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The Effects of Virtual Nature Exposure on State Social Motivation

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by

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ABSTRACT

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The purpose of this study was twofold: 1) to examine the effects of virtual nature exposure on state social motivation, and 2) to investigate adverse childhood experiences as a moderator of those effects. In this online study, adult participants (N = 444) aged 18 to 58 were randomly assigned to one of the three experimental video conditions (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure). After watching a 15-minute video, participants completed measures related to state social motivation. Results revealed a significant main effect of nature exposure on state social motivation. However, the effects of nature exposure on state social motivation were not significantly moderated by adverse childhood experiences. Results suggest that nature exposure may have a positive impact on the development and maintenance of social connections and should be explored further as a social health intervention aimed at improving overall health.

DEDICATION

I dedicate this thesis to my amazing family who allowed me to accomplish this herculean task by giving me space to work, food to eat, and encouragement. First, I could not do anything in this life without Frank, my best friend, partner, life coach, and husband. He gives of himself so generously and someday when I grow up I want to be just like him. As for my kids, Phoebe, Alesandro, and Paiden, I'm going to have to remind them that I still exist when this is all over. I've been hiding out in my tiny office every day for a long time and they've been so patient with me. No accomplishment would be worth anything if I didn't have their beautiful smiling faces and souls to share it with.

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"This is not our world with trees in it. It's a world of trees, where humans have just arrived." ― Richard Powers

"Nature itself is the best physician." – Hippocrates

"The moment you become aware of a plant's emanation of stillness and peace, that plant becomes your teacher." – Eckhart Tolle

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As for my committee, I apologize in advance for the fact that you have to read this very long document; but, I really appreciate the fact that you will likely be one of only ten people (if we're being honest, it's probably more like five people) that ever read this document in its entirety. Dr. Williams and Dr. Dixon, thank you for your time and wisdom.

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Chapter 1. Introduction

In 2017, healthcare costs rose 3.9% to $3.5 trillion dollars, which was 17.9% of the gross domestic product (GDP) for the United States (Centers for Medicare and Medicaid Services, 2017). Increased healthcare costs are a product of many variables: however, growing numbers of people with chronic diseases are the biggest driver. In 2008, 50% of adults were diagnosed with at least one of the following chronic diseases: cardiovascular disease, diabetes, asthma, arthritis, cancer, and chronic obstructive pulmonary disease (Office of Disease Prevention and Health Promotion, 2009). Hospitals, prescriptions, and health care provider treatment accounted for 66% of healthcare costs in 2017 (Centers for Medicare and Medicaid Services, 2017). Low cost, complementary, accessible interventions are needed to conjunctively address this healthcare crisis and to help improve human health and suffering while concomitantly alleviating the burden of healthcare costs. A novel intervention that meets these qualifications has been explored recently in the literature: nature exposure. Research regarding the impact of nature exposure on health has found promising results and needs to be explored further (Bratman et al., 2015; Brown et al., 2013; Capaldi et al., 2014; Chalmers et al., 2014; Coley et al., 1997; Engemann et al., 2019; Farrow & Washburn, 2019; Gladwell et al., 2012; Hartig et al., 2014; Twohig-Bennett & Jones, 2018).

Nature Exposure

Nature exposure is a construct in the research literature that is used to describe experiencing nature, which can be accomplished in many different ways. Individuals can immerse themselves in the natural environment by taking a hike, spending time at a park, sitting under a tree, or looking at natural views. Nature exposure can also be achieved indoors by viewing nature out of a window, or being in an indoor environment where nature is present, such as an indoor setting adorned with plants. In addition, nature exposure can be experienced

virtually by looking at pictures or videos of nature. In order to clarify nature exposure typologies, Keniger et al. (2013) classified them as being indoor, urban, fringe (just outside of a city), production landscape (agricultural), wilderness, or specific species (interacting with animals from/in nature). The vast majority of nature exposure research, irrespective of typology, has focused on nature exposure's impact on physical and mental well-being (Keniger et al., 2013). This research study examined virtual wilderness nature exposure and its effect on state social motivation, an essential component of social health.

Nature Exposure and Health

In order to review the impact of nature exposure on health, it is necessary to define health. The World Health Organization defines health as physical, mental and social well-being (World Health Organization, 1948; Seymour, 2016). Engel's (1977) biopsychosocial model of health echoes the sentiments of the World Health Organization's definition, purporting health as an outcome based on the interconnectedness of biology (e.g., genes, hormones, neurotransmitters), psychology (e.g., personality, mood, optimism/pessimism) and social-cultural influences (e.g., family, environment, friends, culture). Although scientists have conducted a substantial amount of research regarding the impact of nature exposure on physical and mental health, the impact of nature exposure on social health needs to be more developed (Keniger, 2013). In an interconnected system like the biopsychosocial model, if one component is impacted, it follows that there will be an influence on other parts within the system. Past research on social well-being and health outcomes confirms this notion. For example, in eight studies between 1979 and 1994 with over 40,000 participants, greater social integration was associated with lower all-cause mortality (Berkman, 1995). Social isolation was associated with a higher risk to physical health, while social integration was associated with lower physical health risk.

As social health is an integral part of overall health and a gap in the literature exists regarding nature exposure and social health, this research added to the extant literature by examining the impact of nature exposure on state social motivation, an aspect of social health.

In order to better understand this research, a review of the current literature about nature exposure and physical, mental, and social health is necessary. A literature review will elucidate what has been learned and the specific gaps in knowledge that this research seeks to fill. As research in the areas of physical, mental, and social health is examined, it is imperative to remember that each of these areas works synergistically with one another to affect overall health.

Nature Exposure and Physical Health

Pain, Chronic Disease and Immune System Functioning. A plethora of physical health benefits associated with nature exposure have been documented. Ulrich (1984) found that patients who had cholecystectomy surgery (gall bladder removal) recovered faster (left the hospital one day sooner), used less pain medicine, and had fewer post-surgical complications if they were in a hospital room with a window looking at trees as opposed to a hospital room with a window looking at a brick wall. Further evidence of nature's effect on pain perception was garnered in Lohr and Pearson-Mims' (2000) study where pain tolerance, measured by length of time participants were able to keep their arms submerged in an ice bath, improved when participants were tested in a lab containing plants versus no plants. Additionally, a meta-analysis of 143 studies (103 observational and 40 interventions) found that greenspace exposure was associated with reductions in stroke, hypertension, dyslipidemia, coronary heart disease, and asthma, further supporting the premise that physical health benefits are associated with nature exposure (Twohig-Bennett & Jones, 2018).

Improved immune system functioning has also been seen with nature exposure. In fact, the immune system's natural killer cells, lymphocytes (white blood cells) that fight off tumors and viruses, have been found to increase after nature exposure (Kuo, 2015; Li et al., 2008; Li et al., 2009; Lowry et al., 2007; Tsao et al., 2018). Remarkably, employees who work in the forest have shown better cholesterol and fasting blood glucose compared to their counterparts who work in the city (Tsao et al., 2014). Tsao et al. (2014), however, did acknowledge that comparing employees who work in the forest to those who work in an indoor office environment may be a confound which could have affected results (Tsao et al., 2014). For example, employees who work in the forest may get more exercise than employees that work in an office.

Stress and Arousal. Some of the research on health and nature exposure shows that nature exposure seems to work even if the participant is not in direct physical contact with nature but has merely viewed representations of nature (e.g., pictures or video). For example, Ulrich (1981) discovered in a between-subjects study that participants who viewed pictures of nature scenes during a slide show in a lab, experienced reduced arousal compared to when they viewed pictures of urban scenes during a slide show in the lab on a separate occasion. Reduced arousal was measured by lower heart rates (EKG), greater amplitude alpha waves (EEG), and better self-reported mood and affect (Ulrich, 1981). Ulrich's (1991) later research found that when stress was purposely induced in participants and they were then shown videos of urban or natural environments, they were able to recover from stress more quickly when they were viewing videos of nature (Ulrich et al., 1991). Ulrich induced stress by showing participants a ten minute video of simulated workplace accidents involving blood and mutilation. After this first video, participants were then randomized to be shown a second video (ten minutes in duration) of a nature scene or an urban scene. Physiological measurements of stress: muscle tension, skin

conductance, and pulse transit time (longer pulse transit time equates to lower blood pressure) were taken during both videos. Ulrich found that stress-recovery time was faster when participants watched a nature scene video after the stress-inducing video. In other related research, participants who were shown a picture of a hospital room with plants in it versus a hospital room with urban artwork on the wall (with no plants pictured in the room), reported feeling less stress when viewing the picture of the hospital room with plants in it (Dijkstra et al., 2008). In all of these studies, nature exposure involved viewing static pictures or video of nature and was associated with decreased stress or arousal.

Arousal is an important indicator of physical health because it is essentially a physiological response to stress. When humans perceive a threat in the environment due to a stressor, the autonomic nervous system is activated. The sympathetic part of the autonomic nervous system mobilizes the individual (i.e., fight or flight response) and the parasympathetic part of the nervous system calms an individual down after the perceived threat or stimulus is over. Therefore, sympathetic activation is associated with stress whereas parasympathetic activation is associated with relaxation or calming. Many health issues relate back to perceived threats from stressors, and subsequent stress, marked by the arousal that follows. Heart rate variability (HRV), the measurement of the variation in milliseconds between consecutive heartbeats, is a reliable marker of autonomic nervous system activity and it has been used in many studies that have examined the effects of nature exposure. (Brown et al., 2013; Chalmers et al., 2014; Farrow & Washburn, 2019; Gladwell et al., 2012; Gladwell et al., 2016; Kobayashi et al., 2015; Kobayashi et al., 2018; Kok et al., 2013;). For example, in a crossover between-subjects designed study where the participants acted as their own controls, a lunchtime 1.8 km "green" walk (a walk in nature) compared to a 1.8 km "built" walk (a walk near buildings)

showed improved heart rate variability, a marker of parasympathetic activation, during sleep that same night (Gladwell et al., 2016). The study suggests that a daytime walk in nature could improve sleep at night by facilitating a relaxation response. While the current research will not be measuring HRV, it is an aim of the researcher to measure this in future nature exposure studies.

Nature Exposure and Mental Health

Attention. Nature exposure appears to benefit attentional processes. Attention Restoration Theory (ART) proposes that nature exposure restores our attention after we are mentally fatigued because it gives us a sense of being away, fascination, extent (immersion), and compatibility (enjoyment) (Kaplan, 1995). Some evidence to support this theory comes from research that focuses on specific disorders marked by attention difficulties. Remarkably, improvements in ADD/ADHD symptomology have been documented after exposure to nature (Taylor et al., 2001; Taylor & Kuo, 2011). For example, parents of children with ADD/ADHD completed questionnaires that detailed their children's activities and subsequent behaviors following the activities. The researchers coded the children's activities as green (e.g., fishing, soccer), ambiguous (e.g., rollerblading), or not green (e.g., video games, TV). After activities, subsequent behaviors that parents reported involved their children's focus, completion of tasks, listening to and following directions, and whether or not they were easily distracted. Results showed that after playing in green spaces (nature exposure) children's attentional capacities were better than when they played in non-green or ambiguous environments (Taylor et al., 2001), which supports ART. Additionally, a later study by Taylor and Kuo (2011) confirmed these results. Taylor and Kuo (2011) used slightly different categories for location of play in this later study and found that children with ADD/ADHD who played in *big trees and grass* and *open*

grass had milder ADD/ADHD symptoms than children who played in *deep indoors* and *built outdoors*. Further, they found that "green play settings remain a significant predictor of ADHD symptom severity when diagnosis, income, and gender are controlled" (Taylor & Kuo, 2011, p. 296).

The attentional benefits of nature exposure are not limited to children. Hartig et al. (1991) completed two studies and found that adults performed better on a directed attention task after they spent time in nature. In Study 1, a quasi-experimental design, Hartig et al. (1991) divided participants (all who were experienced backpackers) into three groups: those who would take a wilderness vacation (backpacking in the woods), those who would take a non-wilderness vacation, and a non-vacation control group. Hartig et al. (1991) found that when participants returned from their vacations, performance improved on the directed attention task for participants in the wilderness vacation condition while performance declined for participants in the other two groups. In Study 2, an experimental design, researchers induced mental fatigue in participants and then randomly assigned participants to take a 40 minute nature walk, a 40 minute urban walk, or read magazines in the lab for 40 minutes. Participants who took the nature walk performed significantly better on a directed attention task that was given after the experimental manipulation (Hartig et al., 1991).

In other research, Lohr et al. (1996) found that nature exposure increased productivity and lowered stress. Participants were randomly assigned to a computer lab with plants or a computer lab without plants. Measures for blood pressure, reaction times and self-reported attentiveness were all significantly better in the computer lab that had plants (Lohr et al., 1996). These studies support the Attention Restoration Theory premise that spending time in nature restores attentional capacity.

Psychological Well-Being. In addition to attentional benefits, research shows that nature exposure can benefit psychological well-being. Nature exposure has been shown to increase positive mood (Hartig et al., 2014), reduce stress (Lohr et al., 1996; Ulrich, 1981; Ulrich et al., 1991) and decrease rumination (Bratman et al., 2015).

Rumination, a maladaptive thought process whereby a person's distressful thoughts consistently consume their attention, is associated with depression and other psychological disorders (Grierson et al., 2016; Nolen-Hoeksema, 2000). Therefore, mental health initiatives often target ways to decrease rumination. Bratman et al. (2015) conducted an experiment designed to explore the effect of nature exposure on rumination, which specifically looked at the subgenual-prefrontal cortex, an area of the brain that is active during rumination and social withdrawal. Participants were randomized into two groups, those who took a 90-minute walk in nature and those who took a 90-minute walk in an urban environment. Participants were given a cell phone and were told to take 10 photos along their assigned route. The cell phone's GPS and the participants' photos helped researchers track the participants, ensuring their completion of the assigned route while at the same time disguising the purpose of the study. In the lab, participants completed pre- and post-tests for rumination (before and after the walk) and arterial spin labeling (ASL), a neural imaging technique that assessed subgenual-prefrontal cortex activity. Importantly, Bratman et al. (2015) found that people who walked in nature decreased both self-reported rumination and blood perfusion to the subgenual-prefrontal cortex, a biological marker of decreased rumination, compared to those who took the urban walk. Due to these results, Bratman et al. (2015) posit that decreased rumination after nature exposure may be one possible reason that nature exposure is associated with overall better mental health outcomes.

Bratman et al.'s (2015) research incorporated exercise (a walk), which previous research has shown benefits mental health. A growing number of researchers have been interested in extending this knowledge by examining the enhanced benefits of exercise within a nature exposure experience, referred to as green exercise in the literature (Pasanen et al., 2014; Pretty et al., 2005; Pretty et al., 2007). Pasanen et al. (2014) found that participants who exercised in nature reported significant increases in emotional well-being compared to participants who exercised in other locations. Survey data was collected from 2,070 participants in Finland regarding emotional well-being, perceived general health, sleep quality, and frequency and location of physical activity. Location choices for exercise were indoor, outdoor built environment (e.g., city), or nature. In this correlational study, exercising outdoors in nature was associated with greater increased well-being than those exercising in other settings. As the benefits of exercise on mental health are well established, it is important to be careful when interpreting these results. However, the fact that the other participants in this study were also exercising (although in different locales) and did not report emotional well-being levels as high as the participants who exercised in nature, supports the idea that nature exposure while exercising may provide additional benefits to people above exercise itself.

Self-Esteem. The benefits of exercise on mental health seems to work synergistically with nature exposure. Green exercise is associated with elevated mood and elevated self-esteem (Pretty et al., 2007; Pretty et al., 2005). Participants who exercised on a treadmill while viewing pictures of pleasant urban scenes (cityscapes with greenery, parks, gardens, and water features) and pleasant rural scenes (predominantly nature, trees, grass, and water) reported significantly increased self-esteem compared to participants in the control group who viewed no picture at all. Importantly, the positive increase in self-esteem was significantly beyond improvements in self-

esteem that were seen with exercise alone (Pretty et al., 2005). In addition to this experimental research, ten case studies that examined a wide variety of green exercise modalities (e.g., boating, walking, horse riding, fishing, mountain biking, woodland activities) also showed significant improvements in participant self-esteem and mood (Pretty et al., 2007). Interestingly, these improvements in self-esteem and mood were seen irrespective of the duration, intensity, or type of green exercise in which the participants partook (Pretty et al., 2007). These studies suggest that nature exposure during exercise, both indoors and outdoors, is associated with improvements in self-esteem and mood, which are both an integral part of mental health.

Of note, nature exposure may be particularly important for women's self-esteem. One aspect of self-esteem is a person's view of self through a perceived body image. Connectedness to nature is associated with a positive body image for women, but not men (Swami et al., 2016). Swami et al. (2016) found that connectedness to nature is associated with body appreciation, which is mediated by self-esteem. Although it is not clear why men do not seem to experience the same benefit for perceived body image, this evidence still supports nature exposure as a conduit for mental health and well-being.

Positive Emotions. A meta-analysis including 30 samples from 21 studies found a significant positive relationship between nature connectedness and happiness (Capaldi et al., 2014). From an evolutionary perspective, our drive to be connected to nature and to experience nature makes sense because paying close attention to and being in tune with nature most certainly would have contributed to human survival in the not too distant past. Wilson's (1984) biophilia hypothesis supports this view, arguing that humans are innately driven to connect and interact with other forms of life (e.g., plants, animals) in nature. Increased happiness resulting from nature connectedness or nature exposure may have evolutionary roots in human biology.

Increased positive emotions may be the catalyst for improvements in health and well-being due to nature exposure. Awe may be one emotion that helps explain this connection. According to Keltner and Haidt (2003), awe is an emotional response we have toward something that is vast (larger than the self) that our mind needs to accommodate. We create new schema in order to understand and cognitively process our vast experiences. Threat, beauty, ability, virtue, and supernatural causality are examples of experiences that have the potential to incite awe (Keltner & Haidt, 2003). Based on Keltner and Haidt's (2003) definition of awe, nature has the ability to incite awe.

Awe, in turn, may be one positive emotion that acts as a mediator between nature exposure and life satisfaction. An example of this comes from Anderson et al.'s (2018) study which found the emotion of awe that military veterans and youth experienced while whitewater rafting (Study 1) or during nature exposure in their daily lives (Study 2) predicted improvements in well-being, stress, and life satisfaction. In addition to awe, further analysis found that the positive emotions of contentment and gratitude also mediated the effect of nature exposure on increased life satisfaction. Positive emotions elicited due to nature exposure may impact overall mental health.

The advent of social media has created a unique opportunity for researchers to gather large amounts of data on nature exposure in the population relatively easily. Change in perceived happiness, or sentiment change, was calculated in a Twitter study that looked at the tweets people wrote before, during and after visits to San Francisco's urban parks. The researchers used the hedonometer, a tool which analyzes words used in tweets, to evaluate the happiness levels of people who visited these urban parks (Reagan et al., 2017). Results from the study indicate that people were happier when they visited urban parks, compared to when they were not visiting

parks, and this sentiment seemed to last for hours post-visit. Additionally, Regional Parks, the greener and more densely vegetated parks in San Francisco, predicted even more happiness than Civic Plazas and Squares, which were less green and less vegetated (Schwartz et al., 2019).

Proximity to Nature and Psychological Disorders. The potential for nature exposure's protection of mental health has been supported by many correlational studies. Urban greenspace, specifically tree density in London boroughs, was associated with a decrease in antidepressant prescriptions (Taylor et al., 2015). In the Netherlands, lower rates of depression and anxiety disorders were reported in areas where there was more greenery (Maas, Verheij, et al., 2009). Researchers at the University of Montana found that accessibility to nature from home, such as having parks nearby, was associated with reduced impulsivity in decision-making and better mental health, well-being, and general health (Repke et al., 2018).

Impulsivity in decision making was measured in Repke et al.'s (2018) study by using delay-discounting tasks. The delay-discounting task is a measure of temporal discounting, people's inclination to prefer immediate rewards/benefits that are smaller compared to delayed rewards/benefits that are larger. For example, in Study 1, Repke et al. (2018) utilized a delay discounting task that asked participants to choose between a hypothetical smaller amount of money (e.g., $1, $5, $10, $15, $20, $30, $40, $50, $60, $70, $80, $85, $90, $95, $99, $100) now or a larger amount of money $100 later (e.g., 1 day, 1 month, 1 year, or 5 years). Study 2 utilized a delay-discounting task that asked participants to choose between hypothetical fewer days of improved air quality now or more days of improved air quality in the future (e.g., 1 day, 1 week, 1 month, 6 months, 1 year, 5 years, 25 years). Repke et al. (2018) note that previous research has found that increased delay-discounting is associated with increased health risk behaviors (e.g., smoking, alcohol consumption, lack of exercise) and chronic illness. Repke et al. (2018)

speculate that the health benefits from nature exposure may come from reduced impulsivity in decision making which, in turn, impacts mental health, well-being, and general health. Repke et al. (2018) measured mental health using the Depression Anxiety Stress Scale (DASS) where higher scores indicated better mental health. Well-being was measured by asking participants to rate how much they agreed with the statement, "I am happy," on a scale from 1 *(totally agree) to 5 (totally disagree*) and general health was measured by asking participants "How would you rate your overall health at present?" on a scale from 1 (*very good*) to 7 (*very bad*) (Van Herzele & de Vries, 2012).

All of the mechanisms by which nature exposure impacts health are not known. However, one widely accepted theory is Ulrich's (1983) Stress Reduction Theory, which argues that nature exposure after a stressful event leads to positive emotions, which are restorative and help reduce overall stress (Ulrich, 1983; Ulrich et al., 1991). Researchers have postulated that the presence of abundant greenery leads to lower levels of stress, which impacts mental health (Taylor et al., 2015).

A massive correlational study of almost one million people in Denmark examined the association between childhood exposure to greenspace and prevalence of a wide array of psychiatric disorders in adulthood (Engemann et al., 2019). Researchers used normalized difference vegetation index (NDVI) data from 1985-2013, gathered from satellite imagery technology, to ascertain greenspace exposure in childhood. Next, health information for 943,027 people was obtained from the Danish Civil Registration System, the health registry in Denmark, on the prevalence of psychiatric disorders for these adults. Research results indicate that a dose-response relationship between childhood greenspace exposure and psychiatric disorders exists. After controlling for socioeconomic status, urbanization, parental history, and parental age, low

levels of greenspace exposure in childhood was associated with up to 55% higher risk for a diagnosis of *any* psychiatric disorder. The only exceptions were intellectual disabilities and schizoaffective disorders. These data strongly suggest, that childhood greenspace exposure may have a profound positive impact on mental health. The authors argue that the inverse relationship between psychiatric disorders and childhood greenspace exposure logically builds upon previous research findings that show that greenspace "can promote mental health by supporting psychological restoration, encouraging exercise, improving social coherence, decreasing noise and air pollution affecting cognition and brain development, and improving immune functioning" (Engemann et al., 2019, p. 5189; Hartig et al., 2014; James et al., 2015; Twohig-Bennett et al. 2018; Rook, 2013).

Nature Exposure and Social Health

An abundance of research evidence supports the beneficial impact of nature exposure on physical and mental health. The literature surrounding the beneficial impact of nature exposure on social health is less developed. Social health involves being able to form and maintain relationships with others. This research seeks to fill in part of the gap in the research by examining the impact of nature exposure on state social motivation, being motivated towards being social and building relationships, a critical element of social health. In order to understand where gaps lie, it is necessary to examine the existing research surrounding social health in general, understand its significance, and then examine research regarding nature exposure and social health.

Measuring Social Health. Social health has been assessed using a variety of measurements. Renne et al. (1974) assessed social health using measurements of employability, marital satisfaction, sociability, and community involvement. The World Health Organization

(Garcia & McCarthy, 1996) summarized existing measures of social health including those that measured social networks, availability and satisfaction with social support, social roles, and social adjustment. Keyes (1998) introduced a measure for social well-being, another term used to describe social health, that incorporated social integration, social acceptance, social contribution, social actualization, and social coherence. There are an abundance of ways to measure social health, but at the heart of the concept of social health is the ability to form and maintain relationships. The current research focused on measuring state social motivation, an important aspect of social health that involves being oriented toward developing relationships with others. Specifically, this research examined the impact of nature exposure on state social motivation.

Social Support. The research surrounding the healing effects of social support is abundant. A review of 81 studies showed that social support is associated with better functioning of the immune, endocrine, and cardiovascular systems (Uchino et al., 1996). Interventions that focus on strengthening social support are important to improving health and reducing all-cause mortality (Berkman, 1995). Strikingly, Holt-Lunstad et al.'s (2010) meta-analytic review of 148 studies (308,849 participants) showed that stronger social connections were associated with a 50% reduction in risk of early death. Irrespective of personality, social support and social integration help buffer individuals from stress and negative health outcomes (Cohen, 2004; Cohen et al., 1986). Social support helps people cope with stress through instrumental (e.g., financial help), informational (e.g., advice, guidance), and emotional support (e.g., empathy, caring). Social integration involves individuals having a wide range of relationships, roles, and activities in which they participate (Cohen, 2004; Cohen et al., 1986). Due to the overwhelming evidence regarding the health benefits of social relationships, Holt-Lunstad et al. (2017)

recommend that social connection be recognized as a public health priority by government agencies, funders, and healthcare providers.

Facilitation of Social Interaction. One aspect of nature exposure that may contribute to improved social health is the fact that greenspaces facilitate social contact. Coley et al. (1997) found that the mere presence of a greenspace facilitated social interaction among residents in public housing developments in Chicago. Observational data at the public housing developments showed that greater numbers of trees and nearness of trees predicted increased use of the outdoor spaces and greater numbers of congregants. More trees also predicted increased mixed-age social interactions between adults and children in these spaces (Coley et al., 1997). Another study at the same housing development showed that children played more in high-vegetation spaces compared to low-vegetation spaces, had access to more adults in high-vegetation spaces and partook in more creative play when vegetation levels were high (Taylor et al., 1998). The observational evidence showed that greenspaces predicted, and may have actually facilitated, social interaction.

Safety. Increased social interaction in greenspaces around public housing developments may partially be explained by an increased sense of safety. Kuo et al. (1998) found that increases in tree density and grass maintenance surrounding public housing were associated with increased feelings of perceived safety. This perception of safety is supported by actual crime statistics. In another study, levels of vegetation (low, medium, high) were measured for 98 public housing apartment buildings in Chicago and two years of crime statistics for each building were analyzed. "Buildings with high levels of vegetation had 52% fewer total crimes, 48% fewer property crimes, and 56% fewer violent crimes than buildings with low levels of vegetation"

(Kuo & Sullivan, 2001b, p. 355). Seemingly, greenspaces were perceived as safe spaces for social interaction.

Nature Dose. Shanahan et al. (2016) studied the impact of nature-exposure dose (duration, frequency, and intensity) on health (mental health, physical health, social health, and health behavior). Dose-duration was measured by green space visits over the course of a year, dose-frequency was measured by average weekly visits to green spaces, and dose-intensity was measured by examining vegetation complexity using LiDAR maps, maps produced by National Oceanic and Atmospheric Administration (NOAA) aircraft that are made using infrared lasers to map the topography of the Earth, of vegetation cover. Social health was assessed using questions that measured trust, reciprocal exchange within communities, and general community cohesion. Shanahan et al. (2016) found that higher frequency of green space visitations predicted increased social health.

Mygind et al. (2019) conducted a systematic review of immersive nature-experiences on children and adolescents' mental, physical and social health. Immersive nature-experiences were operationalized as, "non-competitive activities, both sedentary and active, occurring in natural environments removed from everyday environments" (Mygind et al., 2019, p. 102136). Eighty-four studies met the inclusion criteria and were evaluated. Mygind et al. (2019) found that children and adolescents who participated in immersive nature-experiences (usually outdoor adventure or therapy programs) reported increases in perceived social support, decreases in perceived peer-rejection, improved family function, and improved skills for cooperation, leadership, and conflict resolution. Two potential limitations of the review were that only 28 of the 84 studies were controlled between-subjects or within-subjects designs, and it is possible that self-selection sampling bias occurred. Research by Mygind et al. (2019) and Shanahan et al.

(2016) supports the hypothesis that nature exposure impacts social health and that dose of exposure matters.

Reasonable Person Model. The relationship between greenspaces and health is well established. However, the exact mechanism of this relationship remains unknown. One study in the Netherlands found that social contacts mediate the relationship between greenspaces and health (Maas, van Dillen, et al., 2009). Even after controlling for socioeconomic status, people felt less lonely and perceived more social support when greenspace was nearby (Maas, van Dillen, et al., 2009).

Kaplan and Kaplan's (2011) Reasonable Person Model (RPM) offers one explanation of for this finding. The Reasonable Person Model is a framework that describes how human interaction with nature helps bring about reasonable behavior, partly through attention restoration. Building better mental models through exploration, producing meaningful action, and being effective are all part of the RPM. Kaplan and Kaplan (2011) posit that exposure to the natural environment helps people accomplish the goals of the RPM, which facilitates bringing out the best in people. An example of this comes from Kuo and Sullivan (2001a). Low levels of vegetation around public housing were associated with lower attentional functioning and mental fatigue, which was ultimately associated with more violence and aggression. According to Kaplan's Reasonable Person Model, vegetation, or the natural environment, may help restore attentional functioning, leading to less fatigue and less impulsive behavior, including violence and aggression. In sum, reasonable behavior facilitated by nature exposure may help facilitate positive social interactions.

Summary

Due to our declination in nature exposure due to urban living, perceived barriers, and more time spent indoors and on screens (Twenge et al., 2018), Bratman et al. (2019) view nature exposure as a determinant of mental health. This supposition logically follows from the research literature that shows that nature exposure is associated with better attention, psychological well-being, self-esteem, positive emotions, and fewer psychological disorders. Keniger et al. (2013) goes one step further and argues that we should look at nature exposure as a public health issue and opportunity. In addition to positive mental health outcomes, studies show that nature exposure has a positive impact on physical health. Nature exposure has been shown to influence pain perception, hospital stays, stress and arousal, immune system functioning and chronic disease. Additionally, in the realm of social health, nature exposure predicts increased social interaction and perceptions of safety and is correlated with reductions in crime and aggressive behavior. Therefore, nature exposure represents a rare opportunity for possible novel prevention and treatment interventions. Awareness of humans' indirect, incidental, and intentional contact with nature and how it may impact health provides an opportunity for deliberate research and planning in many domains about how to increase nature exposure (e.g., urban planning, interior design, healthcare, education, personal exercise, vacations) (Keniger et al., 2013).

This study is aimed at exploring the link between nature exposure and social health due to the gap in the literature on this topic. Specifically, this research will examine the effect of nature exposure on social motivation, an important aspect of social health, that to the author's knowledge, has never been studied before experimentally. Social health works synergistically with physical and mental health and impacts overall health and is, therefore, an important target for research. This study will examine the effect of nature exposure on state social motivation and

whether adverse childhood experiences (ACEs) moderate that relationship. Justification for the use of the state social motivation measures and the ACEs measure follows.

State Social Motivation

It is important to provide rationale for the outcome variate, state social motivation and why it makes theoretical sense. State social motivation is used here as a construct to describe a participant's readiness and motivation in the present moment to engage in social interactions. Three measures comprise the composite outcome variate, state social motivation: State Motivation to Foster Social Connections (Bernstein et al., 2019), State Positive Affect (Watson et al., 1988), and State Anxiety (Spielberger et al., 1983). The relevance and importance of each measure's contribution to the state social motivation construct is discussed.

First the goal of this study was to test nature exposure as an intervention that might improve motivation towards social interactions immediately, in the moment. Trait measures assess enduring, stable traits, while state measures assess acute behaviors, thoughts and feelings. Therefore, trait measures wouldn't suffice and state measures were required. The chosen outcome variate is comprised of three "state" measures.

Most measures explored for use in this study failed to help answer the research question, "Does nature exposure increase participants' readiness and motivation in the present moment to engage in social interaction?" Often, the measures were related to the construct, but not exactly the right fit for the research question. For example, pro-social measures focus on evaluating helping behavior, not necessarily motivation to socialize and make social connections with others (Baumsteiger & Siegel, 2017). Social approach measures often involved behavioral assessments like touching and this was an online study (Schaan et al., 2020). The Social Connectedness Scale measures perceived emotional distance from other people (Lee & Robbins,

1995) and Hill's (1987) the Interpersonal Orientation Scale assesses personal needs and motivations associated with social interaction, which were in the ballpark conceptually, but not quite right. The Need to Belong Scale measures one's enduring desire to be with others, however, as stated earlier, a state measure was essential for this study (Leary et al., 2013).

Finally, the State Motivation to Foster Social Connections scale (SMSC), a newer validated measure that was developed by Bernstein et al. (2019), was unearthed and it was the perfect fit for this study. Interestingly, Bernstein et al. (2019) created this scale because they were having similar difficulties finding a measure to assess their particular research questions. Items on the SMSC evaluate participant in the moment motivation to connect socially with new and existing contacts. SMSC assesses the degree to which participants are oriented toward social connection with higher scores indicating greater state motivation to foster social connections. More specific details about SMSC are discussed in the Measures section in Chapter 2.

While the SMSC scale clearly helps elucidate the state social motivation construct, it doesn't adequately cover the entire concept. Mood is an important predictor of motivation and readiness to socially connect. Trait and state level studies have shown that positive affect is correlated with higher levels of social engagement and higher quality social interactions while Negative Affect is correlated with lower levels of social engagement and lower quality social interactions (Berry & Hansen, 1996; Watson et al., 1992). Since positive affect is associated with higher levels of social engagement and nature exposure has been shown to improve mood, it follows that positive affect may be an important component of state social motivation (McMahan & Estes, 2015; Reynolds et al., 2020). Therefore, the second measure included in the outcome variate is state positive affect, a subscale of the Positive and Negative Affect Schedule (Watson et al., 1988) which assesses positive emotions.

State anxiety was also chosen to be a part of the state social motivation variate because higher state anxiety may be an impediment to developing and maintaining social relationships. For example, disclosure is an important part of relationship building and Post et al. (1978) showed that participants with higher state anxiety disclosed less. Additionally, Bolmont and Abraini (2001) found evidentiary support for the hypothesis that the inverse relationship between high state anxiety and low mood states was because they were actually part of the same construct. State anxiety and mood state seem to be interconnected concepts and research suggests that nature exposure has anxiolytic effects and elevates mood (McMahan & Estes, 2015). Therefore, a third measure included in the outcome variate is state anxiety, a subscale of the State-Trait Anxiety Inventory (Spielberger et al., 1983) which assesses transient worry and apprehension.

The outcome variate, state social motivation, is an amalgamation of State Motivation to Foster Social Connections, State Positive Affect, and State Anxiety. Together, all three measures, inextricably and effectively describe readiness and motivation in the present moment to engage in social interactions. Specific hypotheses are detailed later, however, it was predicted that nature exposure would increase state social motivation. Increased state social motivation is achieved by simultaneously increasing State Motivation to Foster Social Connections, increasing State Positive Affect, and decreasing State Anxiety.

Adverse Childhood Experiences (ACEs)

It is important to know if nature exposure helps facilitate social relationships, however, it is also important to know if this effect extends to vulnerable populations. People who have experienced adverse childhood experiences (ACEs) are at greater risk for developing health risk behaviors and chronic diseases as adults and represent a vulnerable population (Felitti et al.,

1998). Compared to adults without ACEs, ACEs-exposed adults are more likely to adopt health risk behaviors such as smoking and illicit drug use (Felitti et al., 1998). Additionally, ACEs-exposed adults are at greater risk of being diagnosed with chronic diseases, such as ischemic heart disease, diabetes, cancer, stroke, chronic bronchitis/emphysema, and depression. Chronic diseases are major contributors to disability and increased healthcare costs in the United States (Centers for Medicare and Medicaid Services, 2017; Felitti et al., 1998; Office of Disease Prevention and Health Promotion, 2009). Therefore, this study investigated the effect of nature exposure on state social motivation and if that effect was moderated by ACEs.

ACEs Study

Adverse childhood experiences (ACEs) is a term coined by Felitti et al. (1998) in pioneering research that studied the effects of abuse, neglect and household dysfunction in childhood on adult health outcomes. The authors of the study collaborated with a large health maintenance organization (HMO), Kaiser Permanente, to conduct the research. The ACEs study recruited 17,421 adult participants who filled out a questionnaire about their adverse childhood experiences and completed a medical history and evaluation. The questionnaire gathered data about ten adverse childhood experiences: psychological abuse, physical abuse, sexual abuse, neglect, substance abuse in the home, mental illness in the home, divorce, violence in the home toward mother/stepmother, alcoholism in the home, and household criminal behavior. The questionnaire data were then analyzed with the health data from the 17,421 adult participants. The results showed that there was a strong dose-response relationship between the cumulative effects of ACEs and adult health outcomes and health risk behaviors. For example, odds ratios indicated that adult participants with four or more ACEs were more likely to be diagnosed with ischemic heart disease (2.2X), any cancer (1.9X), stroke (2.4X), chronic bronchitis or

emphysema (3.9X), diabetes (1.6X), and depression (4.6X) compared to participants with no ACEs. Additionally, adult participants with four or more ACEs were more likely to adopt behaviors that put their health at risk, such as smoking (2.2X), alcoholism (7.4X), illicit drug use (4.7X), injected drug use (10.3X), and attempted suicide (12.2X). ACEs are common (2/3 of people have at least one ACE), they predict chronic disease and health risk behaviors, and Felitti et al. (1998) argue that ACEs are the leading determinant of health and well-being in the United States. Therefore, this study examined whether or not ACEs scores moderate the effect of nature exposure on state social motivation. First, the author attempted to answer the question: "Does nature exposure increase state social motivation?" Second, "Do individuals who have experienced ACEs also increase state social motivation after nature exposure, albeit to a lesser extent?"

The Centers for Disease Control and Prevention's (CDC) ACEs pyramid provides a visual representation, or framework, that details the possible mechanisms by which negative health outcomes occur in relationship to ACEs (CDC, 2019; Felitti et al., 1998). ACEs can lead to disrupted neurodevelopment, which in turn can lead to social, emotional, and cognitive impairment. These impairments may then lead to the adoption of health risk behaviors, which can then culminate in disease, disability, social problems and early death (Felitti et al., 1998; CDC, 2019). Recommendations to address ACEs and their potential subsequent health outcomes include primary prevention (preventing ACEs in the first place), secondary prevention (preventing health risk behaviors as a reaction to ACEs), and tertiary care (addressing ACEs, chronic disease, and health risk behaviors once they are already present) (Felitti et al., 1998). This research sought to address the need for tertiary care for adults who are ACEs-exposed by studying an intervention that may benefit social health, and therefore, overall health.

Social Support

There is little research on effective interventions for ACEs exposed adults (Kortana et al., 2016). Social support may buffer the effects of trauma. However, the experience of trauma in childhood may impact a person's ability to form and maintain good social connections with others. Poole et al. (2018) found that ACEs exposure predicted adult interpersonal difficulties. Interpersonal difficulties were measured using the Inventory of Interpersonal Problems-32 (IIP-32), a 32 item questionnaire that assesses the degree to which a person is socially inhibited, non-assertive, overly accommodating, self-sacrificing, intrusive/needy, domineering, vindictive, and cold/distant on a scale from 0 (*not at all*) to 4 (*extremely*). Further, emotion dysregulation mediated the relationship between ACEs exposure and interpersonal difficulties (Poole et al., 2018). Previous research suggests that nature exposure could potentially help adults improve emotion regulation. For instance, in an experimental study, Beute and de Kort (2014) found that compared to viewing pictures of urban scenes, viewing pictures of natural scenes for just three minutes increased self-regulation abilities, mood, and heart rate variability in participants. Beute and de Kort (2014) argue that nature exposure has an 'instorative' effect that goes beyond the restorative effects described by Attention Restoration Theory and Stress Reduction Theory that occur after depletion. Could the joint restorative and instorative effects of nature exposure decrease stress, allowing for more self-control and greater possibilities for positive social interactions?

Traumatic Toxic Stress

Traumatic toxic stress (TTS) can occur because of chronic stressors, like ACEs, which may lead to chronic stress response activation (Oral et al., 2016). The hypothalamic pituitary adrenal (HPA) axis and the sympathetic nervous system are involved in stress response

activation (Oral et al., 2016). When a person perceives a stressor, the hypothalamus releases proinflammatory cytokines and corticotropin-releasing hormone triggering the pituitary gland to release adrenocorticotropin-releasing hormone, causing the adrenal glands to release cortisol, norepinephrine, and epinephrine, all of which are all involved in sympathetic nervous system activation and the fight-or-flight response. This cascade of events can lead to neuroendocrine and immune system problems. Acutely, high basal cortisol levels in the system leads to suppression of the immune system which can prompt illness and infection. Interestingly, long-term HPA dysregulation can lead to low basal cortisol levels in the system, resulting in chronic inflammation, an integral part of chronic disease (DeVries et al., 2003; Kalmakis et al., 2015; Oral et al., 2016; Tarullo & Gunnar, 2006).

In addition to these neurobiologic events, traumatic toxic stress can cause remodeling of the hippocampus, prefrontal cortex, and amygdala. The changes in the hippocampus are associated with less neuronal growth and impairments in learning and memory while the changes in the amygdala are associated with an increase in impulsive behavior. Unfortunately, the remodeling of the prefrontal cortex often leads to poor impulse control and planning because of fewer synaptic connections due to underdevelopment (Oral et al., 2016). Therefore, increased impulsivity, coupled with the lessened ability to control impulses, can lead to dire health consequences, such as the adoption of health risk behaviors (often chosen as a maladaptive coping mechanism to deal with the toxic stress), poor social relationships, due in part to impulsivity (Oral et al., 2016), attachment anxiety (Corcoran & McNulty, 2016), and rejection-sensitivity, which entails interpreting ambiguous social interactions as threatening and behaving in a way the breeds further rejection (Downey et al., 1998; Godleski et al., 2019).

Because social relationships seem to be protective for individuals with ACEs exposure, it is imperative that researchers find interventions that help people who have experienced ACEs initiate and maintain relationships with others. This research tested nature exposure as a novel intervention aimed at improving social motivation for ACEs-exposed adults. Currently, to the author's knowledge, there is no published experimental research that has previously examined this problem.

Hypotheses

Based on previous empirical research, it is predicted that compared to non-nature exposure, nature exposure will cause greater state social motivation. Additionally, it is predicted that higher ACE scores will attenuate the effect of nature exposure on state social motivation will be attenuated. The specific hypotheses are below.

H1: State social motivation will significantly differ between nature exposure groups.

H1a: Mean scores for State Motivation to Foster Social Connections will be higher in the nature exposure group compared to the non-nature exposure control groups.

H1b: Mean scores for Positive Affect will be higher in the nature exposure group compared to the non-nature exposure control groups.

H1c: Mean scores for State Anxiety will be lower in the nature exposure group compared to non-nature exposure control groups.

H2: The effects of nature exposure on state social motivation will be significantly moderated by higher ACE scores.

Exploratory Analyses:

1. Will State Motivation to Foster New Social Connections or State Motivation to Foster Existing Social Connections significantly differentiate nature exposure groups by state social motivation?
2. Does Negative Affect impact state social motivation?

Chapter 2. Methods

Power Analysis

An *a priori* power analysis to calculate the target sample size for this study was conducted using G*Power (version 3.1), a free software tool used to conduct statistical power analyses (Faul et al., 2009). In order to conduct a one-way multivariate analysis of variance (MANOVA) for $f^2 = 0.0625$ (medium effect size which is equivalent to $d = .52$; Brysbaert & Stevens, 2018), $1\text{-}\beta = 0.80$, and $\alpha = 0.05$, it was determined that the minimum number of total participants needed for this study was N = 114 (Appendix A). The initial participant sample of N = 700 generously exceeded the number of participants required to detect an effect at $\alpha = 0.05$.

Participants

In order to protect the safety of the study participants, approval for this research was obtained from East Tennessee State University's Institutional Review Board (IRB#: c0620.17sd) prior to recruitment of human subjects and data collection. A total of 700 participants began the online survey, however, 159 (22.71%) did not answer any survey questions or participate in the experimental manipulation and were excluded from data analysis. Additionally, 4 (0.57%) erroneous observations were excluded due to them being the result of the researcher testing the data capture system when the study commenced. Furthermore, 44 (6.28%) participants' data were excluded due to failed attention checks, and 49 (7%) participants were excluded due to insufficient participation time (< 2.2 minutes) in the experimental manipulation (McAllister et al., 2017). After excluding observations for 256 (36.5%) total participants, N = 444 participants remained in the study sample for data analyses, a number well above the required participant sample needed to detect an effect.

Four hundred and forty-four adult participants ranging in age from 18 to 58 years old (M_{Age} = 20.64, SD = 5.52) were recruited through Facebook, an online social media platform, and through Sona Systems (2018), a cloud-based participant management software tool that aids in participant recruitment and management. The majority of participants were female (68.5%) and Caucasian (88.1%). Participants recruited from the general population via Facebook were not given any incentive to participate in this research whereas ETSU undergraduate students recruited through Sona Systems were given course credit for their research participation. Demographics for study participants are included in Table 1.

Table 1

Participant Demographics by Group

	Wilderness Nature Exposure (*n* = 140)		Urban Non-Nature Exposure (*n* = 152)		Indoor Non-Nature Exposure (*n* = 152)		Total Sample (N = 444)	
	n	%	*n*	%	*n*	%	*n*	%
Gender								
Female	96	68.5	103	67.7	105	69	304	68.5
Male	41	29.2	47	30.9	42	27.6	130	29.3
Transgender Female	0	0	0	0	0	0	0	0.0
Transgender Male	2	1.4	1	0.6	1	0.6	4	0.9
Gender variant/ non-conforming	1	0.7	1	0.6	3	1.9	5	1.1
Prefer not to answer	0	0	0	0	1	0.6	1	0.2
Race								
White	120	85.7	136	89.4	135	88.8	391	88.1
African-American or African	20	14.2	13	8.5	12	7.8	45	10.1
Hispanic or Latinx	3	2.1	5	3.2	12	7.8	20	4.5
Middle Eastern	0	0	0	0	0	0	0	0.0
East Asian or South Asian	3	2.1	4	2.6	0	0	7	1.6
Native Hawaiian or other Pacific Islander	0	0	0	0	1	0.6	1	0.2
Native American or American Indian	1	0.7	1	0.6	1	0.6	3	0.7
Caribbean	0	0	0	0	0	0	0	0.0
Other	1	0.7	0	0	1	0.6	2	0.5
	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range	Mean (*SD*)	Range
Age in years	20.3 (5.1)	18-58	21.2 (6.1)	18-57	20.3 (5.2)	18-53	20.64 (5.5)	18-58

Note. Participants are listed in each racial category that they reported. Therefore, totals may be larger than the sample size of each group and the percentages may be greater than 100%.

Materials

Software Platforms

Research Electronic Data Capture (REDCap). REDCap, a secure web-based online survey software platform hosted by East Tennessee State University, was used for study development, data collection, and management (Harris et al., 2019; Harris et al., 2009). REDCap was programmed to randomize participants into one of three experimental conditions and to administer demographic and research questionnaires necessary for the present research. After data collection concluded, study data were downloaded from REDCap for data analyses.

Sona Systems. The study was disseminated through Sona Systems, a cloud-based software platform that helps researchers recruit and manage participant pools (Sona Systems, 2018). Details and inclusion criteria for this online study were advertised on Sona Systems as an opportunity for undergraduate students to earn course credit by fulfilling their research participation requirement (Appendix B). If an undergraduate student decided to participate in the online study, they enrolled in the study through Sona and were awarded research participation credit after completion of the study.

Statistical Package for the Social Sciences (SPSS). International Business Machine (IBM) Statistical Package for the Social Sciences (SPSS) is a software platform used for statistical data analysis (IBM Corporation, 2020). IBM SPSS Version 27 was used to analyze data from this study (e.g. one-way MANOVA, descriptive statistics). IBM SPSS Version 26 was also used to conduct moderation analyses using Hayes' (2018) PROCESS Version 3.4.

PROCESS. PROCESS is free statistical modeling software package created by Andrew Hayes (2018) that can be downloaded into SPSS as a plug-in. PROCESS was used to conduct the moderation analyses in SPSS.

Facebook. In addition to Sona, participants were also recruited through Facebook, software that provides an online social media platform.

Experimental Manipulation Videos

Wilderness Nature Exposure (WNE). The wilderness nature exposure video consists of a 15-minute virtual walk through a verdant forest. Bird and river sounds are present (https://vimeo.com/436820451/f975870a7a). The wilderness nature exposure video was the experimental condition.

Urban Non-Nature Exposure (UNNE). The urban non-nature exposure video consists of a 15-minute virtual walk through urban sidewalks and streets in New York City. Various traffic sounds and sounds of people talking and moving through the space are present (https://www.youtube.com/watch?v=tA3R36vtagY&feature=youtu.be). The urban nature exposure video was a control condition set outdoors.

Indoor Non-Nature Exposure (INNE). The indoor exposure video consists of a 15-minute virtual walk through an indoor shopping mall. Typical mall sounds including music and people talking are present (https://www.youtube.com/watch?v=G5rGI-eJAmc&feature=youtu.be). The indoor non-nature exposure was a control condition set indoors.

Design

An experimental research method was employed to answer the research questions. Specifically, this online research study was a randomized controlled trial (RCT) with a between-subjects, single-blind, post-test experimental design.

Procedure

Participants enrolled in the online study through Facebook or Sona. Once participants entered the study online, participants were immediately greeted by an informed consent

document. Participants were instructed to read the document, which contained information about the study, the researchers, compensation, possible benefits to participation, possible risks to participation, and data use. As this was a deception study, participants were told that the purpose of the study was to examine how going on a virtual walk affects the self while the true purpose of the study was to examine the influence of nature exposure on motivation to foster social connections and to investigate whether or not adverse childhood experiences might moderate that relationship.

After reading the informed consent, participants were asked to affirm that they consented to being in the study, that they read and understood English fluently, and that they were at least 18 years old. If participants consented to being in the study, they were asked to fill out an online demographics questionnaire (Appendix C). If participants did not consent to participation, the online study ended.

Next, participants were told they would watch a 15-minute video and then answer questions on four questionnaires. Participants proceeded to the next online page to read directions related to watching the video.

READ THE DIRECTIONS CAREFULLY BEFORE PROCEEDING

Directions:

Please take a 15 minute virtual walk by watching the video on the next page.

1. Put the video in full-screen mode (bottom right corner of video).

2. Turn the volume on so you can listen to the video while you watch it.

3. If you have headphones, please put on your headphones while you watch this video.

4. Please give your full attention to the 15 minute long video. You will be asked questions about this video after it ends.5. Watch the entire 15 minute video from start to

finish in one sitting. (e.g. don't press pause or fast-forward the video).

6. When you are ready to watch the video, click the "Submit" option and advance to the next page. Then, play the video.

7. If you aren't ready to watch the entire video right now, click the "Save & Return Later" option to come back to the video and this survey at a later time.

When participants proceeded to the video start page they were randomly assigned to watch one of three videos, either a wilderness nature exposure video, an urban non-nature exposure video, or an indoor non-nature exposure video. Participants were not aware that there were three different videos/conditions. The appropriate video played and after the participants finished watching it they moved on to the next page where they answered an attention check question: “Did you see a bear? Yes or No.”

After participants answered the attention check question they were asked to complete an 11-item questionnaire, the State Motivation to Foster Social Connections Scale (SMSC; Appendix D). Participants were asked how much they agreed or disagreed with statements on the questionnaire “right now.” There were 11 items on the questionnaire, 10 items from the scale and one attention check item that read, “Right now I’m paying attention to this survey and I will select disagree.”

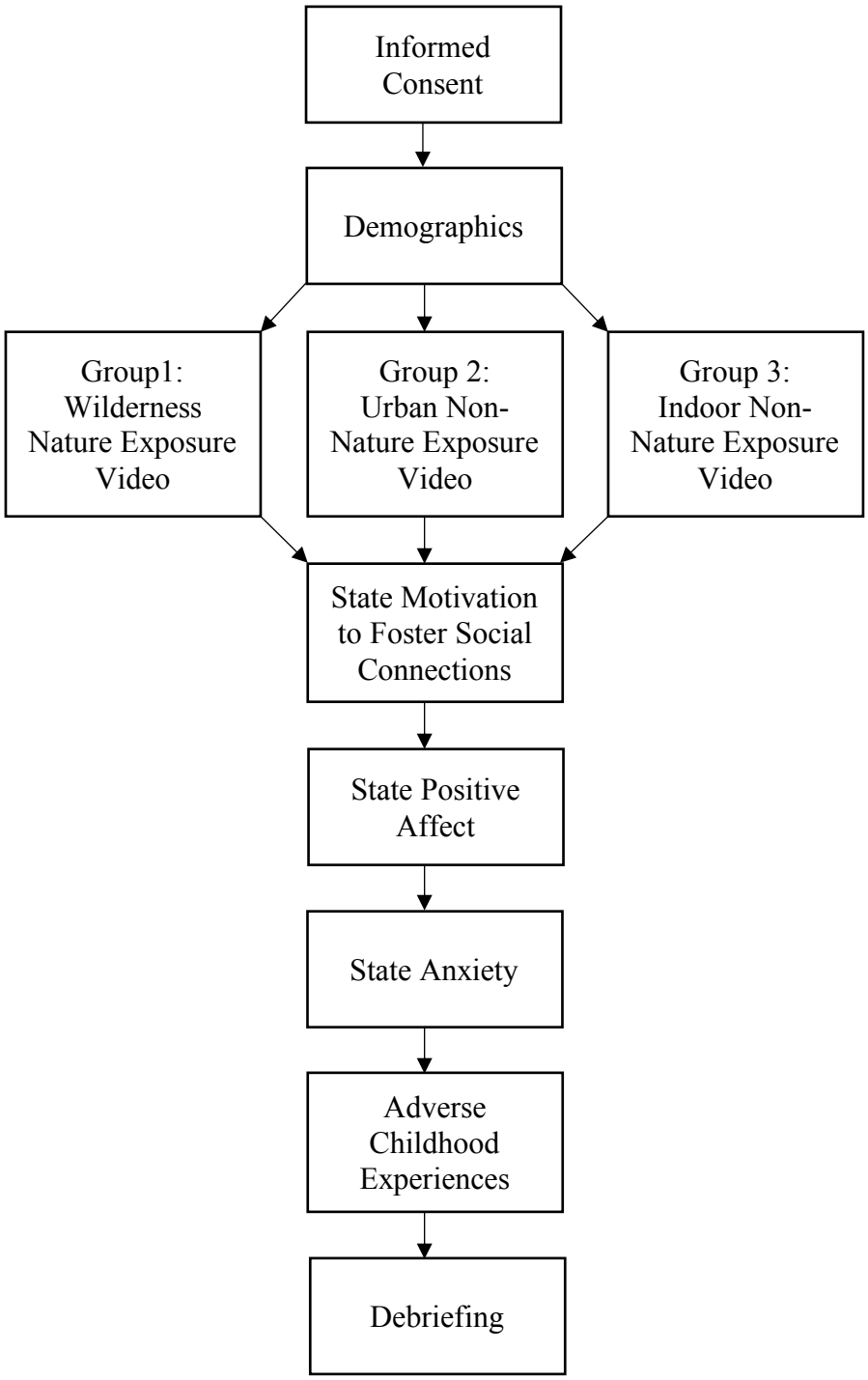
The next questionnaire participants encountered was the Positive and Negative Affect Schedule (Appendix E). Participants were instructed to answer how they felt “at this moment” in regard to the statements provided. There were 21 items on this measure; however, only 20 items were from the actual measure. One item was another attention check question, “I will click on ‘Not At All’ to show that I’m paying attention.” This was the final attention check.

Participants were asked to indicate how they felt “right now” in the “present moment” in

regard to 20 words on the next questionnaire, the state anxiety inventory (Appendix F). Finally, participants answered 10 yes or no questions from the adverse childhood experiences questionnaire (Appendix G) and were then taken to the debriefing page. The debriefing document (Appendix H) thanked participants for their participation, told participants the true purpose of the research, and gave contact information for the researcher in case they had questions and information for mental health resources. A flowchart of the experimental procedure online is represented in Figure 1.

Figure 1

Flowchart of Experimental Procedure Online



Measures

Demographics

The demographics questionnaire (Appendix C) included items about participants' age, gender identity, racial/ethnic identity, and language spoken at home. Demographics for study participants by condition are included in Table 1.

Dependent Variables

State social motivation is a composite outcome variable (variate) comprised of the three dependent variables: State Motivation to Foster Social Connections, State Positive Affect, and State Anxiety.

State Motivation to Foster Social Connections (SMSC). *State Motivation to Foster Social Connections Scale* (SMSC; Bernstein et al., 2019) is a 10-item self-report measure of state motivation to foster social connections with new and existing contacts (Appendix D). The SMSC measure can be utilized by evaluating a total score or one of two subscale scores. The outcome variate included the total score for SMSC. Participants were asked to read statements and rate the extent to which they agreed or disagreed with those statements with regard to how they were feeling "right now." Participants responded to each item on a scale ranging from 1 (*strongly disagree)* to 7 (*strongly agree*). Total scores were summed and could range from 10 to 70 with higher scores indicating greater State Motivation to Foster Social connections. Examples of items from the SMSC include, "Right now, I would like to meet new people" and "Right now, I'd like to be around friends." The SMSC scale has shown good convergent and divergent validity and test-retest reliability (Bernstein et al., 2019). The internal consistency for the SMSC items was α =.92 for this sample.

State Motivation to Foster Social Connections with New Contacts (SMSC-N). The subscale, State Motivation to Foster Social Connections with New Contacts (SMSC – N; Bernstein et al., 2019), was utilized for exploratory analyses. It consists of 5 items from the primary scale (Appendix D). Total scores were summed and could range from 5 to 35 with higher scores indicating greater State Motivation to Foster Social Connections with new contacts. One example item from the SMSC–N subscale states, "Right now, meeting new people and finding out about them is something I am interested in doing." The internal consistency for the SMSC-N items was $\alpha = .94$ for this sample.

State Motivation to Foster Social Connections with Existing Contacts (SMSC-E). The subscale, State Motivation to Foster Social Connections with Existing Contacts (SMSC – E; Bernstein et al., 2019), was utilized for exploratory analyses. It consists of 5 items from the primary scale (Appendix D). Total scores were summed and could range from 5 to 35 with higher scores indicating greater State Motivation to Foster Social Connections with existing contacts. One example item from the SMSC–E subscale states, "Right now, I'd rather be with my friends and family than alone." The internal consistency for the SMSC-E items was $\alpha = .88$ for this sample.

State Positive Affect (PA). The *Positive and Negative Affect Schedule* (PANAS; Watson et al., 1988) is a self-report measure with two affect sub-scales, one 10-item scale that measures positive affect and one 10-item scale that measures Negative Affect. For the purposes of this study, only scores from the sub-scale for State Positive Affect (PA) were included as part of the outcome variate in the primary statistical analysis. Participants read a list of 10 words depicting feelings and were asked to indicate the extent to which they felt this way, "right now, at the present moment." Participants responded to each item on a 5-point Likert scale ranging from 1

(*very slightly or not at all*) to 5 (*extremely*). Examples of items from the PANAS reflecting Positive Affect are interested, excited, strong, and enthusiastic. PA scores were summed and could range from 10 to 50 with higher scores indicating greater levels of Positive Affect (Appendix E). The internal consistency for the PA items was $\alpha = .90$ for this sample.

State Negative Affect (NA). The *Positive and Negative Affect Schedule's* (PANAS; Watson et al., 1988) 10-item sub-scale measuring Negative Affect was utilized for exploratory analyses. Participants responded to each item on a 5-point Likert scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). Examples of items from the PANAS reflecting Negative Affect are distressed, upset, scared, and irritable. NA scores were summed and could range from 10 to 50 with higher scores indicating greater levels of Negative Affect (Appendix E). The internal consistency for the NA items was $\alpha = .90$ for this sample.

State Anxiety (SA). The *State-Trait Anxiety Inventory* (STAI; Spielberger et al., 1983) is a 40-item measure of state and trait anxiety (20 items for state anxiety and 20 items for trait anxiety). The 20-item subscale for state anxiety (*STAI Form Y-1*) was used in this study (Appendix F). For state anxiety, participants were asked to rate how they felt in the moment (e.g., "I am worried; I feel nervous") using answer choices on a 4-point scale from 1 (*not at all*) to 4 (*very much so*). Ten items were reverse scored (e.g., "I feel content; I feel calm") and then all 20 items were summed for a total score. Total scores could range from 20 to 80 with higher scores indicating greater state anxiety. Evidence suggests that the state anxiety inventory is a valid scale with good internal consistency and reliability (Spielberger et al., 1983; Spielberger, 1989). The internal consistency for the SA items was $\alpha = .94$ for this sample.

Potential Moderator

Adverse Childhood Experiences (ACEs). The *Adverse Childhood Experiences Questionnaire* (ACE; Felitti et al., 1998) is a 10-item instrument that assesses adults' exposure to potentially traumatic experiences in childhood (Appendix G). Participants answered 10 dichotomous yes or no questions. The total number of "yes" answers was summed to obtain a score for total exposure to adverse childhood experiences. This is referred to as the ACE score. Higher scores indicate greater exposure to adverse experiences in childhood. Two examples of ACE items include, "Did a parent or other adult in the household often push, grab, or slap, or throw something at you or ever hit you so hard that you had marks or were injured?" and "Did you often feel that you didn't have enough to eat, had to wear dirty clothes, and had no one to protect you or your parents were too drunk or high to take care of you or take you to the doctor if you needed it?" Khan and Renk, (2018) and Corcoran and McNulty (2018) have found the ACE measure to be adequately reliable ($\alpha = 0.86$ and $\alpha = 0.67$ respectively). The internal consistency for the ACE items was $\alpha = .78$ for this sample.

Statistical Analyses

First, Pearson's correlation coefficients were calculated between all dependent variables (SMSC, PA, SA) in order to assess their relationship as a potential outcome variate, state social motivation, as well as to assess for possible multicollinearity. Second, a one-way multivariate analysis of variance (MANOVA) was conducted to investigate group mean differences between nature exposure conditions on state social motivation. Finally, a moderation analysis was conducted to explore ACEs as a moderator of nature exposure and state social motivation. Additionally, as is common with most statistical analyses, assumptions were checked with

various statistical tests and descriptive statistics were conducted in order to understand the data better.

Chapter 3. Results

After data were collected, the data were screened for bias and then analyzed.

Data Screening

Raw data included observations from 700 participants. A large number of participants were removed from the data set due to not completing any survey data (n = 159). Participants were also removed from the data set due to failing attention checks (n = 42) and for failing to watch the randomly assigned video for more than 2.33 minutes (n = 49), which is the lowest nature video time known to the author to have shown/produced an effect (McAllister et al., 2017). This left 444 participant observations for analyses.

Attention Checks

Forty-two participants were removed from the data set because they failed attention checks. One attention check was embedded as a question in the *State Motivation to Foster Social Connections Scale* (e.g., "Right now, I'm paying attention to the survey and I will select disagree") and one attention check was embedded in the *State Anxiety Instrument* (e.g., "I will click on 'Not at All' to show that I'm paying attention"). Oppenheimer et al. (2009) found that using instructional manipulation checks (IMC) helped increase statistical power by removing participants from the data who were answering survey questions randomly and/or not reading the survey instructions/questions.

A third attention check question, "Did you see a bear in this video?", was included in the study directly after participants watched the randomly assigned video. This attention check was excluded from the data cleaning process for two reasons. First, a large number of participants (n = 87) did not watch the entire video and it would be difficult (if not impossible) for them to answer the attention check question correctly if they had not watched the entire randomly assigned video. Specifically, 20 participants in the wilderness nature exposure group did not

watch the entire 15-minute video (range: 2.42 – 12.87 minutes), 33 participants in the urban non-nature exposure group did not watch the entire video (range: 2.37 – 14.93 minutes), and 34 participants in the indoor non-nature exposure condition did not watch the entire video (range: 2.82 – 14.77 minutes). Additionally, the attention check question was deemed problematic due to various interpretations of what "seeing a bear" meant (e.g. live bear, bear on a sign, or a stuffed animal bear).

Virtual Walk Length

Participants in this study were randomly assigned to watch a 15-minute video that took them on a virtual walk inside a shopping mall, on the streets of New York City, or in a natural wilderness. McCallister et al. (2017) found that just 2 minutes and 20 seconds (2.33 minutes) to 2 minutes 35 seconds of video time (i.e., wild nature, urban nature, control) was enough time to significantly influence results in their study. No other studies were found that had less time in their experiments with significant results. Therefore, participants who watched the randomly assigned video for less than 2 minutes 20 seconds were excluded from data analyses and all participants who watched the videos for 2 minutes and 20 seconds or more were included in the data analyses.

One-Way Multivariate Analysis of Variance (MANOVA)

The study data were analyzed using a one-way multivariate analysis of variance (MANOVA) statistical model that was conducted in IBM SPSS (Version 27) software. A one-way MANOVA is a statistical test that analyzes the effects of one or more independent variables (with two or more levels) on more than one dependent variable (Field, 2013). In this study, the one-way MANOVA examined the main effect of the independent categorical variable (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure) on three

continuous dependent variables (SMSC, PA, SA) that were analyzed as one construct, state social motivation. In other words, the one-way MANOVA examined the differences between the means of three groups across three dependent variables simultaneously.

Several strengths that a one-way MANOVA has over multiple one-way ANOVAs are the ability to study several dependent variables at once, the possibility of discovering meaningful differences that might not be accounted for by one-way ANOVAs due to greater statistical power, and the ability to help guard against a Type I error (e.g., conducting multiple ANOVAs instead; Field, 2013; Warne, 2014). Potential limitations of a one-way MANOVA include the fact that the output for a one-way MANOVA can be more complicated to interpret than one-way ANOVAs, further statistical tests usually need to be run to more deeply analyze the data, and there is an assumption that sample sizes will be equal (Field, 2013; Warne, 2014).

Assumptions

There are ten assumptions that need to be satisfied when conducting a one-way MANOVA (Field, 2013). It is important to review the assumptions for one-way MANOVA as they can be sources of potential bias in the results.

The first assumption for one-way MANOVA is that there are two or more continuous dependent variables (DV). The three dependent variables (SMSC, PANAS, SA) are self-report Likert scale questionnaires that produce ranked data (Morling, 2017). There is an ongoing debate about whether or not ordinal (ranked) variables should be considered ordinal data or continuous data when they are being analyzed (Carifio & Perla, 2007; Jamieson, 2004; Norman, 2010). Norman (2010) extensively tested real and simulated Likert scale data (ordinal data) using parametric and non-parametric tests and concluded that parametric tests are more robust statistical tests for examining ordinal data. Field (2013) Carifio and Perla (2007) argue that

Likert scales actually produce interval data that can and should be examined using parametric tests. For example, on a Likert scale from 1 to 7 where 1 = *strongly disagree* and 7 = *strongly agree*, it is assumed by most researchers that the distances between each number on the scale are equal and are, therefore, interval data (Morling, 2017). After consulting the literature, the Likert scale data in this study that make up the dependent variables will be considered interval data (continuous) for the purpose of analysis. Hence, the first assumption one-way MANOVA, two or more continuous dependent variables, was met.

The second assumption for a one-way MANOVA is that there is only one categorical independent variable (IV) with two or more independent groups. Study data met this assumption because there was only one categorial independent variable (level of nature exposure) with three levels (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure).

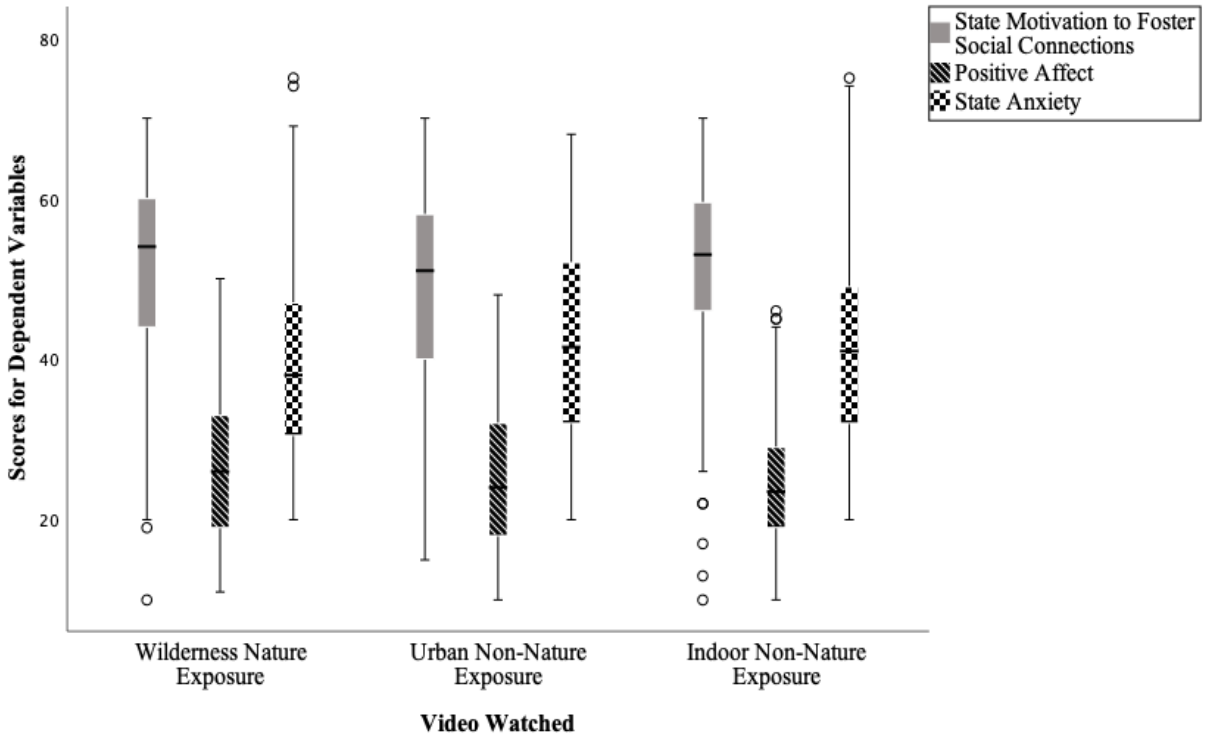
The third assumption for a one-way MANOVA states that there needs to be independence of observations. This means that each group should have different participants that have no relationship. The third assumption was met because participants were randomly assigned to one of three groups and no participants were in more than one group.

The fourth assumption for a one-way MANOVA is that there are no univariate or multivariate outliers. Detection of univariate outliers was assessed by examining boxplots of the data. Thirteen outliers were detected by inspecting boxplots (Figure 2). After closer investigation, all thirteen participant observations were scores in ranges appropriate for the scales (e.g., a score of 10 on a scale that spans from 10 to 70) and did not represent data entry or measurement errors. The 13 univariate outliers were winsorized (Field, 2013), replaced with the next highest score that was not an outlier, to see if it would impact the significance of the one-way MANOVA and it did not. The difference between groups was still statistically significant

with the univariate outliers removed (Roy's largest root = 0.022, $F(3, 440) = 3.208$, $p = 0.023$, partial $\eta^2 = 0.021$). Therefore, the univariate outliers were not removed from the data because they represented genuine data and they did not impact the overall significance of the one-way MANOVA. The one-way MANOVA was significant with and without the univariate outliers.

Figure 2

Boxplot Graph of Participant Scores and Outliers



Note. Each of the circles represents outlier scores. There are thirteen outliers; however, only eleven circles are represented in the graph. Two of the circles actually represent two participant outlier scores (each) that were the same.

Multivariate outliers were assessed by Mahalanobis distance which indicated that there was one multivariate outlier ($p > 0.001$) out of 444 cases. The critical value for three dependent

variables was 16.27 and the one outlier's Mahalanobis distance was 19.943. The one case identified as an outlier scored 13 on the SMSC (scores range from 10 -70), 41 on the PA (scores range from 10 – 50) and 36 on the SA (scores range from 20 – 80). The identified multivariate outlier represents genuine data and was not a measurement error or a data entry error. The multivariate outlier violates one of the assumptions of one-way MANOVA. However, Leys et al. (2019) contend that it is perfectly reasonable to keep meaningful multivariate outliers in the data set if they truly represent the sample, which this case does. Additionally, outliers can sometimes be a source of interesting information that helps researchers generate future hypotheses (Leys et al., 2019). The multivariate outlier was removed to see whether it impacted the significance of the one-way MANOVA and it did not; the difference between groups was still statistically significant with the multivariate outlier removed (Roy's largest root = 0.021, $F(3, 439) = 3.126$, $p = 0.026$, partial $\eta^2 = 0.021$). Therefore, the multivariate outlier case will not be removed and it will be kept in the data set for data analysis because it is an authentic part of the sample population.

Multivariate normality is the fifth assumption for a one-way MANOVA. Normality can usually be assumed in large samples with hundreds of observations because as the sample gets larger the distribution becomes more normal (Altman and Bland, 1995). In fact, Central Limit Theorem states that normal distribution is assumed for sample sizes larger than 30 (Field, 2013, p. 170-172; Lumley et al., 2002). SMSC scores, PA scores and SA scores were approximately normally distributed for the wilderness nature exposure, urban non-nature exposure, and indoor non-nature exposure groups as assessed by visual inspection of their histograms and Normal Q-Q Plots. Contrary to visual inspection and typical "rules of thumb" with large samples, the dependent variables were not normally distributed for any of the three groups, as assessed by the

Shapiro-Wilk test ($p < .05$); however, the Shapiro-Wilk test for normality works better for small groups (<50) (Kim, 2013). Therefore, more normality tests were investigated. Since this was a large sample size, skewness and kurtosis were also used to inspect normality. Normal distribution for this large sample (> 300) was supported by the absolute values of skewness and kurtosis that fell below the cutoffs of 2 and 7 respectively (Kim, 2013). Table 2 contains skewness, kurtosis, and standard error measurements for each of the dependent variables. After assessing the conflicting information about normality, the evidence was weighed and normality was assumed.

Table 2

Skewness, Kurtosis, and Standard Error for Dependent Variables

		Skewness	Kurtosis
SMSC	Wilderness	-711 (.205)	.400 (.407)
	Urban	-.396 (.197)	-.437 (.391)
	Indoor	-.900 (.197)	1.012 (.391)
PA	Wilderness	.284 (.205)	-.680 (.407)
	Urban	.426 (.197)	-.739 (.391)
	Indoor	.576 (.197)	.065 (.391)
SA	Wilderness	.704 (.205)	.058 (.407)
	Urban	.187 (.197)	-.967 (.391)
	Indoor	.457 (.197)	-.088 (.391)

Note. Standard errors for skewness and kurtosis are listed in the ().

[a] SMSC = State Motivation to Foster Social Connections [b] PA = Positive Affect [c] SA = State Anxiety [d] Wilderness = wilderness nature video [e] Urban = urban non-nature video [f] Indoor = indoor non-nature video.

The absence of multicollinearity is the sixth assumption that has to be met for a one-way MANOVA. In a one-way MANOVA, it is desirable to have dependent variables moderately correlated with one another because this shows that the variables have a relationship with one

another that may be meaningful and this provides support for an overall construct of which the dependent variables may be a part. However, it is undesirable to have highly correlated dependent variables because it is a signal that the dependent variables might be measuring the same factor. When dependent variables are highly correlated with one another it is an indication of multicollinearity. SMSC and PA had a moderate correlation ($r = 0.363$, $p < 0.001$), SA and PA also had a moderate correlation ($r = -0.449$, $p < 0.001$), and SA and SMSC had a small correlation ($r = -0.154$, $p = 0.001$). There was no multicollinearity as assessed by Pearson correlation coefficients and the assumption was met. Table 3 shows the Pearson correlation coefficients for the dependent variables.

Table 3

Pearson Correlations for Dependent Variables

Variable	1	2	3
1. State Motivation to Foster Social Connections	-		
2. State Positive Affect	.363**	-	
3. State Anxiety	-.154**	-.449**	-

** Correlation is significant at the 0.01 level (2-tailed).

The seventh assumption for a one-way MANOVA is that there should be linear relationship between the dependent variables for each group of the independent variable. There was a linear relationship between State Motivation to Foster Social Connections, Positive Affect, and state anxiety in each condition, as assessed by a visual inspection of scatterplots (Figures 3, 4, and 5). Therefore, the assumption of a linear relationship between the dependent variables for each group of the independent variable was met.

Figure 3

Scatterplots of Dependent Variables for Wilderness Nature Exposure Condition

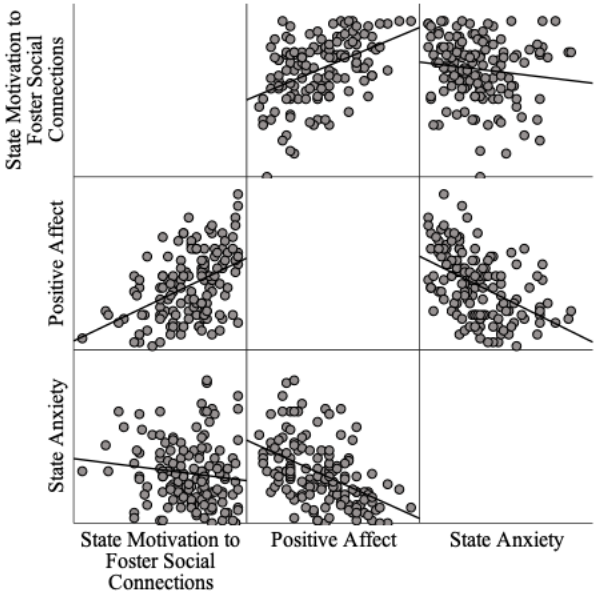


Figure 4

Scatterplots of Dependent Variables for Urban Non-Nature Exposure Condition

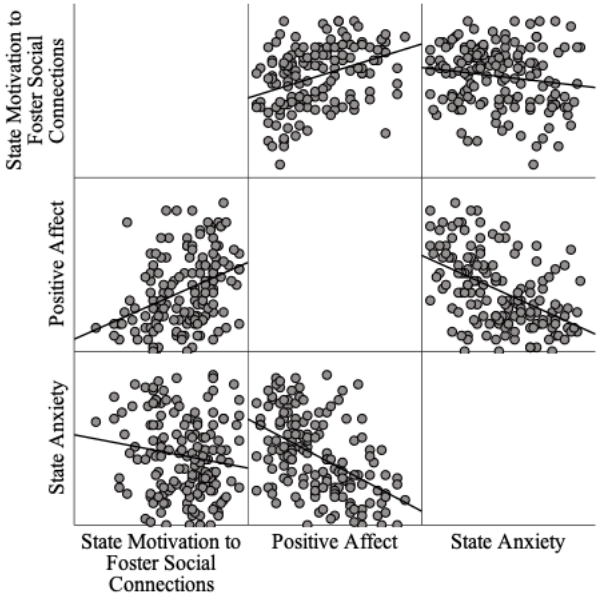
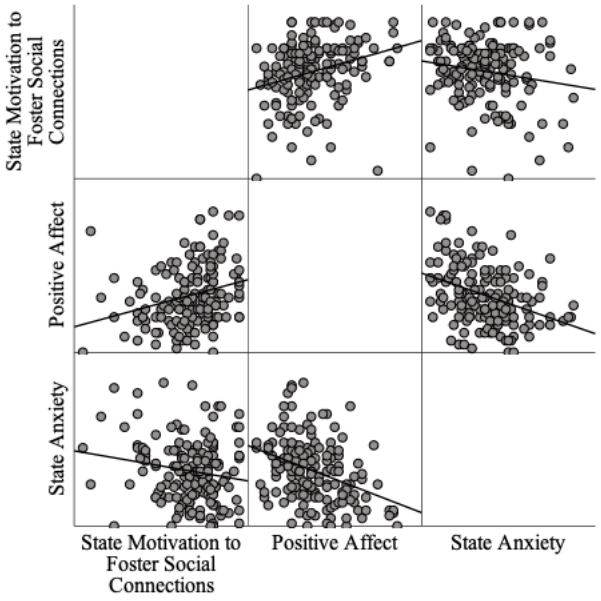


Figure 5

Scatterplots of Dependent Variables for Indoor Non-Nature Exposure Condition



Assumption eight for a one-way MANOVA is adequate sample size. Each condition of the independent variable should have at least as many cases as there are dependent variables to fulfill the minimum requirements for this assumption. There were three dependent variables and each group of the independent variable had well over three cases (see Table 4). Therefore, the assumption of adequate sample size was met.

Table 4

Sample Size for Each Condition of the Independent Variable

		Condition	*n*
Condition	1	Wilderness Nature Exposure	140
	2	Urban Non-Nature Exposure	152
	3	Indoor Non-Nature Exposure	152

Note. $N = 444$

The ninth assumption of one-way MANOVA is homogeneity of variance-covariance matrices which is tested by Box's test of equality of covariance matrices (also known as Box's M). Box's M tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups. If this test is significant ($p < 0.001$) the assumption has been violated. Box's test of equality of covariance matrices indicated that there was homogeneity of variance-covariances matrices ($p = 0.520$). Therefore, the assumption of homogeneity of variance-covariance matrices was met.

The tenth assumption of the one-way MANOVA is that there should be homogeneity of variances between nature exposure groups for each dependent variable. This was tested using Levene's test of equality of variances. A significant Levene's test ($p < .05$) is an indicator that

the variances are significantly different between different groups. Homogeneity of variances for the dependent variable SMSC, assessed by Levene's test of homogeneity of variance, were equal, $F(2, 441) = .430$, $p = .65$. Variances were also equal for SA, $F(2, 441) = .775$, $p = .46$. However, homogeneity of variances for PA was violated $F(2, 441 = 5.091$, $p = .007$. MANOVA is relatively robust to violations of homogeneity of variances especially if the group sizes are roughly equal (which is the case for this study). Additionally, with a large sample size, small differences in group variance can elicit a significant Levene's test that may not be meaningful (Field, 2013). Because there was conflicting information, Hartley's F_{max}, a variance ratio, was conducted to settle the matter regarding homogeneity of variance. The equation for Hartley's F_{max} is F_{max} = Larger Variance / Smaller Variance (Field, 2013; Pearson & Hartley, 1954). According to Hartley, one is the critical value for a sample size > 60 with $k = 3$ (Field, 2013; Pearson & Hartley, 1954). If the F_{max} is close to the critical value of one, homogeneity of variances is assumed. The assumption of homogeneity of variances was evaluated as met, $F_{max} = 1.46$.

Descriptive Statistics

After assumptions were checked, descriptive statistics for each condition were examined. As expected, the means for participants in the wilderness nature exposure condition are higher for State Motivation to Foster Social Connections and Positive Affect than the non-nature exposure control conditions. Additionally, as expected, the means for participants in the wilderness nature exposure condition are lower for State Anxiety compared to the non-nature exposure control conditions. The mean trend across all dependent variables was that nature exposure performed better on the dependent variables associated with state social motivation. Descriptive statistics are presented in Table 5.

Table 5

Descriptive Statistics

	Video	Mean	*SD*	*n*
State Motivation to Foster Social Connections	Nature	51.48	12.08	140
	Urban	48.80	11.79	152
	Indoor	51.13	11.90	152
	Total	50.44	11.95	444
State Positive Affect	Nature	26.63	8.61	140
	Urban	25.51	9.37	152
	Indoor	24.57	7.75	152
	Total	25.54	8.62	444
State Anxiety	Nature	39.16	12.34	140
	Urban	42.15	12.67	152
	Indoor	41.17	12.24	152
	Total	40.87	12.45	444

Note. *SD* = standard deviation, *n* = number of participants in the sample

One-Way MANOVA Results

In order to explore the research question, does nature exposure influence state social motivation, a one-way MANOVA was conducted. MANOVA is an omnibus hypothesis test that discerns whether or not there are mean group differences between the independent variable on the combined dependent variable.

The between-subjects variable was nature exposure (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure) and the combined dependent variable, state social motivation, was comprised of State Motivation to Foster Social Connections, State Positive Affect, and State Anxiety. All four multivariate test statistics showed significant mean group differences. Roy's largest root was the multivariate test statistic chosen to be reported due to its power and robustness (Field, 2013). There was a significant main effect of nature exposure on state social motivation, $\Theta = 0.018$, $F(3, 440) = 2.69$, $p = 0.046$, partial $\eta^2 = 0.018$. Partial eta

squared was 0.018 which means that about 1.8% of the variability in state social motivation (the three dependent variables) was being accounted for by the three group levels. This is considered a small to medium effect size (Brysbaert & Stevens, 2018; Cohen, 1992; Wuensch, 2020).

Based on the one-way MANOVA results, group means were statistically significantly different ($p < .05$) and, therefore, the null hypothesis was rejected and the alternative hypothesis was accepted. In other words, there was a significant difference in group means between the nature exposure and non-nature exposure conditions on state social motivation. Unfortunately, the multivariate test statistic does not differentiate which groups differed from which and instead only tells us there was a difference between groups overall. In order to understand the nature of the difference between the groups, it was necessary to conduct further analyses.

One-Way ANOVA Results

Univariate ANOVAs with a Bonferroni correction ($p < .01$ versus $p < .05$) were conducted in IBM SPSS Version 27 as follow up tests to determine which dependent variables might be contributing to the statistically significant one-way MANOVA (Field, 2013). First, there were non-significant main effects of nature exposure on State Motivation to Foster Social Connections $F(2, 441) = 2.232$, $p = 0.109$, partial $\eta^2 = 0.010$, Positive Affect $F(2, 441) = 2.081$, $p = 0.126$, partial $\eta^2 = 0.009$, and State Anxiety $F(2, 441) = 2.183$, $p = 0.114$, partial $\eta^2 = 0.010$. Due to the non-significant findings of the three separate univariate ANOVAs, no post-hoc tests (e.g., contrasts) were conducted to follow-up on the one-way ANOVAs.

Running separate one-way ANOVAs can be problematic because they evaluate outcome variables independently and not as linear combinations of the outcome variables like the one-way MANOVA test statistic. Instead of conducting one-way ANOVAs as follow up tests to a significant one-way MANOVA, Field (2013) suggests running a discriminant analysis, a

multivariate statistical technique that separates groups by the linear combinations of the dependent variables. “The major advantage of this approach over multiple ANOVAs is that it reduces the dependent variables to a set of underlying dimensions thought to reflect substantive theoretical dimensions. As such, it is true to the ethos of MANOVA” (Field, 2013, p. 644).

Descriptive Discriminant Function Analysis (DDA)

It is common for researchers to conduct one-way ANOVAs after a significant one-way MANOVA. However, there are three good reasons to not run one-way ANOVAs as the follow up test(s) for MANOVA. First, this approach is unwise because it increases the possibility of a Type I error, increasing the likelihood of rejecting the null hypothesis when it should not be rejected (Field, 2013; Buras, 1996). Some argue that testwise alpha levels could be lowered using the Bonferroni correction in order to account for this. However, if the Bonferroni correction is utilized, it can lower power and it increases the likelihood of a Type II error, accepting the null hypothesis when it should be rejected (Buras, 1996). Additionally, follow-up univariate ANOVAs are not really investigating the research question(s) being asked here because they do not take into account the interactions and intercorrelations between the dependent variables like a multivariate test would (Buras, 1996).

According to Huberty and Morris (1989), a descriptive discriminant function analysis (DDA; also known as discriminant analysis) is a more appropriate follow-up test for a one-way MANOVA because DDA uses group membership to predict or explain scores for outcome variables and it incorporates interactions and intercorrelations between the dependent variables into the statistical analyses, unlike one-way ANOVAs (Buras, 1996). In some ways, DDA is like conducting a reverse MANOVA. Instead of predicting combined dependent variables from a grouping variable (MANOVA), DDA is predicting a grouping variable from the combined

dependent variables. DDA can help determine whether or not the dependent variables could be used to distinguish nature exposure participants from non-nature exposure participants. Therefore, DDA was conducted after the one-way MANOVA as a follow-up post-hoc test in order to better understand differences between the groups.

Before conducting DDA, assumptions were checked. Since the assumptions for DDA are the same as for a one-way MANOVA, it was assumed that the assumptions were met for DDA. For example, Box's test was non-significant, $p = .520$, indicating that the covariance matrices are roughly equal (this was the same result for the one-way MANOVA).

Eigenvalues were examined first (Table 6). SPSS converted the eigenvalues for each variate (function 1 and 2), which revealed the percentage of variance accounted for by each function. The first function accounted for 63.2% of the variance while the second function accounted for 36.8% of the variance. Each function's canonical correlation was squared to use as an effect size (Field, 2013). The first function's canonical $R^2 = .0179$. The second function's canonical $R^2 = .0106$.

Table 6

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.018[a]	63.2	63.2	.134
2	.011[a]	36.8	100.0	.103

[a] First 2 canonical discriminant functions were used in the analysis.

In combination, the two functions significantly discriminated the groups, $\Lambda = .972$, $x^2\,(6) = 12.667$, $p = .049$ (Table 7). However, after the first function was removed, the second function alone was non-significant, $\Lambda = .989$, $x^2\,(2) = 4.670$, $p = .097$. Therefore, the two combined functions represent underlying dimensions that explain group differences shown in the one-way MANOVA.

Table 7

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 2	.972	12.667	6	.049
2	.989	4.670	2	.097

In order to determine which variables contributed to the observed group differences, standardized discriminant function coefficients and structure coefficients from the DDA were examined (Table 8). While standardized discriminate function coefficients reveal the relative contributions of each variable to the functions (Field, 2013), structure coefficients represent the observed variable's correlation with the latent discriminant function variable (Sherry et al., 2003). Most researchers examine both. However, there is no consensus in the literature on how to use standardized discriminant function coefficients and structure coefficients for interpretation in DDA (Field, 2013; Finch, 2009; Warne, 2014). Higher correlation with discriminant functions contribute more to group separation (Glaser et al., 2002). Therefore, the author chose to examine and interpret structure coefficients first.

According to the structure coefficients, using a loading criteria of $> |0.30|$ (Finch, 2009; Pedhazur, 1997), it was determined that State Motivation to Foster Social Connections (r = -

.733) and State Anxiety (r = .528) substantially loaded onto the first function and were the two dimensions that differentiated between the three nature exposure groups (Table 10). For the second function, only Positive Affect (r = .940) and State Anxiety (-.670) loaded substantially and were the two dimensions that differentiated between the three nature exposure groups. In other words, the first function differentiated nature exposure conditions by some factor that affects State Motivation to Foster Social Connections differently than state anxiety (SMSC is negative while SA is positive), while the second function differentiated nature exposure conditions by some factor that affects State Positive Affect differently than state anxiety (PA is positive while SA is negative). PA (r = .011) did not contribute substantially to group separation in function 1, while SMSC (r = .158) did not contribute substantially to group separation in function 2. While structure coefficients can indicate whether or not variables contributed to group differentiation, they cannot indicate their "importance" (Warne, 2014).

Next, parallel discriminant ratio coefficients were consulted. Warne (2014) argues that standardized discriminant function coefficients and structure coefficients may be utilized to understand whether or not variables contributed to group separation; however, they should not be used to indicate which variables are more important for distinguishing groups. This should be achieved by calculating and examining parallel discriminant ratio coefficients. Parallel discriminant ratio coefficients are calculated by multiplying each standardized discriminant function coefficient with each structure coefficient. Calculations are located under "Parallel Discriminant Ratio Coefficients" (DRC) in Table 8. For function 1, SMSC (DRC = .632) is indicated as the most important variable distinguishing between the three nature exposure conditions, while state anxiety (DRC = .360) is the second most important variable distinguishing the three nature exposure conditions. For function 2, PA (DRC = .940) is

indicated as the most important variable distinguishing between the three nature exposure conditions, while state anxiety (DRC = -.670) is the second most important variable distinguishing the three nature exposure conditions.

Table 8

Descriptive Discriminant Analysis Results

Standardized Canonical Discriminant Function Coefficients

	Function	
	1	2
State Motivation to Foster Social Connections	-.863	-.208
State Positive Affect	.631	.879
State Anxiety	.683	-.308

Correlation with Discriminant Functions (aka Structure Matrix; aka Structure Coefficients)

	Function	
	1	2
State Motivation to Foster Social Connections	-.733	.158
State Positive Affect	.011	.940
State Anxiety	.528	-.670

Parallel Discriminant Ratio Coefficients

	Function	
	1	2
State Motivation to Foster Social Connections	(-.863)(-.733) = .632	(-.208)(.158) = -.032
Positive Affect	(.631)(.011) = .006	(.879)(.940) = .826
State Anxiety	(.683)(.528) = .360	(-.308)(-.670) = .206

Finally, centroids and a combined-groups plot was examined (Table 9; Figure 6). Centroids are the mean function scores for each condition. The combined-groups plot is a graph of the function scores for each person according to the experimental condition they were in and the centroids. The discriminant function plot and group centroids showed that the first function discriminated the urban non-nature exposure group from the wilderness nature exposure group and indoor non-nature exposure group, and the second function differentiated the wilderness nature exposure group from the urban non-nature exposure group and the indoor non-nature exposure group.

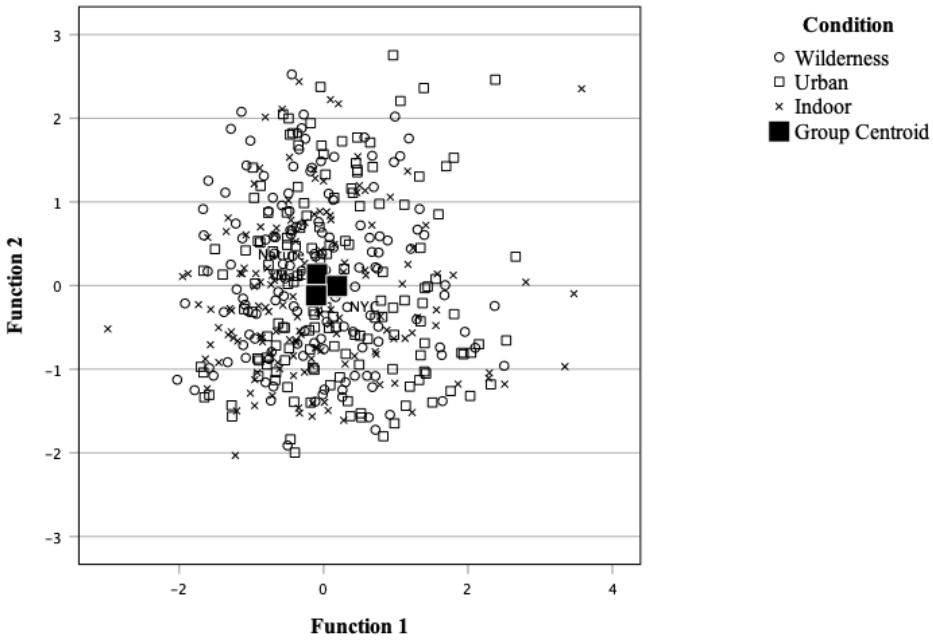
Table 9

Functions at Group Centroids

	Function	
Conditions	1	2
Wilderness Nature Exposure	-.089	.135
Urban Non-Nature Exposure	.187	-.006
Indoor Non-Nature Exposure	-.104	-.118

Figure 6

Combined Groups Plot



Note. Top group centroid box = wilderness nature exposure (WNE); Bottom group centroid box = indoor non-nature exposure (INNE); Rightmost group centroid box = urban non-nature exposure (UNNE). Function 1 discriminated UNNE from WNE and INNE. Function 2 discriminated WNE from UNNE and INNE.

The MANOVA indicated that state social motivation (State Motivation to Foster Social Connections, State Positive Affect and State Anxiety) significantly differed among nature exposure groups with a small to moderate effect size. Post hoc ANOVAs and DDA revealed that nature exposure groups were not significantly differentiated by the individual dependent variables in the outcome variate. Instead, the outcome variate, with all dependent variables included as a composite, significantly differentiated nature exposure groups. Examination of structure coefficients, discriminant ratio coefficients, and group centroid means

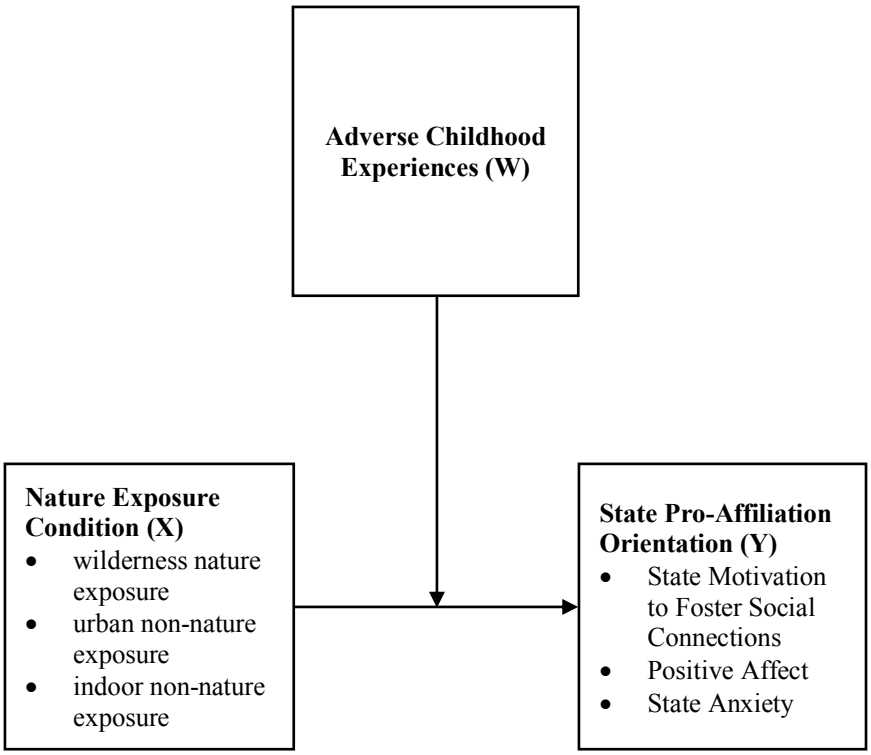
indicated that state social motivation was highest in the nature exposure group and lowest in the urban non-nature exposure group. Means scores for State Motivation to Foster Social Connections (Wilderness Nature Exposure, *M* = 51.48, *SD* = 12.08; Urban Non-Nature Exposure, *M* = 48.80, *SD* = 11.79; Indoor Non-Nature Exposure, *M* = 51.13, *SD* 11.90), Positive Affect (Wilderness Nature Exposure, *M* = 26.63, *SD* = 8.61; Urban Non-Nature Exposure, *M* = 25.51, *SD* = 9.37; Indoor Non-Nature Exposure, *M* = 24.57, *SD* = 8.62), and State Anxiety (Wilderness Nature Exposure, *M* = 39.16, *SD* = 12.34; Urban Non-Nature Exposure, *M* = 42.15, *SD* = 12.67; Indoor Non-Nature Exposure, *M* = 41.17, *SD* = 12.24) corroborated these findings.

Moderation

In order to investigate ACEs as a potential moderator of nature exposure on state pro-social orientation, moderation analyses were performed on each of the three dependent variables. The moderator analyses were performed using SPSS Version 26 and PROCESS Version 3. using Model 1 for moderation (Figure 7; Hayes, 2018).

Figure 7

Conceptual Diagram of PROCESS's Model 1 for Moderation



The first moderation analysis model investigated the dependent variable, State Motivation to Foster Social Connections. Nature exposure (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure) was entered as the categorical independent variable (X) and state motivation to foster social connections was entered as the dependent variable (Y). Adverse childhood experiences were entered as the moderator (W). The overall model was non-significant, F(5.438) = 2.18, p = .054, R^2 = .02. The interaction between nature exposure and ACEs was also non-significant (Table 10; Figure 8).

The second moderation analysis model investigated the dependent variable, Positive Affect. Nature exposure (wilderness nature exposure, urban non-nature exposure, indoor non-

nature exposure) was entered as the categorical independent variable (X) and Positive Affect was entered as the dependent variable (Y). Adverse childhood experiences (ACEs) were entered as the moderator (W). The overall model was significant, $F(5,438) = 3.70$, $p = .002$, $R^2 = .20$. The interaction between nature exposure and ACEs was non-significant (Table 10; Figure 9).

The third moderation analysis model investigated the dependent variable, state anxiety. Nature exposure (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure) was entered as the categorical independent variable (X) and state anxiety was entered as the dependent variable (Y). Adverse childhood experiences (ACEs) were entered as the moderator (W). The overall model was significant, $F(5,438) = 9.53$, $p < .001$, $R^2 = .31$. The interaction between nature exposure and ACEs was non-significant (Table 10; Figure 10).

Table 10

Linear Model for Predictors of State Social Motivation

	b	SE *B*	*t*	*p*
Constant	52.64	1.40	37.38	$p < .001$**
ACEs	-.51	.43	-1.17	$p = .23$
SMSC X1	-2.37	1.97	-1.20	$p = .22$
SMSC X2	.004	1.92	.002	$p = .99$
ACEs x SMSC X1	-.08	.59	-.13	$p = .88$
ACEs x SMSC X2	-.16	.59	-.28	$p = .77$
Constant	28.73	1.00	28.50	$p < .001$**
ACEs	-.92	.31	2.97	$p = .003$*
PA X1	-2.43	1.41	-1.72	*p = .08*
PA X2	-2.84	1.38	-2.06	*p = .03**
ACEs x PA X1	.60	.42	1.43	$p = .15$
ACEs x PA X2	.33	.42	.79	*p = .42*
Constant	35.84	1.41	25.40	$p < .001$**
ACEs	1.46	.43	3.34	$p = .0009$**
SA X1	2.20	1.97	1.11	*p = .26*
SA X2	1.87	1.93	.97	*p = .33*
ACEs x SA X1	.20	.59	.34	$p = .96$
ACEs x SA X2	.08	.59	.14	$p = .88$

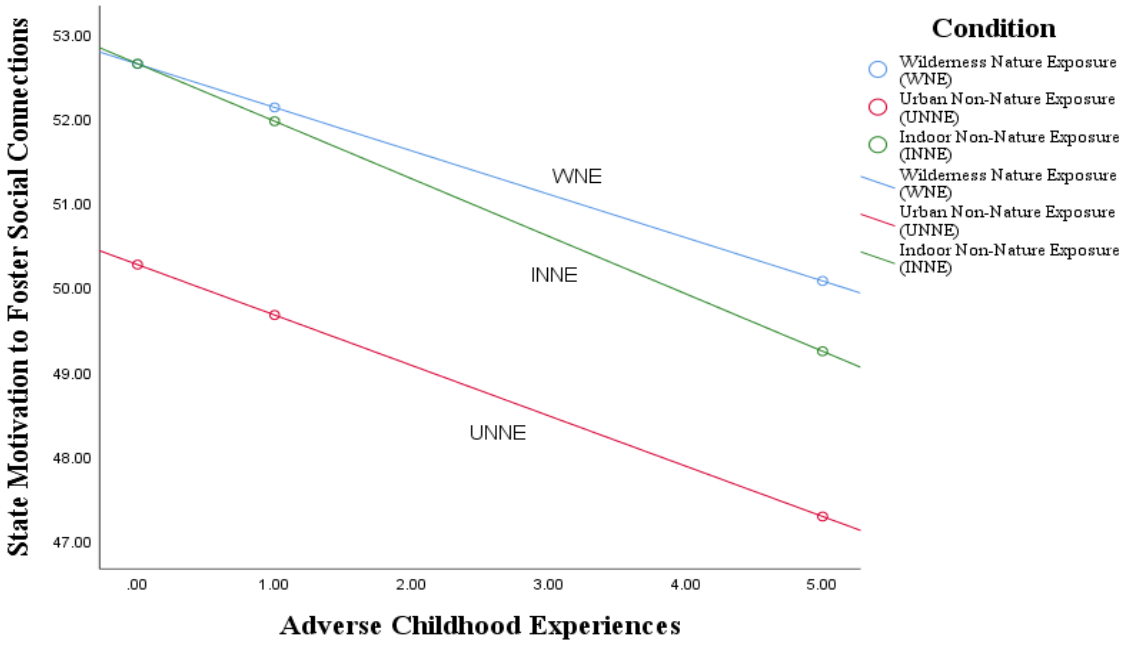
Note. $R^2 = .02$ for SMSC, $R^2 = .04$ for PA, $R^2 = .09$ for SA.

* $p < .05$

** $p < .001$

Figure 8

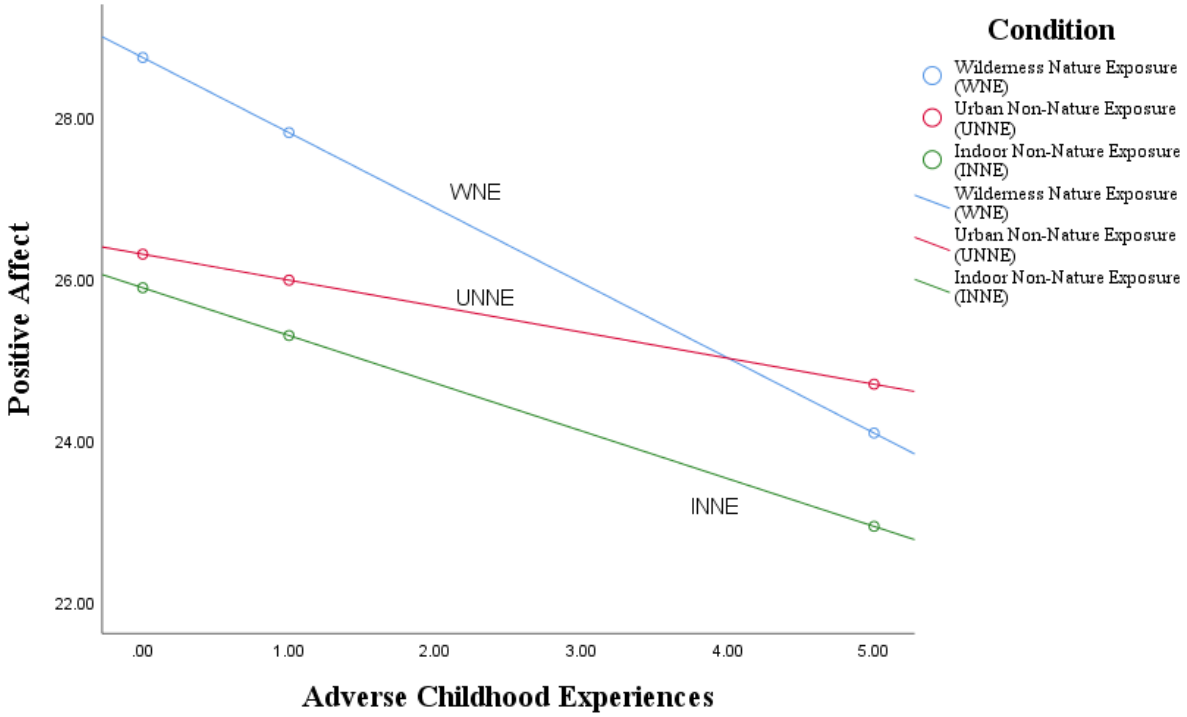
Simple Slopes of the Regression of SMSC on Nature Exposure at 3 Levels of ACEs



Note. The three levels of ACEs are the 16th, 50th, and 84th percentiles for each condition.

Figure 9

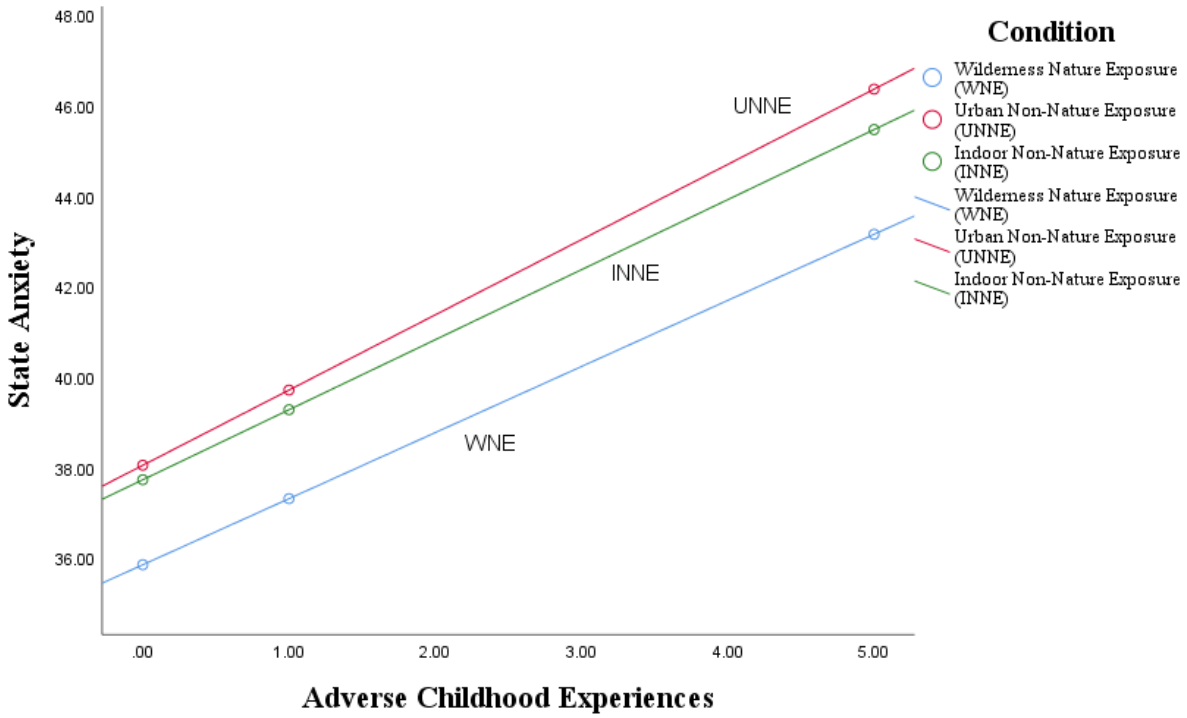
Simple Slopes of the Regression of PA on Nature Exposure at 3 Levels of ACEs



Note. The three levels of ACEs are the 16th, 50th, and 84th percentiles for each condition.

Figure 10

Simple Slopes of the Regression of SA on Nature Exposure at 3 Levels of ACEs



Note. The three levels of ACEs are the 16th, 50th, and 84th percentiles for each condition.

The interactions between ACEs and SMSC, PA, and SA were all non-significant. ACEs did not moderate nature exposure's effect on state social motivation.

A moderator is a variable that affects the strength and/or direction of the effect of the independent variable on the dependent variable (Barron & Kenny, 1986). There are several different statistical techniques that can be utilized to investigate moderation. MANCOVA is a unique technique to use for moderation because it tests for statistically significant mean differences between groups for multiple dependent variables simultaneously (something Hayes' PROCESS moderation is not able to do), with a covariate in the model. A MANCOVA, a

multivariate analysis of variance with a covariate included in the model, was chosen as a way to explore moderation with study data and to ascertain in what direction (if any) ACEs influenced social motivation for each dependent variable. The effects of nature exposure conditions on combined dependent variables of state social motivation were not significantly moderated by adverse childhood experiences, $\Theta = .017$, $F(3, 439) = 2.43$, $p = .064$, partial $\eta^2 = .016$.

In order to understand the data better, mean trends were investigated by exploring estimated marginal means for each group and each dependent variable at various ACE levels. An ACE score of zero was chosen as a point of reference to compare against and ACE scores of 4-10 were chosen for exploration because of the evidence regarding > 4 ACEs and greater health risks (Felitti et al., 1998). The estimated marginal means in Table 11 represent the mean response for each condition, adjusted for the dependent variables and covariates in the model. Figures 11, 12, and 13 offer graphic representations of the estimated marginal means for each dependent variable.

Table 11

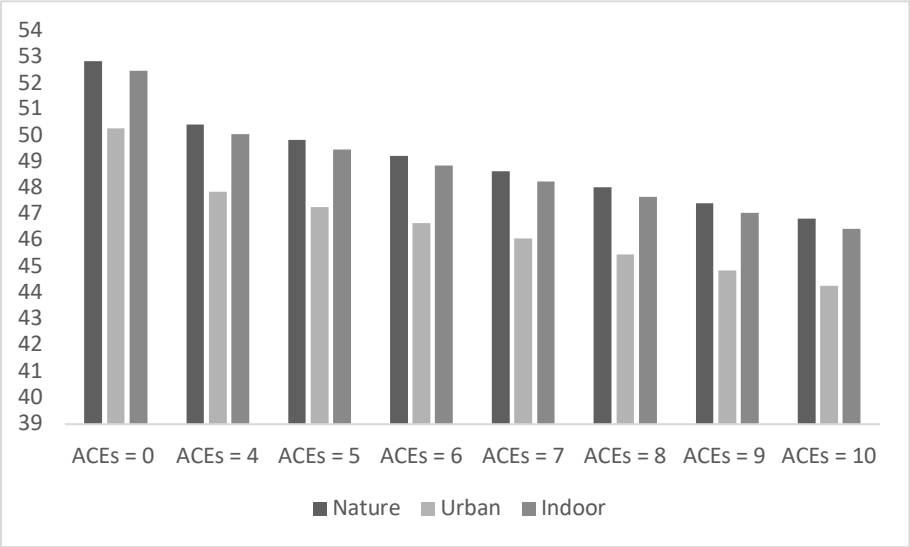
Estimated Marginal Means with Covariate ACEs at Varying Levels

	Video	EMM ACE-0	EMM ACE-4	EMM ACE-5	EMM ACE-6	EMM ACE-7	EMM ACE-8	EMM ACE-9	EMM ACE-10
SMSC	Nature	52.83	50.43	49.83	49.23	48.63	48.03	47.43	46.83
	Urban	50.27	47.87	47.27	46.67	46.07	45.47	44.87	44.27
	Indoor	52.46	50.06	49.46	48.86	48.26	47.66	47.06	46.45
PA	Nature	27.97	25.59	24.99	24.40	23.80	23.21	22.61	22.01
	Urban	26.97	24.59	23.99	23.40	22.80	22.20	21.61	21.01
	Indoor	25.89	23.51	22.91	22.32	21.72	21.13	20.53	19.93
SA	Nature	35.61	41.87	43.43	44.99	46.56	48.12	49.68	51.24
	Urban	38.29	44.54	46.11	47.67	49.23	50.80	52.36	53.92
	Indoor	37.69	43.94	45.51	47.07	48.63	50.20	51.76	53.32

Note. Covariates appearing in the models are evaluated at the following values: Adverse Childhood Experiences (ACEs) 0, 4, 5, 6, 7, 8, 9, and 10 (e.g. ACE-0 = MANCOVA with covariate ACEs at 0; ACE-4 = MANCOVA with covariate ACEs at 4)

Figure 11

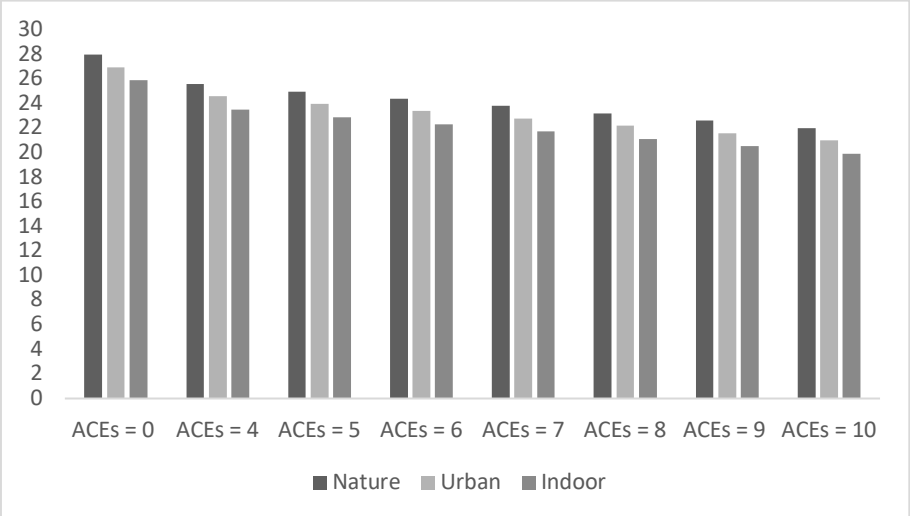
ACEs as a Moderator of State Motivation to Foster Social Connections



Note. Units on *y* axis represent the estimated marginal means of state motivation to foster social connections scores. Higher scores indicate greater motivation to foster social connections.

Figure 12

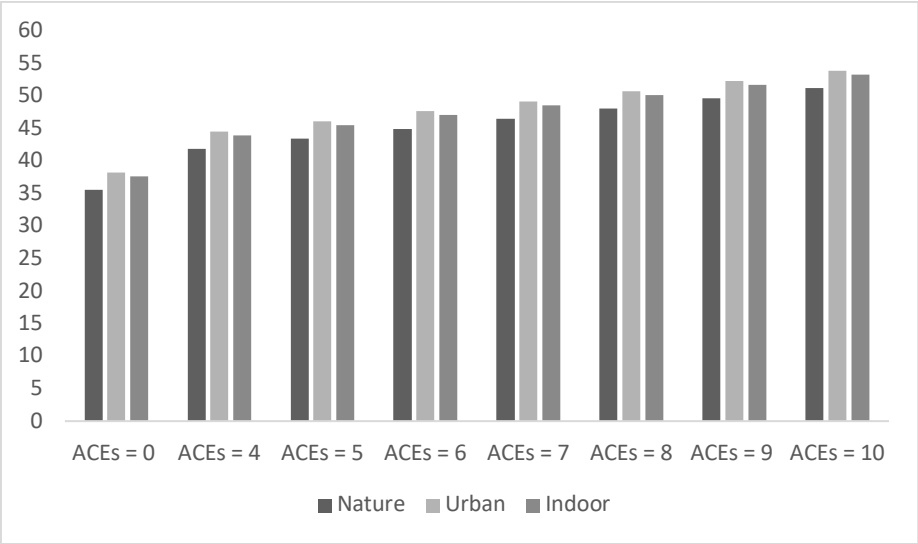
ACEs as a Moderator of Positive Affect



Note. Units on *y* axis represent the estimated marginal means for positive affect scores. Higher scores indicate greater positive affect.

Figure 13

ACEs as a Moderator of State Anxiety



Note. Units on *y* axis represent the estimated marginal means of state anxiety scores. Higher scores indicate greater state anxiety.

Exploratory Analyses

State Motivation to Foster Social Connections: New Versus Existing Contacts

State Motivation to Foster Social Connections has two subscales: State Motivation to Foster New Social Connections and State Motivation to Foster Existing Social Connections. As an exploratory analysis, two one-way MANOVAs were conducted substituting the variables SMSC-N and SMSC-E for the SMSC total score variable in order to ascertain whether motivation toward new or existing social connections altered or influenced results of the original one-way MANOVA in any way. There was a significant main effect of nature exposure on state social motivation (new connections), $\Theta = 0.022$, $F(3, 440) = 3.278$, $p = 0.021$, partial $\eta^2 = 0.022$. Partial eta squared was 0.022 which means that about 2.2% of the variability in state pro-affiliation orientation (new connections) was being accounted for by the three group levels. This

is considered a small to medium effect size (Brysbaert & Stevens, 2018; Cohen, 1992; Wuensch, 2020). There was a non-significant main effect of nature exposure on state social motivation (existing connections), $\Theta = 0.013$, $F(3, 440) = 1.843$, $p = 0.139$, partial $\eta^2 = 0.012$. These results indicate a greater desire for state social motivation with new connections but not with existing connections.

Negative Affect

Previous research has indicated that virtual nature exposure can significantly lower Negative Affect (McAllister et al., 2017); therefore, Negative Affect was investigated in an exploratory analysis. PANAS has two subscales, Positive Affect (PA) and Negative Affect (NA). As an exploratory analysis, a one-way MANOVA was conducted substituting the dependent variable PA with the dependent variable NA (the other two dependent variables remained the same as in the primary analysis) in order to ascertain if Negative Affect influenced state social motivation. There was a non-significant main effect of nature exposure on state social motivation with, $\Theta = 0.016$, $F(3, 440) = 2.333$, $p = 0.073$, partial $\eta^2 = 0.016$. Results suggest that Negative Affect has no impact on the outcome variate.

Chapter 4. Discussion

The purpose of the current research was to compare the effects of virtual nature exposure (wilderness nature exposure, urban non-nature exposure, indoor non-nature exposure) on state social motivation (State Motivation to Foster Social Connections, State Positive Affect, State Anxiety). Additionally, this research examined the influence of adverse childhood experiences (ACEs) as a moderator of nature exposure's effect on state social motivation.

Effects of Virtual Nature Exposure on State Social Motivation (H1)

The present research, to the author's knowledge, is the very first study to establish a causal relationship between nature exposure and social motivation. Hypothesis 1, which stated that state social motivation would significantly differ between nature exposure groups was supported. Specifically, results showed that participants in the nature exposure group reported greater State Motivation to Foster Social Connections than those in the non-nature exposure control groups, which supported Hypothesis 1a. Additionally, participants in the nature exposure group reported higher State Positive Affect scores than those in the non-nature exposure control groups, which supported Hypothesis 1b. Finally, mean scores for State Anxiety were lower in the nature exposure group compared to the non-nature exposure control groups, supporting Hypothesis 1c.

The mechanisms by which nature exposure affects social motivation is unknown. However, there are several theories regarding the mechanisms by which nature exposure reduces stress and improves well-being that might be helpful in understanding this phenomenon. Ulrich's (1983) Stress Reduction Theory argues that nature exposure after a stressful event leads to positive emotions, which are restorative and help reduce overall stress (Ulrich, 1983; Ulrich et al., 1991). Reduced stress could contribute to increased social motivation. That is, when people experience less psychological stress less, it is possible that they are more likely to be motivated

to make social connections. Additionally, Beute and de Kort (2014) argue that nature exposure has an 'instorative' effect that goes beyond the restorative effects described by Attention Restoration Theory and Stress Reduction Theory that occur after depletion. For example, it may not be necessary for a stressful event to occur prior to nature exposure in order to reap the post-benefits of nature exposure. Beute and de Kort's (2014) research involved two studies, one study where mental fatigue was induced and another where it wasn't before participants were exposed nature scenes (pictures on slides) or urban scenes. The results suggested that the "beneficial effects of nature occur regardless of mental fatigue induction" and that nature has "instorative effects on self-regulation rather than restorative effects" (Beute & de Kort, 2014, p. 177). Extrapolating from evidence provided by Beute and de Kort (2014), nature exposure may provide instorative or buffering effects for future events where self-regulation is required, such as social interactions.

Attention Restoration Theory (ART) proposes that nature exposure restores attention after people are mentally fatigued because it gives them a sense of being away, fascination, extent, and compatibility (Kaplan, 1995). Restoration could also contribute to increased social motivation by filling up an individual's reserves, especially attentionally, in order to have the energy to make social connections. Further, Kaplan and Kaplan's (2011) Reasonable Person Model is a framework that describes how nature exposure helps bring about reasonable behavior (e.g., less aggression, less violence, less fatigue), partly through attention restoration, which in turn helps facilitate positive human social interactions. It is highly probable that a combination of these variables helps explain why nature exposure increases social motivation. Nature exposure may prime social interactions by inducing a positive mood, reducing stress, decreasing impulsivity, increasing attentional capacity, increasing emotion regulation capacity and

increasing energy to engage. That said, while all of these theories are informative, more research needs to be done to elucidate the mechanisms by which nature exposure affects social motivation.

There are several notable implications from the results of the current research. Importantly, as little as 2 ½ minutes of virtual nature exposure appears to improve state social motivation. Results suggest that virtual nature exposure may have a positive impact on the development and maintenance of social connections and should be explored further as a social health intervention aimed at improving overall health. Incorporating virtual nature exposure experiences into the lives of people who may have barriers (e.g., ability, geographic area, time constraints) to getting outdoors in order to experience nature may be beneficial and small virtual bursts of nature exposure may be adequate. Reynolds et al. (2020) used virtual nature exposure as an intervention to reduce stress and improve mood in people with substance use disorder. Virtual nature exposure could be used similarly as an intervention to provoke social connection for persons with or vulnerable to impaired social functioning.

Another important implication of this research is that it paves the way to explore various nature exposure typologies and their effects on social motivation: outdoor (e.g., wilderness, urban greenspaces), indoor (e.g., plants, view of nature out a window), virtual (e.g., videos, pictures, guided imagery). Could a walk in nature improve social motivation? Could the presence of indoor plants instigate more conversation between strangers? Could outdoor physical education (P.E.) classes help students create more social connections than indoor P.E. classes? In terms of friendship making, is it better to conduct a university's student activities outside in nature as opposed to inside a building? These research questions are by no means exhaustive. A

door has been opened and the sky is the limit when it comes to testing new hypotheses related to nature exposure and social motivation.

Moderation Analyses (H2)

The effects of nature exposure on state social motivation was not significantly moderated by ACE scores. Therefore, Hypothesis 2 was not supported. To better understand the data, a MANCOVA was conducted in order to ascertain in what direction (if any) ACEs influenced social motivation for each dependent variable.

A MANCOVA revealed that estimated marginal mean scores for SMSC and PA scores did attenuate when ACEs were included as a covariate, and amplify SA scores; however, this change was not statistically significant. For example, wilderness nature exposure estimated marginal mean scores for State Motivation to Foster Social Connections were attenuated with 4 or more ACEs (ACE-0 M = 52.83, ACE-4 M = 50.43, ACE-10 = 46.83) (Table 11). Wilderness nature exposure estimated marginal mean scores for State Positive Affect were also attenuated with 4 or more ACEs (ACE-0 M = 27.97, ACE-4 M = 25.59, ACE-10 M = 22.01) (Table 11). Conversely, amplification of State Anxiety scores occurred in the wilderness nature exposure condition with 4 or more ACEs (ACE-0 M = 35.61, ACE-4 M = 41.87, ACE-10 M = 51.24) (Table 11). In other words, when ACEs was added into the model, the effect of nature exposure on SMSC and PA was attenuated while SA was amplified. However, this effect was not statistically significant. This estimated marginal mean trend was true for each of the dependent variables included in the outcome variate (Table 11).

Limitations

The major limitation (and possible confounder) of this study is that it was initiated at the beginning of the COVID-19 global pandemic. Stay at home orders, social distancing, and

quarantines were mandated in order to slow the spread of the virus and this inevitably led to social isolation and loneliness for many people (Hwang et al., 2020). The extent of damage to psychological, physical, and social health is not fully understood yet as we are still in the middle of this crisis. The current research measured state social motivation, which may very well have been influenced by COVID-19. Some participants' answers on measures may have been influenced by their experience with COVID-19. Lonelier people may have been more motivated toward social contact. Conversely, fear of the virus may have motivated participants away from social contact of any kind. Although the results of this research could have profound positive implications, it is necessary to substantiate these findings with replication research in the future. The design of this study as a randomized controlled trial with an experimental manipulation helps validate the results of this trial. However, post COVID-19 (hopefully that day will come), it is suggested that this research be replicated, when social distancing, stay at home orders, and quarantines are a thing of the past, in order to corroborate the current results.

Another limitation of the study was that there was no behavioral measure of state social motivation included in the measures. Therefore, while the research shows that nature exposure influences self-reported state social motivation, it is not evident that this self-reported increase in state social motivation translates in a meaningful way to participants' actions. Danyluck and Page-Gould's (2019) research on physiological synchrony and affiliation used a simple behavioral measure of affiliation after dyadic interactions occurred. They asked participants, "If you enjoyed your interaction and would be willing to see this person in the future, then please enter your email address below. We will only exchange your contact information if both you and your partner agree to exchange this information (Danyluck & Page-Gould, 2019, p. 12)." Although researchers never exchanged participant e-mails, it was a clever way to behaviorally

assess participant motivation to make new social connections. A modified version of this measure could be used in future nature exposure research as behavioral measure to assess state social motivation in order to add more ecological validity to any results obtained.

The adverse childhood experiences (ACEs) measure that was used in this study to measure trauma exposure in childhood does not incorporate every possible trauma that a child could experience. This could be considered a limitation. There are 14 childhood trauma exposure measures (10 assessed in childhood, 4 assessed in adulthood) that have included additional constructs (that the ACEs Questionnaire does not include), such as the experience of racism/discrimination, parental death, neighborhood violence, being bullied, and living in foster care, to measure adverse childhood experiences (Bethell et al., 2017). The ACEs Questionnaire was chosen as a measure for this study because of the strong data connecting it to health outcomes and the need for a valid and reliable measure; however, it is an imperfect measure. The creation of a validated reliable measure of adverse childhood experiences that incorporates more constructs should be a focus of future research.

Another limitation of the current study concerns the study sample. An attempt was made to recruit a potentially more diverse and representative group of participants by using Facebook as a recruitment tool. However, the numbers of participants recruited from Facebook were very small. The majority of study participants were comprised of undergraduates from a university in the southeastern United States while only a small minority of study participants were recruited from Facebook (n = 428 and n = 16 respectively). This is a limitation because the sample in this research is not representative of the larger population. Relatedly, a common limitation of many studies is having mostly WEIRD (Western, educated, industrialized, rich, democratic) participants (Henrich et al., 2010) because researchers often recruit from the undergraduate

student population at their own universities. Henrich et al. (2010) report, "A 2008 survey of the top psychology journals found that 96% of subjects were from Western industrialized countries — which house just 12% of the world's population." Unfortunately, participants in this study fit the WEIRD criteria, making global generalizations of results ill-advised.

Future Research

After this research study was underway, results from another research study in our lab revealed that ACEs significantly predicted rejection sensitivity and social interaction anxiety through attachment anxiety and emotion dysregulation (Castelblanco et al., 2021). Based on the results from that study, future research should examine the role emotion dysregulation may play in how nature exposure influences social motivation. Richardson (2019) argues that the Attention Restoration Theory and the Stress Reduction Theory do not adequately account for increased well-being in nature and that although emotion regulation is intimately connected to well-being, it is often not included as a measure in nature exposure research. Further, Richard and McEwan (2018) found nature connectedness and happiness was mediated by emotion regulation. Therefore, it seems cogent that future research with nature exposure should include an emotion regulation measure. For example, could nature exposure's influence on social motivation be mediated by emotion regulation? Could nature exposure improve emotion regulation, especially for ACEs exposed adults?

Exploratory analyses revealed that there was a difference in the State Motivation to Foster Social Connections (SMSC) subscales after nature exposure in that SMSC for new contacts (SMSC-N) differed from SMSC for existing contacts (SMSC-E). There was a significant main effect of nature exposure on state social motivation if SMSC-N was part of the outcome variate (along with State Positive Affect and State Anxiety). Conversely, there was a

non-significant main effect of nature exposure on state social motivation if SMSC-E was part of the outcome variate (along with State Positive Affect and State Anxiety). These results suggest that there may be a stronger relationship between nature exposure and the desire to socially connect with new people an individual just met versus people the individual already knows. This should be explored further in future research.

Another topic that needs to be addressed in future research is the duration of the effect of nature exposure. This research examined state social motivation after a brief virtual nature exposure. How long does motivation to socially connect with others last after virtual nature exposure? Is it fleeting? Or does it endure over hours, days, or even weeks? Those questions have yet to be answered. It is recommended that future research investigate social motivation at various time points (e.g. immediately after manipulation, 1 hour later, 24 hours later, 1 week later) after virtual nature exposure.

Finally, included in the limitations section is a discussion about the lack of a behavioral measure of social motivation in this study. Future research examining the link between nature exposure and social motivation should include a behavioral measure of social motivation in order to more clearly ascertain whether self-reported state social motivation translates to behavioral state social motivation as well.

Conclusion

Prior to the current research, there has been a paucity of experimental studies testing the effects of nature exposure on social motivation. This is the first research study to show that nature exposure affects state social motivation. Results suggest that virtual nature exposure may have a positive impact on the development and maintenance of social connections. These results are consistent with prior literature showing that nature exposure predicts increased social health

(Shanahan et al., 2016), increased social affiliation (Coley, 1997; Taylor et al., 1998), perceptions of safety (Kuo et al., 1998), and was associated with reported increases in perceived social support, decreases in perceived peer-rejection, improved family function, and improved skills for cooperation, leadership, and conflict resolution (Mygind et al., 2019). As a result, nature exposure should be explored further as a social health intervention aimed at improving overall health. In addition, virtual nature exposure may offer a way for people who cannot easily access outdoor nature to still benefit from nature exposure.

Although, it is well established that nature exposure positively impacts physical and mental health, the current research adds to the literature by bolstering the evidence about nature exposure's impact on social health. Social health should be recognized as a public health priority and all forms of nature exposure (e.g., outdoor, indoor, virtual) should continue to be investigated as interventions to help improve social health.

References

Anderson, C. L., Monroy, M., & Keltner, D. (2018). Awe in nature heals: Evidence from military veterans, at-risk youth, and college students. *Emotion*, *18*(8), 1195–1202. https://doi.org/10.1037/emo0000442.supp

Baumsteiger, R., & Siegel, J. T. (2019). Measuring prosociality: The development of a prosocial behavioral intentions scale. *Journal of Personality Assessment*, *101*(3), 305–314. https://doi.org/10.1080/00223891.2017.1411918

Berkman, L. (1995). The role of social relations in health promotion. *Psychosomatic Medicine, 57*(3), 245–254. https://doi.org/10.1097/00006842-199505000-00006

Bernstein, M. J., Claypool, H. M., Nadzan, M. A., Schuepfer, K., Benfield, J. A., & Nutt, R. J. (2019). Validating the state motivation to foster social connections scale. *The Journal of Social Psychology*, *159*(6), 709–724. https://doi.org/10.1080/00224545.2018.1558882

Berry, D. S., & Hansen, J. S. (1996). Positive affect, negative affect, and social interaction. *Journal of Personality and Social Psychology*, *71*(4), 796-809.

Bethell, C. D., Carle, A., Hudziak, J., Gombojav, N., Powers, K., Wade, R., & Braveman, P. (2017). Methods to assess adverse childhood experiences of children and families: Toward approaches to promote child well-being in policy and practice. *Academic Pediatrics*, *17*(7 Suppl), S51–S69. https://doi.org/10.1016/j.acap.2017.04.161

Beute, F., & de Kort, Y. (2014). Natural resistance: Exposure to nature and self-regulation, mood, and physiology after ego-depletion. *Journal of Environmental Psychology*, *40*, 167–178. https://doi.org/10.1016/j.jenvp.2014.06.004

Bolmont, B., & Abraini, J. (2001). State-anxiety and low moods: Evidence for a single concept. *Physiology & Behavior*, *74*, 421–424. https://doi.org/10.1016/S0031-9384(01)00575-3

Bratman, G., Hamilton, J., Hahn, K., Daily, G., & Gross, J. (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences of the United States of America*, *112*, 8567–8572. https://doi.org/10.1073/pnas.1510459112

Bratman, G., Anderson, C., Berman, M., Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumpkin, H., Gross, J., Hartig, T., Kahn, P., Kuo, M., Lawler, J., Levin, P., Lindahl, T. Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., Scarlett, L., Smith, J., van den Bosch, M., Wheeler, B., White, M., Zheng, H., & Daily, G. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances*, *5*(7), eaax0903. https://doi.org/10.1126/sciadv.aax0903

Brown, D., Barton, J., & Gladwell, V. (2013). Viewing nature scenes positively affects recovery of autonomic function following acute-mental stress. *Environmental science & technology*, *47*, 5562–5569. https://doi.org/10.1021/es305019p

Brysbaert, M., & Stevens, M. (2018). Power analysis and effect size in mixed effects models: A tutorial. *Journal of Cognition*, *1*(1), 9. DOI: http://doi.org/10.5334/joc.10

Buras, A. (1996, January 26). *Descriptive versus predictive discriminant analysis: A comparison and contrast of the two techniques* [Paper Presentation]. Annual Meeting of the Southwest Educational Research Association, New Orleans, LA. https://eric.ed.gov/?id=ED395981

Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: a meta-analysis. *Frontiers in psychology*, *5*, 976. https://doi.org/10.3389/fpsyg.2014.00976

Carifio, J., & Perla R. (2007). Ten common misunderstandings, misconceptions, persistent myths and urban legends about likert scales and likert response formats and their antidotes. Journal of Social Sciences, *3*(3), 106-116. https://doi.org/10.3844/jssp.2007.106.116

Castelblanco, S., Parish, A., & Blackhart, G. (2021, February 9-13). The role of adverse childhood experiences (ACEs) in social functioning through emotion dysregulation and attachment anxiety. In S. Castelblanco (Chair), *How Trauma, Discrimination, Family Conflict, and Resilience Impact Health* [Symposium]. Society for Personal and Social Psychology Annual Convention, Washington, DC, United States.

Centers for Medicare and Medicaid Services. (2017). *National health expenditure accounts highlights*. https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/highlights.pdf

Centers for Disease Control and Prevention. (2019). *The ACEs Pyramid*. U.S. Department of Health and Human Services. https://www.cdc.gov/violenceprevention/childabuseandneglect/acestudy/ace-graphics.html

Chalmers, J. A., Quintana, D. S., Abbott, M. J., & Kemp, A. H. (2014). Anxiety disorders are associated with reduced heart rate variability: A meta-analysis. *Frontiers in psychiatry*, *5*, 80. https://doi.org/10.3389/fpsyt.2014.00080

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*(1), 155. https://doi.org/10.1037/0033-2909.112.1.155

Cohen, S. (2004). Social relationships and health. *American Psychologist*, *59*(8), 676–684. https://doi.org/10.1037/0003-066X.59.8.676

Cohen, S., Sherrod, D. R., & Clark, M. S. (1986). Social skills and the stress-protective role of social support. *Journal of Personality and Social Psychology*, *50*(5), 963–973. https://doi.org/10.1037/0022-3514.50.5.963

Coley, R. L., Kuo, F. E., & Sullivan, W. C. (1997). Where does community grow? The social context created by nature in urban public housing. *Environment and Behavior*, *29*(4), 468–494. https://doi.org/10.1177/001391659702900402

Corcoran, M., & Mcnulty, M. (2018). Examining the role of attachment in the relationship between childhood adversity, psychological distress and subjective well-being. *Child Abuse & Neglect*, *76*, 297–309. https://doi.org/10.1016/j.chiabu.2017.11.012

Danyluck, C., & Page-Gould, E. (2019). Social and physiological context can affect the meaning of physiological synchrony. *Scientific Reports (Nature Publisher Group), 9*, 1-13. doi: http://dx.doi.org/10.1038/s41598-019-44667-5

DeVries, A., Glasper, E., & Detillion, C. (2003). Social modulation of stress responses. In *Physiology & Behavior*, *79*, 399–407. https://doi.org/10.1016/S0031-9384(03)00152-5

Dijkstra, K., Pieterse, M., & Pruyn, A. (2008). Stress-reducing effects of indoor plants in the built healthcare environment: The mediating role of perceived attractiveness. *Preventive Medicine*, *47*, 279–283. https://doi.org/10.1016/j.ypmed.2008.01.013

Downey, G., Freitas, A. L., Michaelis, B., & Khouri, H. (1998). The self-fulfilling prophecy in close relationships: Rejection sensitivity and rejection by romantic partners. *Journal of Personality and Social Psychology*, *75*(2), 545–560. https://doi.org/10.1037/0022-3514.75.2.545

Engel, G. (1977). The need for a new medical model: A challenge for biomedicine. *Science, 196*(4286), 129-136. https://doi.org/10.1126/science.847460

Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J. C. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *116*(11), 5188–5193. https://doi.org/10.1073/pnas.1807504116

Farrow, M., & Washburn, K. (2019). A review of field experiments on the effect of forest bathing on anxiety and heart rate variability. *Global Advances in Health and Medicine*, *8*, 1-7. https://doi.org/10.1177/2164956119848654

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149-1160.

Felitti, V., Anda, R., Nordenberg, D., Williamson, D., Spitz, A., Edwards, V., Koss, M. & Marks, J. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The adverse childhood experiences (ACE) study. *American Journal of Preventive Medicine*, *14*, 245–258. https://doi.org/10.1016/S0749-3797(98)00017-8

Field, A. (2013). *Discovering statistics using IBM SPSS statistics: And sex and drugs and rock "n" roll* (4th ed.). Sage.

Finch, H. (2009). Identification of variables associated with group separation in descriptive discriminant analysis: Comparison of methods for interpreting structure coefficients. *The Journal of Experimental Education*, *78*(1), 26-52. https://www-tandfonline-com.libproxy.lib.unc.edu/doi/full/10.1080/00220970903224602

Garcia, P., & McCarthy, M. (1996). Measuring health. A step in development of city health profiles. *Copenhagen: World Health Organization*. https://www.euro.who.int/__data/assets/pdf_file/0017/101645/WA95096GA.pdf

Gladwell, V. F., Brown, D. K., Barton, J. L., Tarvainen, M. P., Kuoppa, P., Pretty, J., H., Suddaby, J.M., & Sandercock, G.R.H. (2012). The effects of views of nature on autonomic control. *European Journal of Applied Physiology, 112*(9), 3379-86. http://dx.doi.org/10.1007/s00421-012-2318-8

Gladwell, V. F., Kuoppa, P., Tarvainen, M. P., & Rogerson, M. (2016). A lunchtime walk in nature enhances restoration of autonomic control during night-time sleep: Results from a preliminary study. *International Journal of Environmental Research and Public Health, 13*(3), 1. http://dx.doi.org/10.3390/ijerph13030280

Glaser, B. A., Calhoun, G. B., & Petrocelli, J. V. (2002). Personality characteristics of male juvenile offenders by adjudicated offenses as indicated by the MMPI–A. *Criminal Justice and Behavior*, *29*(2), 183–201. https://doi.org/10.1177/0093854802029002004

Godleski, S. A., Eiden, R. D., Kachadourian, L., & Lucke, J. F. (2019). Etiological pathways to rejection sensitivity in a high-risk sample. *Personality and Social Psychology Bulletin*, *45*(5), 715–727. https://doi.org/10.1177/0146167218795486

Grierson, A. B., Hickie, I. B., Naismith, S. L., & Scott, J. (2016). The role of rumination in illness trajectories in youth: Linking trans-diagnostic processes with clinical staging models. *Psychological medicine*, *46*(12), 2467–2484. https://doi.org/10.1017/S0033291716001392

Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., & Duda, S. N. (2019). The REDCap consortium:

Building an international community of software platform partners. *Journal of Biomedical Informatics*, *95*, 103208. https://doi.org/10.1016/j.jbi.2019.103208

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, *42*(2), 377–381. https://doi.org/10.1016/j.jbi.2008.08.010

Hartig, T., Mang, M., & Evans, G.W. (1991). Restorative effects of natural environment experiences. *Environment and Behavior*, *23*(1), 3-26. https://doi.org/10.1177/0013916591231001

Hartig, T., Mitchell, R. de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health, 35*, 207-228. https://doi-org.libproxy.lib.unc.edu/10.1146/annurev-publhealth-032013-182443

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis*. (2nd Ed.). The Guilford Press.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature*, *466*(7302), 29–29. https://doi.org/10.1038/466029a

Hill, C. A. (1987). Affiliation motivation: People who need people… but in different ways. *Journal of Personality and Social Psychology*, *52*(5), 1008–1018. https://doi.org/10.1037/0022-3514.52.5.1008

Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, *7*(7). https://doi.org/10.1371/journal.pmed.1000316

Holt-Lunstad, J., Robles, T., & Sbarra, D. A. (2017). Advancing social connection as a public health priority in the United States. *The American Psychologist*, *72*(6), 517–530. https://doi.org/10.1037/amp0000103

Huberty, C. J., & Morris, J. D. (1989). Multivariate analysis versus multiple univariate analyses. *Psychological Bulletin*, *105*(2), 302–308. https://doi.org/10.1037/0033-2909.105.2.302

Hwang, T.-J., Rabheru, K., Peisah, C., Reichman, W., & Ikeda, M. (2020). Loneliness and social isolation during the COVID-19 pandemic. *International Psychogeriatrics*, 1–4. https://doi.org/10.1017/S1041610220000988

IBM Corporation. (2020). *IBM SPSS Statistics for Windows* (Version 27) [Computer Software]. IBM Corp. https://www.ibm.com/products/spss-statistics

Jamieson, S. (2004). Likert scales: How to (ab)use them. *Medical Education*, *38*(12), 1217–1218. https://doi.org/10.1111/j.1365-2929.2004.02012.x

James, P., Banay, R., Hart, J., & Laden, F. (2015). A Review of the health benefits of greenness. *Current Epidemiology Reports*, *2*, 131–142. https://doi.org/10.1007/s40471-015-0043-7

Kalmakis, K. A., Meyer, J. S., Chiodo, L., & Leung, K. (2015). Adverse childhood experiences and chronic hypothalamic–pituitary–adrenal activity. *Stress: The International Journal on the Biology of Stress*, *18*(4), 446–450. https://doi-org.libproxy.lib.unc.edu/10.3109/10253890.2015.1023791

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. In *Journal of Environmental Psychology*, *15*, 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

Kaplan, R., & Kaplan, S. (2011). Well-being, reasonableness, and the natural environment. *Applied Psychology: Health and Well-Being*, *3*(3), 304–321. https://psycnet.apa.org/record/2013-12592-005

Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and Emotion*, *17*(2), 297–314. https://doi-org.libproxy.lib.unc.edu/10.1080/02699930302297

Keniger, L. E., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the benefits of interacting with nature?. *International journal of environmental research and public health*, *10*(3), 913–935. https://doi.org/10.3390/ijerph10030913

Keyes, C. L. M. (1998). Social well-being. *Social Psychology Quarterly, 61*(2), 121-140. https://login.iris.etsu.edu:3443/login?url=https://search.proquest.com/docview/212699330?accountid=10771

Khan, M., & Renk, K. (2018). Understanding the pathways between mothers' childhood maltreatment experiences and patterns of insecure attachment with young children via symptoms of depression. *Child psychiatry and human development*, *49*, 928–940. https://doi.org/10.1007/s10578-018-0808-6

Kim, H.Y. (2013). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics*, *38*(1), 52–54. https://doi.org/10.5395/rde.2013.38.1.52

Kobayashi, H., Song, C., Ikei, H., Kagawa, T., & Miyazaki, Y. (2015). Analysis of individual variations in autonomic responses to urban and forest environments. *Evidence-Based Complementary & Alternative Medicine (ECAM)*, *2015*, 1–7. https://doi.org/10.1155/2015/671094

Kobayashi, H., Song, C., Ikei, H., Park, B., Lee, J., Kagawa, T., & Miyazaki, Y. (2018). Forest walking affects autonomic nervous activity: A population-based study. *Frontiers in Public Health*, *6*, 278. https://doi.org/10.3389/fpubh.2018.00278

Kok, B., Coffey, K., Cohn, M., Catalino, L., Vacharkulksemsuk, T., Algoe, S., Brantley, M., & Fredrickson, B. (2013). How positive emotions build physical health: Perceived positive social connections account for the upward spiral between positive emotions and vagal tone. *Psychological Science*, *24*, 1123–1132. https://doi.org/10.1177/0956797612470827

Kuo, F. E., Bacaicoa, M., & Sullivan, W. C. (1998). Transforming inner-city landscapes: Trees, sense of safety, and preference. *Environment and Behavior*, *30*(1), 28–59. https://doi.org/10.1177/0013916598301002

Kuo, F. E., & Sullivan, W. C. (2001a). Aggression and violence in the inner city: Effects of environment via mental fatigue. *Environment and Behavior*, *33*(4), 543–571. https://doi.org/10.1177/00139160121973124

Kuo, F., & Sullivan, W. (2001b). Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior*, *33*, 343–367. https://doi.org/10.1177/0013916501333002

Kuo M. (2015). How might contact with nature promote human health? Promising mechanisms and a possible central pathway. *Frontiers in psychology*, *6*, 1093. https://doi.org/10.3389/fpsyg.2015.01093

Leary, M. R., Kelly, K. M., Cottrell, C. A., & Schreindorfer, L. S. (2013). Construct validity of the need to belong scale: Mapping the nomological network. *Journal of Personality Assessment*, *95*(6), 610–624. https://doi.org/10.1080/00223891.2013.819511

Lee, R. M., & Robbins, S. B. (1995). Measuring belongingness: The social connectedness and the social assurance scales. *Journal of Counseling Psychology*. *42*(2), 232-241.

Leys, C., Delacre, M., Mora, Y. L., Lakens, D., & Ley, C. (2019). How to classify, detect, and manage univariate and multivariate outliers, with emphasis on pre-registration. *International Review of Social Psychology*, *32*(1), 5. https://doi.org/10.5334/irsp.289

Li, Q., Morimoto, K., Kobayashi, M., Inagaki, H., Katsumata, M., Hirata, K., Hirata, Y., Suzuki, H., Li, Y.J., Wakayama, Y., Kawada, T., Park, B.J., Ohira, T., Matsui, N., Kagawa, T., Miyazaki, Y., & Krensky, A. M. (2008). Visiting a forest, but not a city, increases human natural killer activity and expression of anti-cancer proteins. *International Journal of Immunopathology and Pharmacology*, 117–127. https://doi.org/10.1177/039463200802100113

Li, Q., Kobayashi, M., Wakayama, Y., Inagaki, H., Katsumata, M., Hirata, Y., Hirata, K., Shimizu, T., Kawada, T., Park, B.J., Ohira, T., Kagawa, T., & Miyazaki, Y. (2009). Effect of phytoncide from trees on human natural killer cell function. *International Journal of Immunopathology and Pharmacology*, 951–959. https://doi.org/10.1177/039463200902200410

Lohr, V.I., Pearson-Mims, C.H., & Goodwin, G.K. (1996). Interior plants may improve worker productivity and reduce stress in a windowless environment. *Journal of Environmental Horticulture*, *14*, 97-100. https://doi.org/10.24266/0738-2898-14.2.97

Lohr, V. I., & Pearson-Mims, C. H. (2000). Physical discomfort may be reduced in the presence of interior plants. *Horttechnology, 10*(1), 53-58. https://doi.org/10.21273/HORTTECH.10.1.53

Lowry, C., Hollis, J., de Vries, A., Pan, B., Brunet, L., Hunt, J., Paton, J.F.R., van Kampen, Knight, D.M., Evans, A.K., Rook, G.A.W., & E., Lightman, S. (2007). Identification of an immune-responsive mesolimbocortical serotonergic system: Potential role in regulation of emotional behavior. *Neuroscience*, *146*, 756–772. https://doi.org/10.1016/j.neuroscience.2007.01.067

Lumley, T. Diehr, P., Emerson, S., & Chen, L. (2002). The importance of the normality assumption in large public health data sets. *Annual Review of Public Health*, *23*, 151-169.

Maas, J., van Dillen, S., Verheij, R., & Groenewegen, P. (2009). Social contacts as a possible mechanism behind the relation between green space and health. *Health and Place*, *15*, 586–595. https://doi.org/10.1016/j.healthplace.2008.09.006

Maas, J., Verheij, R., De Vries, S., Spreeuwenberg, P., Schellevis, F., & Groenewegen, P. (2009). Morbidity is related to a green living environment. *Journal of Epidemiology and Community Health, 63*(12), 967-973. https://doi.org/10.1136/jech.2008.079038

McAllister, E., Bhullar, N., & Schutte, N. S. (2017). Into the woods or a stroll in the park: How virtual contact with nature impacts positive and negative affect. *International Journal of Environmental Research and Public Health*, *14*(7). http://dx.doi.org.libproxy.lib.unc.edu/10.3390/ijerph14070786

McMahan, E. A., & Estes, D. (2015). The effect of contact with natural environments on positive and negative affect: A meta-analysis. *The Journal of Positive Psychology*, *10*(6), 507–519. https://doi.org/10.1080/17439760.2014.994224

Morling, B. (2017). *Research methods in psychology* (3rd ed.). WW Norton.

Mygind, L., Kjeldsted, E., Hartmeyer, R., Mygind, E., Bølling, M., & Bentsen, P. (2019). Mental, physical and social health benefits of immersive nature-experience for children and adolescents: A systematic review and quality assessment of the evidence. *Health and Place*, *58*, 102136. https://doi.org/10.1016/j.healthplace.2019.05.014

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology*, *109*(3), 504–511. https://doi.org/10.1037/0021-843X.109.3.504

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education*, *15*(5), 625–632. https://doi.org/10.1007/s10459-010-9222-y

Office of Disease Prevention and Health Promotion. (20009). *Healthy People 2020 – General Health Status - Chronic Disease Prevalence*. https://www.healthypeople.gov/2020/about/foundation-health-measures/General-Health-Status#chronic

Oppenheimer, D. M., Meyvis, T., & Davidenko, N. (2009). Instructional manipulation checks: Detecting satisficing to increase statistical power. *Journal of Experimental Social Psychology, 45*(4), 867-872.

Oral, R., Ramirez, M., Coohey, C., Nakada, S., Walz, A., Kuntz, A., Benoit, J., & Peek-Asa, C. (2016). Adverse childhood experiences and trauma informed care: The future of health care. *Pediatric Research, 79*(1-2), 227-233. http://dx.doi.org/10.1038/pr.2015.197

Pasanen, T. P., Tyrväinen, L. and Korpela, K. M. (2014). Perceived Health and Activity in Nature. *Applied Psychology: Health and Well-Being*, *6*, 324-346. https://doi.org/10.1111/aphw.12031

Pearson, E. S., & Hartley, H. O. (1954). *Biometrika tables for statisticians, Volume I*. Cambridge University Press.

Pedhazur, E. J. (1997).Multiple regression in behavioral research: Explanation and prediction (3rd ed.). Harcourt Brace College Publishers.

Poole, J., Dobson, K., & Pusch, D. (2018). Do adverse childhood experiences predict adult interpersonal difficulties? The role of emotion dysregulation. *Child Abuse & Neglect, 80*, 122-133. http://search.proquest.com/docview/2077579991/

Post, A. L., Wittmaier, B. C., & Radin, M. E. (1978). Self-disclosure as a function of state and trait anxiety. *Journal of Consulting and Clinical Psychology*, *46*(1), 12. https://doi.org/10.1037/0022-006X.46.1.12

Pretty J, Peacock J, Sellens M, & Griffin M. (2005). The mental and physical health outcomes of green exercise. *International Journal of Environmental Health Research*, *15*(5), 319–337. 10.1080/09603120500155963

Pretty, J., Peacock, J., Hine, R., Sellens, M., South, N., & Griffin, M. (2007). Green exercise in the UK countryside: Effects on health and psychological well-being, and implications for policy and planning. *Journal of Environmental Planning & Management*, *50*(2), 211–231. https://doi.org/10.1080/09640560601156466

Reagan, A. J., Danforth, C. M., Tivnan, B., Jake, R. W., & Peter, S. D. (2017). Sentiment analysis methods for understanding large-scale texts: A case for using continuum-scored words and word shift graphs. *EPJ Data Science, 6*(1), 1-21. http://dx.doi.org/10.1140/epjds/s13688-017-0121-9

Renne, K. (1974). Measurement of social health in a general population survey. *Social Science Research*, *3*(1), 25–44. https://doi.org/10.1016/0049-089X(74)90017-9

Repke M.A., Berry M.S., Conway L.G. III, Metcalf A., Hensen R.M., Phelan C. (2018). How does nature exposure make people healthier?: Evidence for the role of impulsivity and expanded space perception. *PLOS ONE*, *13*(8), e0202246. https://doi.org/10.1371/journal.pone.0202246

Reynolds, L., Rogers, O., Benford, A., Ingwaldson, A., Vu, B., Holstege, T., & Alvarado, K. (2020). Virtual nature as an intervention for reducing stress and improving mood in people with substance use disorder. *Journal of Addiction*. https://doi.org/10.1155/2020/1892390

Richardson, M., & McEwan, K. (2018). 30 days wild and the relationships between engagement with nature's beauty, nature connectedness and well-being. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01500

Richardson, M. (2019). Beyond restoration: Considering emotion regulation in natural well-being. *Ecopsychology*, *11*(2), 123–129. https://doi.org/10.1089/eco.2019.0012

Rook, G. (2013). Regulation of the immune system by biodiversity from the natural environment: an ecosystem service essential to health. *Proceedings of the National Academy of Sciences of the United States of America*, *110*, 18360–18367. https://doi.org/10.1073/pnas.1313731110

Schaan, V. K., Schulz, A., Bernstein, M., Schächinger, H., & Vögele, C. (2020). Effects of rejection intensity and rejection sensitivity on social approach behavior in women. *PLoS ONE*, *15*(1). https://doi.org/10.1371/journal.pone.0227799

Schwartz, A., Dodds, P., O'Neil-Dunne, J., Danforth, C., & Ricketts, T. (2019). Visitors to urban greenspace have higher sentiment and lower negativity on Twitter. *People and Nature*, *1*, 476-485. https://doi.org/10.1002/pan3.10045

Seymour, V. (2016). The human-nature relationship and its impact on health: A critical review. *Frontiers in Public Health*, *4*, 260. https://doi.org/10.3389/fpubh.2016.00260

Shanahan, D., Bush, R., Gaston, K., Lin, B., Dean, J., Barber, E., & Fuller, R. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports*, *6*(1), 28551. https://doi.org/10.1038/srep2855

Sona Systems. (2018). *Cloud-based participant pool management software: An effective system for improving and increasing research productivity*[Brochure]. https://www.sona-systems.com/sales/brochure.pdf

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press.

Spielberger, C. (1989). *State-Trait Anxiety Inventory: Bibliography* (2nd ed.). Consulting Psychologists Press.

Swami, V., von Nordheim L., Barron, D. (2016). Self-esteem mediates the relationship between connectedness to nature and body appreciation in women, but not men. *Body Image*, *16*, 41–44, https://doi.org/10.1016/j.bodyim.2015.11.001

Tarullo, A., & Gunnar, M. (2006). Child maltreatment and the developing HPA axis. *Hormones and Behavior*, *50*, 632–639. https://doi.org/10.1016/j.yhbeh.2006.06.010

Taylor, A., Wiley, A., Kuo, F., & Sullivan, W. (1998). Growing up in the inner city: Green spaces as places to grow. *Environment and Behavior*, *30*, 3–27. https://doi.org/10.1177/0013916598301001

Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (2001). Coping with ADD: The surprising connection to green play settings. *Environment and Behavior*, *33*(1), 54–77. https://doi.org/10.1177/00139160121972864

Taylor, A. F., & Kuo, F. E. (Ming). (2011). Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Applied Psychology: Health and Well-Being*, *3*(3), 281–303. https://doi.org/10.1111/j.1758-0854.2011.01052.x

Taylor, M., Wheeler, B., White, M., Economou, T., & Osborne, N. (2015). Research note: Urban street tree density and antidepressant prescription rates—A cross-sectional study in London, UK. *Landscape and Urban Planning*, *136*, 174–179. https://doi.org/10.1016/j.landurbplan.2014.12.005

Tsao, T.-M., Tsai, M.-J., Wang, Y.-N., Lin, H.-L., Wu, C.-F., Hwang, J.-S., Hsu, S.-H. J., Chao, H., Chuang, K.-J., Chou, C.-C., & Su, T.-C. (2014). The health effects of a forest environment on subclinical cardiovascular disease and heath-related quality of life. *PLOS ONE*, *9*(7), e103231. https://doi.org/10.1371/journal.pone.0103231

Tsao, T. M., Tsai, M. J., Hwang, J. S., Cheng, W. F., Wu, C. F., Chou, C. K., & Su, T. C. (2018). Health effects of a forest environment on natural killer cells in humans: an observational pilot study. *Oncotarget*, *9*(23), 16501–16511. https://doi.org/10.18632/oncotarget.24741

Twenge, J., Martin, G., & Campbell, W. (2018). Decreases in psychological well-being among American adolescents after 2012 and links to screen time during the rise of smartphone technology. *Emotion 18*, 765–780. https://doi.org/10.1037/emo0000403

Twohig-Bennett, C., and Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research*, *166*, 628–637. https://doi.org/10.1016/j.envres.2018.06.030

Uchino, B. N., Cacioppo, J. T., & Kiecolt-Glaser, J. K. (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms

and implications for health. *Psychological Bulletin*, *119*(3), 488–531. https://doi.org/10.1037/0033-2909.119.3.488

Ulrich, R. (1981). Natural versus urban scenes: Some psychophysiological effects. *Environment and Behavior*, *13*, 523–556. https://doi.org/10.1177/0013916581135001

Ulrich R.S. (1983) Aesthetic and affective response to natural environment. In: Altman I., Wohlwill J.F. (eds). *Behavior and the Natural Environment*. Springer. https://doi-org.libproxy.lib.unc.edu/10.1007/978-1-4613-3539-9_4

Ulrich, R. (1984). View through a window may influence recovery from surgery. *Science, 224*, 420-421. https://doi.org/10.1126/science.6143402

Ulrich, R., Simons, R., Losito, B., Fiorito, E., Miles, M., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Van Herzele, A., & de Vries, S. (2012). Linking green space to health: A comparative study of two urban neighbourhoods in Ghent, Belgium. *Population and Environment, 34*(2), 171-193. http://dx.doi.org/10.1007/s11111-011-0153-1

Warne, R. (2014). A Primer on multivariate analysis of variance (MANOVA) for behavioral scientists. *Practical Assessment, Research, and Evaluation, 19*(17), 1-10. https://doi.org/10.7275/SM63-7H70

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063-1070. https://doi.org/10.1037/0022-3514.54.6.1063

Watson, D., Clark, L. A., McIntyre, C. W., & Hamaker, S. (1992). Affect, personality, and social activity. *Journal of Personality and Social Psychology*, *63*(6), 1011. https://doi.org/10.1037/0022-3514.63.6.1011

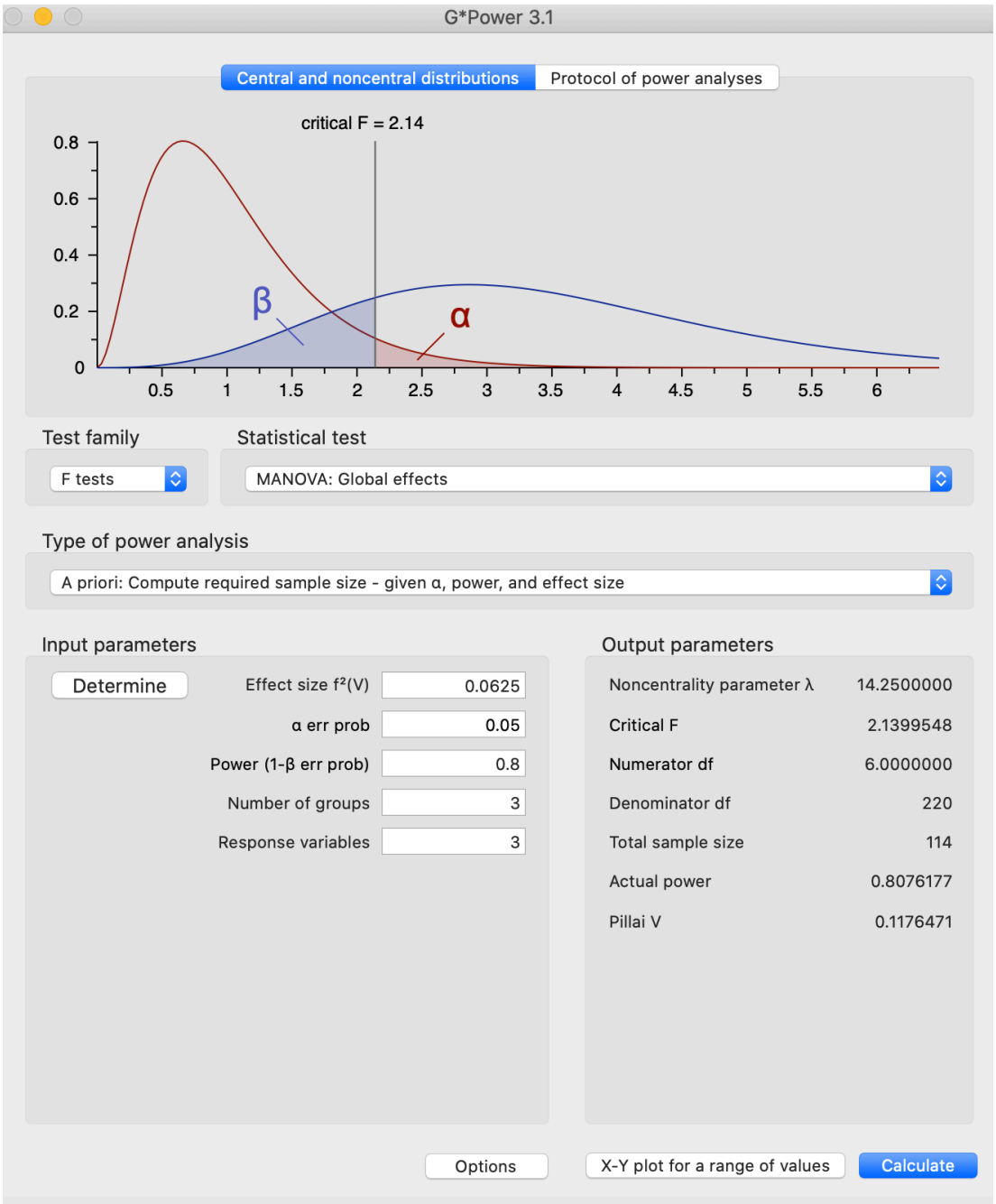
Wuensch, K. (2020, September). *An overview of power analysis*. East Carolina University. http://core.ecu.edu/psyc/wuenschk/StatHelp/PowerAnalysis_Overview.pdf

Wilson, E. O. (1984). *Biophilia*. Harvard University Press.

World Health Organization. (1948). Constitution of the World Health Organization. American Journal of Public Health, *36*(11), 1315-1323. https://doi.org/10.2105/AJPH.36.11.1315

APPENDICES

Appendix A: A priori G*Power Analysis



Small Effect Size: $f^2 = 0.01$, Medium Effect Size: $f^2 = 0.0625$, Large Effect Size: $f^2 = 0.16$ (Brysbaert and Stevens, 2018; Cohen, 1992; Faul et al., 2009)

Appendix B: Sona Systems Description

Study name: Walk This Way

Brief Abstract: The purpose of this research is to examine how going on a virtual walk affects the self. Participation in this online study may take up to one hour.

Eligibility Requirements: You must be 18 years of age or older to participate. You must also be able to read English fluently.

Duration: 1 hour

Credits: 1 Sona research credit

Appendix C: Demographics Questionnaire

1. Sona ID

2. Age

3. Gender Identity:

    Female

    Male

    Transgender female

    Transgender male

    Gender variant / non-conforming

4. What is your racial / ethnic identity (check all that apply)?

    White / Caucasian

    Black, African-American, or African

    Hispanic or Latinx

    Middle Eastern

    East Asian or South Asian

    Native Hawaiian or other Pacific Islander

    Native American or American Indian

    Caribbean

    Other

5. What is the primary language that you speak at home?

Appendix D: State Motivation to Foster Social Connections Scale (SMSC)

Please read the following statements and rate the extent to which you agree or disagree with those statements with regard to how you are feeling **right now**. Use the following scale:

	1 Strongly Disagree	2	3	4	5	6 Strongly Agree
Right now, I would like to meet new people. (1)						
Right now, I'd like to be around friends. (2)						
Right now, I would like to talk with and get to know an unfamiliar person. (3)						
Right now, I would like to be close with friends, family, and significant others. (4)						
Right now, forming new relationships is very important to me. (5)						
Right now, I'd like to be around people I know. (6)						
Right now, I would like to form new friendships/relationships. (7)						
Right now, being close with my friends, family, and significant others is important to me. (8)						
Right now, meeting new people and finding out about them is something I am interested in doing. (9)						
Right now, I'd rather be with my friends and family than alone. (10)						

State Motivation to Foster Social Connections Total Score: Add up scores from all items.
State Motivation to Foster Social Connections with New People Score: Add up scores from items 1, 3, 5, 7, and 9.
State Motivation to Foster Social Connections with Existing People Score: Add up scores from items 2, 4, 6, 8, and 10. (Bernstein et al., 2019)

Appendix E: Positive and Negative Affect Schedule (PANAS)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment. Use the following scale to record your answers.

		1 Very Slightly Or Not At All	2 A Little	3 Moderately	4 Quite A Bit	5 Extremely
1	Interested					
2	Distressed					
3	Excited					
4	Upset					
5	Strong					
6	Guilty					
7	Scared					
8	Hostile					
9	Enthusiastic					
10	Proud					
11	Irritable					
12	Alert					
13	Ashamed					
14	Inspired					
15	Nervous					
16	Determined					
17	Attentive					
18	Jittery					
19	Active					
20	Afraid					

Positive Affect Subscale: Add scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19
Negative Affect Subscale: Add scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20
(Watson et al., 1988)

Appendix F: State Anxiety Inventory (STAI Form Y-1)

A number of statements which people have used to describe themselves are given below. Read each statement and then choose the appropriate number to the right of the statement to indicate how you feel *right now*, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	1 Not At All	2 Somewhat	3 Moderately So	4 Very Much So
I feel calm (1)				
I feel secure (2)				
I am tense (3)				
I feel strained (4)				
I feel at ease (5)				
I feel upset (6)				
I am presently worrying over possible misfortunes (7)				
I feel satisfied (8)				
I feel frightened (9)				
I feel comfortable (10)				
I feel self-confident (11)				
I feel nervous (12)				
I am jittery (13)				
I feel indecisive (14)				
I am relaxed (15)				
I feel content (16)				
I am worried (17)				
I feel confused (18)				
I feel steady (19)				
I feel pleasant (20)				

STAI Score: Reverse score items 1, 2, 5, 8, 10, 11, 15, 16, 19, and 20 (e.g. 1 becomes 4) and then add up the total score. (Spielberger et al., 1983)

Appendix G: Adverse Childhood Experiences (ACEs)

	While you were growing up, during your first 18 years of life:	Yes	No
1.	Did a parent or other adult in the household **often...** Swear at you, insult you, put you down, or humiliate you? **or** Act in a way that made you afraid that you might be physically hurt?		
2.	Did a parent or other adult in the household **often...** Push, grab, slap, or throw something at you? **or** Ever hit you so hard that you had marks or were injured?		
3.	Did an adult person at least 5 years older than you **ever**… Touch or fondle you or have you touch their body in a sexual way? **or** Try to or actually have oral, anal, or vaginal sex with you?		
4.	Did you **often** feel that... No one in your family loved you or thought you were important or special? **or** Your family didn't look out for each other, feel close to each other, or support each other?		
5.	Did you **often** feel that... You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you? **or** Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?		
6.	Were your parents **ever** separated or divorced?		
7.	Was your mother or stepmother: **Often** pushed, grabbed, slapped, or had something thrown at her? **or** **Sometimes or often** kicked, bitten, hit with a fist, or hit with something hard? **or** **Ever** repeatedly hit over at least a few minutes or threatened with a gun or knife?		
8.	Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?		
9.	Was a household member depressed or mentally ill or did a household member attempt suicide?		
10.	Did a household member go to prison?		

ACE Score: Add up the "Yes" answers - 1 point each. (Felitti et al., 1998)

Appendix H: Debriefing Document

Title of Research: Walk This Way
Principal Investigator: Samantha Castelblanco, M.A**.**

DEBRIEFING

Thank you for participating in this research today.

The true purpose of this research was to examine the influence of nature exposure on motivation to foster social connections and how adverse childhood experiences might moderate that relationship. You answered online survey questions about yourself and you were randomly assigned to watch a video of a virtual walk in nature, the city, or a mall. Although there may not be any direct benefits to you at this time, participating in this research today may have provided you with the opportunity to learn a bit more about yourself and about the psychological research process. If you are an ETSU student, you will also earn 1 Sona credit for completing this research study. If you are not an ETSU student, you will not receive compensation for participation in this study. Possible benefits for you and others include gaining a better understanding of how nature exposure influences motivation to foster social connections and how adverse childhood experiences might moderate that relationship.

Only study staff will have access to the answers you provided in response to the survey questions. Your data, including your answers to survey questions, will never be shared with anyone outside of study staff and the ETSU IRB. All data collected from you today will be coded with your Sona ID only and will never be associated with your name or any other personally identifying information. Your data will then be combined with other participants' data and the overall results, once analyzed statistically, will be shared with the public.

We again want to sincerely thank you for your participation in this research. Should you have any questions or concerns regarding this research after you leave the lab, please e-mail Samantha Castelblanco at castelblanco@etsu.edu.

In addition, if you feel that you need to speak to a professional, you may contact the ETSU Student Counseling Center at 423-439-3333, the ETSU Behavioral Health and Wellness Clinic at 423-439-7777, the ETSU Community Counseling Clinic at 423-439-4187, or BucsPRESS2, a 24-hour mental health helpline, at 423-439-4841.

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