or the smooth texture of a round pebble, are refreshing to the brain and invoke bottom-up processes by focusing the sensory input of nature-based environments, compared to eliciting top-down processes to process the surroundings. These bottom-up processes, that nature is theorized to elicit, are less taxing and require less effort which allows attention systems to function with less strain, resulting in more optimal functioning, articulated as better attention, for example.

Benefits of nature. Exposure to nature is linked with several positive attention outcomes. The small number of existing studies find that even 20 minutes of outdoor exposure can be beneficial for children in 4-8 year olds who are typically developing (Schutte et al., 2017) and in samples such as children with ADHD (Taylor & Kuo, 2009) and children with ADD (Taylor et al., 2001). Berto (2005) found that adults performed better on sustained attention tasks after having their attention fatigued and then viewing images of restorative environments, compared

to those who viewed nonrestorative, city images. Additionally, Pilotti and colleagues (2015) found that viewing a nature video at work helped to improve memory in adults. Overall, the ART highlights nature-based environments as being beneficial for attention abilities broadly, and sustained attention abilities specifically. It is noteworthy to mention that most literature that discusses the benefits of nature exposure via the ART work with adult samples and samples of children with ADHD. This lack of research rationalizes the importance of studying the ART in the context of nature-based environments for children of a normative sample. Overall, nature improves attention through the process of restoration. This process allows attention to rest from focusing of various stimuli, therefore allowing other cognitive functions that rely on attention, such as inhibitory control and working memory, the ability to rest and not be overwhelmed with information.

Exposure to Nature via Outdoor Play

Outdoor play has long been associated with positive developmental outcomes, such as opportunities to practice and refine social skills (Li, Hestenes & Wang, 2016) and motor skills (Fjørtoft, 2001), and health outcomes, such as obesity prevention (Ansari, Pettit & Gershoff, 2015). It is only in recent years that attention has turned toward the cognitive benefits of outdoor play.

Schoolyard "greening" is a movement in the education field that describes the changes that schools are using to restore classrooms to more natural habitats. School yard greening includes things such as planting trees and gardens and bringing nature back into the classroom design (Broda, 2007). Greenings also includes the use of nature materials for play structures, compared to the traditional plastic structures, as well as open green space with space for children to run and to provide opportunities for large group activities. Greening of playgrounds can also

include quiet spaces, providing opportunities for small social groups. Gardening, secluded spaces from low-hanging branches and nature paths are also common in "green" playgrounds. Importantly, greening also includes the provision of nature-based activities outdoors. Typically, such activities involve natural materials, such as pebbles, sand, grass, leaves and bark, and are designed to support young children's engagement with the natural environment. Outdoor planning is an area in the preparation of the early childhood environment in which teachers often report a lack of knowledge and confidence (Ernst, 2014). This is problematic given that "greening" is associated with more optimal outcomes in children. Green schoolyards not only provide a stronger connection between play and learning but also promote more active and constructive play (Dyment & Bell, 2008). Most greening of schools has occurred as part of efforts to provide environmental conservation education and to promote sustainable environments (Morgan, Hamilton, Bentley, & Myrie, 2009; Wu, 2002). Having schools restore outdoor environments to more nature based practices, including activities utilizing natural elements, is important because nature based environments have been shown to help facilitate learning (Dowdell, Gray & Malone, 2011). Outdoor play is the one of few opportunities children have to connect with nature during the school day. Some early childhood programs are using the importance of outdoor play as a main focus for curriculum design. Specifically, nature-based preschools are growing in popularity all around the United States. Based on Patti Bailie's Natureness of a program scale (not published), outdoor classrooms can be characterized as having 45% of the classroom time spent outdoors with indoor and outdoor play that are nature-like (bark, leaves, soil, organic and loose material such as sand and dirt). For the purposes of this study with a shorter timeline, an outdoor playground that is already embellished with nature-based items was studied with a facilitation of planned nature-based activities for children.

Examining associations between nature-based experiences and children's attention, among other development outcomes, is particularly needed and critical given the dimensioning outdoor time provided to children in early childhood and elementary schools. Over the past 20 years, outdoor play time provided during the school day has decreased significantly (Bassett, John, Conger, Fitzhugh & Coe, 2015; Hofferth, 2009). Even many preschools and childcare centers are reducing outdoor time as a deliberate strategy to increase time for "academics" and this is certainly true for elementary schools. The No Child Left Behind Act holds schools accountable for closing the achievement gap in education, and focuses on using standardized testing to measure school achievement. Though this is not something implemented at the preschool years, it certainly influences how teachers educate children, as there is a pressure to get children prepared for the standardized tests. Some elementary schools are decreasing the amount of outdoor play time they give to children in an effort to better prepare children for standardized performance tests, as the school's funding relies on the high test scores. With a focus on test scores, children have fewer opportunities to be outdoors during recess and free play time. This underscores the importance of studying nature-based environments in an effort to restore outdoor play that is slowly diminishing.

Playgrounds are important environments for the facilitation of outdoor play and nature-based experiences. Some playground structures consist of plastic climbing structures and play equipment and are accompanied by plastic accessories and other smaller play items. Nature-based playgrounds however forgo the synthetic play materials and utilize nature-based materials, such as wood and authentic nature-based materials for play, as discussed above. Nature-based activities help to promote children's connectedness with nature by fully engaging them with nature. Whereas children simply exposed to a nature-based playground would have the potential

to experience nature, engaging children in nature-based activities increases the likelihood that the child will experience nature. With the facilitation of nature-based activities on playground, children have the potential to gain an even closer relationship with nature, thus increasing their chances of having beneficial nature-based experiences.

Exposure length. Several studies have demonstrated variations in the amount of time and the type of exposure it takes for a person to gain the benefits of nature exposure. With young adults, aged about 25, a 50-minute walk was shown to be effective for increased working memory. With children, there has been very little work with children; most existing work has focused on children with attentional or behavioral difficulties. Taylor and Kuo (2009), examined attention with children aged 7 to 12 with ADHD. They had children completed the Digit Span Backward test to assess memory before and after taking a 20 minute walk. During the walks, conversations were kept to a minimum. With normative samples, research follows a similar trend. Schutte and colleagues found that 4 to 5 and 7 to 8 year olds performed better on the Digit Span Backward test after having attention fatigued with a puzzle task and going on a 20-minute walk. Similar to above, conversations were kept to a minimum on the walks.

To date, the few existing studies of exposure to nature in preschool aged children have focused on the benefits of nature walks instead of outdoor playground experiences. Minimal studies have focused on the amount of nature exposure via outdoor play that is beneficial. Fjørtoft (2001) found that one-2 hour episode of play outside each school day for an entire school year yielded positive benefits for 5-7 year olds, such as increased motor skills after given the EUROFIT, a physical activity assessment. To date, there are no existing studies that examine early attention skills in nature-based early childhood contexts. Given the amount of time that many young children spend in out-of-home early childcare and education environments,

examining the effects of nature exposure in early childhood settings is necessary. In the current study, children at the participating early childhood center typically play outdoors at least 30 minutes in the morning and 30 minutes in the afternoon. As noted, most teachers are uncertain as how to enhance outdoor experiences. Therefore, the current study utilized nature-based activities, using natural elements and materials, as key features of the outdoor, nature-based environment. Results were expected to have implications for teacher training. Nature-based activities were provided over the course a 5 days and activities were provided in the morning because some children tended to leave early in the summer program in the afternoons. A week at preschool is an ecologically valid unit of time and playground play is a feasible context for early childhood programs (i.e., nature walks may not be possible for some urban early childhood programs). Thus, the playground setting provides an ecologically valid and more generalizable setting for the study of nature exposure. This study does not have the timeline or resources to expose children for an entire school year such as Fjørtoft (2001); however, results have shown that minimal exposure can be beneficial, so this study finds a middle ground for exposure length.

Teacher Facilitation of Outdoor Activities

Teachers play a key role in the ways in which children learn in outdoor environments through the ways in which they support the environment (Wilson, 2012). A handful of studies have shown that teachers lack the time to use natural environments in intentional ways for learning (Ernst, 2014), view their role in the outdoor play environment as supervisory (McClintic & Petty, 2015) and often miss key opportunities for enhancing children's learning in the outdoor environment (Maynard & Waters, 2007). Overall, research suggests that less attention is given to planning of the outdoor play environment as compared to the indoor environment (Wellhousen, 2002). To date, most research on facilitation of outdoor activities centers on teacher's facilitation

of gross motor activities. While such facilitation promotes children's physical activity (Hui-Tzu Wang, 2004), there is no research on teachers' facilitation of nature-based activities aimed at promoting cognitive functioning.

Interestingly, the scant existing literature on nature-based exposure examined the effects of brief nature-walks in which there is little interaction between teacher and child. As described, this study takes a different approach by including teachers' facilitation of nature-based activities. This decision was driven by the practical realities of many early childhood environments. As noted, early childhood teachers need assistance in how to plan the outdoor environment. Second, early childhood programs in urban or even semi-urban locations often lack access to take nature walks. While quiet walks could be taken on a playground, the reality is that most playgrounds are shared among classes, making it more difficult to create a quiet walk experience. Hence, this study took a very practical approach to how to integrate the quality of a nature based walk (opportunities to notice natural elements in a relaxed fashion) with the realities of most playground contexts and teachers' needs for information on how to plan outdoor activities.

Other Characteristics Related to Sustained Attention

The focus of this study is on relations of nature exposure via nature-based outdoor activities to children's sustained attention. However, information was collected on two additional characteristics relative to children's sustained attention in early childhood contexts. Specifically, both the quality of the early childhood environment and children's behavioral problems are salient to an examination of children's sustained attention. These characteristics are included for descriptive purposes to better understand associations between nature exposure and children's attention. Below is a discussion of each these characteristics and the respective evidence cited by literature.

Classroom quality. Classroom quality consists structure and processes within the early childhood classroom (Cassidy et al., 2005), whereas structure consists of materials and activities, space and furnishings whereas processes include interactions between staff and children and children and their peers, program structure, and language and reasoning within the classroom. Both the structural and process elements of childcare quality contribute to the conceptual definition of classroom quality. All of these factors help to create a climate that optimizes learning and development for young children. Classroom quality, defined as the organization of program, schedules, activities and materials, equipment, interactions, and supervision of children, is associated with the social and academic growth trajectories from preschool to second grade (Peisner-Feinberg et al., 2001). There are several ways in which general classroom quality could contribute to children's sustained attention. For example, a well-organized, emotionally-supportive preschool classroom contributes to fewer behavioral problems (Broekhuizen, Mokrova, Burchina, Garrett-Peters, & the Family Life Project Key Investigators, 2016). There is also some research to suggest that children's one-one-one or small group engagement with teachers promotes preschoolers' greater task orientation and fewer dysregulatory behaviors (Williford, Vick Whittaker, Vitiello, & Downer, 2013). Further, there is recent literature that suggests that the environments that teachers design for children influence children's sustain attention through the perception of choice (DiCarlo et al., 2016). The children's opportunities to make their own choices contribute to their engagement in activities and materials thus their sustained attention. Overall, classroom quality and the ways in which the classroom is it designed for children's learning is important and influential for children's sustained attention abilities was considered a descriptive in this study.

Child behavior. Children's behavior problems and poor attentional skills are often linked (Aebi, Metzke & Steinhausen, 2010; DuPaul et al., 2001). This study operationalizes child behavior as externalizing behavior because much of the literature describes attention abilities as related to behavior problems. The research that examines child behavior problem and sustained attention is somewhat limited as most work has focused on ADHD as the problem behavior (Barkley, 1997) and does not focus on whether sustained attention influences problem behavior broadly or vice versa. There is a lot of overlap with sustained attention and hyperactivity, for example. Reck and Hund (2011) tease apart omission and commission errors in sustained attention by stating that high omission scores often relate to inattention and high commission scores often relate to hyperactivity. As I will discuss in my limitations, this suggests that the main outcome measure and descriptive measures overlap. However, it would be extremely difficult to find a measure of externalizing behavior that did not in some way also reflect attentional difficulties, as these concepts are closely linked. Examining child problem behavior might be able to give information about children's personal characteristics and their engagement with the nature-based activities and their sustained attention.

Conclusions

Attention, specifically sustained attention, in preschoolers is an important skill related to a range of developmental outcomes in children over time. Interests in children's exposure to nature as it relates to attentional abilities is growing and is particularly relevant to early childhood contexts where teachers are in need of support in planning nature-based activities and experiences outdoors. The ART is the predominant conceptual framework utilized in emerging research on nature- exposure and posits that attention systems operate more optimally and with less stress on cognitive resources in natural environments, resulting in better sustained attention,

among other outcomes. Outdoor play is a main source of nature exposure for children. This study proposed that children who play on an outdoor playground embellished with nature-based activities with teachers would display more optimal sustained attention following a week of nature-based activity exposure.

Chapter 3: Methods

Methods for recruitment, data collection and data analyses for this single group pretest-posttest study are outlined in this chapter. Data collection methods included administering attention tasks to preschoolers, observing overall classroom quality, and attaining teacher ratings of child behavior. Data were collected from a child development center at a university in the Midwest in July 2016.

Sample and Recruitment

Using convenience sampling, data were collected from two preschool classrooms. The 4-year-old classroom had a total of 21 children, 14 of whom were consented to the study and the 3-year-old classroom had a total of 12 children, three of whom were consented to the study. There were 12 males and five females enrolled in the study. The mean age of children was 53.59 months (SD = .68 months). The 4-year-old classroom had three teachers and the 3-year-old classroom had two teachers. Both lead teachers held bachelor's degrees. Classroom schedules followed a traditional early childhood structure, with free play, outdoor play, small group, large group and a meal time. The summer program at the center typically has a smaller enrollment of children, fewer classrooms in operation and fewer university students completing classroom practicum experiences than during the academic year. This will be discussed further in the methods section.

Consent Procedures

After receiving approval from the University Human Research Protection Program and from the center's review board, families received a letter describing the study sent home in children's backpacks. Parents consented to their children to participate in the study. Additionally, teachers gave written consent to give teacher ratings of child behavior. Lastly, to obtain child

assent, the teachers introduced the researcher to the child and asked the child if he/she would like to come to the hall or to another part of the classroom to play a game. To obtain child assent, the child needed to verbally or nonverbally (e.g., nodding) agree to do the task with the researcher. If a child became upset during any task for more than 30 seconds, showed extreme disinterest, or verbally or nonverbally indicated a desire to stop the task, the task ended and the child was escorted back to the classroom.

Outdoor Playground

To enhance the playground, which has elements of nature-based materials, daily lesson plans were designed and implemented by teachers and the lead researcher. The playground has nature-based elements such as sandboxes for digging, hills, open space, quiet area, natural and loose materials, all of which are indicators of an outdoor environment according to Patti Bailie's Natureness of a program scale (not yet published). Additionally, the outdoor playground has an entry feature, open area for large motor activities, climbing/crawling area, messy materials area, building area, nature art area, music and movement area, garden area, gathering area and storage area, all of which are one of three parts of indicators for the Nature Exploration certificate that this program is working to achieve currently. Photos of the playground are provided in Appendix A. It became evident after the study was being designed that the playground was being redesigned to represent more of a nature-based playground, therefore it seemed logical to expand on this idea with the facilitation of nature-based activities, particularly since teachers often report a lack of preparation of outdoor environments (Ernst, 2014).

Creating nature-based activities. The outdoor activities (see Table 2) were conceptualized by the lead researcher after attending a workshop led by Rachel Larimore, director at the nature preschool at Chippewa Nature Center in Midland, Michigan. After they

were created there was given input by the teachers and main researcher over one meeting. After the teachers gave input and changes were made, the activities were implemented. Having the teachers give input on activities was beneficial in the sense that it gave the teacher some motivation for implementing activities. Also, by having the materials provided for the teachers, that promoted buy in such that they were probably more likely to implement activities. Outdoor activities were observed and children's participation in the activities were recorded, as described more fully below in Table 2. See Appendix B for full activities.

Table 2. Nature-Based Activities Provided

Activity Name	Brief Description
1) Nature Collection	Teachers gave children bags in which to collect nature based items. The children collected any items from the playground to create their own nature artwork.
2) Rock Scavenger Hunt	Teachers read the book If You Find a Rock. During outdoor play, teachers invite children to help find the rocks. The rocks are hidden in multiple places throughout the playground such as under leaves, behind larger rocks, or under a bush.
3) Create a Bird Nest	Teachers invite children to design a bird egg using art materials, such as water color paint and a wooden egg. Next, children found material, such as grass, sticks, leaves and sand to build their egg and nest.
4) Nature Soup	Teachers invite children to design a nature soup. Using a mortar and pestle, children manipulate organic materials, whether it be through tearing, slicing or mashing organic material with a mortar and pestle.
5) Leaf Discovery	Teachers ask children to use the magnifying glass to explore the parts of the leaf and to identify the functions of the leaf.

Overview of Data Collection Methods/Procedure

Data were collected by three undergraduate students who were trained on all the measures by the lead researcher. Data collectors were blind to the study questions to ensure quality data collection. In week 1 of the study (which occurred in the third week of the Summer B session at the center), the sustained attention task was administered to each participating child

individually at a research table in the hallway outside the child's classroom. Classroom quality was also assessed via observation and child problem behaviors were rated by teachers. Following the pretest of children's attention skills, teachers facilitated five nature-based activities on the outdoor playground. After a week of playing on the playground with the nature-based activities available during their outdoor time children were retested on attention with a different version of the attention task. There was a two-day period over the weekend during which children were not at school between their exposure to the outdoor playground and the posttests; this is a limitation of the study.

There was no monetary compensation for the participation in the study. All data were labeled with participant IDs to ensure confidentiality and privacy. All data were locked in a filing cabinet with limited access to keys, and electronic data were stored on a password protected computer server.

Children's Attention

Children's attention was measured through the Picture Deletion Test for Preschoolers-Revised (PDTP-R). This task has been used for ages as young as 3 years. It uses pictures as stimuli and has children respond to various stimuli with a bingo stamper. Children search through booklet where targets and nontargets are presented and have to put a mark with the bingo stamper on the target image. This particular target design comes from a study conducted recently by Palmer and colleagues (2013). There is a 5 minute, 2 page familiarization pre-test and then the actual test that takes up to 25 minutes. Form A pre-test uses squares (target) and circle, octagon, diamond and triangle (distractor). The Form A test includes images of various animals; lions, alligators, zebras, elephants and monkeys. The monkey is the target animal and the rest are distractors. Form B pre-test uses triangles (target) and circle, square, diamond and

octagon (nontarget). For form B, the lion is the target and the remaining animals are the distractors. There are a total of 480 animals; 120 target and 260 distractors. This is presented over 8 pages with 15 targets and 45 distractors on each page. Usually the task codes the overall speed; however, this study focused on sustained attention so the number of omission (failure to respond to target) and commission (responsiveness to a nontarget) were counted as two independent scores and used for analysis (Corkum & Byrne, 1995); many studies use this coding method as an indicator of sustained attention (E.g., DeWolfe, Byrne & Bawden (1999); Palmer et al., 2013; Reck & Hund, 2011). The higher the score in both omission and commission means less sustained attention. Due to this technique of coding, it can result in a wide array of scores. Reck & Hund (2011) suggest that increased omission scores are indicative of inattention whereas increased commission errors are indicative of hyperactivity. Information about reliability and validity is slim for this measure, as it is a variation of Continuous Performance Tests. Though Continuous Performance Tests are usually for older children, variations are being made to include younger children that use technology (Conners, 2001). Psychometric properties from this measures show split-half reliability ranging from 0.72 to 0.88 and work in normative, typical developing and clinical groups with children with and without ADHD are being examined for validity. As noted, there are two versions of the test both completely comparable. Given the short time span between pre and posttest, children completed different versions of the test and pre and post. The order of the versions was randomized.

Participation in Nature-Based Activities

Children's participation in nature-based activities was observed by the lead researcher. Children's participation in each activity was coded as: (2) fully participated, never leaving the activity the entire duration of outdoor play; (1) partially participated in the activity, engaged in

the activity but then engaged in other activities during outdoor play; or, (0) never participated. There was a possibility of a maximum score of 0 to 10 with the higher score indicating greater participation.

Classroom Quality

Classroom quality was assessed using the Early Childhood Environment Rating Scale Revised (ECERS-R; Harms et al., 1998). This measures look globally at classroom quality. It consists of 43 total items with seven subscales; space and furnishings, personal care routines, language-reasoning, activities, interactions, program structure and parents and staff. There were a total of 6 subscales used in this paper constructed each yielding the following scale reliabilities: space and furnishings (.91), personal care routines (.81), language and reasoning (.93), activities (.93), interactions (.94) and program structure (.67). Each subscale is rated on a scale of 1(inadequate) to 7(excellent). The ECERS-R requires high inter-rater reliability of 85% for observers, and the two observers for this study reached a reliability of 92%. This measure is seen to be a stable measure over a long period of time given stable teachers throughout the year in the classroom (Clifford, 2005). Classroom quality provides descriptive information about the classroom environment and provides useful information when considering associations between nature exposure and children's sustained attention.

Child Behavior

Child behavior was measured using the teacher-rated Child Behavior Check List (CBCL; Achenbach & Rescorla, 2000). The CBCL/1.5-5 is designed for children ages 1.5 to 5 years old. This measure examines 90 problem behaviors of children as well as descriptions for respondents to answer about concerns and best things about the child. Each behavior is rated on a scale of 0 (not true, as far as you know) to 2 (very true or often true). For the purposes of this study, the

aggressive behavior and attention problems subscale was used, yielding a mean score for each subscale. This measure was standardized with 700 non-referred children by Achenbach and Rescorla (2000), revealing test-retest coefficients for scale variables from .68 to .92 with a mean of .85 for all scales. Child behavior was examined minimally and descriptively to consider associations between child behavior problems and children's sustained attention.

Analysis Plan

Data were analyzed first by utilizing descriptive analysis including examining study variable means and standard deviations. The primary study questions regarding whether children's lower omission and commission errors on attention tasks are associated with exposure to nature-based activities were examined using paired t-tests to exam differences in pre-test and post-test scores in omission and commission scores. The paired t-tests are appropriate for single group, pre/post designs. Although the nested nature of the data are recognized, (children nested within classrooms), the sample size of this pilot study is not sufficient to conduct multilevel modeling. For descriptive purposes, correlations were examined between children's sustained attention and behavior problems, children's sustained attention and their participation in nature-based activities, as well as children's sustained attention scores and mean age in months. Classroom quality means were examined to give a contextual description of the two classrooms.

Chapter 4: Results

Analysis

Beginning with the main outcome of sustained attention, paired samples t-tests were conducted to compare pre and post omission and commission scores. With the very small sample size, significant findings were not expected and, thus, means were examined descriptively as well. There were not significant differences in the pre omission scores (M=59.86, SD=43) and post omission scores (M=43.13, SD=40); t (14), p=.131, d=.41. A second paired samples t-test was conducted to compare pre and post commission scores. There was no significant difference in the pre commission scores (M=9.20, SD=11.65) and the post commission scores *(*M=6.86, SD=11.91); t (14), p=.381, d=.23. Effect sizes were small (medium effects are .50 or greater for Cohen's d). Though there was no significant difference in the mean scores, it is noteworthy that both omission and commission scores decreased quite substantially from pre to post.

Nature-based activity participation. Participation in nature-based activities was recorded. The lead researcher noted whether or not child fully participated (never left the activity the entire duration of the outdoor play session), partially participated (if the child participated in any part of the activity but left to do something else during the duration of the outdoor play session) or did not participate at all. It was coded 2, 1, and 0 respectively. Since there were a total of five activities each child had a chance of having a score from either 0 to 10. The overall mean participation (with 0 minimum and 10 maximum) reports as M=5.00*;* SD= 2.82. The frequency of participation of each activity is reported in Table 3. The most popular activities in terms of partial or full participation were Activities 2, 3, 4. Means are reported in the Table 4 below. These means show the average participation in each activity with a mean of 0 to 2.

Table 3. Frequencies of Activity Participation

	No Participation	Partial Participation	Full Participation
Participation in Activity 1: Nature Collection	9	4	4
Participation in Activity 2: Rock Scavenger Hunt	3	8	6
Participation in Activity 3: Create a Bird's Nest	7	2	8
Participation in Activity 4:Nature Soup	4	6	7
Participation in Activity 5: Leaf Discovery	8	3	6
Note. N = 17 children			

Table 4. Mean Scores of Activity Participation

	Mean	SD
Activity 1: Nature Collection	0.71	0.85
Activity 2: Rock Scavenger Hunt	1.18	0.73
Activity 3: Create a Bird's Nest	1.06	0.97
Activity 4: Nature Soup	1.17	0.81
Activity 5: Leaf Discovery	0.88	0.93

Descriptives. Mean scores for the three and four-year-old classrooms are reported in Table 5. Overall, the 3-year-old classroom had higher classroom quality scores (descriptively; these data were not analyzed statistically) than the 4-year-old classroom. See Table 5 below.

Table 5. Mean Scores of Classroom Quality

	3 year old	4 year old	overall
Space and Furnishings	6.81	4.13	4.59
Personal Care Routines	6.4	3.7	4.18
Language and Reasoning	6.88	2.5	3.27
Activities	6.39	3.94	4.38
Interactions	6.9	2.7	3.44
Program Structure	7	6	6.12

In general, ratings of child behavioral problems suggested teachers had few behavioral concerns in the classrooms. Mean child behavior problems scores for the four year old children are reported as *M*=.07, *SD*=.10 for aggressive behavior and *M*=.01, *SD*=.05 for attention problems (maximum score of 2). Mean child behavior problems scores for the three year old children are reported as *M*=.94, *SD*=.25 for aggressive behavior and *M*=.80, *SD*=.35 for attention problems. Collectively, the overall mean child behavior problem was *M*=.94, *SD*=.25 for aggressive behavior and *M*=.80, *SD*=.35 for attention problems. See Table 6 below.

Table 6. Mean Child Behavior

Behavior	3 year old	4 year old	overall
Aggressive Behavior	0.94	0.07	0.22
Attention Problems	0.80	0.01	0.15

Correlational Analysis

Bivariate correlations are reported in Table 7. Interestingly, omission and commission scores were not correlated. Omission errors were positively correlated at pre and post and commission errors were positively associated at pre and post. There was a significant correlation between aggressive behavior and pretest and posttest omission scores.

For aggressive behavior, there was a significant correlation with posttest commission scores. Moving onto the attention problems subscale, there was a significant correlation with pretest and posttest omission scores. Finally, there is significant, positive correlation between posttest commission scores and attention problems. See Table 7 below. All of these correlations suggest a positive relationship between children's behavior problems and their omission and commission scores. Though not significant, it is worth noting that children's age shows a negative relationship with pre and post omission and commission scores. This means that

children's age has the potential to influence sustained attention errors. I discuss associations between participation in nature-based activities and sustained attention in the next section.

Table 7. Correlations of Omission and Commission Errors, Activity Participation, Child Behavior, and Child Age in Months

	1	2	3	4	5	6	7	8	9
1. Total omission for pretest errors	--								
2. Total omission for posttest errors	.543*	--							
3. Total commission for pretest errors	0.301	0.106	--						
4. Total commission for posttest errors	0.358	0.339	.641**	--					
5. Sum of participation in all 5 activities	0.476	0.274	0.299	.527*	--				
6. Sum of participation in activities 2,3 4	0.424	0.120	0.331	.571*	.949**	--			
7. Sum of participation in activities 1,5	0.442*	0.467*	0.165	0.305	.832**	.616**	--		
8. Aggressive behavior	.526*	.522*	0.287	.711**	.576*	.577*	0.425*	--	
9. Attention problems	.590*	.596*	0.397	.771*	.511*	.510*	0.383	.961**	--
10. Child age in months	-0.29	-0.33	-0.384	-0.44*	-0.052	-0.80	0.120	-0.304	0.453*
Note: ** Correlation is significant at the 0.01 level (1-tailed).									
* Correlation is significant at the 0.05 level (1-tailed).									

Post hoc analysis. Because there were descriptive differences in participation by activity (i.e., Activities 2, 3, 4 had greater participation), I looked more closely at the associations between participation overall and participation in specific activities with children's sustained attention. As noted previously, participation in each activity was coded from 0-2, with 2 indicating maximum participation. Because we know so little about nature-based activities as they relate to sustained attention, examining aspects of participation provides meaningful pilot data. For heuristic interest, I calculated participation scores reflecting participation in both

Activities 1 & 5 and participation in Activities 2, 3 and 4. As noted in Table 7, overall participation in the five activities was positively associated with post-test commission errors. Additionally, there was a significant correlation between activities 2, 3 and 4 and post commission scores. Participation in Activities 1 and 5 were not associated with commission errors. Participation was not association with omission errors. As I will discuss in the next chapter, Activities 1 & 5 were potentially different from Activities 2, 3 and 4 because Activities 1 and 5 were less structured. For example, teachers facilitated exploration of a leaf and had children explore the playground for nature-base materials, compared to Activities 2, 3, and 4 which had more structured objectives, often eliciting children to pick out nature-based materials for use in a creative process ending in a product (e.g., rock collection, birds nest, and soup).

Participation and child behavior. Regarding associations between activity participation and child behavior, there was a significant correlation between children's aggressive behaviors and children's participation in all five activities. There was also a significant correlation between aggressive behavior and participation in Activities 2, 3, and 4. Additionally, children's attention problems were significantly correlated with the sum of participation of all five activities and Activities 2, 3, and 4; see Table 7. Child behavior was not correlated with participation in Activities 1 and 5 (although these were also the least popular activities in general).

As another lens from which to view associations between participation and children's sustained attention, I examined children in the top 50% relative to sustained attention errors at pretest and those in the bottom half of the sample who exhibited the fewest errors at pretest. The same was done for posttest. Upper errors reflect less sustained attention (higher errors means less sustained attention) while lower errors represent more sustained attention. Overall, children with more sustained attention errors (reflected in the upper error means for omission and commission,

both pretest and posttest) participated in more nature-based activities. This patterns holds true when looking at all three combination of activities (all five activities; Activities 1 and; Activities 2, 3 and 4). The only mean that falls out of this pattern was pretest commission errors whereas upper performing errors (*M*=.50*)* is smaller than lower performing errors (*M*=.63*)*. Overall these means suggest that children who performed with more errors of omission and commission, with pretest and posttest participated in more nature-based activates. See Table 8 below.

Table 8. Mean Errors by Upper and Lower Error Groups and Activity Participation

	All 5 Activities	Activities 1 and 5	Activities 2,3, and 4
Pretest Omission Upper 50% of Errors	1.88	1.13	0.75
Pretest Omission Lower 50% of Errors	1.06	0.63	0.38
Posttest Omission Upper 50% of Errors	2.38	1.50	0.88
Posttest Omission Lower 50% of Errors	1.50	1.12	0.38
Pretest Commission Upper 50% of Errors	1.60	0.94	0.50
Pretest Commission Lower 50% of Errors	1.31	0.82	0.63
Posttest Commission Upper 50% of Errors	2.25	1.50	0.76
Posttest Commission Lower 50% of Errors	1.63	1.12	0.50

Chapter 5: Discussion

There were not significant differences in pre to post and omission and commission errors, although errors did decrease from pre to post assessments of sustained attention. The decrease was quite large and may reflect individual differences in pre and posttest performances. For example, there were a few children with vastly different scores at pre and posttest. This could suggest that other factors, such as the child's mood or environmental conditions could have influenced the child's performance. The wide range of scores in such a short period of time underscores the need to carefully document potential characteristics that could influence performance. Additionally, the effect sizes for omission (.41) and commission (.23) suggest a small to medium effects, suggesting that statistical significance might have been evident in a larger sample, particularly with regard to omission errors. Linking these findings to the theoretical underpinnings of this paper, there is no significance in the paired t-tests. However, the overall decrease in means suggests support for the ART. Interestingly, though, the directions of the associations between participation in the nature-based activities and errors in sustained attention were unexpected.

Activity Participation

Activities 1 and 5 were more open-ended activities and were, interestingly, correlated with post omission errors. Activities 2, 3, and 4 were more structured and were related to post commission scores. Omission scores are thought to reflect inattention difficulties while commission errors are thought to suggest hyperactivity. On the whole, children who made errors in the sustained attention tasks, whether omission or commission errors, had higher activity participation than children who made fewer attention errors. It may be that children with more attentional difficulties seek out the structure of structured activities (although the degree of

structure may vary as in activities 1 and 5 versus activities 2, 3, 4). As I discuss in my future implication sections, these types of findings suggest the need to carefully study how children engage in nature-based environments and what child characteristics are associated with participation and engagement in nature-based experiences. For example, it may be that children who have greater regulatory skills tend to engage in emerging, unstructured play experiences while other children rely on teachers' facilitation of nature explorations.

To some degree, each of the five activities represented top-down attentional processing. As a reminder, top-down processing requires that the child focus on particular stimuli (e.g., nature items for soup, a rock that looks similar to the one in a story) rather than bottom-up processing which is driven by the child's intake of sensory information in a more free-form fashion. Hence, it is possible that the provision of nature-based activities, as opposed to completely open ended experiences such as a nature walk, might not provide the replenishment of attention systems as outlined by ART. Such a finding has key implication for teachers' outdoor planning. On the one hand, teachers feel pressure and should attend to outdoor planning, particularly given the frequent lack of attention to the outdoor early childhood environment. On the other hand, my results suggest, at least to some degree, that formal activities to enhance nature exploration may not provide the same benefits to attentional systems as leisurely, unstructured explorations in natural environments. What this suggests is that nature-based activities for teachers should be examined more closely in terms of whether an activity is more beneficial if it is open-ended or more close-ended and structured.

Child Behavior

As expected, child behavior (aggression and attention problems) was significantly associated with pre and post omission and commission scores. It makes sense that children with

more behavior problems to perform with more errors on attention tasks. This is not surprising, especially given that higher omission scores relate to inattention and higher commission scores relate to hyperactivity (Reck & Hund, 2011). These findings have implications for future nature intervention design.

Classroom Quality

Overall classroom quality was higher for the younger 3-year-old classroom than the 4-year-old classroom. It should be noted that the 4-year-old classroom was observed on a different day than the 3-year-old classroom and was also observed on a Friday which can be a tiresome day for early childhood educators as it is towards the end of the week, often altering the way the classroom functions. What this suggests is that the classroom quality score has the potential of identifying some reasons why sustained attention scores fell the way they did within the sample. However, with a small sample it is not possible to run any other significant tests with classroom quality, so this study leaves it as a descriptive that broadly describes the two classrooms.

Future Directions

Future research should explore children's attention abilities in nature-based environments over a longer period of time. It may beneficial to examine over an entire school year (from start to finish) to better understand how children in early childhood environments interact with nature in ways that may invoke both bottom-up and top-down processing. Such careful observations would provide valuable insights to teachers in planning how to support children's development. Second, other contexts should be given consideration when planning research on children's outdoor experiences. For example, the home environment might be an important context to consider as some children might live in rural areas while others live in urban areas and these differing contexts mean children's nature-based experiences may vary widely outside of school

contexts. As far as future directions for nature-based activities, there are several considerations to be made. It the future, an experimental study designed to allow for the examination of nature-based outdoor playground and non-nature-based outdoor playground experiences would shed light on how young children may benefit from nature-based experiences. As noted, studying how children engage with nature both in unstructured experiences (likely invoking bottom-up processes) and in more structured experiences (probably invoking top-down processing) would yield valuable information. I measured participation in the nature-based activities in this study. However, as activities likely stimulated children's top-down processing, it might have been beneficial to examine *non*-participation, with the question as to whether children who were not engaging in the activities might have been engaged in more bottom-up processing in their interactions with the playground materials. Such "non-participation" might be more consistent with the purported restorative effects of nature on attention abilities. Thus, research should seek to determine whether participation can measure the benefits of nature in a bottom-up way or if other methods should be used. Future work should also look at helping teachers to design less structured nature-based activities that are more child-led.

Limitations

A significant limitation to this study is sample size, which limited statistical power. Likewise, there was no control condition in the study, and, therefore, isolating any effects of the activities on outcomes was not possible. Children's sustained attention scores could well have been influenced by other influences such as testing conditions, prior experiences on the playground, and home contexts to name a few. The post measurement occurring 2-5 days after the last day of the intervention is another limitation. This suggests that the days after the intervention, effects could have worn off before the posttest was given. This study does

recognize that the data collection took place in the summer time, often a time when families vacation, having the potential to expose children to nature outside of this study. This has the possibility of limiting the strength of dosage the intervention had on children's sustained attention scores. Additionally, as stated above, the design of the activities (as being more structured, thus eliciting more top-down processes for children) is a limitation because it conflicts with the ART which states the nature is beneficial due to its bottom-up process. It should also be recognized that participation might be similar to scaffolding and that teacher's efforts to have children participate in nature-based activities with them might have influenced the participation scores this study found. Children might have taken the nature-based items from activities and used them elsewhere on the playground that was not captured to count towards participation scores. This type of adaptation of materials and experiences may have been quite beneficial to children and suggests an avenue to construction methods and measures in future studies. Overall this pilot study yields nonsignificant results in the main outcome, but suggests the need to more thoroughly examine nature-based activities and their impacts on development. This study shows that overall children's sustained attention has the potential to decrease after a series of nature-based activities. It also shows that children's problem behavior has the potential to guide their participation in certain nature-based activities based on objectives of the activity. Future work on nature-based environments in the early childhood setting is needed in an effort to promote optimal child development.

APPENDICES

Appendix A

Outdoor Playground

Figure 2. Entry Feature

Figure 3. Quiet Area

Figure 4. Gathering Area

Figure 5. Climbing/Crawling Area

Figure 6. Loose Materials

Figure 7. Sandbox/Building Area

Figure 8. Messy Materials/Art Area

Figure 9. Music and Movement Area

Figure 10. Open Space

Figure 11. Garden Area

Figure 12. Storage Area (right)

Appendix B

Nature-Based Activities

Activity # 1

Title: "Nature Collection"

Age Group: This activity is geared toward preschool-aged children, most appropriately three to four-year olds.

Number of Children: This activity can be done with a small or large group of children, and individually during outdoor play time.

Time of Day: This activity is designed to be implemented during outdoor play time.

Domain: This activity fosters growth in fine motor skills as it requires children to use their hands to pick up small materials. Additionally, it fosters growth in creativity and art.

Objective: Through the nature collection activity, children will use their creative skills to create nature art projects. Secondly, children will use and grow fine motor skills as they pick up pieces of nature-based materials for later art materials. Through this activity, children will engage their attention to natural aspects with will allow for restoration of attention.

Materials:

- Assorted loose organic materials small enough for art (things children will find on the playground such as leaves, small twigs, small rocks, bark and flowers).
- Bags for collecting items
-Glue
-Paper

Directions:

During outdoor play time, teachers will give children a bag to collect nature based items. The children will then go and collect items from the playground and use those items to create a nature artwork.

Lesson Extension: Teachers can extend and have children compare and contrast items from each other's bags which promote peer interactions and prosocial behavior. Additionally, teachers can discuss the materials children are finding, such as asking what the material is and where it comes from. They can also engage sense by having children feel the materials and describing their texture.

Activity # 2

Title: "Rock Scavenger Hunt"

Age Group: This activity is geared toward preschool-aged children, most appropriately three to four-year olds

Number of Children: This activity can be done with a large group or a small group of children. Teachers can read the book *If You Find a Rock* prior to outdoor play and have the book available outside on the playground

Time of Day: This activity is designed to be implemented during outdoor play time.

Domain: This activity fosters growth in cognitive functioning through exploration and problem solving and fosters growth in receptive and expressive language skills as they problem solve to find the rocks throughout the playground and express which of the rocks from the book they have found.

Objective: Through the rock scavenger hunt, children will have opportunities to explore the natural aspects of the rocks which contribute to cognitive development children will increase their language skills and gain new vocabulary about different types of rocks and through conversations about the rocks. Additionally, it will foster engagement in children's attention.

Materials:

- Assorted rocks that are featured within the book
- *If You Find a Rock* by Peggy Christian
- Bags/buckets to collect rocks
- Hand shovels for digging
- Laminate copies of each of pictures/names of the rocks from the books that children will find

Directions: During outdoor time: Teachers will read the book and ask children if they know these rocks. Then teachers will invite children to help find the rocks. Each child that is interested will be given a laminated sheet of a picture/the name of one of the rocks from the book (for example, one rock is nicknamed “wishing rock”), then the children will be asked to find the rock. The rocks will be hidden in multiple places throughout the playground.

Lesson Extension: This lesson can be used interchangeably with other organic and natural materials. Children and teachers can also engage in discussions about how rocks are formed and created, where rocks are located and what kind of rocks grow in various environments. Teachers can also ask children what rocks are used for.

Activity # 3

Title: "Create a Birds Nest"

Age Group: This activity is geared toward preschool-aged children, most appropriately three to four-year olds.

Number of Children: This activity can be done with a large group or a small group.

Time of the Day: This activity is designed to be implemented during outdoor play time.

Domain: This activity fosters creativity and fine motor skills through the exploration of the environment.

Objective: Through this activity children will foster creativity by designing a bird egg in the art area. Children will utilize fine motor skills to find materials for a nest for their bird eggs. Additionally, this will allow children to explore the natural environment which will engage their attention to natural stimulus.

Materials:

- Wood eggs
- Art materials for the eggs (Non-toxic water color paint)

Directions: Teachers will invite children to design a bird egg using art materials and a wooden egg. Children will then be asked to find material around the playground to build their egg and nest.

Lesson Extension: Teachers can ask children what types of materials are best for a nest and why (e.g. hay because it is soft and the egg is delicate), which promote cognitive development. Additionally, teachers can ask children to compare and contrast the design and each other's eggs which promotes peer interaction.

Activity # 4

Title: "Nature Soup"

Age Group: This activity is geared toward preschool-aged children, most appropriately three to four-year olds.

Number of Children: This activity can be done with a large group or a small group.

Time of the Day: This activity is designed to be implemented during outdoor play time.

Domain: This activity fosters creativity and fine motor skills through the manipulation of organic materials.

Objective: Through this activity children will foster creativity by designing a nature soups and utilize fine motor skills to manipulate, tear, slice and smash organic materials to create a nature soup.

Materials:

- Organic materials that are able to be torn, sliced, and smashed (leaves, dirt, and bark)
- Mortar and pestle and bowls
-Water color with eye droppers

Directions: Teachers will invite children to design a nature soup. Using the tools and materials, children will manipulate organic materials, whether it is through tearing, slicing or mashing organic material with a mortar and pestle.

Lesson Extension: Teachers can ask children why some organic materials are more watery than others (e.g. leaves have water in them). Additionally, teachers can ask what types of animals would eat the different types of ingredients that are being used in the soup.

Activity # 5

Title: "Leaf Discovery"

Age Group: This activity is geared toward preschool-aged children, most appropriately three to four-year olds.

Number of Children: This activity can be done with a large group or a small group.

Time of the Day: This activity is designed to be implemented during outdoor play time.

Domain: This activity fosters cognitive development and fine motor skills.

Objective: Through this activity children will explore the anatomy of a leaf in depth with a magnifying glass, which engages fine motor skills. Children will engage cognitive skills to explore the parts of a leaf and gain word knowledge about the parts of the leaf and the way it functions. This activity will allow children to closely engage with nature and to explore one element of nature.

Materials:

-Various leaves

-Magnifying glass

Directions: Teachers will ask children to use the magnifying glass to explore the parts of the leaf and to identify the functions of the leaf.

Lesson Extension: Teachers can ask children to explore other nature materials in depth, such as rocks or bark.

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