

ANALYZING PSYCHOLOGICAL AND PHYSIOLOGICAL RESPONSES TO
IMMERSIVE VIRTUAL REALITY ENVIRONMENTS

by

HEWITT BERNARD ROGERS

(Under the Direction of Alan E. Stewart)

ABSTRACT

Human interaction with nature has existed since the dawn of mankind. As time progressed, so did human technology which in turn changed the way people lived and interacted with the environments around them (Harari, 2015; Selhub & Logan, 2012). This study showed how immersive virtual reality environments (IVREs), specifically natural versus built environments, can impact one's mood, connection to nature, and perceived restoration. Using a within-subject design, participants viewed a nature and industrial IVRE video. Each participant completed a pretest prior to video exposure then a posttest following viewing each video. Results indicated that participants scored lowest on the Brunel Mood Scale (BRUMS) after exposure to the nature video when compared to baseline and the industrial video demonstrating that there was a reduction in negative mood states after being exposed to a nature IVRE video. Also, results suggested that participants experienced significantly more connectedness to nature following exposure to the nature video. Furthermore, findings indicated that participants perceived the nature video to be significantly more restorative than the industrial video as

exhibited by significantly higher scores on the Perceived Restorativeness Scale (PRS) following exposure to the nature video as well as lower levels of arousal indicated by significantly lower standardized galvanic skin response (GSR) means and middle-range heartrate (HR) means. A further breakdown of the significant findings can be found in the Results section of this manuscript. Additionally, implications for these findings as well as strengths and limitations are expanded upon in the Discussion section.

INDEX WORDS: Nature, Ecopsychology, Immersive Environments, Virtual Reality, Psychophysiological, Mood States, Restoration, Connectedness to Nature

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HEWITT BERNARD ROGERS

B.S., Mississippi State University, 2011

M.Ed., The University of Mississippi, 2013

Ed.S., The University of Mississippi, 2014

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HEWITT BERNARD ROGERS

Major Professor: Alan E. Stewart
Committee: Linda F. Campbell
Lenoir Gillam

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
December 2021

DEDICATION

I dedicate this dissertation to my children Mae Frances Rogers and Brunson Maddox Rogers. It is my hope that my academic work and achievements will demonstrate to both of you what can come from persistence and determination. I love both of you more than you could imagine.

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CHAPTER I
ANALYZING PSYCHOLOGICAL AND PHYSIOLOGICAL RESPONSES TO
IMMERSIVE VIRTUAL REALITY ENVIRONMENTS

Statement of the Problem

Human interaction with nature has existed since the dawn of mankind. Early humans depended on the natural environment to provide every necessity in almost all aspects of everyday life (Harari, 2015). Whether it be for food from nearby vegetation and animals or natural resources such as lumber and stone for tools, shelter, and protection, humans would not have made it as far as they are today had nature not provided such an abundance of riches. As time progressed, so did human technology which in turn changed the way humans lived and interacted with the environment around them (Harari, 2015; Selhub & Logan, 2012). Although humans still depend on the natural environment today, many may not be cognizant of that dependence at all due to the fact that it is not the same type of dependence as early humans experienced. With the lure of bright lights from the big city, the newest and greatest electronic gadget seemingly being released every day, and rapid urbanization in areas all across the world, people have begun to lose the vital connection to nature which early civilizations recognized as being so valuable not just for materialistic reasons, but also for psychological and spiritual purposes (Harari, 2015). Although what has just been said may seem like doom and gloom, all hope is not lost. There has been a steady growth in the awareness of what nature

provides, but more specifically there has been a reemergence in the value of nature. Perhaps the consequences of people's actions have forced them to reevaluate their lives leading to a rediscovery of the benefits that human interaction with nature provides; or perhaps it is deeper than that and there is a true bond between humans and nature that can never be severed no matter what obstacles get in the way.

Another component of human life that often strangles the human/nature connection is work. When one looks at how much time humans spend working, it is easy to discern that a large majority of people spend more time working and with colleagues and engaged in personal care such as sleeping than they do with family and friends engaged in rest and leisure. For instance, South Korea recently enacted a law limiting the amount of time an individual is allowed to spend at work. Koreans are now limited to working only 52 hours a week down from an astounding 68 hours a week (Wamsley, 2018). That amount of time spent at work takes a toll on the body both mentally and physically while leaving little time to recover before the next workweek arrives (OECD Better Life Index, n.d.). In addition to work, humans spend a considerable amount of time indoors in general, often engaged with electronic devices further exacerbating the disconnect with nature. On average, Americans spend 87% of their time indoors and 6% of their time in a vehicle (Klepeis et al., 2001) leaving one to deduce that only approximately 7% is spent outdoors in some shape or form, although that does not necessarily equate to time spent immersed in nature. Furthermore, the same person who spends an exorbitant amount of time at work and then uses available free time

engaged with some form of electronic device, whether it be a video game system, phone, or television, that person spends little to no time engaged with nature.

What previous literature has shown about the human connection to nature is that nature interaction, whether it be direct or indirect, provides restoration and supports general well-being (Selhub & Logan, 2012). Different variables used in prior research to demonstrate the benefits of nature have taken the form of views of nature from pictures or windows, audio recordings of nature sounds, interaction in nature, or video recordings of nature scenes, and more recently, immersive virtual reality environments (Annerstedt et al., 2013; Berman et al., 2012; Calogiuri et al., 2018; Tennessen & Cimprich, 1995; Ulrich, 1984). That progression delineates the path to exposing subjects to environments that are more lifelike; the more participants believe and feel as if they are interacting with or are within a real environment, one may infer that the individuals will have more realistic psychological and physiological responses thus providing researchers with more accurate representations of the human/nature connection.

Given the inevitable advancement and use of technology in society, it is important not to fight against the current but to move with or alongside it. That is why it will be important to find more ways to integrate nature and technology though I want to make it clear that I am not suggesting this as a replacement for humans spending time outdoors immersed in nature. Although previous literature supports that exposure to actual nature is better than virtual nature (Calogiuri et al., 2018), virtual nature exposure may be better than no form of nature exposure at all. The purpose of the study discussed below will further elucidate my research

regarding technology and nature, but more specifically outline the purpose of exploring the connection between different environments and its impact on humans through the use of immersive virtual reality environments (IVRE).

Purpose of the Study

This study will seek to further clarify how immersive virtual reality environments, particularly natural versus built environments, impact mood, restoration, and connection to nature. Previous studies have explored the effects that exposure to nature has on humans from Berman and colleagues (2012) who investigated its potential use in the treatment of people suffering from major depressive disorder (MDD) to Tennessen and Cimprich (1995) who discovered that views of nature improved attentional ability, but few studies have investigated the human/nature connection by means of immersive virtual reality environments. As the purpose of this study is to use immersive virtual reality environments to elicit psychological and physiological responses to help determine their impact on mood, restoration, and connectedness to nature, it is important for participants to experience an environment as realistic as possible. That is why one of the latest and most advanced examples of consumer virtual reality (VR) equipment, the HTC Vive, was used for the following study. Also, the environmental scenes that participants were exposed to were filmed using 5.2K 360° footage to increase 'presence' and provide the most lifelike experience.

Furthermore, it is possible that the research findings from this study will not just expand the growing base of literature on the subject, but also contribute to the practical applications of IVRE. For instance, could nature-based IVRE interventions

be used in conjunction with traditional psychotherapy for improved treatment outcomes? Nature-based IVRE interventions could also be used more as a preventive measure and health promotion tool as opposed to strictly a treatment tool. In regard to whom this applies, it can be used by and with almost anyone. Using this technology could help those who live in heavily built or urban environments and lack immediate access to nature; it could provide individuals with disabilities a means to experience and immerse themselves in nature when otherwise they would not be able to do so in the same way those without disabilities could, or it could simply be a convenient way for people to strengthen their connection to nature and in turn improve their overall health. What this should not be is a replacement for actual nature interaction altogether, but a supplemental tool to boost and encourage individuals' engagement with and enjoyment of nature so that they may take in some of the many benefits the natural world around them offers.

Definitions

Definitions used in this study are summarized in the following:

Adventure therapy: The prescriptive use of adventure experiences provided by mental health professionals, often conducted in natural settings that kinesthetically engage clients on cognitive, affective, and behavioral levels

Being Away: An environment that provides psychological distance from routine or ordinary mental processes

Biophilia: Innate emotional affiliation human beings have with other living organisms

Connectedness to Nature: Emotional connectedness to the natural world

Compatibility: An environment where one's purpose can 'fit' with the environment at ease

Cybersickness: Experience of motion-like sickness during or after exposure to virtual immersive environments; symptoms may include but are not limited to general discomfort, headache, nausea, vomiting, and disorientation

Ecopsychology: Study of the relationship between human beings and the natural world through ecological and psychological principles

Ecotherapy: Treatment modalities that include the natural world in relationships of mutual healing and growth, and as such is a form of applied ecopsychology

Environmental psychology: The scientific study of the transactions and interrelationships between people and their physical surroundings (including built and natural environments, the use and abuse of nature and natural resources, and sustainability-related behavior.

Extent: An environment with richness and coherence so that it feels as though it constitutes a whole other world

Fascination: A central component that triggers restoration by stimulating involuntary attention; effortless, interest-driven attention

Greenspace: An umbrella term used to describe either maintained or unmaintained environmental areas, which can include nature reserves, wilderness environments, and urban parks

Immersive virtual reality environment (IVRE): Simulated environments that mimic lifelike environments

Nature therapy: Sometimes interchangeable with ecotherapy, but often is less inclusive and focuses more on experiencing nature and less on integrating a traditional therapeutic technique with nature

Presence: A felt sense of authentic reality that would result from engagement with sophisticated media

Restoration: Recovery of capabilities and resources that are progressively exhausted by the demands of everyday life

Shinrin yoku: Japanese practice of “forest bathing” or taking in the natural environment to recover from stress or fatigue or improve well-being

Research Questions

Through this study I explored the psychological and physiological effects that different virtual reality environments may have on people. In this study, I investigated the following questions:

1. Does interacting with nature through an immersive virtual environment lead to an improved mood state?
2. How does interaction with nature through an immersive virtual environment impact one’s connection to nature?
3. Can interacting with nature through an immersive virtual environment lead to restoration?

Mood state and connectedness to nature (CN) were determined by the administration of psychological measures while restoration was assessed by a psychological measure as well as physiological measures of arousal. For example, participants' affect was assessed using the Brunel Mood Scale (BRUMS), an abbreviated mood scale based on the Profile of Mood States Questionnaire (POMS), with six subscales containing four mood descriptors. Participant connectedness to nature (CN) was measured by Mayer and Frantz's (2004) Connectedness to Nature Scale, and lastly, restoration was measured by the Perceived Restorativeness Scale as well as galvanic skin response and heart rate using the HK-TA psychophysiological instruments developed by Iworx.

Hypotheses

The following hypotheses are based on the findings of previous research described in detail in the literature review in the following chapter.

Primary hypotheses:

1. Participants who are exposed to nature through an immersive virtual reality environment (IVRE) will show an increase in positive affect.
2. Participants will show a higher connectedness to nature after being exposed to the nature IVRE.
3. Participants will experience more perceived restoration after exposure to a nature IVRE when compared to participants exposed to an urban/industrial IVRE.

CHAPTER II

LITERATURE REVIEW

The purpose of this literature review is to introduce the reader to research supporting humans' innate connection to and preference for nature, but more specifically the psychological benefits that humans obtain when interacting with or immersing themselves in nature. After a brief history of the early human/nature connection, this paper will introduce the reader to two major theoretical foundations on which much of the environmental and ecopsychology research is based. Then, I will review previous and current research that demonstrates how humans respond psychologically and physiologically to nature before discussing the need for replication research within the field of psychology. I will reference a particular study which will be replicated in part so that the gap between technology – virtual reality – and nature may be reduced by integrating the two seemingly contradictory elements. Lastly, limitations to this area of research will be introduced to protect potential at-risk populations and hopefully stimulate new ideas for future research within the field of ecopsychology.

Human/Nature Connection History

Now, if one thinks back to childhood and tries to recall specific favorite memories and locations where those memories occurred, certain commonalities are evident. Who or what was there? What took place? Where did it take place? It should come as no surprise that for a vast majority of the population, a memory

would most likely be associated with a person, an animal, or a natural setting, so simply put, with living things. If one were to recall more memories, one would uncover more connections with living things or the natural world, whether it be connecting with friends at an outdoor cookout, time spent playing with a family pet, or looking up in awe at the magnificent magnolia tree in the neighbor's yard. This is because humans have an affinity for living things.

From an evolutionary perspective, humans spent the vast majority of their lives evolving in natural settings, thus creating a special bond between human and nature with nature being all living organisms. Ulrich (1991) points out that although evolutionary perspectives may vary, it is agreed that there is a common argument that humans have an innate predisposition to take notice and respond positively to natural elements. Nature provides sustenance, protection, and joy among many other things. In certain cultures, nature acted as a vessel to connect with the spiritual realm, and in other cultures nature was a living, breathing God in and of itself (Harari, 2015). As humans evolved and cultures became more industrialized, nature suffered as a consequence. Moving further ahead in time, humans began to realize their mistreatment of nature and the resources it provided; they began to notice the value of nature and the need to protect it. One man who noticed humans' detrimental impact on nature was George Marsh. He contended that wherever man stepped, destruction and disruption of the natural order soon followed (Marsh, 1864, as cited in Nash, 1968). Frederick Law Olmsted was another individual who saw the value in nature and worked to help others see it as well. As a landscape architect, he helped plan and design Central Park in New York City so

that people had a refuge to escape the chaotic and stressful urban environment, and as an activist he worked with Congress to protect wilderness areas and ensure their presence for decades to come. He saw human interaction with the natural world as vital to appropriate mental health (Olmsted, 1952, as cited in Nash, 1968).

Further evidence of human knowledge about the importance of nature can be seen in “Biophilia”; a term that has been around since the early 1900’s (Selhub & Logan, 2012), though Edward O. Wilson might be most popular for bringing the term to prominence. Wilson (1984, p.31) defined the term biophilia as an “innate emotional affiliation of human beings to other living organisms.” Wilson described the human connection with nature as being so deep that it is present cross-culturally. Researchers from Japan, Sweden, Britain, Australia, and the United States, as well as other nations, have investigated different aspects of the human/nature connection and concluded it to be beneficial to human psychological and physiological health, thus supporting Wilson’s intuitive thinking. (Hartig et al., 2003; Kaplan, 1995; Lee et al., 2011; Shin et al., 2010; Ulrich, 1981; Ulrich et al., 1991; White et al., 2013).

Emergence of Ecopsychology

The birth of ecopsychology has been linked to the environmental movement that began in the 1960s when people recognized that the modern industrial world had produced an environmental catastrophe, but it did not become formally defined until Theodore Roszak’s use of the word in his 1992 book *Voice of the Earth: An Exploration of Ecopsychology* (Hibbard, 2003). Since the environmental movement in the 1960’s, the field of ecopsychology has steadily progressed and grown as a

field with no signs of slowing down. While the field has grown, some might say that it has grown so much and in so many directions that it lacks a clear and concise path or organization; even the term ecopsychology lacks a decisive, commonly recognized definition (Hibbard, 2003). Given that Roszak first coined the term ecopsychology in 1992, it may be helpful to try to understand it as he did; ecopsychology is the synthesis of the ecological and the psychological (Hibbard, 2003).

Considering humans' intrinsic connection to nature, one may infer that when a person is disconnected from nature, the body suffers both psychologically and physiologically, but when a person is connected to nature in some way, even in a small sense, the body and mind can recover from stress, improve mood and affect, and increase cognitive functioning (Berman et al., 2012; MacKerron & Nourato, 2013; Parson et al., 1998). One of the first measures - Connectedness to Nature Scale (CNS) - to explore human connection to nature was devised by Mayer and Frantz (2004); it was constructed to properly assess the level of emotional connectedness to the natural world. This measure helped researchers determine several things such as how much humans value nature as well as their ecological behavior (Mayer & Frantz, 2004). From their studies, they were able to deduce that when people feel as one with nature, they will be more likely to protect nature as it is tantamount to protecting themselves (Mayer & Frantz, 2004). Several other studies have used the CNS to further investigate connectedness to nature (CN) and well-being. For example, CN was strongly correlated to indicators of well-being such as meaningfulness; the authors stated that individuals who rate high for

meaningfulness believe their lives are fulfilling and unencumbered by anxiety, hopelessness, and depression (Cervinka et al., 2012).

Dutch researchers explored the relationship between greenspace and health and found that a natural living environment was a greater factor in self-reported health than an urban environment; they also learned that those who lived in greener areas did not present with as many symptoms and believed themselves to be in better health generally as well as mentally (de Vries et al., 2003). This can be explained by the innate human connection to nature, but also human preference for nature. For instance, functional magnetic resonance imaging (fMRI) was used while participants viewed rural and urban environments and suggested a participant preference for natural environments over urban environments (Kim et al., 2010). Further proof of how human interaction with the natural world can be shown to improve well-being is seen by looking at more of the body's physiological responses to nature. Viewing or interacting with nature can reduce blood pressure, decrease heart rate, and lower cortisol levels (Gidlow, et al., 2016; Lee et al., 2011; Ochiai et al., 2015).

In addition to improving the general well-being of healthy individuals, human/nature interaction has also been shown to improve the health of those with mental illness. Harold Searles, prominent figure in the field of psychoanalysis and one who was called a proto-ecopsychologist (Fisher, 1996), recognized the role that the non-human environment, particularly nature, played in mental health. Searles (1960) believed that there was a bond humans had with nature and when that bond was either consciously or unconsciously neglected or denied, humans' psychological well-being suffered. In addition, Searles (1960) posited that nature generally improved mood states, encouraged

self-realization, grounded people in reality, and promoted appreciation and acceptance of others. Furthermore, Marc Berman and colleagues (2012) found that individuals with Major Depressive Disorder (MDD) showed improved affect and suggested supplementing nature interaction with typical MDD treatment for better overall treatment outcomes. One may reason that as the field of ecopsychology continues to blossom, so will the use of nature either in conjunction with previously established evidence-based therapeutic practices or as a stand-alone measure to treat mental health concerns.

Even though ecopsychology is seen as a newer area within the broader field of psychology in general, there is a multitude of complex topics that encompass the many facets of the natural environment. For simplicity, the major focus of ecopsychology within this portion of the paper will center on the more therapeutic aspects or ecotherapy. For instance, wilderness therapy is often used with youth, commonly at-risk youths or juvenile delinquent populations, and has been shown to be effective in improving interpersonal skills and supporting behavior change (Bedard et al., 2003 as cited in Chalquist, 2009). The United States government has even seen the healing powers of nature and wilderness and provided funding for research for non-traditional treatments such as adventure therapies (Gass et al., 2012). In one qualitative study used to investigate the potential of wilderness experiences to help post-9/11 combat veterans, researchers found that veterans who participated in a thru-hike of the Appalachian Trail showed improvement and recognized the following four themes that emerged: social reconnection, life-improving change, inner peace/psychological healing, and processing and reflection (Dietrich et al., 2015).

One does not have to go into extreme natural environments to reap benefits similar to those of the above-mentioned studies. For example, horticulture therapy provides individuals with multiple avenues to engage with nature. Whether it be through active means of participation such as working in a garden (Fleming, 2015) or passive means such as viewing a courtyard with plants from a hospital room (Reeve et al., 2017), individuals are able to select an avenue which is best suited to them.

Up to this point nature has been discussed in terms of plants and landscapes, but not animals. Animals should not be excluded or discounted for there is an entire niche within the field devoted to animal-assisted therapy. Equine therapy is one such modality that allows people to bond with and care for horses (DeMayo, 2009; Nurenberg et al., 2015). Canines are another species which has been used to assist with therapy and provide patients with additional relief from psychological distress (Schuck et al., 2015). There are even more anecdotal cases and research regarding other living creatures and how they have a significant impact on human life. As an overarching theme, nature, which includes all living and non-living aspects, plays an important role in psychological well-being from both a preventive and curative standpoint.

Theoretical Underpinnings

As this study is investigating the psychological effects of interacting with nature through an immersive virtual reality environment, it may be useful to review the literature on the theoretical underpinnings on which much of the nature-based research is grounded. The amount of research within the field of ecopsychology has

increased significantly over the past several decades, and a large majority of the research stems from two major theoretical bases. The first of these perspectives involved stress reduction, a psycho-evolutionary theory developed by Roger Ulrich and the second was Attention Restoration Theory (ART) which was posited by Stephen Kaplan and further brought to prominence by the ongoing research he and his wife, Rachel Kaplan, conduct. The studies that have grown from the two aforementioned theoretical foundations have not taken place just in sterile laboratory settings, but have also been implemented *in vivo* and have provided sound evidence of the benefits of human engagement and interaction with aspects of nature or natural environments themselves.

Psycho-Evolutionary Theory

Roger Ulrich's research made significant contributions to the field of ecopsychology; specifically, his research on human responses to stress in relation to environment is important to this paper. Ulrich bases his definition of stress on Baum and colleagues' (1985) work defining stress as "the process by which an individual responds psychologically, physiologically, and often with behaviors, to a situation that challenges or threatens well-being (Ulrich et al., 1991, p.202)." Ulrich's research on stress is based on a psycho-evolutionary perspective in which Ulrich asserts that due to the fact that humans evolved in natural environments as opposed to built environments, they may be predisposed to exhibit more positive specific reactions - psychological and physiological states of arousal - to natural environments (Ulrich, 1983; Ulrich et al., 1991). If one were to take a second and think about why this might be the case, it makes sense; humans fought

to survive on a daily basis. Whether it was foraging or hunting for food, battling inhospitable weather or environments, or fighting off predators and avoiding dangerous insects, reptiles, and/or mammals, there was little time to sit back and relax. The three components that make up the psychological domain are 1) emotions, 2) coping responses, and 3) cognitive appraisal of the situation, while the physiological domain consists of bodily responses (e.g., neuroendocrine, cardiovascular, and skeletomuscular systems) (Ulrich, 1991).

The second component to his theory is that of stress recovery or restoration; “recovery from states characterized by excessive psychological and physiological arousal, but could also apply to recuperation, for instance, from under-stimulation or excessively low arousal (Ulrich, 1991, p.202).” Given Ulrich’s ideas about stress and stress recovery, one may wonder whether overstimulated or under-stimulated states of arousal may be brought back to equilibrium by exposure to the appropriate environment – i.e., nature.

Although not all humans are still fighting for survival in the primitive or primal sense of the meaning, stress is still present in everyday life; humans do not face the same kind of environmental stressors, but they are just as real and just as threatening. One way to test Ulrich’s theory is to research human responses to natural vs. built environments. Testing Ulrich’s theory can be done in several different ways, but most of the research can be broken down into two broad categories: viewing nature and interacting with nature. Viewing nature may be defined as sights of nature or greenspace, but a lack of contact with nature itself. This means the only sense involved would be sight, and other senses such as

touch, hearing, and smell are excluded. Interacting with nature might best be described as a more immersive experience in which individuals are within nature or more fully interacting with nature and incorporation the use of multiple senses.

Viewing nature. Parsons and colleagues (1998) investigated the implications for stress recovery and immunization by exposing students to one of four different simulated drives through outdoor environments preceding and following mildly stressful events. Participants' physiological responses showed that those who were exposed to drives with more natural views exhibited less sympathetic arousal (Parsons et al., 1998). The researchers' findings supported their hypotheses in that nature-dominated drives facilitated quicker recovery from stress, but also that immunization from later stress occurred.

The research described above is in line with an earlier study which investigated the restorative effect of views of nature on surgery patients (Ulrich, 1984). Patients whose view from their hospital recovery room was dominated by brick showed more distress, and nurses' recorded notes of those patients supported that. Also, patients with brick wall views from their recovery room spent more time in the hospital post-surgery. In contrast, patients with views of trees had more positive notes from nurses and spent less time in recovery. Furthermore, recovery rooms with more natural views were said to provide a more therapeutic environment thus leading to more positive outcomes and recovery for patients (Ulrich, 1984).

Interacting with nature. Consistent with Ulrich's and others' beliefs, interaction with nature is helpful in assisting people recover from stress. For

example, several studies investigated participant cortisol levels before and after exposure to different environments to determine the level of impact that environment had on stress (Gidlow et al., 2015; Lee et al., 2011; Ochiai et al., 2015; Song et al., 2016; Tyrväinen et al., 2014). Forest bathing or shinrin yoku, an emerging practice in Japan, has significant effects on the mind and body which further prove the invaluable benefits of interacting with nature. Belief in nature's healing and restorative abilities led Japan to establish "forest therapy stations" throughout multiple forests to thoroughly study the psychological and physiological benefits (Lee et al., 2012).

Results from one field experiment investigating the effects of forest bathing on young Japanese male subjects supported previous and current hypotheses that it can be used to promote health. In the field experiment, participants were exposed to both urban and forest environments where physiological and self-reported psychological data was gathered. Results indicated a significant reduction in salivary cortisol levels in the forest compared to the urban setting as well as reduced pulse rate in the forest versus the urban setting (Lee et al., 2012). Psychological measures also further supported physiological indicators of stress reductions in that participants felt calmer and rejuvenated in the forest as opposed to the urban environment (Lee et al., 2012).

More recent findings support Lee and colleagues' (2012) research, but also showed that it is not just males that benefit from nature exposure. Middle-aged females showed a decrease in pulse rate, lower salivary cortisol levels, as well as

increase in positive feelings and a reduction of negative feelings after “forest therapy” (Ochiai et al., 2015).

Attention Restoration Theory

While Ulrich’s psycho-evolutionary perspective theorizes that natural environments influence mood states by stimulating recuperation from stress, Attention Restoration Theory (ART), which grew from the work of Rachel and Stephen Kaplan, takes a slightly different approach by focusing on the more cognitive side by looking at attentional capacity, fatigue, and experiences that lead to recovery from a fatigued state. Kaplan (1995) states that the constructs for attention which helped shape ART stem from William James’s work on voluntary attention and involuntary attention. Voluntary attention can be described as having to maintain focus on particular boring stimuli when there might be other competing stimuli. Taken from James’s work on attention, he defines it as seeking “to discriminate a sensation merged in a mass of others that are similar; we get it whenever we resist the attractions of more potent stimuli and keep our mind occupied with some object that is naturally unimpressive” (James, 1890, p.420). What Kaplan points out about James’s theories surrounding attention, and what is also vital to ART, is that James did not discuss the effect of fatigue in relation to voluntary attention. Kaplan also brought attention to the distinguished landscape architect, Frederick Law Olmsted, who was aware of attentional capacity, its ability to become fatigued, and the ability of nature to help in the restoration of attentional fatigue. Olmsted pointed out that although early civilizations may not have discussed mental capacity and fatigue, they suffered from it and tried to remedy it;

affluent members in early civilizations often owned rural properties so as to escape the draining environment of the city. To further illustrate his beliefs about nature's benefits, Olmsted (Olmsted, 1865, as cited in Nash, 1968, p.21) stated the following:

In the interest which natural scenery inspires there is the strongest contrast to this. It is for itself and at the moment it is enjoyed. The attention is aroused and the mind occupied without purpose, without a continuation of the common process of relating the present action, thought or perception to some future end. There is little else that has this quality so purely....

...This, however, is in very slight degree, if at all, the case with the enjoyment of the emotions caused by natural scenery. It therefore results that the enjoyment of scenery employs the mind without fatigue and yet exercises it; tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system.

In ART, Kaplan uses the term 'directed attention' rather than voluntary attention and described it as "a mechanism with the following properties: it requires effort, plays a central role in achieving focus, is under voluntary control (at least some of the time), is susceptible to fatigue, and controls distraction through the use of inhibition (Kaplan, 1995, p.170)." Furthermore, he provided an example of a student or person who has worked on a project diligently only to find themselves mentally depleted. ART suggests that to restore depleted capacity for directed attention, certain environmental conditions must be present, and nature is one such

environment that provides the right conditions. Nature provides respite from fatigue by stimulating involuntary attention and providing directed attention a rest. Restoration occurs when the following four components are present (Kaplan & Kaplan, 1989):

1. "Being Away" – an environment that provides psychological distance from routine or ordinary mental processes.
2. "Extent" – an environment with richness and coherence so that it feels as though it constitutes a whole other world.
3. "Compatibility" – an environment where one's purpose can 'fit' with the environment at ease.
4. "Fascination" – a central component that triggers restoration by stimulating involuntary attention; "effortless, interest-driven attention" (Hartig et al., 2003, p.110).

Viewing nature. Given what is known thus far about nature and its impact on humans, we can begin to look at the different types of interactions with nature and the benefits people can reap from those interactions. One form of interaction, which might be better described as connecting with nature through sight, is by means of strictly observing or viewing nature, whether through artificial means such as viewing pictures or videos of plants or natural environments or observing actual aspects of nature or natural environments. This could include seeing nature from the window of a car on the way home from work or on a trip, or it might even involve simply having a view of nature from a window in one's house or living

quarters. It might also involve views of indoor plants in work or living environments.

One study that tested Kaplan's theory and investigated the benefits of viewing nature only was a field study conducted by Tennessen and Cimprich (1995) in which they investigated whether college students with more natural views from their dormitory windows would score better on tasks of directed attention than students with less natural views. They found that students with more natural views performed better on some of the tasks used to measure directed attention. Specifically, when all four conditions were compared – all natural view, mostly natural view, mostly built view, all built view – students with all natural views scored significantly higher on an objective measure of directed attention than those with less natural or built views. Further, they found that when the four groups were combined into two groups – more natural views vs. more built views – and analyzed, the group with more natural views performed significantly better on two of the objective measures of attention.

Other results from experiments conducted by Berto (2005) also demonstrated that prolonged directed attention leads to attentional fatigue and that natural environments have the ability to restore fatigued directed attention abilities. One can infer that college students spend a great deal of time directing their attention towards academic work so that they may excel and eventually earn a degree. This type of behavior can lead to mental exhaustion causing emotional distress and a depleted state of attentional capacity. The above-mentioned research seems to help support Kaplan's theory that natural environments help restore

students' ability to direct attention as assessed by cognitive ability measures, but more specifically executive functioning and working memory measures. In addition to objective measures, subjective measures supported nature's perceived restorative ability as well (Berto, 2005).

Due to the rapid urbanization in China, researchers sought to determine which specific urban greenspace components provided the most restoration, improved cognition, and increased well-being. Wang and colleagues' (2016) results supported previous findings that viewing nature helps individuals recover from stress and provides restorative effects. After participants viewed different environmental scenes, those that viewed scenes with more nature dominant features, such as an urban park with a lake and no others present, showed increase in attention levels and lower stress levels as compared to those that viewed a city plaza with others present in the scene (Wang et al., 2016).

Interacting with nature. Another study tracked the attention restoration potential of interacting with different environments; natural and urban settings were selected and evidence further support ART in that nature was more beneficial. The researchers evaluated the positive benefits of nature and its ability to restore attentional capacity as evidenced by participant performance on an objective measure of attention – ability to inhibit Necker Cube pattern reversals; participants showed slight improvement while in the nature setting, but participants in the urban setting showed a significant decline in performance (Hartig, et al., 2003).

One study by Berman, Jonides, and Kaplan (2008, Experiment 1) set out to further investigate nature exposure and its impact on directed attention and their study results indicated improved cognitive performance after exposure to nature versus a downtown urban environment; participants performed better on a backward digit span (BDS) task post nature walk compared to walking downtown. Even when taking into account participant mood, as assessed by the PANAS, and weather, results were not affected. Consistent with ART, their participants' directed attention ability improved after interacting with nature and the authors conclude that simple and short-lived engagement with nature can yield noticeable increases in cognitive control and that to consider nature as simply an feature fails to acknowledge the significance of nature on adequate cognitive performance (Berman et al., 2008).

In addition, a study conducted by researchers in the United Kingdom found similar results of participants feeling restored after visits to nature (White et al., 2013). Besides comparing restorative effects of nature versus built environments, they further investigated which nature environments were most restorative as well as whether specific activities within nature contributed to restoration and improved emotional state. For instance, those that were surveyed reported the greatest level of restoration from coastal environments where beaches and coastlines were present in comparison to open countryside; upland and wooded environments provided similar reported restoration as coastal environments (White et al, 2013). Even when participants visited urban parks and greenspace, they still

showed the least amount of restoration when compared to pure nature visits (White et al., 2013).

Although those that visited urban greenspace did not enjoy the same level of restoration as those that visited pure natural environments, urban greenspace still has restorative as well as other properties. In addition to nature visits' restorative potential, they also can act as a buffer to stress and serve a preventive role. A prime example of this was a study that looked at nearby nature in the lives of children and the role it played in buffering children from life's stressors. It was found that children who lived in rural towns and whose housing environments had higher levels of naturalness – amount of nature in view from window, indoor plants, makeup of their yard – buffered the impact of life stress (Wells & Evans, 2003). Specifically, stressful life events did not impact children as much if their home environment had a higher level of naturalness (Wells & Evans, 2003).

Furthermore, a systematic review of ART and more broadly, attention restoration potential of exposure to natural environments, was recently conducted. The authors examined thirty-one studies varying in design. Although the authors found that there was support for restoration from exposure to nature, not all measures that were analyzed showed clear evidence. It was also noted that the different studies had not come to a consensus on which measures of attention worked best or which form of attention processes (alerting, orientating, or executive processes) were being restored through exposure to nature (Ohly et al., 2016).

This meta-analysis revealed some flaws in the approaches that researchers have taken in regard to ecopsychology studies and by doing so provides future

researchers with factors to consider to improve methodology as well as working towards a consensus on what is being measured and what needs to be used to measure it.

Virtual Reality

When researchers conduct experiments, it can be most helpful to expose participants to conditions and environments that are exactly the same or as close as possible to the same as the actual scenario or environment. Although this is desirable, it is not always feasible whether it be prohibitive due to financial, logistical, or other reasons. However, as technology advances, researchers are able to more closely mimic the natural world through the use of virtual reality (VR). VR has advanced by leaps and bounds within the past couple of decades and will continue to make progress in the realism of the environments they depict. Gone are the days of pixelated scenes that look like Mine Craft, and here are the days when 4K and 5K images transport viewers into a world almost as real as their own. A term frequently used in the VR world that describes how VR can be so effective in transporting a viewer to an artificial world or environment yet making the viewer feel as if it is real is called presence. Bowen and colleagues (2017, p.240) define presence as, "a felt sense of authentic reality that would result from engagement with sophisticated media." One such device that achieves a level of presence unlike many others available is the HTC Vive. The HTC Vive is a headset device which is worn and covers both the eyes, but also provides the user with two hand controllers so that the user has two virtual hands with which to aid in navigating the immersive

environment. More recently, HTC released the Vive Pro that provides an even more immersive experience through integrated audio.

Even though some might associate VR with video games and relegate it to leisure time, VR has been used in research for quite some time (Bown et al., 2017). VR has been used in the fields of automotive design, engineering, and architecture to quickly and more efficiently produce working models for companies or prospective clients (Bown et al., 2017; Salanitri et al., 2016; Sapto, et al., 2018;). VR has also been implemented in several different areas for training purposes so that trainees could be put into environments and train without being subjected to the dangers and adverse effects of actual environments (Bown et al., 2017). More closely aligned with the topic of this paper, VR has been used in research and treatment within the field of psychology. For example, some combat veterans who suffer from Post-Traumatic Stress Disorder (PTSD) use VR as a therapeutic tool. As a form of exposure therapy, VR immerses veterans in realistic virtual combat scenarios or scenes of war; veterans who engaged in this form of therapy showed a significant reduction in PTSD symptoms (Waldrop, 2017). Waldrop (2017) also points out that VR can be used to treat other disorders such as phobias. One factor the above-mentioned article stresses is that given the advances in VR technology and accessibility to it, prices have declined considerably and more people in the consumer market are able to access VR as opposed to just industry and research professionals. For example, the cost of VR equipment – the Oculus Rift and HTC Vive – is in the \$800-\$1000 range; this is significant given that

previous, lower quality technology could cost as much as \$200,000 (Slater as quoted by Waldrop, 2017).

Virtual Reality and Nature

When considering how relatively new Virtual Reality (VR) is and how much it has advanced and grown in the past couple decades, it should not be surprising that there are few research studies that have investigated aspects of ecopsychology using VR, and particularly aspects of nature and restoration. Even though the studies on the aforementioned topic are sparse, there is literature to support the benefits of exposure to nature through VR immersive environments.

Before looking at VR immersive environments, it may be helpful to see how researchers used other methods to immerse subjects in an environment. de Kort and colleagues (2006) were interested in the differences of low and high immersion environments, particularly whether one was superior in restorative properties and stress reduction. They created their immersive environments by subjecting participants to one of two conditions: low immersion – participants viewed nature film on a small screen; high immersion – participants viewed nature film on a large screen. Data gathered from physiological measures showed that participants who were exposed to the high immersion nature film after a stress-inducing task showed a greater reduction in arousal as evidenced by skin conductance levels and heart rate (de Kort et al., 2006). Their research further illustrates that the more immersed an individual is in an environment, the greater that environment will impact that person.

As previously mentioned, early VR environments were pixelated, quite unrealistic, and lacking qualities found in real life; but as the technology advanced, researchers were able to use gaming software to construct more realistic 3D nature environments. Wind could be simulated as evidenced by leaves blowing in the trees, and rays of sunshine could now sparkle on bodies of water; these are just two examples (Depledge et al., 2011) of increased authenticity. Even though that was a significant improvement in regard to how immersive and realistic environments had become, researchers began to shift away from 3D constructed environments and move towards even more natural scenes using ultra high definition (4K) recordings to simulate environments that were as real as possible (Annerstedt et al., 2013).

One might wish to examine the work by Calogiuri and colleagues (2018) for a prime example of integrating VR and nature; they investigated the effects of experiencing nature through immersive virtual environments (IVE). By subjecting their participants to one of three conditions - a nature walk, sitting in a nature IVE, and walking while viewing the same nature IVE - the researchers were able to determine affective responses to the different environments as well as perceptions of the environments. Not surprising, the real walk in nature was associated with a reduction in negative affect as well as fatigue (Calogiuri et al., 2018). What might be surprising is that although perceived levels of restorativeness were somewhat equivalent across all three conditions, IVEs led to undesirable emotions (Calogiuri et al., 2018). The authors note that this may be attributed to the participants' experience with IVE being disruptive due to cyber sickness; a typical problem

associated with IVE technology. These findings stand in contrast to other virtual environments that are not as immersive.

What the previous research has done is open the door for future experiments, and it will lead to more realistic and immersive environments. One might ask, “Why is this needed or such an important endeavor?” The answer is simple. It provides those who cannot engage with nature with an experience that is as close to the real thing as possible, thus allowing those users to reap some of the benefits nature provides. For instance, people with different medical conditions or physical limitations, such as the elderly or ill, even those who have experienced some form of trauma which may produce symptoms that prevent their interaction with nature could now take part (Depledge et al., 2011). There are some limitations to VR nature when comparing it to real, natural environments. For example, VR users will not experience the stimulation to all senses which would typically occur in real life. Subsequently, users would not reap the benefits of breathing in the different aromas, hearing the different sounds, or experiencing tactile stimulation, all of which provide comfort and reduce stress (Lee et al., 2012). What was done to combat this limitation was to introduce nature sounds as well as scents during either views of nature scenes or VR immersion to simulate a more genuine nature experience (Annerstedt et al., 2013; Knight et al., 2012). Although VR nature exposure has its limitations, so does exposure to a true natural environment. In congruence with Ulrich’s theory (1991), humans are attuned to their environment and alert for environmental dangers such as animals, weather, and terrain. Gatersleben and Andrews (2013) point out that not all environments are

restorative; environments with dense vegetation may conceal possible dangers thus leading to arousal and in turn reducing chances of restoration. Therefore, it is important to understand that virtual and real nature each have advantages and disadvantages which should be strongly considered when conducting research or incorporating some form of nature into therapy.

Taken altogether, the literature strongly supports the positive effects on cognition, psychological health, and physical health when humans engage in nature-based experiences or interact with some aspect of nature, such as viewing a mountain stream. Considering the urbanization, the proliferation of technological devices, and a seemingly unnoticed disconnect from nature by many, it makes logical sense to bridge the gap between nature and technology for research and therapeutic purposes for the health and well-being of humankind.

CHAPTER III

METHODOLOGY

Overview

This chapter focuses on the methodology processes of the study. As stated earlier, this study seeks to demonstrate the effects that immersive virtual reality environments may have on people. Furthermore, this chapter addresses the research design, data collection procedure flow chart (Figure 1), materials and measures used, and restates the research hypotheses. In addition, this section describes participant selection process, data processing, ethical assurances, and limitations to the study. This study will provide a meaningful contribution to the field of ecopsychology, particularly due to the fact that few studies have used virtual reality to investigate the impact that nature may have on human psychological health.

Participants

This experiment recruited and enrolled 28 ($M_{\text{age}} = 20.59$, $SD = 1.37$; 88.89% female & 11.11% male) college student participants from the research pool of the Department of Counseling and Human Development Services in the College of Education at the University of Georgia, administered through the SONA system; one participant's demographic information was not available for analysis due to missing data, which resulted in 27 participants available for the actual analysis. It is also worth mentioning that no participants had to exit the study due to any complications or symptoms related to cyber sickness.

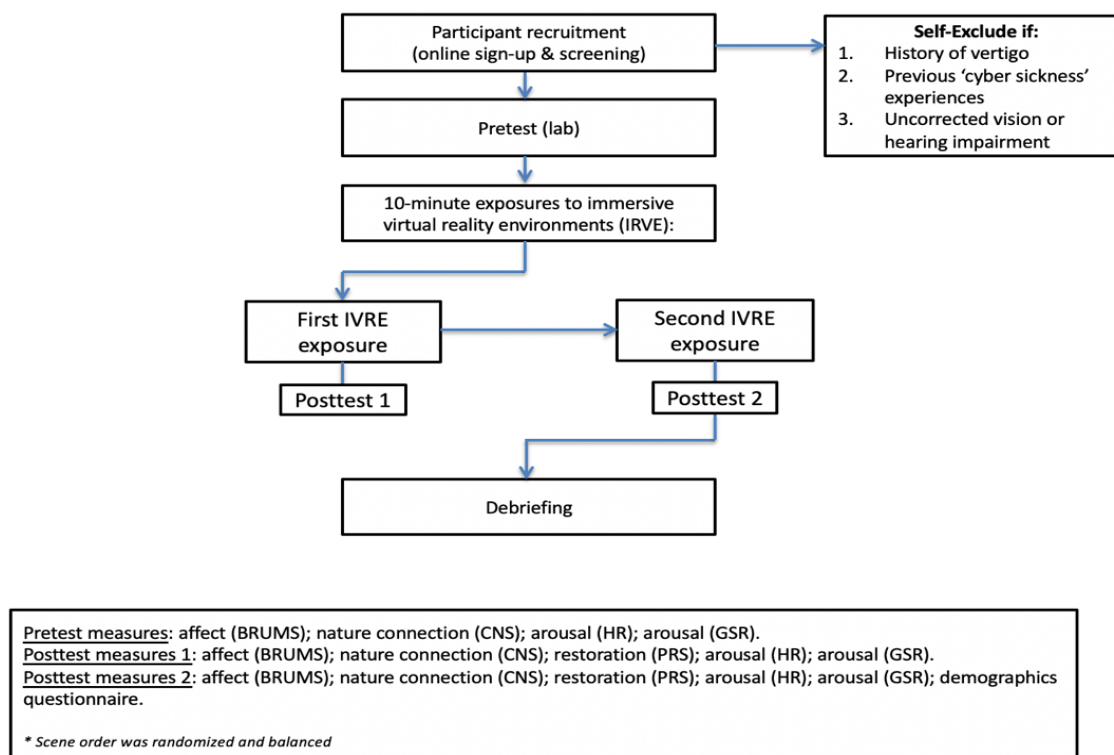


Figure 1. Data Collection Procedure Flow Chart

In regard to participants' race and ethnicity, 59.3% identified as White, 18.5% as Black/African American, 7.4% as Latina/o, 3.7% as Native American or Alaskan Native, 3.7% as Asian, 3.7% as Biracial, and 3.7% as Multiracial. Concerning health factors that could impact immersive virtual reality experiences, 92.6% reported no history of vertigo while 7.4% reported a history; 96.3% reported no history of cybersickness with 3.7% having reported a history; and 96.3% reported no uncorrected vision or hearing impairments while 3.7% reported an uncorrected vision and/or hearing impairment. Specifically, the research pool consisted of undergraduate students enrolled in departmental courses and who are required to obtain three (3) research hours per semester by participating in research projects through the department's SONA system. Participants were able to review available

studies and elect to participate in studies that would fulfill the requisite number of research participation hours. The research team aimed to enroll approximately 40 participants, but due to the global COVID-19 pandemic, our ability to recruit and run participants before the University shut down was somewhat limited.

G power software was used to determine the appropriate sample size. The power analysis was conducted for a repeated measure ANOVA with two conditions (experimental and control) and two times (pretest and posttests). The required sample size is calculated with power ($1-\beta$) of .80 and $\alpha = .05$ and a medium effect size ($f=.25$). The results of the power analysis suggested that a minimum sample size ($N=34$) is required. Again, given the interruption by the COVID-19 global pandemic, 28 participants took part in this study.

Participants received an informed consent letter upon entering the research lab and prior to completing any measures or questionnaire. In addition, participants were informed at the time of sign up that if they met any of the exclusionary criteria, which included a personal history of experiences of vertigo, cyber sickness, or uncorrected vision and/or hearing impairments, they should not take part in this study. By implementing the exclusionary criteria, the research team was able to better control for people who might have negative experiences during the study and skew results after the data analysis. At the completion of the study, participants were asked to complete a brief demographic questionnaire (see Appendix A).

Assessment Methodology

If participants did not self-exclude and signed up for the study, participants then arrived at the research lab in Aderhold Hall on the day and time of their allotted sign-up and were randomly assigned to start with one of two immersive virtual reality environment (IVRE) conditions; condition one is the nature IVRE (Figure 2 & Figure 3) and condition two is the industrial IVRE (Figure 4 & Figure 5).



Figure 2. Virtual Reality Nature Scene Screenshot 1



Figure 3. Virtual Reality Nature Scene Screenshot 2



Figure 4. Virtual Reality Industrial Scene Screenshot 1



Figure 5. Virtual Reality Industrial Scene Screenshot 2

Before participants were exposed to an IVRE, they were asked to complete two psychological measure pretests, the BRUMS and CNS, via their personal mobile devices to establish a baseline before then connecting physiological monitoring equipment and verifying proper connection and function. Physiological measures consisted of testing participants' autonomic nervous system's state of arousal by collecting galvanic skin response (GSR) and heart rate (HR) data. Once the physiological measures equipment was checked (GSR and HR) and psychological pretests (BRUMS and CNS) were administered, participants were instructed that

they were to stay seated for approximately 10 minutes while they viewed the first of their randomly assigned IVRE scenes. Participants were then exposed to the first of two IVRE experiences through the use of the HTC Vive. Following the first IVRE exposure, participants then completed the first set of posttests, which included three psychological measures (BRUMS, CNS, and PRS). Also, data for physiological measures (GSR and HR) was recorded during the first IVE exposure. Participants accessed the posttest measures through the Qualtrics system by using their personal mobile devices. Next, participants were exposed to the second IVRE they had not yet viewed. Following the exposure to the second IVRE, participants once again completed three psychological measures (BRUMS, CNS, and PRS) as well as a demographics questionnaire using Qualtrics via their personal mobile devices under observation by a research team member. Lastly, participants were debriefed by a research team member and provided with contact information for the study team members should the participant have questions or concerns about any aspect of the study. The total time to completion per participant took approximately one hour from the time they entered the lab until the conclusion of the debriefing.

Initially, this study was proposed as a between-subjects design but was changed to a within-subjects design after piloting the measures and procedures for this study. I, along with Dr. Stewart, determined that the change would provide a stronger research design and lead to more valid results as it would allow participants to serve as their own control thus reducing variability that would have been present in a between-subjects design (Shadish et al., 2002). Even though there are some disadvantages inherent with within-subject designs which could have

occurred in this study (e.g., fatigue effects and order effects), those were accounted for when establishing amount of time each participant viewed each video and by randomizing and counterbalancing (Shadish et al., 2002). Furthermore, the collection of data from participants took place just prior to the onset of the COVID-19 pandemic and the eventual shutdown of in-person learning at the University of Georgia. Given the change to stronger research design, the amount of time it took per participant to complete the study, as well as the significant results that were found, the research team was able to utilize a smaller sample size while still maintaining the integrity of the study.

Brunel Mood Scale (BRUMS; Terry et al., 1999; see Appendix B). The 24-item questionnaire is a highly used and validated quick assessment of mood states for adolescents and adults which was derived from the Profile of Mood States (POMS) questionnaire (McNair et al., 1971). The BRUMS consists of six subscales – anger, confusion, depression, fatigue, tension, and vigour - with each of the subscales containing four mood descriptors – angry, nervous, unhappy, and energetic. Completion time takes approximately one to two minutes. Responses are recorded using a five-point Likert scale with the standard reference timeframe used being “How you feel right now,” although other variations may be used; lower values indicate better mood. The internal consistency of six constructs (i.e., anger, confusion, depression, fatigue, tension, and vigour) ranged from .75 to .85 from the original validity study. Internal consistency of this measure from this study ranged from .57 to .92.

Perceived Restorativeness Scale (PRS) (PRS; Hartig et al., 1997b; see Appendix C). The PRS is a 26-item measure developed by Hartig and colleagues (1997b) and based off of Kaplan's Attention Restoration Theory's four factors (Being Away, Fascination, Coherence/Extent, and Compatibility). This measure uses a 7-point scale and allows participants to rate their experience of a given environment (0 = Not at all; 6 = Completely). The internal consistency of the PRS was .94 (Berto, 2007). Internal consistency of this measure from this study ranged from .77 to .94.

Connectedness to Nature Scale (CNS) (CNS; Mayer & Frantz, 2004; see Appendix D). The 17-item CNS, normed on a community and college student population, uses a five-point Likert scale to assess a person's emotional connection to the natural world. This measure was based on Aldo Leopold's ideas which posit one must feel a connection to the broader natural world in order to place an importance on protecting the natural environment and addressing problems concerning it (Mayer & Frantz, 2004). Furthermore, a high degree of connectedness to nature has been associated with elevated levels of positive affect which reflect positive psychological well-being (Mayer et al., 2009). The internal consistency ranges from alpha levels of .79 to .84 from the original validity study. Internal consistency of this measure from this study ranged from .7 to .82.

Galvanic Skin Response (GSR). GSR was included as an objective measure of the level of emotional arousal. Since skin conductance is representative of the intensity of arousal, but not the actual emotion experienced during arousal, another objective measure such as heart rate variability can be used to determine emotion during aroused state. The Iworx HK-TA kit was used along with LabScribe software

to measure GSR; the equipment and software are popular for use with both research and teaching purposes.

Heart Rate (HR). HR was included as an objective measure of autonomic nervous system arousal by comparing the relationship between the inhibitory parasympathetic nervous system and the excitatory sympathetic nervous system. The sympathetic nervous system is known to be more active during times of stress while the parasympathetic is more dominant during times of restoration or rest. The Iworx HK-TA kit was used along with LabScribe software to measure pulse; the equipment and software are popular for use with research and for teaching purposes.

Internal consistency of the BRUMS, PRS, and CNS from this study was measured by Cronbach's α , which is presented in Table 1.

Table 1. Cronbach's α of BRUMS, PRS, and CNS.

Measures <i>Subscales</i>	Cronbach's α		
	Baseline (before VR)	after the Nature video	after the Industrial video
BRUMS			
<i>Anger</i>	0.844	0.680	0.883
<i>Confusion</i>	0.570	0.922	0.792
<i>Depression</i>	0.673	0.866	0.852
<i>Fatigue</i>	0.835	0.899	0.880
<i>Tension</i>	0.872	0.854	0.902
<i>Vigour</i>	0.566	0.880	0.753
PRS			
<i>Being Away</i>		0.918	0.942
<i>Fascination</i>		0.901	0.917
<i>Coherence</i>		0.771	0.898
<i>Compatibility</i>		0.831	0.909
CNS	0.702	0.811	0.821

Data Analysis Plan

For analysis, I used Statistical Analysis System (SAS), version 9.4 for all data analytic procedures. Precisely, for the analysis of the data on Qualtrics, I used the general linear models (GLM) procedure for a completely within-groups repeated measures design. Psychophysiological variables were standardized prior to analysis to put each participant's responses on a standard, uniform scale. Standardization makes it easier to detect treatment effects by rescaling the data of the more reactive participants (Bush et al., 1993). By standardizing the psychophysiological data, each participant served as their own control. In addition, for this procedure, I specified *a priori* contrasts between the pre-video, the industrial, and nature videos. The principal investigator and study assistants screened the data, assessed missing data, and detected

outliers. Normality, homogeneity of variances, and sphericity were checked, which are all necessary assumptions for repeated measures analysis of variance (ANOVA). The descriptive statistics such as means and standard deviations are also provided. In addition, a correlation matrix is provided to explore the relationship between connectedness to nature, restoration, and mood state.

Following the descriptive analysis, a repeated measures analysis of variance (ANOVA) was conducted to examine whether the intervention caused changes to dependent variables in this study. Specifically, interaction effect was the focus of this analysis to show any changes in trajectories were different between conditions.

Hypotheses

Primary hypotheses:

1. When participants are exposed to nature through an immersive virtual reality environment (IVRE) they will show an increase in positive affect.

This hypothesis was tested by conducting a repeated measures analysis of variance (ANOVA) testing whether there was a significant interaction effect between time (i.e., pretest versus posttest) and condition regarding mood state. Specifically, the researchers expect that the BRUMS score will be decreased significantly more in the experimental group than the control group.

2. Participants will show a higher connectedness to nature after being exposed to the nature IVRE.

This hypothesis was tested by conducting a repeated measures analysis of variance (ANOVA) testing whether there was a significant interaction effect between time and condition regarding connectedness to nature. Specifically, the researchers

expected that the CNS score will be increased significantly more in the experimental group than the control group.

3. Participants will experience more perceived restoration after exposure to a nature IVRE when compared to participants exposed to an urban IVRE.

This hypothesis was evaluated by conducting a repeated measures analysis of variance (ANOVA) testing whether there was a significant interaction effect between time and condition regarding perceived restoration. Specifically, the researchers expect that the PRS score will be increased significantly more in the experimental group than the control group.

CHAPTER IV

RESULTS

Data Analysis

Prior to the main outcome analyses, 1 participant was excluded due to their participation in the study twice. Of the remaining 29 participants, 1 participant failed to report demographic information. Descriptive statistics are reported in Table 2, categorized by three different conditions (i.e., Baseline (before VR); after the Nature video; after the Industrial video).

Table 2. Descriptive statistics

Measures <i>Subscales</i>	Mean (sd)		
	Baseline (before VR)	after the Nature video	after the Industrial video
BRUMS			
<i>Anger</i>	4.57 (1.26)	4.33 (1.00)	5.07 (1.92)
<i>Confusion*</i>	5.29 (1.33)	4.59 (1.47)	6.12 (2.31)
<i>Depression*</i>	4.96 (1.32)	4.48 (1.12)	5.86 (2.49)
<i>Fatigue</i>	8.89 (3.02)	8.93 (3.97)	9.68 (3.73)
<i>Tension</i>	6.39 (2.51)	4.93 (1.88)	5.93 (2.46)
<i>Vigour*</i>	9.32 (2.33)	8.11 (3.11)	6.64 (2.33)
PRS			
<i>Being Away*</i>		21.07 (6.88)	7.39 (8.28)
<i>Fascination*</i>		36.89 (9.46)	16.50 (10.61)
<i>Coherence*</i>		26.56 (2.15)	19.57 (6.96)
<i>Compatibility*</i>		28.37 (9.75)	13.39 (12.08)
CNS*	49.96 (5.23)	52.63 (6.92)	49.64 (7.12)

Results

Psychological results. Regarding the first research question in which I asked whether interacting with nature through an IVRE could lead to an improved mood state, our analyses revealed that in general, participant means on the Brunel Mood Scale (BRUMS) following exposure to the nature IVRE were lower compared to baseline and after exposure to the industrial IVRE, meaning negative mood states were reduced. Specifically, there were no significant differences on the BRUMS anger subscale when looking at baseline, nature and industrial IVRE videos, $F(2, 50) = 2.22, p = 0.1194, \eta^2 = .09$. On the confusion subscale, there were significant differences, $F(2, 50) = 6.02, p = 0.0045, \eta^2 = .24$. It seems people reported fewer feelings related to confusion following the nature IVRE video compared to pre-test/baseline, $F(1, 25) = 5.84, p = 0.0233, \eta^2 = .23$ and the industrial IVRE video, $F(1, 25) = 8.30, p = 0.0080, \eta^2 = .33$. Depression was significantly different across the pre-test/baseline, nature, and industrial conditions, $F(2, 50) = 5.13, p = 0.0094, \eta^2 = .21$. There was significantly less depression following the nature video than compared to the pre-test/baseline condition, $F(1, 25) = 9.82, p = 0.0044, \eta^2 = .39$ or to the industrial video, $F(1, 25) = 6.42, p = 0.0179, \eta^2 = .26$. Concerning the BRUMS fatigue subscale, there were no statistically significant differences among the mean values for the pre-test/baseline, the industrial IVRE video or nature IVRE video, $F(2, 50) = 0.56, p = 0.5724, \eta^2 = .02$. Greater levels of vigour were observed following the nature video compared to the industrial video, $F(2, 50) = 11.73, p < 0.0001, \eta^2 = .47$. The overall ANOVA was statistically significant and then, the contrasts showed greater mean values of vigour following the nature video compared to either the

baseline measurement $F(1, 25) = 6.02, p = 0.0215, \eta^2 = .24$ or the industrial IVRE video, $F(1, 25) = 5.86, p = 0.0230, \eta^2 = .23$.

Second, I wanted to know whether exposure to nature through an IVRE would impact one's connectedness with nature (CN). Through the use of a repeated measures analysis of variance (ANOVA), I found that Connectedness to Nature Scale (CNS) total scores differed significantly from each other (see mean table for CNS above), $F(2, 50) = 4.61, p = 0.0153, \eta^2 = .18$. The pre-test/baseline and industrial IVRE means on CNS scores did not differ from each other. But, after the nature video, however, people reported significantly higher CNS means. Furthermore, the order in which people viewed the videos (i.e., nature-industrial or industrial-nature) did not make a difference. After viewing the nature IVRE video ($M = 52.6$), the participants reported significantly higher CN compared to the pre-test/baseline measurement of general nature connectedness ($M = 50.0$), $F(1, 25) = 6.46, p = 0.0176, \eta^2 = .26$. In addition, those who viewed the nature IVRE video demonstrated greater nature connectedness than when viewing the industrial IVRE video ($M = 49.6$), $F(1, 25) = 8.46, p = 0.0075, \eta^2 = .34$.

Third, I sought to determine whether interacting with nature through an IVRE could lead to psychological restoration. Again, using a repeated measures analysis of variance (ANOVA), I found that regardless of the order in which participants viewed the two videos, they reported significantly higher levels of Being Away, a subscale on the Perceived Restorativeness Scale (PRS), after viewing the nature IVRE video compared to the industrial IVRE video, $F(1, 25) = 33.58, p < 0.0001, \eta^2 = 1.34$. Again, following the nature IVRE video, participants reported

significantly higher fascination, $F(1, 25) = 33.24, p < 0.0001, \eta^2 = 1.33$, irrespective of the order in which the videos were viewed. Following a similar pattern as above, there was greater coherence on the PRS after viewing the nature IVRE video compared to viewing the industrial IVRE video, $F(1, 25) = 25.12, p < 0.0001, \eta^2 = 1.00$. Lastly, there was significantly more compatibility following exposure to the nature IVRE video than after exposure to the industrial IVRE video, $F(1, 25) = 20.32, p = 0.0001, \eta^2 = .81$.

After conducting correlation analyses, connectedness to nature (CN) prior to being exposed to any IVRE videos was correlated with CN observed after viewing both the nature IVRE scene ($r = .57, p < .01$) as well as the industrial IVRE scene ($r = .54, p < .01$) as shown in Table 3. Also, as shown in Table 4, at pre-test, CN was most associated with the affect of vigour, $r = .46, p < .05$, which is defined as feelings of exhilaration, physical energy, and vigilance (Terry et al., 1999).

Table 3. Connectedness to Nature Correlations

	1	2	3
1. connectedness to nature scale - pretest	1.00		
2. connectedness to nature scale – after nature video	.57**	1.00	
3. connectedness to nature – after industrial video	.54**	.65***	1.00

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

Table 4. CNS-Pre Correlations with Pre-test levels of Emotionality

	Connectedness to nature scale_pre
anger_pre	.19
confusion_pre	-.21
depression_pre	.10
fatigue_pre	-.15
tension_pre	-.10
vigour_pre	.46*

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

When referencing Table 5, one can begin to see how perceived restorativeness subscales, emotional state subscales, and connectedness to nature variables are interrelated within the condition of the nature IVRE video and align with my assumptions as well as previous literature and research findings. For example, Perceived Restorativeness Scale (PRS) subscales of being away ($r = .44, p < .05$), fascination ($r = .58, p < .01$), and compatibility ($r = .60, p < .001$), were positively correlated with connectedness to nature (CN), meaning that if one experienced CN during or after viewing the nature IVRE video, then one would also experience most of the necessary variables (e.g., being away, fascination, and compatibility) needed to aid in perceived restoration.

Regarding emotional states, two of the subscales – anger ($r = -.45, p < .05$) and confusion ($r = -.44, p < .05$) – which represent undesirable moods states were negatively associated with CN while the more desirable subscale of vigour ($r = .43, p < .05$) was positively correlated with CN. What this shows is that in the context of the nature IVRE video, if one perceived a connection to nature then one experienced lesser degrees of negative moods while showing an increased level of what could be associated with more of a positive emotional state. Furthermore, perceived restorativeness scale (PRS) subscales of being away ($r = -.69, p < .01$), fascination ($r = -.53, p < .01$), and compatibility ($r = -.46, p < .05$) were negatively correlated with emotional state subscale anger. Each of the aforementioned PRS subscales of being away ($r = -.51, p < .01$), fascination ($r = -.54, p < .01$), and compatibility ($r = -.54, p < .01$) were each negatively associated with confusion.

Also, several of the negative emotional states were positively correlated with each other; anger showed a high level of positive correlation with confusion ($r = .85, p < .001$), depression ($r = .71, p < .001$), fatigue ($r = .50, p < .01$), and tension ($r = .67, p < .001$). Together, these results suggest that the interrelation of negative emotional states with each other was strong and when one negative state is present then the others are likely to co-occur, too. It is noteworthy that the emotional state subscale of depression was not significantly negatively correlated with CN variables. This stands in contrast to what Berman and colleagues (2012) research showed when their study indicated positive affect increased and negative affect decreased in participants diagnosed with major depressive disorder (MDD) after they engaged in a nature walk.

Table 6 shows the intercorrelations of the perceived restorativeness subscales, emotional state subscales, and CNS variables for the industrial IVRE video. Compared to Table 5, it is noteworthy that for the industrial video, there were fewer statistically significant correlations overall, which illustrates the relative lack of positive effect of this video. For the correlations that were statistically significant, fascination ($r = .63, p < .001$) and compatibility ($r = .67, p < .001$) were positively correlated with being away. Also, being away ($r = .42, p < .05$) and compatibility ($r = .39, p < .05$) were positively correlated with vigour. Regarding emotional states, confusion ($r = .41, p < .05$) was positively correlated to depression and tension ($r = .55, p < .01$) was positively correlated with anger.

Given that there were far fewer significant correlations for the industrial video when compared to the nature video, and based on the types of correlations observed, it appears that the nature video produced more perceived restorativeness. One may also

infer that participants experienced a more positive emotional state given the lack of negative emotional state present when compared to participants' experience after watching the industrial video.

Table 5. Correlation analyses for nature video conditions

	1	2	3	4	5	6	7	8	9	10	11
1. cns_nat	1.00										
2. prs_being away	.44*	1.00									
3. prs_fascination	.58**	.66***	1.00								
4. prs_coherence	-.23	-.21	.01	1.00							
5. prs_compatibility	.60***	.56**	.67***	-.31	1.00						
6. anger_nat	-.45*	-.69***	-.53**	.12	-.46*	1.00					
7. confusion_nat	-.44*	-.51**	-.54**	.07	-.54**	.85***	1.00				
8. depression_nat	-.34	-.63***	-.39*	.24	-.31	.71***	.56**	1.00			
9. fatigue_nat	-.34	-.48*	-.45*	.13	-.15	.50**	.35	.60**	1.00		
10. tension_nat	-.23	-.37	-.37	.20	-.41*	.67***	.74***	.60***	.17	1.00	
11. vigour_nat	.43*	.50**	.47*	-.11	.26	-.21	-.18	-.30	-.45*	.08	1.00

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

CNS – Connectedness to Nature Scale;

PRS – Perceived Restorativeness Scale;

Anger, Confusion, Depression, Fatigue, Tension, and Vigour – Brunel Mood Scale (BRUMS)

Table 6. Correlation analyses for industrial video

	1	2	3	4	5	6	7	8	9	10	11
1. cns_ind	1.00										
2. prs_being away	.22	1.00									
3. prs_fascination	.16	.63***	1.00								
4. prs_coherence	-.18	.23	.32	1.00							
5. prs_compatibility	.20	.67***	.56**	.26	1.00						
6. anger_ind	-.08	-.24	-.17	-.20	-.15	1.00					
7. confusion_ind	-.09	-.14	-.12	-.43*	-.24	.24	1.00				
8. depression_ind	-.20	-.08	-.13	.06	-.19	.14	.41*	1.00			
9. fatigue_ind	-.05	.18	.25	-.13	-.08	.04	.16	.25	1.00		
10. tension_ind	-.21	-.20	-.22	-.03	-.38*	.55**	.26	.15	-.16	1.00	
11. vigour_ind	.09	.42*	.31	.02	.39*	.26	-.02	-.02	-.07	.20	1.00

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$

CNS – Connectedness to Nature Scale;

PRS – Perceived Restorativeness Scale;

Anger, Confusion, Depression, Fatigue, Tension, and Vigour – Brunel Mood Scale (BRUMS)

Table 6 shows the intercorrelations of the perceived restorativeness subscales, emotional state subscales, and CNS variables for the industrial IVRE video. Compared to Table 5, it is noteworthy that for the industrial video, there were fewer statistically significant correlations overall, which illustrates the relative lack of positive effect of this video. For the correlations that were statistically significant, fascination ($r = .63, p < .001$) and compatibility ($r = .67, p < .001$) were positively correlated with being away. Also, being away ($r = .42, p < .05$) and compatibility ($r = .39, p < .05$) were positively correlated with vigour. Regarding emotional states, confusion ($r = .41, p < .05$) was positively correlated to depression and tension ($r = .55, p < .01$) was positively correlated with anger.

Given that there were far fewer significant correlations for the industrial video when compared to the nature video, and based on the types of correlations observed, it appears that the nature video produced more perceived restorativeness. One may also infer that participants experienced a more positive emotional state given the lack of negative emotional state present when compared to participants' experience after watching the industrial video.

Psychophysiological results. Unlike the psychological measures discussed above which provided useful but subjective data, physiological measures help provide a different type of data, objective data, further explaining the whole story. This is important because physiological results are more indicative of arousal, and arousal is used to help determine whether restoration may have occurred when participants viewed the IVRE videos. To analyze psychophysiological data, our research team performed a within-groups restricted maximum likelihood analysis of variance on the standardized

galvanic skin response (GSR) and heart rate (HR) data for people who viewed each video; the design was counter balanced and every participant viewed each video.

For the GSR (See Figure 6), there was a statistically significant difference, $F(1, 577) = 20.15, p < .0001$, according to the video seen, meaning that participants who viewed the nature video exhibited significantly lower standardized GSR means ($M = -.179$) than when viewing the industrial video ($M = .179$). This supports the notion that participants experienced a lower degree of arousal while viewing the nature video. Furthermore, there were no significant effects according to video order or the interaction of order with the video.

During the analysis of heart rate, no significant differences in the standardized mean values of heartrate were observed according to video, $F(1, 577) = 1.09, p = .30$. Although there was a slight trend (see Figure 7), it was not statistically significant. After further investigation, I conducted an analysis of the middle-range values for heartrate (minutes 3,4,5, and 6) and found that heartrate for the nature video was statistically significantly lower than the middle-range heartrate values for the industrial video, $F(1, 229) = 5.27, p = .02$. These findings may be attributed to participants needing a few minutes viewing the videos before heartrate began to be affected.

Taken together, participants seemed to experience lower levels of arousal while viewing the nature video compared to the industrial video which supports the notion that there is a greater likelihood of restoration occurring when viewing nature. When looking at Figure 6, one can see that GSR means over time for both the nature video and industrial video initially followed similar trajectories (e.g., gradual increase then plateau), but starting at the six minute mark during the videos, there was a noticeable shift; GSR

means for the nature video began to decrease while GSR means for the industrial video stayed constant if not increasing slightly. When referencing Figure 6 and Figure 7, it may be helpful to note that the middle, horizontal axis on the graph represents the minute timeline of the video. These physiological results seem to align with participants' ratings on the PRS which showed participants perceived more restoration after watching the nature video compared to the industrial video. An explanation for the trend in GSR results as depicted in Figure 6 during the videos could be explained by the following: anticipation of what was to come led to increase in GSR, GSR stabilized once participants knew what to expect, and effect of IVRE videos became noticeable

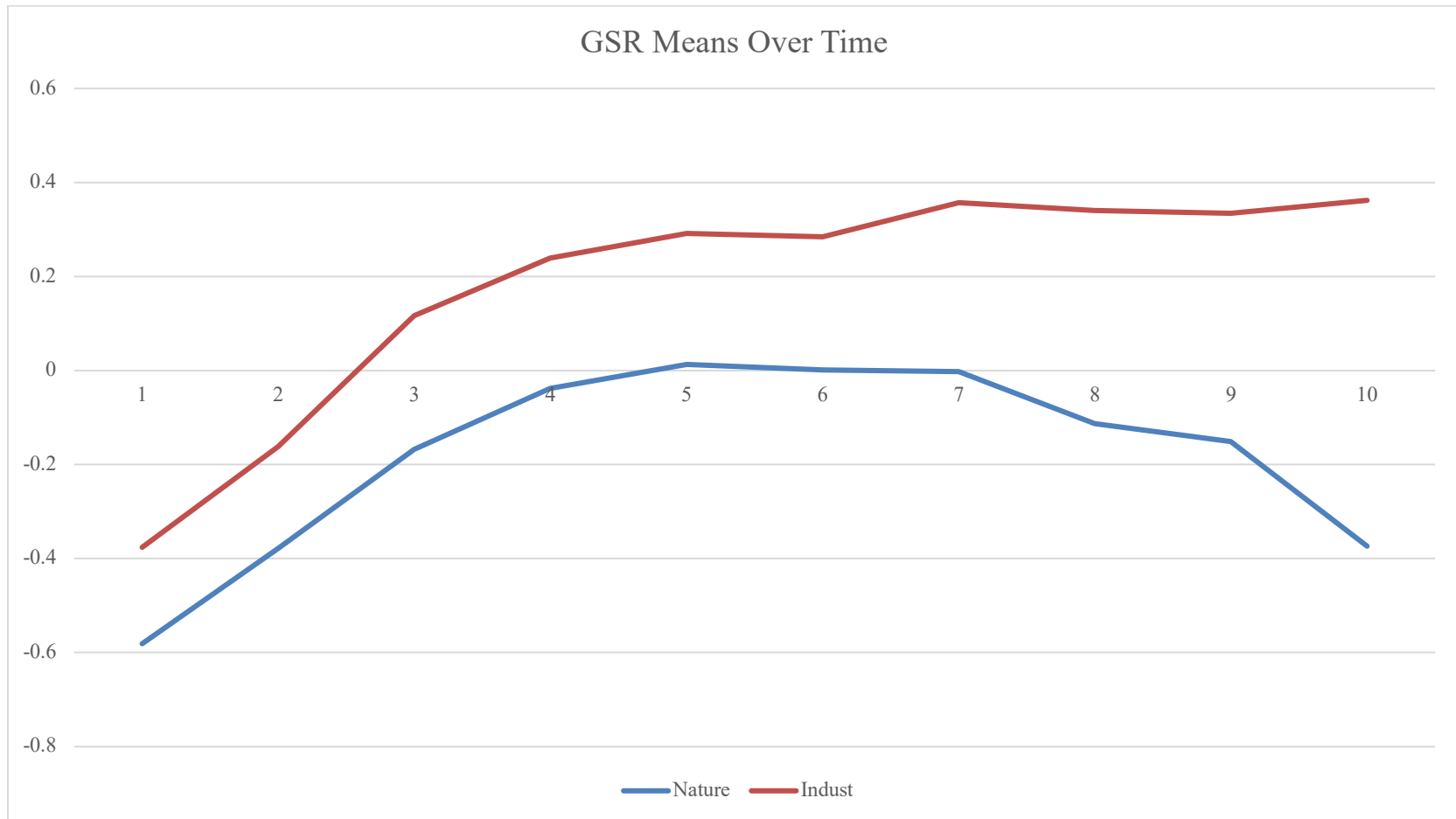


Figure 6. Galvanic Skin Response Means Over Time



Figure 7. Heart Rate Means Over Time

CHAPTER V

DISCUSSION

Summary

This study set out to determine the impact that exposure to nature through an immersive virtual reality environment (IVRE) might have on people, but more specifically, it sought to investigate how exposure to nature through IVRE affects a person's mood, their connection to nature, as well as whether they experienced a sense of restoration after exposure. The benefits of interacting with or being exposed to nature or some aspect of nature has been demonstrated to enhance a person's well-being, increase positive affect, and restore cognitive functioning from fatigue (Berman et al., 2012; Depledge et al., 2011; Kaplan, 1995), though few studies have investigated whether exposure to nature through an IVRE can have the same or similar effects. Considering the relatively recent emergence of ecopsychology and a lack of studies incorporating IVRE, this study represents a meaningful contribution to ecopsychology as well as the field of psychology in general. Hopefully lead to further bridging the gap between nature and technology.

To bridge the gap between nature and technology, this study utilized HTC Vive virtual reality equipment to immerse participants in two different environments, a nature setting and an industrial setting; each setting or some aspects of the settings was similar to ones that participants have most likely been exposed to at some point during their life. This study showed and supported findings from previous studies and literature that

exposure to a nature-based IVRE can have a significant positive impact on one's psychological health.

For example, the first research question – Does interacting with nature through an IVRE lead to an improved mood state? – received some indirect support. This study showed that participant means on the BRUMS, when compared to baseline, were lower following exposure to the nature IVRE but increased following exposure to the industrial IVRE. What this means is that lower levels of negative mood states were present after exposure to the nature IVRE video leading one to infer that participants' mood improved. This only partially supports the hypothesis that mood improved following nature IVRE exposure because one may infer that positive mood is present when negative mood is absent, but the BRUMS did not specifically measure positive mood aside from one subscale (vigour), so one cannot explicitly state there was an increase in positive mood states or affect. Although this study did not specifically measure positive mood, similar studies have. When comparing virtual nature and urban environments, researchers found that levels of positive affect were higher after participants were exposed to virtual nature (Schutte et al., 2017). Similarly, a study conducted by Browning, Mimnaugh, van Riper, Laurent, & LaValle (2020) found that higher levels of positive affect were found after viewing virtual reality nature when compared to baseline levels of affect.

Regarding my second research question and its corresponding hypothesis, this study also found that there was a significant increase in a participant's connectedness to nature (CN) following exposure to the nature IVRE video when compared to baseline and/or following exposure to the industrial IVRE video. This finding did not come as a surprise given previous studies have shown one's connection to nature increases after

viewing, being exposed to, or interacting with some aspect of nature (Mayer & Frantz, 2004; Tennessen & Cimprich, 1995). In this regard, the current research replicates the results of the aforementioned researchers.

Lastly, this study sought to determine whether interacting with nature through an IVRE would lead to a sense of psychological restoration and the results from this study indicated that participants did feel more restored after being exposed to the nature IVRE video when compared to the industrial IVRE video. This was because the different factors attributed to restoration – being away, extent, compatibility, and fascination (Kaplan & Kaplan, 1989) – were perceived to be present in the nature IVRE video but were not present in the industrial IVRE video or if it was, it was not present to the same degree as in the nature IVRE. This finding is in line with a previous study's findings in which participants perceived a nature IVRE to be more restorative than an urban IVRE (Schutte et al., 2017). In addition to participants endorsing items on the Perceived Restorativeness Scale, which provided subjective data on the perceived restorativeness of each IVRE video, galvanic skin response (GSR) and heart rate (HR), both physiological and objective ways to measure arousal, were taken to strengthen the validity of the findings. Based on participants' middle-range HR means and GSR means, there were significantly lower levels of arousal. Taken together, the results for the PRS, HR, and GSR analysis indicated that the conditions present during the nature IVRE contributed to perceived restoration as well as actual physical restoration.

Implications

Although at the time this study was conducted it was one of only a few studies to incorporate virtual reality technology with ecopsychology research, our findings seem to

align with previous ecopsychology research and further support the fact that human interaction with nature is vital to one's psychological health as well as overall well-being. Even though the use of virtual reality as means to reap the benefits of human/nature interaction may have seemed counterintuitive, the outcome of this study proved otherwise. Given the rate at which technology has advanced in the past few decades and continues to advance today, there is no telling how immersive virtual reality will become, and in turn, the benefits that could come from those advancements.

By having more immersive virtual environments, people could experience enhanced effects by engaging in nature-based IVREs in the future. Although nature-based IVREs are not recommended as a replacement for real human/nature interaction, it could be used to help those who have few opportunities to engage with nature. For example, this could include people living in urban environments. Depending on the location of the urban environment, there may be few if any greenspaces within close proximity making nature-based IVREs the only viable option. Also, older people with more physical complaints may not be able to engage or interact with nature in the same way as younger people or individuals without disabilities. For instance, people with limited mobility could put themselves at risk of injury if they were to try to utilize an actual nature trail. Furthermore, people may just lack the time to engage with nature due to work, school, family, or other time constraining obligations and by utilizing nature-based IVREs, they could reap similar benefits of their counterparts who are able to actually get out and experience nature. Lastly, nature-based IVREs also have the potential to be used in conjunction with traditional psychotherapeutic approaches or interventions to prevent or treat mental health concerns. Take for instance a patient

diagnosed with major depressive disorder (MDD) with a seasonal pattern specifier. If the patient with MDD lives in a climate with harsh and dark winters, nature-based IVREs could provide a boost to traditional psychotherapy by allowing the patient to escape their harsh wintery climate and enjoy warm coastal areas or tropical forests.

Limitations

The first major limitation to this study could be attributed to the Brunel Mood Scale (BRUMS). The BRUMS was used to determine participants' moods throughout the study, though the measure focused primarily on negative mood. Even though one might conclude that if a negative mood is absent, a neutral or positive mood must be present, it would have increased this study's validity and more thoroughly answered the first research question if a different or additional measure was used. That would allow researchers the ability to determine not just whether negative mood was present or absent, but also assess for the presence or absence of positive mood. This limitation could easily be remedied by either incorporating another measure in addition to the BRUMS that focused primarily on positive mood states or by utilizing a single measure, such as the Positive and Negative Affect Scale (PANAS), that accounted for positive and negative mood states.

Another limitation to this study could be attributed to virtual reality equipment and the amount of immersion participants experienced. Although participants had an unobstructed 360-degree view and could hear the sounds associated with each IVRE, other senses such as touch and smell were not stimulated like they would have been had the participants been in the actual environments; other studies have shown that olfactory and tactile stimulation can have a significant positive effect on psychological and

physiological health. By increasing immersion through incorporating different scents and tactile sensations, participants would be closer to the real-world environments being simulated and one could infer that presence would be magnified therefore participants would experience pronounced or new effects from the IVREs closer to what would be expected from the real-world environments.

Aside from the two major limitations listed above, there were two minor limitations to this study. First, this study and more studies within the field of ecopsychology should be replicated. By replicating studies, researchers give greater validity to their findings when similar results arise. If results are not supported, then that provides useful data and allows researchers to investigate why there could have been different results. Second, the demographics of this study could be broadened in the future and be more inclusive of different ages, genders, ethnicities, and physical ability.

Recommendations for Future Research

Regarding recommendations for future research, I believe it would be beneficial to address some of the limitations listed above by enrolling participants from outside of a college setting. This could assuage any concerns related to demographics such as age, ability status, and gender identity to name a few. For example, conducting a study using participants from a variety of settings such as local hospitals (e.g., Mercy Health Center), community mental health clinics (e.g., Center for Counseling and Personal Evaluation), or collaborating with Veteran Affairs healthcare system (e.g., Athens VA community-based outpatient clinic) would provide a more diverse participant pool.

Given that previous studies in ecopsychology have incorporated different types of physiological measures such as using fMRI to assess brain function while viewing nature

(Kim et al., 2010; Selhub & Logan, 2012) or assessing salivary cortisol levels when participants are engaging with nature (Lee et al., 2011), it would be intriguing to see how those physiological measures could be combined with nature-based IVREs. For instance, researchers could compare brain activation in participants viewing pictures or videos of nature versus an IVRE, or researchers could compare salivary cortisol levels of participants who engaged with nature *in vivo* against those who engaged with nature through IVREs. Also, it could be helpful to incorporate more interactive forms of nature-based IVREs; this would provide participants with the ability to explore more and possibly enhance the effects one might get from nature-based IVRE interactions. Lastly, it would be highly beneficial to compare in-vivo nature with virtual nature to better determine whether a simulated environment can provide the same or similar benefits as the actual environment being simulated.

From a therapeutic perspective, using nature-based interventions as a stand-alone modality to promote wellness and/or as an adjunctive therapy to traditional evidence-based psychotherapeutic approaches could serve as a cost-effective method to improve treatment outcomes or serve as preventative measure. This would allow the practitioner to bring the outdoors indoors so that those who might not be able to benefit from real nature could benefit from virtual nature. Although exposure and interaction with real nature has a multitude of benefits for people, there are also aspects of nature (e.g., insects, vegetation, weather) that may cause individuals seeking help to shy away from nature-based interventions. By incorporating nature-based IVREs, clients would be able to experience some of the benefits without having to deal with the potential negative aspects of actually being outdoors.

REFERENCES

- Annerstedt, M., Jönsson, P., Wallergård, M., Johansson, G., Karlson, B., Grahn, P., Hansen, Å., & Währborg, P. (2013). Inducing physiological stress recovery with sounds of nature in a virtual reality forest — Results from a pilot study. *Physiology & Behavior, 118*, 240-250. <https://doi:10.1016/j.physbeh.2013.05.023>
- Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with Nature. *Psychological Science (0956-7976), 19*(12), 1207-1212. <https://doi:10.1111/j.1467-9280.2008.02225.x>
- Berman, M. G., Kross, E., Krpan, K. M., Askren, M. K., Burson, A., Deldin, P. J., & ... Jonides, J. (2012). Interacting with nature improves cognition and affect for individuals with depression. *Journal of Affective Disorders, 140*(3), 300-305. <https://doi:10.1016/j.jad.2012.03.012>
- Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25*(3), 249-259.
- Berto, R. (2007). Assessing the restorative value of the environment: A study on the elderly in comparison with young adults and adolescents. *International Journal of Psychology, 25*, 249-259.
- Bown, J., White, E., & Boopalan, A. (2017). Looking for the ultimate display: A brief history of virtual reality. In J. Gackenbach, J. Bown, J. Gackenbach, J. Bown (Eds.), *Boundaries of self and reality online: Implications of digitally constructed*

realities (pp. 239-259). San Diego, CA, US: Elsevier Academic Press.

<https://doi:10.1016/B978-0-12-804157-4.00012-8>

Browning, Matthew H. E. M., Mimnaugh, Katherine J., van Riper, Carena J., Laurent, Heidemarie K., & LaValle, Steven M. (2020). Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. *Frontiers in Psychology, 10*.

<https://doi.org/10.3389/fpsyg.2019.02667>

Bush, L. K., Hess, U., & Wolford, G. (1993). Transformations for within-subject designs: A Monte Carlo investigation. *Psychological Bulletin, 113*(3), 566–579.

<https://doi.org/10.1037/0033-2909.113.3.566>

Calogiuri, G., Litleskare, S., Fagerheim, K. A., Rydgren, T. L., Brambilla, E., & Thurston, M. (2018). Experiencing nature through immersive virtual environments: Environmental perceptions, physical engagement, and affective responses during a simulated nature walk. *Frontiers In Psychology, 8*.

<https://doi:10.3389/fpsyg.2017.02321>

Cervinka, R., Roderer, K., & Hefler, E. (2012). Are nature lovers happy? On various indicators of well-being and connectedness with nature. *Journal of Health Psychology, 17*(3), 379-388.

Psychology, 17(3), 379-388.

Chalquist, C. (2009). A look at the ecotherapy research evidence. *Ecopsychology, 1*(2),

64-74. <https://doi:10.1089/eco.2009.0003>

de Kort, Y. A., Meijnders, A. L., Sponselee, A. A., & IJsselsteijn, W. A. (2006). What's wrong with virtual trees? Restoring from stress in a mediated environment.

Journal of Environmental Psychology, (4). 309.

- DeMayo, N., (2009). Horses, humans, and healing. In L. Buzzell & C. Chalquist (Eds.), *Ecotherapy: Healing with nature in mind*. (pp.149-156). Berkley, CA: Counterpoint.
- de Vries, S., Verheij, R., Groenewegen, P., & Spreeuwenberg, P. (2003). Natural environments - healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environment and Planning A*, 35(10), 1717-1731.
- Dietrich, Z. C., Joye, S. W., & Garcia, J. A. (2015). Natural Medicine: Wilderness experience outcomes for combat veterans. *Journal of Experiential Education*, 38(4), 394-406.
- Depledge, M. H., Stone, R. J., & Bird, W. J. (2011). Can natural and virtual environments be used to promote improved human health and wellbeing?. *Environmental Science & Technology*, 45(11), 4660-4665. <https://doi:10.1021/es103907m>
- Fisher, A. (1996). Toward a more radical ecopsychology - Therapy for a dysfunctional society. *Alternatives Journal*, 22(3), 10-26.
- Fleming, L. L. (2015). Veteran to farmer programs: An emerging nature-based programming trend. *Journal of Therapeutic Horticulture*, 25(1), 27-48.
- Gass, M. A., Gillis, H. L., & Russell, K. C. (2012). *Adventure therapy: theory, research, and practice*. New York: Brunner-Routledge.
- Gatersleben, B., & Andrews, M. (2013). When walking in nature is not restorative- the role of prospect and refuge. *Health & Place*, 20, 91-101. <https://doi:10.1016/j.healthplace.2013.01.001>
- Gidlow, C. J., Jones, M. V., Hurst, G., Masterson, D., Clark-Carter, D., Tarvainen, M. P., Smith, G., & Nieuwenhuijsen, M. (2016). Where to put your best foot forward:

Psycho-physiological responses to walking in natural and urban environments.
Journal of Environmental Psychology, 45, 22-29.

<https://doi:10.1016/j.jenvp.2015.11.003>

Harari, Y. N. (2015). *Sapiens: a brief history of humankind*. New York: Harper.

Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Garling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, 23(2), 109-123.

Hartig T., Korpela K., Evans G.W. & Garling T. (1997b) A measure of restorative quality in environments. *Scandinavian Housing and Planning Research* 14(4), 175–194.

Hibbard, W. (2003). Ecopsychology: A review. *Trumpeter: Journal of Ecosophy*, 19(2), 23-58.

James, W. (1890). Attention. In, *The principles of psychology, Vol I* (pp. 402-458). New York, NY, US: Henry Holt and Co. <https://doi:10.1037/10538-011>

Kaplan, R. & Kaplan, S. (1989). *The Experience of Nature: A psychological perspective*. New York: Cambridge University Press.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal Of Environmental Psychology*, 15(3), 169-182. [https://doi:10.1016/0272-4944\(95\)90001-2](https://doi:10.1016/0272-4944(95)90001-2)

Kim, T., Jeong, G., Baek, H., Kim, G., Sundaram, T., Kang, H., Lee, S., Kim, S. & Song, J. (2010). Human brain activation in response to visual stimulation with rural and urban scenery pictures: A functional magnetic resonance imaging study. *Science of The Total Environment*, 408(12), 2600-2607.

- Klepeis, N. E., Nelson, W. C., Ott, W. R., Robinson, J. P., Tsang, A. M., Switzer, P., Behar, J.V., Hern, S.C., & Engelmann, W. H. (2001). The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Analysis and Environmental Epidemiology*, *11*(3), 231-252.
- Lee, J., Park, B., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Original Research: Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health*, *125*, 93-100. [https://doi: 10.1016/j.puhe.2010.09.005](https://doi.org/10.1016/j.puhe.2010.09.005)
- Lee, J.; Li, Q.; Tyrvaainen, L.; Tsunetsugu, Y.; Park, B.J.; Kagawa, T.; Miyazaki, Y. (2012). Nature therapy and preventive medicine. In *Public Health—Social and Behavioral Health*; Maddock, J., Ed.; Intech: Rijeka, Croatia, pp. 325–350.
- MacKerron, G., & Mourato, S. (2013). Happiness is greater in natural environments. *Global Environmental Change*, *23*, 992-1000. [https://doi:10.1016/j.gloenvcha.2013.03.010](https://doi.org/10.1016/j.gloenvcha.2013.03.010)
- Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology*, *24*(4), 503-515.
- Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial? The role of connectedness to nature. *Environment And Behavior*, *41*(5), 607-643.
- McNair, D. M., Lorr, M., & Droppleman, L. F., (1971). Manual for the profile of mood states. San Diego: Educational and Industrial Testing Services.

- Nash, R. (1968) *The American environment: Readings in the history of conservation*. Reading, MA: Addison-Wesley Publishing Company.
- Nurenberg, J. R., Schleifer, S. J., Shaffer, T. M., Yellin, M., Desai, P. J., Amin, R., Bouchard, A., & Montalvo, C. (2015). Animal-assisted therapy with chronic psychiatric inpatients: Equine-assisted psychotherapy and aggressive behavior. *Psychiatric Services, 66*(1), 80-86. <https://doi:10.1176/appi.ps.201300524>
- Ochiai, H., Ikei, H., Song, C., Kobayashi, M., Takamatsu, A., Miura, T., Kagawa, T., Li, Q., Kumeda, S., Imai, M., & Miyazaki, Y. (2015). Physiological and psychological effects of forest therapy on middle-aged males with high-normal blood pressure. *International Journal of Environmental Research and Public Health, 12*(3), 2532-2542. <https://doi:10.3390/ijerph120302532>
- Ochiai, H., Ikei, H., Song, C., Kobayashi, M., Miura, T., Kagawa, T., Li, Q., Kumeda, S., Imai, M., & Miyazaki, Y. (2015). Physiological and Psychological Effects of a Forest Therapy Program on Middle-Aged Females. *International Journal of Environmental Research and Public Health, 12*(12), 15222-15232. <https://doi:10.3390/ijerph121214984>
- OECD Better Life Index (n.d.) *Work-Life Balance*. Retrieved August 7, 2018, from <http://www.oecdbetterlifeindex.org/topics/work-life-balance/>
- Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology & Environmental Health: Part B, 19*(7), 305-343. <https://doi:10.1080/10937404.2016.1196155>

- Parsons, R., Tassinary, L. G., Ulrich, R. S., Hebl, M. R., & Grossman-Alexander, M. (1998). Regular Article: The view from the road: Implications for stress recovery and immunizations. *Journal of Environmental Psychology, 18*, 113-140.
<https://doi:10.1006/jevp.1998.0086>
- Reeve, A., Nieberler-Walker, K., & Desha, C. (2017). Healing gardens in children's hospitals: Reflections on benefits, preferences and design from visitors' books. *Urban Forestry & Urban Greening, 26*, 48-56.
<https://doi:10.1016/j.ufug.2017.05.013>
- Salanitri, D., Lawson, G., & Waterfield, B. (2016). Future directions for the development of virtual reality within an automotive manufacturer. *Applied Ergonomics, 53*, 323-330.
- Sapto Pamungkas, L., Meytasari, C., & Trieddiantoro, H. (2018). Virtual reality as a spatial experience for architecture design: A study of effectiveness for architecture students. *SHS Web of Conferences, Vol 41, P 05005 (2018)*, 05005.
<https://doi:10.1051/shsconf/20184105005>
- Schuck, S. B., Emmerson, N. A., Fine, A. H., & Lakes, K. D. (2015). Canine-assisted therapy for children with ADHD: Preliminary findings from the Positive Assertive Cooperative Kids study. *Journal of Attention Disorders, 19*(2), 125-137. <https://doi:10.1177/1087054713502080>
- Schutte, N. S., Bhullar, N., Stilinović, E. J., & Richardson, K. (2017). The impact of virtual environments on restorativeness and affect. *Ecopsychology, 9*(1), 1-7.
<https://doi.org/10.1089/eco.2016.0042>

- Searles, H. F. (1960). *The nonhuman environment in normal development and in schizophrenia*. Madison, CT: International Universities Press, Inc.
- Selhub, E., & Logan, A. (2012). *Your brain on nature*. Ontario, CA: HarperCollins.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton, Mifflin and Company.
- Shin, W. S., Yeoun, P. S., Yoo, R. W., & Shin, C. S. (2010). Forest experience and psychological health benefits: the state of the art and future prospect in Korea. *Environmental Health and Preventive Medicine*, (1), 38.
- Tennessen, C. M., & Cimprich, B. (1995). Views to nature: Effects on attention. *Journal of Environmental Psychology*, 15(1), 77-85. [https://doi:10.1016/0272-4944\(95\)90016-0](https://doi:10.1016/0272-4944(95)90016-0)
- Terry, P. C., Lane, A. M., Lane, H. J., & Keohane, L. (1999). Development and validation of a mood measure for adolescents. *Journal of Sports Sciences*, (11), 861-872, <https://doi:10.1080/026404199365425>
- Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., & Kagawa, T. (2014). The influence of urban green environments on stress relief measures: A field experiment. *Journal of Environmental Psychology*, 38, 1-9. <https://doi:10.1016/j.jenvp.2013.12.005>
- Song, C., Ikei, H., & Miyazaki, Y. (2016). Physiological effects of nature therapy: A review of the research in Japan. *International Journal of Environmental Research and Public Health*, 13(8), <https://doi:10.3390/ijerph13080781>

- Ulrich, R. S. (1981). Natural versus urban scenes: some psychophysiological effects. *Environment & Behavior, 13*, 523-556.
- Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. *Human Behavior & Environment: Advances in Theory & Research, 6*, 85-125.
- Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science, 224*(4647), 420-421. <https://doi:10.1126/science.6143402>
- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201-230. [https://doi:10.1016/S0272-4944\(05\)80184-7](https://doi:10.1016/S0272-4944(05)80184-7)
- Waldrop, M. M. (2017). Virtual reality therapy set for a real renaissance: As the technology becomes cheaper and more accessible, and as research on its effectiveness matures, virtual reality is treating an array of vexing mental ailments. *Proceedings of The National Academy of Sciences of The United States, (39)*, 10295. <https://doi:10.1073/pnas.1715133114>
- Wamsley, L. (March 1, 2018) South Korea shortens 'inhumanly long' workweek. *NPR*. Retrieved from <https://www.npr.org/sections/thetwo-way/2018/03/01/589895641/south-korea-shortens-inhumanly-long-work-week>
- Wang, X., Rodiek, S., Wu, C., Chen, Y., & Li, Y. (2016). Stress recovery and restorative effects of viewing different urban park scenes in Shanghai, China. *Urban Forestry & Urban Greening, 15*, 112-122. <https://doi:10.1016/j.ufug.2015.12.003>
- Wells, N. M., & Evans, G. W. (2003). Nearby nature: a buffer of life stress among rural children. *Environment & Behavior, 35*(3), 311-330.

White, M. P., Pahl, S., Ashbullby, K., Herbert, S., & Depledge, M. H. (2013). Feelings of restoration from recent nature visits. *Journal of Environmental Psychology*, 3540-51. <https://doi:10.1016/j.jenvp.2013.04.002>

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

APPENDIX A

Screening Questions

Please answer yes or no to each question.

	Yes	No
Do you have a prior history of experiencing vertigo attacks?		
Have you ever experienced cyber sickness while immersed in a virtual reality environment?		
Do you have any vision impairments that have not been corrected?		

Demographic Questions

Please check all that apply.

Gender	
Female	
Male	
Transgender	

Please check all that apply.

Race/Ethnicity	
Asian	
Black or African American	
Latina/o	
Native American or Alaska Native	
Native Hawaiian or Pacific Islander	
White	
Biracial	
Multiracial	

APPENDIX B

Brunel Mood Scale (BRUMS)

Below is a list of words that describe feelings. Please read each one carefully. Then mark the box that best describes HOW YOU FEEL RIGHT NOW. Make sure you answer every question.

Item	Not at all	A little	Moderately	Quite a bit	Extremely
1. Panicky					
2. Lively					
3. Confused					
4. Worn out					
5. Depressed					
6. Downhearted					
7. Annoyed					
8. Exhausted					
9. Mixed-up					
10. Sleepy					
11. Bitter					
12. Unhappy					
13. Anxious					
14. Worried					
15. Energetic					
16. Miserable					
17. Muddled					
18. Nervous					
19. Angry					
20. Active					
21. Tired					
22. Bad tempered					
23. Alert					
24. Uncertain					

APPENDIX C

Perceived Restorativeness Scale (PRS)

Please indicate on the 7-point scale the extent to which the given statement describes your experience in the setting (0 = Not at all; 6 = Completely).

0	1	2	3	4	5	6	Item
							Being here is an escape.
							Spending time here gives me a break from my day-to-day routine.
							It is a place to get away from it all.
							Being here helps me to relax my focus on getting things done.
							Coming here helps me to get relief from unwanted demands on my attention.
							This place has fascinating qualities.
							My attention is drawn to many interesting things.
							I want to get to know this place better.
							There is much to explore and discover here.
							I want to spend more time looking at the surroundings.
							This place is boring.
							This setting is fascinating.
							There is nothing worth looking at here.
							There is too much going on.
							It is a confusing place.
							There is a great deal of distraction.
							It is chaotic.
							Being here suits my personality.
							I can do things I like here.
							I have a sense that I belong here.
							I can find ways to enjoy myself here.
							I have a sense of openness with this setting.
							There are landmarks to help me get around.
							I could easily form a mental map of this place.
							It is easy to find my way around here.
							It is easy to see how things are organized.

APPENDIX D

Connectedness to Nature Scale (CNS)

Please answer each of these questions in terms of the way you generally feel. There are no right or wrong answers. Simply state as honestly and candidly as you can what you are presently experiencing.

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I often feel a sense of oneness with the nature world around me.					
I think of the natural world as a community to which I belong.					
I recognize and appreciate the intelligence of other living organisms.					
I often feel disconnected from nature.					
When I think of my life, I imagine myself to be a part of a larger cyclical process of living.					
I often feel a kinship with animals and plants.					
I feel as though I belong to the Earth as equally as it belongs to me.					
I have a deep understanding of how my actions affect the natural world.					
I often feel part of the web of life.					
I feel that all inhabitants of Earth, human and nonhuman, share a common 'life force'.					
Like a tree can be part of a forest, I feel embedded within the broader natural world.					
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.					
I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.					
My personal welfare is independent of the welfare of the natural world.					