NURTURING NATURE IN VIRTUAL REALITY: A STUDY OF PUBLIC SERVICE EXPERIENCES AND THEIR EFFECTS ON ENVIRONMENTAL ATTITUDES AND BEHAVIORAL INTENTIONS

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ABSTRACT

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The effects of human intervention on the environment are numerous and increasingly devastating. Many species of animals have become endangered due to environmental changes and an encroachment on their natural habitats. Unfortunately, research indicates that it can be difficult to keep people informed and actively engaged with environmental issues. In the United States, a common method to keep the public informed and engaged with environmental issues are public service announcements (PSAs). However, some research indicates that PSAs may not be as effective with millennial viewers in a modern day multi-media landscape. Recent studies have indicated that virtual reality (VR) may provide an effective means of engaging the public via public service experiences (PSEs).

The present study builds and expands upon the PSE literature by continuing to explore possible mechanisms, and their relation to one another, that may account for PSE effects. Furthermore, this study fills a gap in the literature related to gradient manipulations of immersive factors. Additionally, this study also makes a contribution to the literature by examining the concepts of natural mapping and narrative interactivity from two distinct perspectives. Specifically, natural mapping is examined along naturalness and intuitiveness dimensions while narrative interactivity is examined along technical and content interactivity dimensions. Finally, this study seeks to explore the possibility that pro-environmental PSE’s might have the ability to activate other associated environmental attitudes.

In order to explore the above questions, an experiment was conducted which tested the potential impacts of narrative interactivity and naturally mapped movement in a PSE. The experiment was a between-subjects factorial design. Specifically, the experiment was a 2 (high and low narrative interactivity) X 3 (low, medium, and high natural mapping) factorial design. The sample for this study consisted of 183 undergraduate college students obtained from a large mid-western university in the United States. The experiment involved exposing participants to approximately a 10-minute virtual experience/environment which includes endangered wildlife, such as elephants.

Naturally mapped locomotion and narrative interactivity should be considered a multi-dimensional concept with both naturalness and intuitiveness sub-constructs and technical and content sub-constructs respectively. In this case, perceived locomotion intuitiveness was a statistically significant predictor of participants' feelings of spatial presence while perceived locomotion naturalness was not. Similarly, perceived content interactivity was a statistically significant predictor of participants' feelings of narrative transportation while perceived technical interactivity was not. Spatial presence and narrative transportation then served as a mediators between natural mapping/narrative interactivity and participants' pro-environmental attitudes and behavioral intentions. This study makes both theoretical and practical contributions to the literature. Theoretically, both natural mapping and narrative interactivity should be considered multi-dimensional constructs which have implications for the formation of spatial presence and narrative transportation. Practically, designers of PSEs should consider the importance of making locomotion more intuitive rather than more natural while emphasizing users' ability to interact with virtual stories rather than just virtual environments.

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CHAPTER 1: INTRODUCTION

"Nothing ever becomes real till it is experienced – Even a proverb is no proverb to you till your Life has illustrated it." – John Keats

The present research explores new ways, using the immersive and interactive affordances of virtual reality (VR), to disseminate novel pro-environmental experiences to young adult audiences. In the past, "Public Service Announcements" (PSAs) were a common method for engaging the public with pro-environmental information (Cialdini, 2003). More recently, pro-environmental VR-based experiences have been shown to increase participants' involvement with nature, the perception of environmental risk, pro-environmental behavioral intentions, and environmental efficacy (Ahn, Bailenson, & Park, 2014; Ahn et al., 2016). The repurposing of VR to convey pro-social *experiential* messages to the public has been recently referred to as "Public Service Experiences" (PSEs)(Ball, 2018). PSEs specifically, have been shown to have positive indirect effects on pro-environmental attitudes and behavioral intentions (such as support for conservational policies) via the mediating roles of spatial presence and narrative engagement (Ball, 2018).

However, there are still lingering questions regarding the mechanism behind the impacts of VR-based pro-social experiences such as PSEs (Ahn, Fox, Dale, & Avant, 2015). In particular, there is a need to better understand the dimensions and roles of narrative and interactivity in PSE effects (Ahn et al., 2014; Ahn et al., 2015; Christy & Fox, 2016; Peng, Lee, & Heeter, 2010). Specifically, PSEs, unlike PSAs, may provide ideal contexts to create and disseminate interactive narratives which may result in more engaging and influential experiences (Green & Jenkins, 2014). Furthermore, there is a need in the literature to explore granular differences in immersive affordances in order to draw more precise conclusions regarding the nature of PSE effects (Cummings, Bailenson, & Fidler, 2012). Therefore, the present research attempts to build on previous literature by testing a new theoretical model that might help explain PSE effects. This study also tests the impact of granular differences in immersion factors, tests the potential importance of interactive narratives in the context of PSEs, and tests the cognitive bounds of PSE effects.

1.1. Environmental Communication Challenges

The effects of human intervention on the environment are numerous and increasingly devastating. Environmental threats, such as global warming, originate from human actions (Cook et al., 2016). However, despite the human cause of many environmental issues, such problems are frequently difficult for the public at large to identify and engage with in a proactive and significant way (Ahn et al., 2016). Environmental awareness can be limited by a number of emotional and cognitive barriers such as a lack of environmental knowledge or the distancing of emotional reactions (Kollmuss & Agyeman, 2002). To make matters worse, communication scholars have discovered that communicating human-related environmental threats to the public can often be challenging for a number of important reasons (Ahn et al., 2016; Ahn et al., 2015).

First, environmental problems are often not immediately observable (Ahn et al., 2016; Kollmuss & Agyeman, 2002; Preuss, 1991). In other words, normally, people are not able to directly observe environmental degradation such as ocean pollution first hand. For example, people are not typically able to notice the accumulation of greenhouses gases on the atmosphere in a tangible way (Kollmuss & Agyeman, 2002). Instead, we can only perceive the effects, such as superstorms or warmer weather. The fact that many environmental issues are not immediately observable also indicates a degree of “time lag” (Kollmuss & Agyeman, 2002, p. 253). People often only perceive or recognize environmental issues after the damage has become severe, and thus more noticeable. Not being able to directly witness environmental threats can make them less cognitively and emotionally relevant.

Second, there is often a temporal distance between the cause and effect of environmental problems that can also result in environmental issues becoming more difficult to acknowledge (Ahn et al., 2016; Ahn et al., 2015). For instance, leaving the water running in a bathroom or leaving the lights on in an apartment might not have observable effects on the environment for an extended period of time, if ever. Another temporal related cognitive barrier is that environmental degradation is often a very slow and gradual process (Kollmuss & Agyeman, 2002; Preuss, 1991). In general, people are adept at noticing extreme and abrupt changes but we are usually inept at noticing moderate and incremental changes (Kollmuss & Agyeman, 2002). In the case of environmental issues, humans can be likened to frogs that if placed in boiling water will jump out, but if frogs are placed in warm water which is then slowly brought to boil, then the frogs will not notice that they are being boiled alive (Kollmuss & Agyeman, 2002).

Third, another cognitive and emotional barrier towards environmental awareness simply originates from the complexity of the issue at hand. The environment itself is an astonishingly complex system of systems, which means that environmental problems are also enormously complex (Kollmuss & Agyeman, 2002). In fact, the environment is so complex that people tend to simplify their understanding of the environment in an attempt to understand its systems linearly (Fliegenschnee & Schelakovsky, 1998; Preuss, 1991). Our inability to fully conceptualize the complexity of the environment, and our impact upon it, limit our ability to obtain a deep understanding of environmental issues. In fact, the publics' general lack of a deep understanding related to environmental issues can lead to an underestimation of the severity of the environmental problems we face, which can subsequently impact emotional engagement and pro-environmental behavioral intentions (Kollmuss & Agyeman, 2002). In the end, humans shape the world to suit our needs, but such changes can often have profound repercussions for the planet which can often be difficult to acknowledge and engage with in a meaningful way. However, while humans have a substantial impact on the environment in general, we also have a significant impact on wildlife in particular, such as various species of whales and elephants.

1.2. The Impact on Animals

Humans have been adapting and modifying their environment to suit their needs for millennia, with various benefits to society and detriments to the environment. Humans shape the world in countless ways which can often have profound repercussions for the planet and the other life with which we share our planet. In particular, our environmental tampering has a substantial impact on large mammal wildlife, sometimes referred to as “megafauna”(Ripple et al., 2016). Megafauna include endangered terrestrial and marine mammals such as the various species of whales and elephants. Large-bodied mammals such as elephants and whales have a higher risk for extinction than smaller mammals due to both intrinsic traits (i.e., low reproductive rates) and environmental factors (i.e., habitat elimination) (Cardillo et al., 2005). Therefore, we must strive to better understand the blight of both whales and elephants.

Earth is primarily covered by incredibly biodiverse oceans, which comprise 90% of the livable space on Earth (UNESCO, 2016). Unfortunately, these oceans are under constant assault from various human factors, such as overfishing, global warming, and industrial pollution. Currently, over half (60%) of the world’s oceans are being damaged by pollutants. As a result, some figures project that across the span of one lifetime, over half of Earth’s oceanic species may be approaching extinction (UNESCO, 2016). In particular, numerous species of whales have been pushed to the brink of extinction due to commercial whaling practices and other man-made threats.

The commercial hunting of whales began as far back as the 1800s ("Whale Threats," 2017). Whales were hunted for their valuable resources such as food and oil. In the 1930s the development of factory ships led to the killing of approximately 50,000 whales per year (Francis, 2010). During this period of time whales were almost driven to the brink of extinction. In 1946, the International Whaling Commission was formed to regulate commercial whaling practices in an attempt to stem the decline of whale populations around the world (Francis, 2010). The past century has seen a decline in whaling practices as commercial whaling has become illegal in many places. However, the effects of commercial whaling practices are still felt as some species of whale have never recovered and approximately 1,000 whales are still hunted every year around the world. While the threat of commercial whaling has dissipated substantially, there are other mounting threats, such as global warming, that remain a persistent threat.

Global warming is a human-made problem (Marlon, Leiserowitz, & Feinberg, 2013). In fact, a review of the research indicates that 97% of the scientific literature agrees that global warming is occurring and that it is human-made (Cook et al., 2016). And yet, only 41% of Americans concur with the scientific consensus that global warming exists and that humans play a role in its propagation (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013). For example, 31% of Americans believe that global warming stems from natural causes and 20% simply believe that there is no evidence of global warming at all (Funk & Kennedy, 2016). The negative effects of global warming are often framed in terms of human-related consequences, such as the generation of powerful superstorms (Hansen et al., 2016). However, global warming also has a tremendous impact on marine life around the globe such as whales.

Warming of the oceans kills trillions of oceanic microorganisms each year, which are the primary food source for baleen whales. Baleen whales (such as gray and humpback whales) are under constant threat from environmental issues, such as global warming and pollution, because they consume these microorganisms via bristle-like structures which strain them from the water (World Wildlife Fund, 2016). The consistent elimination of these microorganisms due to pollution now results in the starvation of hundreds of whales each year (Conservation for the Oceans Foundation, 2016). Whales are an essential part of the global food chain and the overall health of our oceans (World Wildlife Fund, 2016). Unfortunately, despite whales being consistently under threat, studies suggest that there is a lack of awareness regarding the plight of whales and the various human-related sources of their suffering such as global warming (Leiserowitz et al., 2013; Parsons, Rice, & Sadeghi, 2010). There must be greater attempts to inform the public, college-age individuals in particular, regarding whale conservation issues (Parsons et al., 2010). However, whales and other oceanic wildlife are not the only inhabitants of Earth that are currently under threat from human intervention. Unfortunately, terrestrial wildlife such as numerous species of elephant are also in danger.

Much like whales, elephants have often been the target of human intervention that has reduced their numbers significantly. In the 1930s there were estimated to be between 5 to 10 million elephants inhabiting the continent of Africa alone (Kasnoff, 2018). However, approximately 40 years later in 1979 there were only estimated to be 1.3 million remaining. By 1989, the estimation dropped once again to a mere 600,000 elephants, which is less than one percent of the original population of African elephants (Kasnoff, 2018; Lemieux & Clarke, 2009). Elephants are considered important keystone species which play an important role in shaping the environment through dispersal and germination of plant life (World Wildlife Fund, 2017). Therefore, there is an imperative need to stem the tide of elephant declines around the globe. The reasons for the rapid decline of elephants are numerous.

First, over time humans have increasingly encroached on the habitat of elephants. The elimination of elephant habitats like forests and savannahs for crops, timber, housing, etc. has had a negative impact on elephant populations (Kasnoff, 2018; World Wildlife Fund, 2017). Elephants are large mammals which require a substantial amount of room to graze for food and water and the land available for elephants to live has been drastically and consistently shrinking over time (World Wildlife Fund, 2017). Second, the most substantial threat to elephants stems from ivory poaching. In the 1970s a sudden oil crisis had a negative impact on the world's economy. During this time period the value of ivory increased to approximately 100 dollars a pound and during this time ivory became known as "white gold" (Kasnoff, 2018).

In the 1980s it was estimated that approximately 100,000 elephants were hunted each year for their ivory (World Wildlife Fund, 2017). In 1989, a ban was placed on the international trade of ivory but the effects of poaching on elephant populations are still felt. Studies have shown that poaching has had long-term genetic, physiological, and reproductive impacts on elephants populations that have persisted for decades (Gobush, Mutayoba, & Wasser, 2008). Worse, while the ban did help stem the immediate decline of elephant populations in some countries, such as Tanzania, recent findings indicate the problem of poaching still exists in other countries, such as Congo (Lemieux & Clarke, 2009). Furthermore, some tactics such as snares used to poach elephants can also have impacts on other local wildlife, such as lions (Becker et al., 2013). Therefore, it is essential that we explore new and innovative ways to raise awareness regarding the plight of these majestic mammals on both the land and in the sea. Previously, a conventional method for engaging the public with environmental and conservation-related issues were "Public Service Announcements" (PSAs)(Cialdini, 2003).

1.3. The Need for New Public Service Communication

PSAs have been employed to broadcast various kinds of prosocial messages out to the public for decades (The Office of the Federal Register, 1973). Though definitions vary by country, in the United States (US) the Federal Communication Commission (FCC) defines PSAs as "any announcement for which no charge is made and which promotes programs, activities, or services of federal, state, or local governments or the programs, activities or services of non-profit organizations and other announcements regarded as servicing community interest"(The Office of the Federal Register, 1973, p. 160). The early history of the use of PSAs in the US can be traced back to the civil war when print advertisements were used to sell war bonds (Goodwill, 2016). The creation and dissemination of PSAs in a more traditional sense began during World War II (WWII). During WWII the non-profit organization known as the War Advertising Council began to create PSAs with famous propaganda catchphrases like "loose lips sink ships" (Museum of Broadcast Communications, 2016). Over time, PSAs would continue to evolve as they would come to address a wide range of topics and use a wide range of communication mediums.

More recently, PSAs have been used to tackle a plethora of social issues with a number of different goals. For example, PSAs have been used to promote positive behaviors such as safe driving practices (Boyle et al., 2014; Shead, Walsh, Taylor, Derevensky, & Gupta, 2011). PSAs have also been implemented to prevent negative behaviors such as drug use (Fishbein, Hall-Jamieson, Zimmer, von Haeften, & Nabi, 2002; Shead et al., 2011). PSAs have also been found to increase interest and concern for important health-related topics, such as AIDs prevention

(Shead et al., 2011). Billboard based PSAs have also been found to increase help-seeking attitudes regarding suicide prevention (Klimes-Dougan, Wright, & Klingbeil, 2016). Finally, PSAs have even been disseminated to improve the public's knowledge regarding specific topics such as epilepsy (Martiniuk, Secco, Yake, & Speechley, 2010). Furthermore, PSAs have been shown to be effective with particular populations and across demographics such as African Americans and college students (Keys, Morant, & Stroman, 2009; Klimes-Dougan et al., 2016). In general, PSAs have been widely regarded as a benefit to society (Roth, 1985).

Unfortunately, as the modern media landscape continues to evolve at an increasingly rapid pace, the viability of PSAs has been questioned. One factor of concern is the rising cost of PSA campaigns. By definition, PSA airtime is free, however, the actual practical cost of producing PSA commercials and materials is not free (Bonk, Griggs, & Tynes, 1999). For instance, reports indicate that the cost to produce a single 30-second television commercial currently hovers around $354,000 on average (Advertising Age, 2015; American Association of Advertising Agencies, 2013). Issues related to cost also impact the length of typical PSAs, most are less than 1 minute in length, thus limiting the amount of material they can potentially present (Perse, Nathanson, & McLeod, 1996). To make matters worse, because PSA airtime is free, they are more likely to end up being aired during what are sometimes referred to as "junk times." Junk times are the periods between 1 am and 5 am when most people are sleeping (Goodwill, 2014). The likelihood of being aired during poor viewing hours and the rising costs of television production may make PSAs less viable over time.

The efficacy of PSAs to achieve the desired prosocial outcomes has also been questioned. One study found that traditional PSAs were actually less effective for viewers that were under the age of 30 (Boyle et al., 2014). Another study conducted an experiment examining the effects of many anti-drug PSAs. The study found that most of the PSAs were more effective than watching a control program. However, the researchers also found that some of the PSAs were actually less effective than the control program (Fishbein et al., 2002). Another study examining the effect of producer type on PSA effects found that regardless of producer type a series of anti-child abuse PSAs had no impact on viewers' behavioral intentions. The study also found that watching a "fear" based PSA first actually had a negative impact on viewers' attitudes toward the PSA and their behavioral intentions (Paek, Hove, Ju Jeong, & Kim, 2011).

Finally, PSAs can also send potentially confusing or contradictory normative messages to young people. In other words, some PSAs may run the risk of propagating misconceptions that some socially adverse activities are actually widespread, thereby harming their prosocial persuasive intent (Cialdini, 2003). In general, poorly conceived PSA campaigns can be ineffective, can have a boomerang effect (Michael Slater, 2006), and can even exacerbate some of the issues PSAs attempt to address (Ti, Fast, Small, & Kerr, 2017). For example, PSAs that contained stigmatized portrayals of people with eating disorders actually resulted in a greater feeling of contempt towards people suffering from eating disorders (Iles, Atwell, & Waks, 2016). The above studies indicate that if the construction and dissemination of PSAs are not carefully considered then they can end up being a costly and counterproductive mistake.

Traditionally, PSAs have primarily used communication mediums such as print advertisements, billboards, and television advertisements. Over the past decade, there has been a push to incorporate and harness more non-traditional or emerging mediums for the purposes of disseminating prosocial messages (Grow & Christopher, 2008). For example, there has been a growing interest in using new media platforms such as YouTube for PSA purposes (Paek et al., 2011; Walther, DeAndrea, Kim, & Anthony, 2010). However, while these new mediums show promise, the transition from a traditional media environment to a modern multi-media landscape can be challenging. For instance, the creation of PSAs for YouTube can incite ethical concerns if they are made to look user-generated, which can also backfire resulting in prosocial message resistance (Paek et al., 2011). Furthermore, negative user comments on YouTube PSAs have been shown to negatively impact the evaluation of PSAs themselves (Walther et al., 2010). Given that social media platforms might not provide an ideal vehicle for PSAs, I propose that we continue to explore new ways to disseminate prosocial messages. In particular, I propose that we attempt to harness the affordances of our modern media landscape in new ways and with the new mediums such as VR.

Research indicates that recently released consumer-grade VR may provide an effective means of engaging the public via public service experiences (PSEs)(Ball, 2018). Studies show that environmental VR applications, both tailor-made and commercially available, can have a positive impact on a wide range of pro-environmental perceptions, attitudes, and behavioral intentions (Ahn et al., 2014; Ahn et al., 2016; Ball, 2018). For instance, pro-environmental VR experiences, such as PSEs, have been shown to increase participant's involvement with nature, the perception of environmental risk, pro-environmental behavioral intentions, and environmental efficacy (Ahn et al., 2014; Ahn et al., 2016; Ball, 2018). Furthermore, these studies have begun to explore potential theoretical frameworks which help to increase our understanding of the mechanisms behind the positive effects of PSEs. Specifically, the immersive features of PSEs appear to have an indirect effect on pro-environmental variables based on the mediating roles of key theoretical constructs such as spatial presence and narrative engagement (Ball, 2018). However, while the results of these studies are promising, there are still questions remaining regarding the theoretical concepts behind the effects of PSEs.

The present study seeks to build and expand upon the PSE literature by continuing to explore possible mechanisms and their relation to one another which may deepen our understanding of PSE effects. Furthermore, this study seeks to fill a particular gap in the literature related to gradient manipulations of immersive factors. Many studies related to technological immersion only compare “high vs low” conditions, ignoring potentially important and subtle differences in immersive factors (Cummings et al., 2012). The results should provide substantial contributions to the literature surrounding VR effects, environmental communication, PSEs, technological immersion, narrative persuasion, and spatial presence.

CHAPTER 2: LITERATURE REVIEW

Before delving into the literature surrounding the research design of this study I must first define the technology at the core of this study, VR. VR can be considered a medium such as television, which can be conceptualized via its attributes (such as goggles) or VR can be considered a perceptual process based on people's sense of presence (Steuer, 1992). In this study, VR is defined as "a high-end user-computer interface that involves real-time simulation and interactions through multiple sensorial channels" (Burdea Grigore & Coiffet, 2003, p. 2). In terms of VR's key characteristics, VR creates simulations via computer graphics that respond to user's actions and inputs (Burdea Grigore & Coiffet, 2003). Therefore, one of the key elements of VR is real-time interactivity (Burdea Grigore & Coiffet, 2003). Another key functionality is transportation to virtual/simulated worlds. In other words, a primary goal of VR is to transport users to places and environments that are not easily or normally experienced (Latta & Oberg, 1994). Now with a basic conceptualization of VR, I will briefly examine the historical origins of VR. Please see Table 1 at the end of this chapter for a full list of the conceptual definitions used in this study.

2.1. Virtual Reality: A Brief History

With the recent release of modern consumer-grade VR technology, such as the HTC Vive and Oculus Rift, there has been a resurgence of interest in VR applications and effects. However, VR technology has existed in some form or fashion for decades and perhaps even millennia. Some scholars posit that humans have been crafting "virtual environments" since prehistoric times. For example, the ancient cave paintings found in Lascaux, France date back approximately 17,000 years and historians believe that these caves served as media theaters that engaged all of the peoples' senses while performing rituals (Packer & Jordan, 2002). The creation of such multimedia environments which are designed to surround and immerse participants is not too unlike the Cave Automatic Virtual Environment (CAVE) systems that would be developed thousands of years later. The CAVE system creates a VR via projection-based technology in which the 3D virtual environment is projected onto the four walls of a room (Creagh, 2003). The above example demonstrates that though the technologies we use have changed and evolved over time, humans have always had an interest in expressing themselves via the crafting of multi-sensory virtual experiences (Packer & Jordan, 2002).

However, the history of modern VR as it is currently conceptualized in this study does not date back quite as far. The origins of modern VR can be traced back approximately 50 years to the early 1960s when a cinematographer named Morton Heilig invented and patented his "Sensorama Simulator" which would later become recognized as the first VR arcade experience (Burdea Grigore & Coiffet, 2003; Heilig, 1962). Heilig's goal was to create a "cinema of the future" in which people would be surrounded by reproductions of life that were so convincing that people would feel like they were transported to another world (Packer & Jordan, 2002). The sensorama arcade was a revolutionary invention which combined 3D color video, stereo sound, and even smells, wind effects, and vibrations as the machine simulated riding a motorcycle (Burdea Grigore & Coiffet, 2003). Heilig would continue to pioneer modern VR technology by imagining and patenting a head-mounted television screen (Burdea Grigore & Coiffet, 2003). The mask-like head-mounted display (HMD) that Heilig envisioned looks remarkably similar to the modern VR "goggles" of today (see Figure 1 below).

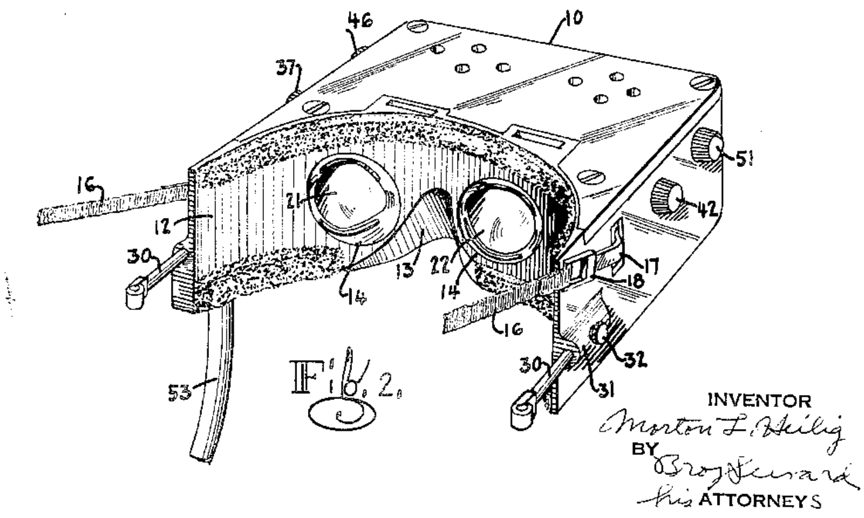

Figure 1: Patent Picture of Heilig HMD (Sutherland, 1960)

Unfortunately, Heilig was never able to complete his vision of a functional HMD. However, his work would go on to serve as inspiration for other pioneers in the field of VR. In 1966, Ivan Sutherland would take steps towards realizing Heilig's vision by creating the first HMD which used two cathode ray tubes (CRTs) mounted in front of each eye (Burdea Grigore & Coiffet, 2003). He wanted to create "the ultimate display" which could present new realities via his new technological "looking-glass" (Sutherland, 1965). He would also become a pioneer behind the software development that would lead to the creation of digital worlds. Sutherland created the software known as Sketchpad, which was the first interactive graphics software (Packer & Jordan, 2002). The creation of Sketchpad marked a shift in VR thinking from capturing real-world scenes/images towards generating digital computer graphics instead (Burdea Grigore & Coiffet, 2003). In the end, the early work of both Heilig and Sutherland would lay the foundation for modern VR.

Around the 1970s and 1980s, various industries and agencies became interested in the potential of VR which further spurred its design and development. In particular, the National Aeronautics and Space Agency (NASA) became interested in the potential of computer-based simulators to help train astronauts (Burdea Grigore & Coiffet, 2003). While working at the NASA-Ames Research Center, Scott Fisher helped to create the Virtual Interface Environment Workstation (VIEW) which consisted of a HMD with two LCD screens, a microphone, earphones, head tracking, and gesture tracking gloves (Packer & Jordan, 2002). The VIEW system shares many features that have since become standard for modern consumer-grade VR systems. Later, Fisher predicted that such new technologies would give rise to immersive environments which would give rise to new forms of interactive and participatory storytelling (Fisher, McGreevy, Humphries, & Robinett, 1987; Packer & Jordan, 2002).

2.2. Virtual Reality: Applications and Effects

So why might modern consumer-grade VR technologies provide an effective and largely untapped avenue to disseminate prosocial messages such as PSEs? Furthermore, why might PSEs be more effective than traditional PSAs? In order to begin to answer these questions, I will review some of the previous VR research with a particular focus on VR effects across contexts and disciplines. With a better understanding of how VR has been used effectively in the past, we may be able to more accurately predict its potential impacts in the context of future PSEs.

VR technology has been used in a multitude of contexts and across numerous disciplines for quite some time. For example, VR has been used to train doctors to perform complex surgeries and help military personnel develop stress resilience prior to being deployed (Gurusamy, Aggarwal, Palanivelu, & Davidson, 2008; Rizzo et al., 2011; Seymour, 2008). In particular, VR has been applied to clinical settings to help patients with various ailments, both physical and psychological, for many years. For example, VR has been used successfully to help patients during stroke rehabilitation treatment (Henderson, Korner-Bitensky, & Levin, 2007). In fact, many studies found that VR therapy was actually more effective than traditional and conventional rehabilitation techniques (Henderson et al., 2007; Laver, George, Thomas, Deutsch, & Crotty, 2012). VR has also been used to help distract patients in hospital settings from the pain associated with changing dressings, pain from burn treatments, and pain-related anxiety (Malloy & Milling, 2010; Morris, Louw, & Grimmer-Somers, 2009). Studies related to VR pain distraction indicate that more immersive and advanced VR technologies result in the greatest pain relief (Malloy & Milling, 2010). Therefore, immersion (i.e., a technology's ability to shut-out physical reality) appears to be an important mechanism related to VR effects because of its ability to captivate participants inside of a new engaging reality (Cummings et al., 2012; Mel Slater & Wilbur, 1997).

VR technology has also been harnessed to help treat mental health problems for many years. For instance, VR based therapy has been used successfully to treat a wide range of mental health issues, such as panic disorders, post-traumatic stress disorders, and body image disorders (Gregg & Tarrier, 2007). In fact, in some cases VR treatment was found to be effective with fewer treatment sessions, thereby making it more financially viable than more costly traditional methods (Gregg & Tarrier, 2007). VR has also been used frequently to treat various kinds of phobias. VR exposure therapy (VRET) has been used to effectively treat fears associated with heights, flying, and spiders (Krijn et al., 2004; Morina, Ijntema, Meyerbröker, & Emmelkamp, 2015). VRET has also been shown to actually result in real-world behavioral change in patients related to their phobias, which indicates that VR experiences can influence future real-world behaviors (Morina et al., 2015). Furthermore, the concept of "presence" (i.e., the feeling of “being there” virtually) has also been found to be particularly important in VR treatment but further research is still required to understand its effect on various outcomes of interest (Botella Arbona, Fernández-Álvarez, Guillén Botella, García-Palacios, & Baños Rivera, 2017).

So how do VR interventions have so many positive effects across various contexts and outcomes? There are a number of neurological and theoretical explanations that help us to better understand the mechanisms behind VR effects. For example, the concept of presence is a cognitive process which helps people apply their reasoning skills in a virtual environment to better understand both physical and social causation (Lee, 2004). In other words, when people are mentally situated in an immersive virtual environment they are better able to learn and reason in a natural manner. Likewise, immersive technologies such as VR encourage people to focus more of the attentional resources to the virtual environment by shutting out the real world (Hofer, Wirth, Kuehne, Schramm, & Sacau, 2012; Mel Slater & Wilbur, 1997; Wirth et al., 2007). Immersive VR also allows for more stimuli/cues from the media content/environment which allows for a high degree of information exchange (Mel Slater & Wilbur, 1997). Therefore, VR provides a unique media context in which people are more focused on the media content (i.e., mediated environment), which can contain substantial and varied information, while also engaging their cognitive processes more fully.

With the resurgence of interest in VR, researchers have begun to explore its enormous potential to increase interest and empathy for conservational issues (McMillan, Flood, & Glaeser, 2017). Recently, VR has been explored as a means to influence peoples’ pro-environmental attitudes and behavioral intentions. For instance, one study allowed participants to embody animals in various contexts, such as cows before being loaded onto trucks for slaughter and pieces of coral reef that were being destroyed by ocean acidification (Ahn et al., 2016).

Embodying animals in immersive VR environments resulted in participants reporting greater feelings of connection to nature, involvement with nature, and awareness of environmental risk compared to a video condition (Ahn et al., 2016). Furthermore, VR based experiences related to environmental conservation have also been shown to influence behavioral intentions and even behavior.

Specifically, one recent PSE study found that a short ocean-related VR experience had an impact on participants' support for conservation policies and activism intentions via the mediating roles of spatial presence (i.e., the feeling of being in a virtual environment with the ability to act) and narrative engagement (i.e., being mentally and emotionally engaged with the content of the experience)(Ball, 2018). That study also found that participants in the immersive VR condition reported greater levels of spatial presence and narrative engagement than those that watched a video (Ball, 2018). Another study found that the act of cutting down a virtual tree in VR had a greater impact on paper conservation behaviors than watching a film or reading about the tree cutting process (Ahn et al., 2014). Furthermore, the effects of many of the pro-environmental VR experiences mentioned above have been shown to last up to 1 week after exposure (Ahn et al., 2014; Ball, 2018). Therefore, the above research indicates that VR may provide a viable and effective avenue for pro-environmental message dissemination but further research is needed.

2.3. Technological Immersion: A Pathway to New Realities

Immersion is a concept which has been examined across numerous contexts, technologies, and outcomes. Definitions, conceptualizations, and types of immersion can vary by study which can sometimes lead to confusion. In this study, immersion is conceptualized as a quantifiable attribute of technology, otherwise known as technological immersion (Mel Slater, Linakis, Usoh, Kooper, & Street, 1996). In general, a specific technology is more or less immersive based on its capacity to shut out "physical reality" and present the user with a "virtual reality" (Cummings et al., 2012; Mel Slater & Wilbur, 1997). The term immersion is sometimes used synonymously with other conceptually similar concepts such as "presence," which has been generally defined as a sense of "being there" in a virtual environment (Brown & Cairns, 2004; Jennett et al., 2008; Lee, 2004). For instance, immersion can also be conceptualized as a human tendency/characteristic which naturally varies from person to person (Hou, Nam, Peng, & Lee, 2012). In other words, people can naturally differ regarding how easily they feel "immersed" when experiencing mediated environments, much like feelings of presence.

However, in the present study, technological immersion is distinguished from presence and immersive tendency by adhering to the perspective that immersion is a quantifiable attribute of a technology while presence and immersive tendency are attributes of a person's psychology (i.e., an individual attribute that is intrinsic to people)(Hou et al., 2012; Mel Slater & Wilbur, 1997). In other words, technological immersion is inherently an aspect of technological systems while presence is an aspect of users' consciousness (Cummings et al., 2012; Mel Slater et al., 1996). Contextualized to VR, immersion refers to an objective level of sensory fidelity provided by the HMD and other associated technologies, such as motion controls, while presence refers to a subjective psychological response to the VR experience itself (Bowman & McMahan, 2007; Mel Slater, 2003).

Technological immersion itself has been conceptualized in a number of ways. In general, media technologies such as television or VR naturally vary in their ability to immerse users based on several important technological factors and attributes (Bowman & McMahan, 2007; Cummings et al., 2012; Mel Slater & Wilbur, 1997). First, technologies with the capability to present users with high fidelity simulations via multiple sensory modalities will be more immersive than those with fewer sensory modalities. For instance, modern consumer-grade VR has the capability to present users with 3D stereoscopic vision, high definition images, a wide field-of-view, and surround sound audio (Hou et al., 2012; McMahan, Gorton, Gresock, McConnell, & Bowman, 2006). Therefore, VR would be quantifiably more immersive than other media technologies such as televisions which typically do not offer 3D stereoscopic vision and offer a limited field-of-view.

Second, technologies that have the capability to map users' natural/physical movements/actions and translate them to into natural actions in virtual environments will be more immersive than those with more obtuse or unintuitive action inputs. For example, modern consumer-grade VR has the capability to map users' actions directly into the virtual environment via various sensors and motion-based controllers, which makes VR inputs more immersive than other typical computer or game console inputs such as game controllers or keyboards (Huang, 2017). Finally, technologies that have the capability to transport users to virtual environments via self-contained narratives will be more immersive than those that lack this capability. For instance, modern consumer-grade VR has the capability to create self-contained narratives in which the users can actually participate/interact with the story, thus removing themselves from reality while traditional media technologies such as television do not typically allow for viewer participation in narrative experiences (Gorini, Capideville, De Leo, Mantovani, & Riva, 2011; Ryan, 2001).

Technological immersion has also been conceptualized as a technology's capability to be inclusive, extensive, vivid, matching, and surrounding (Mel Slater et al., 1996). Inclusive technologies effectively shut out the sensory data from the real world. VR technologies achieve inclusion via the HMDs ability to shut out the real world. Extensive technologies have multiple sensory modalities to more accurately mimic the real world. VR is extensive because it allows for visual, auditory, and haptic feedback. Vivid technologies have the capability to transmit a variety of rich sensory information. VR is vivid because most HMDs contain high-definition displays. Matching technologies more accurately sync users' actions with the virtual environment. VR has a high level of matching via room-scale sensors and motion controls which accurately match users' hand, head, and body movements within the virtual environment. Surrounding technologies have the capability to mimic sensory information from multiple directions (Mel Slater et al., 1996). VR is able to surround participants via surround sound functionality as well as directional head-tracking capabilities.

Based on all of the technological attributes and factors detailed above, it stands to reason that VR should deliver a more immersive experience to users than other traditional media technologies that are typically used to deliver PSA messages, such as televisions or computers. VR is considered by participants to be more immersive than a high-definition display (Ball, 2018). Furthermore, research has demonstrated that immersion level can have an impact on other important variables such as presence (Ball, 2018; Cummings et al., 2012; McMahan, Bowman, Zielinski, & Brady, 2012). Immersion has also been linked to more captivating and engaging narrative experiences (Ball, 2018; Gorini et al., 2011). Metaphorically, the immersive difference of VR and traditional media, such as television, has been likened to the difference of looking through the window of a glass bottom boat and scuba diving into the ocean (Dede, 1995; Wilson, 1996).

Immersion has been linked positively to pro-environmental PSE outcomes such as connection to nature, environmental risk awareness, conservation behaviors, and activism intentions (Ahn et al., 2014; Ahn et al., 2016; Ball, 2018). However, while the above findings are promising, there still exists a gap in the literature. Subtle differences in technologies, such as screen size, can influence participants' mood, sense of presence, and even impression of media such as games (Hou et al., 2012; Kim & Sundar, 2013). Furthermore, studies have indicated that particular immersive features like user-tracking are more important than other features like surround sound (Cummings & Bailenson, 2016). However, few studies have yet to examine potentially important "fine gradients of immersion" as they relate to immersive technologies such as VR (Cummings et al., 2012, p. 2). In other words, most experiments examine immersion as a binary (i.e., High vs Low). While such studies still provide important contributions to the literature, they may miss the potentially important impacts of granular differences in immersive features, such as levels of naturally mapped movement or narrative interactivity (Cummings et al., 2012). Therefore, the present research attempts to isolate and explore the impacts of subtle differences in immersive factors, such as natural mapping, in order to draw more precise conclusions regarding the nature of VR effects (Ball, 2018; Cummings et al., 2012).

2.4. Natural Mapping: Importance of Movement Naturalness

One of the largest challenges facing immersive VR experiences is simply designing natural methods for moving within virtual environments that mesh with the constraints of our everyday reality. In essence, virtual worlds have the capability to be limitless in size and scope; however, the spaces in which we use VR, such as workspaces, are not (Multon & Olivier, 2013; Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013). For example, a player may find themselves in a virtual field that stretches for miles in all directions but they may only be able to walk a few feet in their actual room before bumping into a wall or desk. As a result, researchers, designers, and developers have been searching for effective means to remedy this problem via the technologies such as treadmills (Nilsson, Serafin, Laursen, et al., 2013). For example, the Virtuix Omni is a 360-degree treadmill that allows users to walk or run in any direction without injury (Virtuix, 2017). While promising, treadmill options such as the Virtuix Omni are currently cost prohibitive and still require a significant space commitment (Nilsson, Serafin, Laursen, et al., 2013). A more cost-effective and practical solution may come from the natural mapping literature.

The concept of natural mapping dates back more than 30 years when Norman originally proposed the idea that systems should be designed to harness the immediate understanding that can originate from physical analogies and cultural knowledge (Norman, 1988; Skalski, Tamborini, Shelton, Buncher, & Lindmark, 2011). At the time, Norman was not talking about the relationship between people’s actions in the real world and their subsequent actions in a virtual world (Nilsson, Serafin, & Nordahl, 2013). Rather, early natural mapping was more concerned with designing objects to be more intuitive to use, such as stovetop dials that match up with the position of the burners so that people would immediately understand which dial controlled each burner (Norman, 1988). The concept of natural mapping would later be effectively applied to the study of human-computer interaction.

While definitions of natural mapping vary, in the context of VR, natural mapping is “the ability of a system to map its controls to changes in the mediated environment in a natural and predictable manner” (Steuer, 1992, p. 47). In essence, a “natural” action in a virtual environment is one that is intuitive, predictable, and lines up with the user’s expectations (Skalski et al., 2011). With the above conceptualizations in mind, “naturalness” is a psychological state which originates from both technological affordances and individual differences (Skalski et al., 2011). In other words, the technology must provide a means of achieving a natural input (such as motion controllers) but people possess different kinds of experience which can influence how "natural" a particular technology or action might be. In the context of digital experiences such as VR and video games, achieving a level of controller or movement naturalness is particularly relevant for the formation of spatial presence.

Natural mapping is linked to spatial presence via mental models. Mental models are mental representations of situations that can exist in both the real world or in the virtual world and they can involve relationships between entities and events (Roskos-Ewoldsen, Roskos-Ewoldsen, & Carpentier, 2002). Mental models can form from real and mediated experiences, such as those found in video games or VR (Skalski et al., 2011). Naturally mapped controls in video games can help users match their real world and virtual world mental models (Huang, 2017; Skalski et al., 2011). Naturally mapped controls thereby result in greater feelings of presence because their real-world mental models are more easily applied, thereby reducing their need to focus on complicated controller inputs (Tamborini & Skalski, 2006). In essence, when using naturally mapped controls users are able to focus more of their attention on the virtual environment rather than on the controls (Huang, 2017).

A sizable amount of research has explored the relationship between perceived controller naturalness in the context of video game play and spatial presence across many different genres and controller types (Huang, 2017; Kim & Sundar, 2013; McGloin, Farrar, & Fishlock, 2015; Schmierbach, Limperos, & Woolley, 2012; Skalski et al., 2011; Tamborini & Bowman, 2010; Williams, 2014). However, there are far fewer studies that have examined movement/locomotion naturalness in the context of VR experiences (i.e., Dannatt, Barlow, & Lakshika, 2016; Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013). Specifically, one study found that traditional "walking-in-place" movement methods were actually not as natural as other methods such as “arm-swinging” (Nilsson, Serafin, Laursen, et al., 2013). In fact, this study found that “arm-swinging” was actually one of the most natural movement methods (Nilsson, Serafin, & Nordahl, 2013). As a result, there is a large gap in the literature related to modern and emerging naturally mapped locomotion techniques that are currently being employed by VR game designers and their effects on spatial presence. Specifically, there are three means of VR movement that are currently being employed.

First, many VR experiences have been designed with traditional video game controls involving a gamepad while seated or standing. The use of a gamepad for movement is considered *directional mapping* in which a movement of a joystick in one direction corresponds to the movement of the virtual self (Skalski et al., 2011). Second, one of the most popular methods for VR locomotion is “teleportation.” Teleportation usually involves the player standing in the center of the room and then teleporting to different areas in the virtual environment using gestural and motion controls. Teleportation would be considered *incomplete natural mapping* as it involves a partial simulation of natural actions such as standing and pointing (Skalski et al., 2011). Finally, another recent method of VR locomotion involves simulated walking movements, particularly arm swinging. Arm swinging locomotion involves the user swinging their arms back in forth like they are walking and it has been shown to be both natural and closer to real walking than actually walking in place (Nilsson, Serafin, & Nordahl, 2013). Arm swinging would be considered *realistic natural mapping* because it is the closest to actually walking compared to the above movement methods (Nilsson, Serafin, & Nordahl, 2013; Skalski et al., 2011).

The present study seeks to examine how these three naturally mapped movement techniques, which are largely unique to VR, influence the formation of spatial presence and subsequently impact the potentially persuasive impact of PSEs. Furthermore, this study makes a contribution to the literature by examining the concept of natural mapping from two distinct perspectives. First, this study attempts to establish which form of natural locomotion in VR is considered to be the most "natural" by participants. In other words, which form of locomotion is the most similar to walking in real life (Nilsson, Serafin, & Nordahl, 2013). Second, this study attempts to establish which form of natural locomotion in VR is considered to be the most predictable or intuitive (Skalski et al., 2011; Steuer, 1992). By examining these two dimensions of naturally mapped locomotion separately, we can gain a better nuanced understanding of their importance in the formation of spatial presence and their potential impact on the efficacy of PSEs.

H1: Participants' perceived natural mapping will be positively associated with participants' reported feelings of spatial presence.

2.5. Spatial Presence: Present in Nature

Another important factor that has been shown to be significant when examining PSE effects is the concept of presence (Ahn et al., 2016; Ball, 2018). The presence literature has been growing and developing for decades, resulting in many variations and definitions of presence (Lee, 2004). For instance, virtual presence relates to the feeling of "being there" or simply feeling present in a virtual environment (Sheridan, 1992). Meanwhile, social presence is more specific as it relates to the feeling of "being there" with other people in virtual environments (Biocca, 1997; Biocca & Harms, 2002; Heeter, 1992). Likewise, physical presence specifically relates to the feeling of being physically located in a virtual environment (Biocca, 1997). As indicated by the above conceptualizations, the basic idea at the core of the presence concept is the feeling of "being there" when using various kinds of technologies (Heeter, 1992; IJsselsteijn, de Ridder, Freeman, & Avons, 2000; Sheridan, 1992). Broadly speaking, the concept of presence has been defined as the “illusion that a mediated experience is not mediated” (Lombard & Ditton, 1997, p. 1).

In this study, I am particularly interested in the concept of spatial presence as it relates to immersive PSE effects. In the present study, spatial presence is conceptualized as the feeling that an individual’s body is occupying the virtual environment and their physical actions are in sync with the virtual experience (Ahn et al., 2016; Ball, 2018; Hartmann et al., 2016; Lombard & Ditton, 1997). In other words, people feel spatially present when they feel like their body and actions have been successfully transported and translated into a virtual environment. While spatial presence may appear conceptually similar to immersion, it is important to once again emphasize their conceptual distinctions. Spatial presence does not account for immersive attributes of technologies; instead, spatial presence captures users’ subjective/psychological experiences while using technologies (Cummings et al., 2012; Mel Slater et al., 1996). While technologies such as VR can be designed to deliver particular kinds of experiences (Heeter, 2003) the feeling of being spatially present is a subjective experience instead of a quantifiable attribute of technology (Mel Slater & Wilbur, 1997).

The above definition indicates that spatial presence is a two-dimensional construct which accounts for two distinct aspects of peoples’ virtual experiences. Specifically, the two dimensions of spatial presence are “self-location” and “possible actions” (Hartmann et al., 2016; Hofer et al., 2012; Wirth et al., 2007). In line with other conceptualizations of presence, self-location refers to the feeling of “being there” in a virtual or mediated environment. The dimension of “possible actions” refers to the feeling that a person is able to carry out actions within a virtual or mediated environment. The combination of feeling located in a virtual environment with the ability to act leads to increased levels of spatial presence.

The concept of spatial presence has been used effectively in both the fields of psychology (Blascovich et al., 2002; Wirth et al., 2007) and communication sciences (Lee, 2004). Over the years spatial presence has been explored across various contexts while examining numerous outcomes of interest such as media enjoyment. In particular, numerous studies have explored the effects of various controllers on the formation of spatial presence. For example, one study manipulated controller interactivity (i.e., natural mapping) and found that spatial presence was a significant predictor of video game enjoyment (Shafer, Carbonara, & Popova, 2011). Likewise, another study also manipulated controller naturalness, which was found to impact spatial presence which then impacted enjoyment of a video game (McGloin, Farrar, & Krcmar, 2011). Yet another study manipulated the level of haptic feedback of a controller and found that presence impacted the effectiveness of a vehicle-based advergame (i.e., a video game with advertisement elements) (Jin, 2010). Based on the above findings, I again posit that those in the naturally mapped controller condition will report greater levels of spatial presence.

In general, VR related immersive experiences have been linked to increased levels of presence when compared to more traditional media technologies such as television (Cummings et al., 2012; Li, Daugherty, & Biocca, 2001, 2002; North & North, 2016). Most importantly for the present study, spatial presence has been found to be an important factor in the examination of pro-environmental PSE effects (Ahn et al., 2016; Ball, 2018). For instance, one study examined the effects of custom created pro-environmental VR experiences that used advanced VR laboratory equipment such as a floor equipped with haptic floor vibrations (Ahn et al., 2016). The study found that after exposure participants' feelings of involvement with nature increased via spatial presence (Ahn et al., 2016). Another study examined the effects of consumer-grade VR and a commercial-off-the-shelf PSE experience (Ball, 2018). The study found that the PSE had an effect on participants' environmental attitudes and behavioral intentions via the mediating role of spatial presence and narrative engagement (Ball, 2018). Based on the above findings, I posit that spatial presence will mediate any relationship between the immersive VR experience and environmental attitudes and behavioral intentions.

H2: Spatial presence will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.

H3: Spatial presence will mediate the relationship between perceived natural mapping and participants' (a) environmental attitudes and (b) behavioral intentions.

The present study builds off of and adds to the above literature in some important ways. First, few studies have examined the effects of pro-environmental experiences in VR (Ahn et al., 2014; Ahn et al., 2016). Fewer studies have examined the effects of recently released commercially available VR equipment and software (Ball, 2018). Therefore, there is still a need to explore pro-environmental VR effects using commercially available VR technology and experiences. Second, while there has been research on the effects of natural mapped input mechanisms on various gaming outcomes (McGloin et al., 2011; Shafer et al., 2011), there has been little to no research conducted on new and emerging controller/movement techniques on spatial presence formation in the context of VR. Therefore, there is a need to explore how modern VR input techniques affect feelings of spatial presence, which may have a subsequent effect on environmental attitudes and behavioral intentions. Finally, research also indicates that narrative in the context of persuasion and interactivity may play an important role in the formation of spatial presence and VR effects, but the results are mixed (Balakrishnan & Sundar, 2011; Ball, 2018). Therefore, there is also a need to continue to explore the role that narrative plays in the context of VR experiences.

2.6. Narrative Persuasion: The Outcome of Change

Narrative persuasion is a concept with has been utilized across many fields ranging from advertising, health communication, and educational entertainment (Durkin & Wakefield, 2008; Escalas, 2007; Moyer-Gusé, 2008). In essence, a narrative or story is simply a symbolic representation of events (Abbott, 2002; Ryan, 2007). Narrative persuasion is a field of study which explores and examines how persuasive narratives are often processed differently by people than typical argumentative persuasive messages such as PSAs. Therefore, narrative persuasion is "any influence on beliefs, attitudes, or actions brought about by a narrative message through processes associated with narrative comprehension or engagement" (Bilandzic & Busselle, 2013, p. 201).

There are many examples of the persuasive power of narratives. The narratives contained within media such as novels and television shows have received quite a lot of attention in the literature. For instance, the book *Uncle Tom's Cabin* is credited with changing people's attitudes towards slavery before the start of the US Civil War (Strange, 2002). Furthermore, the television show *Sex and the City* was found to actually increase STD awareness and discussion among watchers (Moyer-Gusé, Chung, & Jain, 2011). While there are studies examining the impact of traditional narratives are essential, they are not the only sources of potentially persuasive narratives. Narratives can consist of a single sentence or they exist in the form of a single image (Abbott, 2002). For instance, a painting of a wrecked sailboat on a rocky coast can impart a narrative that the boat was caught in a storm and ran ashore (Bilandzic & Busselle, 2013).

There are four psychological mechanisms at the heart of narrative persuasion: 1) inhibited counterarguing, 2) increased elaboration, 3) use of mental imagery, and 4) vicarious experience (Bandura, 2004; Bilandzic & Busselle, 2013). First, traditional persuasive messages, such as

PSAs, typically engage their audiences logically or pragmatically, asking viewers to evaluate the evidence and change their attitudes or behaviors accordingly. Unfortunately, this method of persuasion can result in increased levels of counterarguing as people defend against the new information. However, by nesting a persuasive message within the context of a narrative, viewers are much more likely to absorb and understand the message in the story without the typically defensive or counter-argumentative stance. Second, viewers are much more likely to reflect upon and process a narrative via elaboration than by scrutinizing or dissecting an argument that would be found in an overtly or explicitly persuasive message. Third, viewers are also more likely to process the message or content of a narrative emotionally via imagery rather than logically and pragmatically like in a typical persuasive media message. Finally, instead of processing an argument, people can vicariously learn from a narrative which can result in strong behavioral change (Bandura, 2004; Bilandzic & Busselle, 2013). In the end, the above mechanisms work together to avoid many of the challenges associated with typical persuasive messages such as PSAs.

Another important factor that leads to narrative persuasion is narrative engagement or transportation (Appel & Richter, 2010; Busselle & Bilandzic, 2009; Murphy, Frank, Moran, & Patnoe-Woodley, 2011). Briefly, an individual is much more likely to become persuaded by a narrative (i.e., have their attitudes, beliefs, and behaviors changed) if the person is deeply engaged or involved with the narrative (Green & Jenkins, 2014; Murphy et al., 2011). This link is important for the current study because immersive virtual experiences (such as VR), can result in increased narrative engagement/immersion/transportation (Gorini et al., 2011; Sundar, Oh, Kang, & Sreenivasan, 2013). Broadly, narrative transportation refers to a psychological state of becoming cognitively and emotionally immersed into a narrative (Green & Jenkins, 2014). More specifically, narrative transportation is a mental process which involves the integration of attention, imagery, and emotions (Green & Brock, 2000). In essence, the greater the level of narrative transportation within VR (an inherently rich modality), should facilitate narrative persuasion (Gorini et al., 2011; Sundar et al., 2013). For instance, VR has been used effectively to impact peoples' emotions and attitudes towards fire safety (Chittaro & Zangrando, 2010). More importantly, a previous study examining the persuasive impact of a VR based PSE found that being in the VR condition resulted in greater feelings of narrative engagement, which subsequently impacted environmental attitudes and behavioral intentions (Ball, 2018).

However, while promising, empirically validated mechanisms related to narrative persuasion and spatial presence have not yet been systematically applied to practice (Sundar et al., 2013). Furthermore, in the past the relationship between narrative transportation and spatial presence has sometimes been found to be counterintuitive (Balakrishnan & Sundar, 2011), indicating a need for further research regarding the relationship between these variables. The present study seeks to examine all of the above constructs of interest, and their potential relationships with one another, in order to arrive at both practical and theoretical insights that can help to inform the creation of future PSEs. Therefore, the following section will review the literature related to narrative interactivity, which is a potential antecedent of narrative transportation and persuasion.

2.7. Narrative Interactivity: First Step Toward Persuasion

Research indicates that many aspects of narratives may help to predict and understand the potential effects of PSEs in the context of VR experiences. In particular, over the course of the following sections, I will explore how the concepts of narrative interactivity and narrative transportation may influence the ability of the narratives to persuade participants in the context of PSEs. Narrative interactivity is a fundamental element which should facilitate narrative transportation (Green, Brock, & Kaufman, 2004). Narrative transportation should, in turn, facilitate narrative persuasion (Appel & Richter, 2010; Murphy et al., 2011).

I will begin by examining the importance and impact of narrative interactivity. Traditional narratives such as those contained within books or movies are largely passive experiences in which the viewer simply consumes the narrative content. However, modern narratives such as those contained within video games and VR are largely interactive experiences in which the player participates with the content. Metaphorically speaking, in traditional mediums the person is a narrative passenger while in modern mediums the person is the narrative driver (Green & Jenkins, 2014).

The concept of interactivity has been used across various fields with varying definitions, which has led to conceptual confusion. Defining interactivity can be complicated due to the fact that the kind of interactivity can differ depending on the medium being examined (Green & Jenkins, 2014). For instance, the kind of interactivity associated with reading a book (i.e., reading the words and turning the pages) is very different from the kind of interactivity associated with playing a video game (i.e., controlling a character and progressing the story). As a result, some studies examine interactivity as an attribute of a technology while others examine interactivity as an attribute of content (Green & Jenkins, 2014; Sundar, Kalyanaraman, & Brown, 2003). One of the contributions of this study is to explore the effects of both conceptualizations of interactivity, both as an aspect of technology and content. Specifically, this study seeks to manipulate interactivity from a technical level by allowing some participants to manipulate the virtual environment and from a content level by exploring participants' subsequent perceived impact on the narrative of their VR experience.

In the context of VR and in this study, interactivity itself is defined as “the extent to which users can participate in modifying the form and content of a mediated environment in real time” (Steuer, 1992, p. 14). In this case, interactivity is an affordance of technology and not the user because the technology itself is what allows for user input (Sundar, 2004). However, this conceptualization leaves out the potentially important component of narrative content interactivity. Therefore, the above definition is modified to accommodate narrative interactivity as “the extent to which users can participate in modifying the form and content of a mediated environment, *in the context of a narrative*, in real time.” This new definition captures both the way the reader engages with the narrative (a technological affordance) and their impact on the story itself (a content component) (Green & Jenkins, 2014).

Narrative interactivity is important because it has strong potential for changing peoples’ attitudes and behaviors (Green & Jenkins, 2014). Furthermore, the high levels of interactivity provided by VR may alter persuasive processes by allowing users to physically engage with PSE messages (Ahn & Bailenson, 2011; Ahn et al., 2015). Interactivity is associated with greater audience involvement (Fortin & Dholakia, 2005), positive attitude change (Sundar et al., 2003), and health behaviors (Baranowski, Buday, Thompson, & Baranowski, 2008). More importantly, interactivity has also been linked to various pro-environmental outcomes (Ahn et al., 2014). For example, in the context of a virtual tree cutting experience, interactivity impacted both pro-environmental behavioral intentions as well as pro-environmental self-reported behavior (Ahn et al., 2015). Furthermore, as mentioned previously, narrative interactivity should facilitate narrative transportation (Green et al., 2004) which should in turn impact narrative persuasion (Appel & Richter, 2010; Murphy et al., 2011). Therefore, I posit that narrative interactivity will be associated with greater narrative transportation and ultimately pro-environmental persuasion.

H4: Participants' perceived narrative interactivity will be positively associated with participants' reported feelings of narrative transportation.

H5: Participants' perceived narrative interactivity will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.

2.8. Narrative Transportation: A Mechanism of Persuasion

Human life and history is full of stories (Van Laer, De Ruyter, Visconti, & Wetzels, 2013). People spend countless hours engrossed in various media and partaking in various narratives for many reasons, such as the simple fact that they make people happy (Green et al., 2004). Research indicates that while consumption of media is a pleasant pastime, it can also have a wide range of persuasive effects (Bandura, 2004; Green & Jenkins, 2014; Igartua & Frutos, 2017; Murphy et al., 2011; Quintero Johnson & Sangalang, 2017). One of the primary mechanisms behind narrative persuasion is the concept of "transportation" (Appel & Richter, 2010; Green & Brock, 2000). So what is narrative transportation?

The transportation/travel metaphor was first used by Gerrig in the context of novels (Gerrig, 1993; Van Laer et al., 2013). Gerrig wrote about how the traveler (i.e., reader) can become transported to a narrative world, away from reality, and when the traveler returns they can become "changed by the journey" (Gerrig, 1993, p. 11). Again, narrative transportation is a concept that refers to a psychological state of becoming cognitively and emotionally engaged with a narrative (Green & Jenkins, 2014). Narrative transportation is a mental process which involves the integration of attention, imagery, and emotions (Green & Brock, 2000). While definitions and conceptualizations of narrative transportation sometimes differ, there are three key features that are relatively consistent (Van Laer et al., 2013). First, narrative transportation naturally requires the consumption and processing of a narrative. Second, the receiver becomes transported via empathy and mental imagery. Third, the receiver loses track of their physical reality (Van Laer et al., 2013). The concept of narrative transportation is conceptually distinct from spatial presence because it involves both the cognitive and emotional processing of a narrative, rather than simply feeling present in a mediated environment. In other words, one can feel spatially present in a virtual environment without feeling emotionally engaged with the story that takes place within it and vise versa.

The concept of transportation is important because it can influence peoples' real-world beliefs (Green & Brock, 2000). In other words, when a person loses themselves into a story, their attitudes, beliefs, and behavioral intentions can change to reflect those found within the story (Green et al., 2008; Van Laer et al., 2013). For example, one study examined how narrative transportation could encourage positive outcomes (Murphy et al., 2011). The study found that narrative transportation was the best predictor of lymphoma knowledge, attitude, and behavior change after watching a television drama (Murphy et al., 2011). Other studies have examined how narrative transportation can discourage negative outcomes (Green & Clark, 2013). The studies found that narrative transportation was also associated with smoking attitude, belief, and behavior change after watching entertainment media (Green & Clark, 2013).

Narrative transportation is particularly relevant for the present study for a number of reasons. First, there is a need to better understand the role of narrative in VR effects and narrative transportation has been proven insightful when examining narrative effects in the context of video games (Christy & Fox, 2016). Second, there is a "narrative of use" when examining interactive media such as video games and VR experiences (Balakrishnan & Sundar, 2011). In other words, interactive media experiences, such as those provided by VR, often feature participatory narratives which unfold while the player "uses" the medium. Therefore, it is important that we seek to better understand the effects of locating a person within such interactive narratives (Balakrishnan & Sundar, 2011).

Third, narrative transportation may serve as a moderator of perceived controller naturalness and spatial presence (Carassa, Morganti, & Tirassa, 2004, 2005). Specifically, it has been proposed that being mentally situated (i.e., transported) within a narrative can enhance the impact of technology-related variables (i.e., perceived controller naturalness) on presence because each action within the context of a narrative should lead to a more grounded (i.e., present) experience in a virtual world (Balakrishnan & Sundar, 2011; Carassa et al., 2004, 2005). Fourth, narrative transportation may be particularly relevant when examining spatial presence in narrative contexts where the receiver is the protagonist, as in video games and VR experiences (Balakrishnan & Sundar, 2011). In other words, when users assume the role of a specific character, such as a protagonist rather than an observer, they may become more inclined to become transported within a narrative and to feel subsequently present in the virtual environment.

Finally, a previous PSE study found that narrative engagement (sometimes used as a synonym for transportation) was linked to both pro-environmental attitudes and behavioral intentions (Ball, 2018). Specifically, participants that felt more engaged with a first-person narrative involving an encounter with a whale reported feeling more connected to nature with greater intentions to become a pro-environmental activist. In other words, the immersive VR experience allowed participants to focus more of their cognitive and attentional resources on the content (i.e., narrative) of the virtual experience, which in turn increased their feelings of connection with nature and desire to protect it. Therefore, I posit that those with greater levels of narrative transportation will report greater attitude and intention changes (i.e., narrative persuasion).

H6: Narrative transportation will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.

H7: Narrative transportation will moderate the relationship between perceived controller naturalness and spatial presence.

H8: Narrative transportation will partially mediate the relationship between narrative interactivity and participants' (a) environmental attitudes and (b) behavioral intentions.

2.9. Spreading Activation Theory: Cross-pollination of Environmental Effects?

A final area of interest for the present study is the exploration of associated effects across environmental conditions in VR. In other words, this study attempts to answer the question, do environmental attitudes formed in one kind of VR environment (i.e., the savannah) have a subsequent effect on participants' attitudes regarding other potentially associated environments (i.e., the ocean)? Specific pro-environmental experiences, such as being a piece of coral in VR can have an effect on general environmental attitudes and associated behaviors (Ahn et al., 2014; Ahn et al., 2016). Furthermore, one study found that a specific pro-environmental experience which involved meeting a whale in the ocean had a subsequent effect on general environmental attitudes and behavioral intentions as well as specific attitudes related to the ocean conservation specifically (Ball, 2018). However, to my knowledge, there are currently no studies that examine if the attitudinal effects of a specific PSE environment/experience might transfer to other potentially related/associated environments.

In order to inform this research question, I draw upon the spreading activation theory of memory. The spreading activation theory actually has its origins in the early human-computer interaction design of the 1960s (Quillian, 1962). The theoretical core at the center of spreading activation theory was the idea that while searching our memory for information, intersections are also found along other conceptual nodes (Quillian, 1962). Over the years, the conceptual core at the center of spreading activation theory would later be revised and expanded outside of just human-computer interaction (Anderson, 1983; Collins & Loftus, 1975).

In essence, modern spreading activation theory posits that information, attitudes, beliefs, etc. are stored within a person's memory as nodes in a vast neural network of related information (Collins & Loftus, 1975). Priming certain concepts can then activate other related concepts (Collins & Loftus, 1975). Therefore, when a person develops an attitude or belief about a specific concept through an experience, it may then become intertwined with other related concepts (Anderson, 1983; Bohner & Dickel, 2011). For example, one study examined the impact of priming certain negative and positive attributes in the context of various video games (Peña, Hancock, & Merola, 2009). In the study, researchers found that priming certain negative characteristics such avatars dressed as a KKK member would activate other related attitudes and behaviors such as aggression and lower levels of affiliation (Peña et al., 2009). Likewise, the study also found that priming certain positive characteristics such as avatars dressed as a doctor would activate related attitudes such as achievement concepts (Peña et al., 2009).

Unsurprisingly, previous research has shown that positive experiences with an attitude-object are naturally associated with positive attitudes towards said attitude-object (Nabi & Krcmar, 2004). One of the goals of PSEs is to give people positive pro-social experiences which subsequently have a positive impact on related attitudes and future behaviors. Therefore, the concept of spreading activation is important for PSE research to explore because attitude accessibility has a significant impact on subsequent behaviors (Fazio, Powell, & Williams, 1989;

Krosnick, 1989). Research is needed to investigate if PSEs have the capability to not only make positive attitudes more accessible and subsequently relevant but if they also have the capability to activate and change associated attitudes as well. With this goal in mind, the present study poses the following research question:

R1: Does exposure to an environmentally specific PSE have an impact on other associated environmental attitudes?

2.10. Hypotheses, Research Question, and Conceptual Framework

Based on the above literature, the proposed hypotheses, research question, and conceptual framework (See Figure 2) can be found below. The perception of naturally mapped controls helps users match their virtual mental models with their real mental models, thus providing users with a greater sense of presence (Huang, 2017; McGloin et al., 2011; Seibert & Shafer, 2018; Skalski et al., 2011; Tamborini & Skalski, 2006). Therefore, I predict that participants' perceived natural mapping will positively predict participants' reported feelings of spatial presence (H1). Furthermore, spatial presence has been found to predict changes in participants' environmental attitudes and behavioral intentions (Ahn et al., 2016; Ball, 2018). Therefore, I hypothesize that spatial presence will be associated with greater environmental attitudes and behavioral intentions (H2). Additionally, a study of PSE effects found that spatial presence was a mediator between immersive VR experiences and changes in participants' pro-environmental attitudes and behavioral intentions (Ball, 2018). Therefore, I hypothesize that spatial presence will serve as a mediator between perceived natural mapping and pro-environmental and behavioral intention change (H3).

Narrative interactivity is associated with positive attitude change, behaviors, and pro-environmental outcomes (Ahn et al., 2014; Baranowski et al., 2008; Sundar et al., 2003).

Therefore, I hypothesize that participants' perceived narrative interactivity will positively predict their environmental attitudes and behavioral intentions (H5). Furthermore, narrative interactivity should naturally facilitate narrative transportation (Balakrishnan & Sundar, 2011; Green et al., 2004). Therefore, participants' perceived narrative interactivity is hypothesized to positively predict their narrative transportation (H4).

Narrative transportation has also been shown to be related to changing people's attitudes and behaviors (Appel & Richter, 2010; Murphy et al., 2011). Therefore, I hypothesize that narrative transportation will be associated with more positive environmental attitudes and behavioral intentions (H6). Narrative transportation may also serve as a moderator of perceived controller naturalness and spatial presence (Balakrishnan & Sundar, 2011; Carassa et al., 2004, 2005). Given this, I predict that narrative transportation will moderate the relationship between perceived controller naturalness and spatial presence (H7). Likewise, as narrative transportation has been shown to mediate knowledge, attitudes, and behavior (Appel & Richter, 2010; Murphy et al., 2011), I hypothesize that narrative transportation will partially mediate the relationship between narrative interactivity and participants' environmental attitudes and behavioral intentions (H8). Finally, spreading activation theory posits that priming certain concepts can activate other related concepts (Collins & Loftus, 1975). Therefore, spreading activation theory provides theoretical grounds to explore the possibility that environmental attitudes formed in one kind of VR environment (i.e., the savannah) might have a subsequent effect on participants' attitudes regarding other potentially associated environments (i.e., the ocean) (R1). The eight hypotheses and one research question are summarized below.

H1: Participants' perceived natural mapping will be positively associated with participants' reported feelings of spatial presence.

H2: Spatial presence will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.

H3: Spatial presence will mediate the relationship between perceived natural mapping and participants' (a) environmental attitudes and (b) behavioral intentions.

H4: Participants' perceived narrative interactivity will be positively associated with participants' reported feelings of narrative transportation.

H5: Participants' perceived narrative interactivity will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.

H6: Narrative transportation will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.

H7: Narrative transportation will moderate the relationship between perceived controller naturalness and spatial presence.

H8: Narrative transportation will partially mediate the relationship between narrative interactivity and participants' (a) environmental attitudes and (b) behavioral intentions.

R1: Does exposure to an environmentally specific PSE have an impact on other associated environmental attitudes?

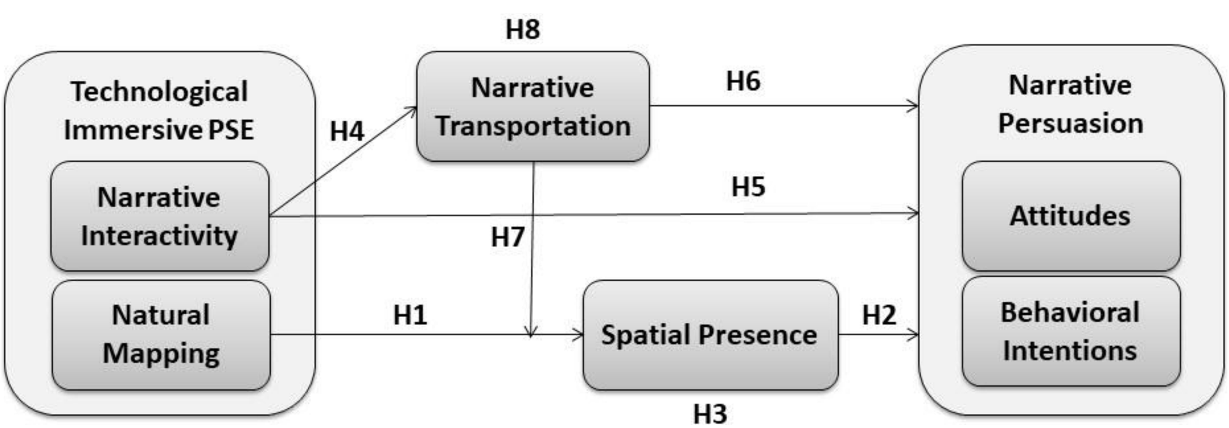

Figure 2: Conceptual Framework

Table 1: Conceptual Definitions	
Concept	Definition
Technological Immersion	A specific technology is more or less immersive based on its capacity to shut out “physical reality” and present the user with a “virtual reality” (Cummings et al., 2012; Mel Slater & Wilbur, 1997).
Natural Mapping	“The ability of a system to map its controls to changes in the mediated environment in a natural and predictable manner” (Steuer, 1992, p. 47).
Spatial Presence	The feeling that an individual’s body is occupying the virtual environment and their physical actions are in sync with the virtual experience (Ahn et al., 2016; Ball, 2018; Hartmann et al., 2016; Lombard & Ditton, 1997)
Narrative Persuasion	“Any influence on beliefs, attitudes, or actions brought about by a narrative message through processes associated with narrative comprehension or engagement” (Bilandzic & Busselle, 2013, p. 201).
Narrative Interactivity	The extent to which users can participate in modifying the form and content of a mediated environment, in the context of a narrative, in real time (Steuer, 1992).
Narrative Transportation	A psychological state of becoming cognitively and emotionally immersed into a narrative (Green & Jenkins, 2014).

CHAPTER 3: METHODOLOGY

The purpose of this study was to investigate the gradient impacts of perceived naturally mapped movement in VR on spatial presence and persuasion. Furthermore, another goal of the study was to explore the potential importance and impacts of perceived narrative interactivity on narrative transportation and persuasion. This study exposed participants to an approximately 10-minute virtual experience involving a savannah habitat, which included endangered wildlife such as elephants. Before and after the virtual experience participants were primed with a short narrative prompt to add context to their VR experience (See Appendix C for prompts). A random selection of participants were allowed to alter the environment in positive ways while others were only allowed to explore the environment. Furthermore, participants were randomly assigned to use directional locomotion controls, teleportation locomotion controls, or arm-swinging locomotion controls during their virtual experience. The experiment was a between-subjects factorial design, a 2 (high and low narrative interactivity) X 3 (low, medium, and high natural mapping) factorial design. This experimental design was selected because of it has high internal reliability; it allows for the exploration of main effects across conditions, and it also allows for the exploration of potential interaction effects among the variables of interest (Trochim, 2006).

3.1. Participants

The participants for this study consisted of 183 undergraduate college students from a large-sized Midwestern University in the United States. The age of the participants was restricted to those 18 to 30 years old to reduce for potential confounding effects caused by high variations in the age of college undergraduates. College students were the population of interest in the present study because there is a need to explore new methods of increasing their environmental awareness and political engagement (Boyle et al., 2014; Parsons et al., 2010). Specifically, college students between the ages of 18 and 30 years old were selected for two important reasons. First, college students, in particular, lack awareness regarding certain environmental issues, such as whale conservation issues (Parsons et al., 2010). As a result, there was a need for greater college student outreach regarding conservational issues in order to encourage their political engagement (Parsons et al., 2010). Second, college students with an age limit of 30 were selected because previous research indicates that traditional PSAs can be less effective for those less than 30 years of age (Boyle et al., 2014).

As mentioned above, all participants were at least 18 years of age, with a maximum age of 30 years old. Participant recruitment was accomplished via the College of Communication Arts and Sciences (CAS) SONA system. The CAS SONA system helps to connect researchers with interested participants by means of an online sign-up system. The SONA system allows researchers to attract potential participants with cash incentives or extra class credit. The participants in this study were given extra credit worth approximately 1.25% of their final grade for participating in this study.

Regarding the sample size of 183 students, previous meta-analyses found that both presence (0.5) and narrative transportation (0.44) had medium effect sizes (Cummings & Bailenson, 2016; Van Laer et al., 2013). Sample size calculations indicated that approximately 125 students would be sufficient to achieve a statistical power of at least .80 (Bausell & Li, 2002; Cohen, 1988). However, the present study contained six distinct conditions so a more robust sample size of 180 students (with a goal of 30 students per condition) was selected (Roscoe, 1975). Data were ultimately collected from 183 participants, which were reduced to a sample size of 173 usable participants after data cleaning. Furthermore, because the present study tests for both mediating and moderating relationships among certain key variables, the PROCESS path-analysis was used, which is a bootstrap capable test which further increases the power of the analysis (Fritz & MacKinnon, 2007; Hayes, 2016).

3.2. Stimulus and Materials

The selected stimulus for this study was *Nature Treks VR* (Carline, 2017). *Nature Treks VR* is a nature-based VR experience which was created for the HTC Vive and Oculus Rift. *Nature Treks VR* is an experience in which players select from a diverse selection of natural environments to explore. Players are then encouraged to freely wander the environments, "relax and immerse" themselves in nature, and interact with the various kinds of wildlife (Steam, 2017). In this study, I selected the "savannah" environment, which includes endangered animals such as elephants. See Figure 3 below for a screenshot of the savannah environment within *Nature Treks VR*.

There are a number of key reasons why *Nature Treks VR* (Carline, 2017) was selected for the present study. First, *Nature Treks VR* was a commercial-off-the-shelf experience which had a "Very Positive" review rating based on over 70 reviewers (Steam, 2017). As a result, *Nature Treks VR* may be able to provide design insights into the creation of future PSEs in order to make them more appealing and marketable to audiences. Second, *Nature Treks VR* was a rather simplistic experience which did not require extensive training or tutorials to appreciate, so it did not have many of the typical skill barriers associated with traditional VR games. Third, *Nature Treks VR* was ideal and unique because it allowed for all three of the previously mentioned locomotion methods. Specifically, the experience allowed for directional locomotion, incomplete teleportation, and realistic arm-swinging locomotion. Finally, Nature Treks also had a feature that allowed players to manipulate features of the environment, such as growing different kinds of trees, growing grass, and making it rain. Importantly, the ability to interact with the environment could also be disabled allowing for the manipulation of interactivity during the VR experience.

Figure 3: *Nature Treks VR* Screenshot of the Savannah Environment and Wildlife

The HTC Vive Pro was the chosen VR equipment for this study. The HTC Vive Pro equipment included a Head-Mounted Display (HMD), two motion tracking controllers, and two infrared base stations which track users' movements in 3D space. The HTC Vive Pro was selected for this study for a number of reasons. First, the Vive Pro HMD had high definition screens and was capable of simulating 3D stereoscopic vision. The Vive Pro HMD also came equipped with 3D spatial audio headphones. Furthermore, the Vive Pro HMD allowed for 360-degree head tracking capabilities, thus allowing users to look in any direction. Finally, the Vive Pro came with two motion tracking controllers which accurately translated users hand movements into VR inputs. The included motion controllers could also be used for traditional direction gamepad style movement, teleportation, and arm-swing tracking. The combinations of the above features allowed for gradations in immersive VR features.

There were a number of materials used to conduct this study. First, the survey software Qualtrics was used to gather participants' pre and posttest responses. Qualtrics was a flexible survey solution that allowed for the collection of participants' data and its exportation to other statistical software packages such as SPSS. Second, various paper materials were provided for those not comfortable with reading text on computer screens. The pre-printed materials included the informed consent documentation as well as a series of tutorial sheets that participants could review while the virtual reality equipment was being set up. Third, an Alienware Aurora R7 desktop computer with a Nvidia GeForce GTX 1080Ti graphics card was used. This computer setup provided enough graphical power to run *Nature Treks VR* at the required 90 frames per second in order to avoid motion sickness. Finally, this study took place in a laboratory space which only included a desk and a chair and the necessary VR related equipment and no other distracting elements. The experimenter sat behind a partition during the pre and posttest process. The experimenter then observed the participants while in VR in order to take notes and record the number of environmental interactions they performed while using a counter device.

3.3. Design

A 2 (high narrative interactivity vs low narrative interactivity) × 3 (high natural mapping, medium natural mapping, low natural mapping) between-subjects factorial experimental design was used. The study was designed to assess the short-term impacts of the PSE experience, the effects of subtle differences in immersive factors (i.e., natural mapping movement), and the effects of narrative interactivity. All participants experienced a savannah-based PSE experience in VR. Participants were randomly assigned as evenly as possible between the six conditions using a random number table. Specifically, the condition was switched after every participant.

The six conditions and the number of participants in each condition can be seen in Table 2 below.

Table 2: Two Factorial Between-Subjects Design

		Natural Mapping Movement		
		Directional	**Teleportation**	**Arm-Swinging**
Interactivity	**Narrative Interactivity**	29	29	30
	No Narrative Interactivity	29	28	28

3.4. Procedure

Participants were randomly assigned to one of the six conditions before arriving at the laboratory. Upon arriving at the laboratory, participants were greeted and told that the objective of this study was to examine their perceptions of digital graphics in VR. They were then led to a computer terminal with the informed consent information present on the screen and in paper format. After agreeing to participate in the study they completed the pretest survey. Afterward, participants were instructed on how to use the Vive controllers based on their natural mapping condition.

If participants were randomly assigned to the low natural mapping condition then they were instructed on how to use the Vive controllers for directional movement. If participants were assigned to the medium natural mapping condition then they were instructed on how to use the Vive motion controllers for teleportation movement. If participants were assigned to the high natural mapping condition then they were instructed on how to use the Vive motion controllers for arm-swinging movement. In order to limit participants' ability to use other unintended movement systems, certain movement options such as "arm-swinging" were turned off. The experimenter also monitored participants during the experience to make sure that they used the assigned movement system. To reduce the potential for confounding variables, all participants interacted with the environment, in the same way, using the Vive motion controls (i.e., by reaching out and "touching" interactivity spheres). Furthermore, all of the participants were asked to stand in the center of the room during the virtual reality experience. After the brief tutorial, the experimenter confirmed that the participant was comfortable and ready to proceed.

Participants were given approximately 10 minutes to explore the virtual environment and mingle with the wildlife. After 10 minutes had passed, participants were given the option to continue exploring the environment or to move onto the next portion of the study. Participants randomly assigned to the high narrative interactivity condition had the ability to alter and interact with the environment (i.e., technological interactivity). Participants assigned to the low narrative interactivity condition did not have the ability to alter and interact with the environment. This ability was activated or shut off during the setup process which took approximately 1 to 2 minutes. After their VR experience, participants were instructed to complete the posttest survey. The entire study took approximately 45 to 60 minutes to complete. The extra credit was dispensed regardless of completion of the data collection. For a complete summary of all the hypotheses, analytic techniques, variables, and time periods measured see Appendix B.

3.5. Operational Definitions of Independent Variables

The *independent variables* in this study consisted of participants' perceived levels of narrative interactivity (both perceived technical and content interactivity) and perceived naturally mapped movement (both perceived controller naturalness and intuitiveness). The levels of perceived narrative interactivity were manipulated via the ability to alter the VR environment. Specifically, those randomly assigned to the narrative interactivity condition were given the ability to alter the virtual environment in positive ways. For example, participants in the narrative interactivity condition were allowed to grow trees and grass. Those randomly assigned to the non-interactivity condition were simply allowed to explore the virtual environment.

The level of perceived natural mapped movement was manipulated via controller input locomotion variations. Specifically, those assigned to the low natural mapped movement condition experienced *directional mapping* by using buttons on the Vive controller to turn left, right, and forward. Participants assigned to the medium natural mapped movement condition experienced *incomplete natural mapping* by using point-based teleportation. Finally, participants in the high natural mapped movement condition experienced *realistic natural mapping* by using motion controller-based arm swinging locomotion (Skalski et al., 2011). Arm swinging locomotion was actually more natural than other similar VR locomotion methods such as walking in place (Nilsson, Serafin, & Nordahl, 2013).

This study also explored the possibility that the effects from one kind of pro-environmental experience could spread to other related environments. In other words, this study attempted to answer the question, "does meeting an elephant influence people's attitudes towards the ocean?" Therefore, while participants only experienced a savannah-based VR environment they still answered questions regarding their ocean attitudes. Participants' environmental attitude toward multiple environments was used to determine if the effects of one pro-environmental experience influence other related pro-environmental attitudes.

3.6. Operational Definitions of Dependent Variables

There were five *dependent variables* in this study: 1) narrative transportation, 2) spatial presence, 3) environmental attitudes (which includes: general environmental attitudes, elephant attitudes, and connectedness to nature), 4) environmental behavioral intentions (which includes:

support for conservation and activism intentions and 5) oceanic attitudes. See Appendix A for a complete list of the scale items included in this study. See Appendix B for a complete summary of all the hypotheses, analytic techniques, variables, and time periods measured. The narrative transportation, spatial presence, and the majority of the environment related attitudes and behavioral intentions were measured at the posttest (time 2). General environmental attitudes and oceanic attitudes were measured at the pretest (time 1) and the posttest (time 2) so that participants' initial general environmental attitudes could be controlled.

Narrative transportation was measured using a modified version of the Transportation Scale (Green & Brock, 2000). The Transportation scale was the standard for assessing when "all mental systems and capacities become focused on the events occurring in the narrative" (Green & Brock, 2000, p. 701). The Transportation scale normally consists of 11 items which were reduced down to 3 items to make it applicable to a VR-based study. A total of four scale items that were related to visual imagery were eliminated due to the shift from a textual context to a VR context. A total of four more items were then eliminated to increase the reliability of the measure to an acceptable level (α= 0.75). Importantly, the reduced scale still included items that accounted for the cognitive and emotional attributes of narrative transportation. The Transportation scale questions were originally intended for text-based stories; they were modified slightly to suit VR based experiences, such as adding the word "experience" to the questions. Example questions include, "The narrative experience affected me emotionally." The response options for Transportation Scale questions consisted of a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree) (Green & Brock, 2000). The scale items were totaled and then averaged to produce an overall transportation score.

In this study, spatial presence was measured using the Spatial Presence Experience Scale (SPES) (Hartmann et al., 2016). The SPES was an 8-item instrument (α= 0.87) which accounted for both dimensions of spatial presence: self-location and possible actions. Specifically, self-location was measured using 4-items, with questions such as, "I felt as though I was physically present in the environment." Meanwhile, possible actions were also measured using 4-items, with questions such as, "I felt like I could move around among the animals in the environment." The response options for the SPES questions consisted of a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The scale items were totaled and then averaged to produce an overall spatial presence score.

Environmental attitudes were measured using multiple scales. Specifically, environmental attitudes consisted of participants' connectedness to nature, general environmental attitudes, and elephant attitudes. Participants' feelings of being connected to nature were measured using the Connectedness to Nature Scale (CNS) (Mayer & Frantz, 2004). The CNS consisted of 14-items (α= 0.82) with questions such as, "I often feel a kinship with animals and plants." Participants' general environmental attitudes were measured using the revised New Ecological Paradigm (NEP) scale (Dunlap, Van Liere, Mertig, & Jones, 2000). The revised NEP consisted of 15-items which were reduced to 14-items to increase the reliability of the scale (α= 0.81). The eliminated question was, "Human ingenuity will insure that we do NOT make the earth unlivable", which appeared difficult for participants to understand. The revised NEP included questions such as, "The balance of nature is very delicate and easily upset." The response options for the CNS and NEP measures consisted of 7-point Likert scales, ranging from 1 (strongly disagree) to 7 (strongly agree). The scale items for each instrument were totaled and then averaged to produce an overall connectedness to nature and environmental attitude scores.

Elephant-related attitudes were measured using a modified version of the Visitor Predispositions Scale (VPS) (Luebke, 2012; Luebke, Watters, Packer, Miller, & Powell, 2016). The scale was modified to eliminate zoo specific questions and the mention of zoos related to elephants. The modified 7-item (α= 0.85) version used in this study was elephant specific (Hacker & Miller, 2016). Example questions included, “Elephants are an important part of nature” and “Humans have the right to modify nature even if it impacts elephants.” The reason that an elephant specific scale was selected instead of a savannah specific scale was because the savannah itself was not under environmental threat so much as their elephant inhabitants specifically. Both of the environment/animal specific scales were measured using a 7-Point Likert-like scale ranging from 1 (strongly disagree) to 7 (strongly agree). The items for each scale were totaled and then averaged to produce an overall ocean and elephant related attitudes and behavioral intentions scores.

Pro-environmental behavioral intentions were also measured using multiple scales. Specifically, environmental behavioral intentions consisted of participants’ support for conservation and activism intentions. Participants’ intention to support conservational policy and their intention to engage in activism related behaviors were both measured using scales from the Environmental Attitudes Inventory (EAI) (Milfont & Duckitt, 2010). Support for conservation was measured using a 10-item scale (α= 0.87), with questions such as, “Controls should be placed on industry to protect the environment from pollution, even if it means things will cost more.” Environmental activism intentions were also measured using a 10-item scale (α= 0.87), with questions such as, “If I ever get extra income I will donate some money to an environmental organization.” The response options for both EAI measures consisted of 7-point scales, ranging from 1 (strongly disagree) to 7 (strongly agree). The items for each behavioral intention scale was totaled and then averaged to produce overall support for conservation and activism intention scores.

Lastly, ocean-related environmental attitudes and behavioral intentions were measured using select items from The Ocean Project Tracking Survey (The Ocean Project, 2009). The Ocean Project Tracking Survey measured a wide range of environmental issues, including questions related to specific environmental knowledge and seafood consumptions safety information. A total of 10 survey items ($\alpha = 0.88$) were selected based on their relevance to the present study. Example questions included, "I am worried about the future health of the ocean" and "I would donate money to help conserve the world's ocean."

3.7. Control Variables

Based on previous studies, a number of variables were controlled in this study. First, basic demographics such as age, race, and gender were controlled (Felnhofer, Kothgassner, Beutl, Hlavacs, & Kryspin-Exner, 2012; Fox, Arena, & Bailenson, 2009). Second, participants' previous VR experience was controlled. Previous VR experience was measured using the question, "On average, over the past month, how often did you use virtual reality (i.e., Oculus Rift, PSVR, HTC Vive, Samsung Gear VR)?" with five-point response options which ranged from 1 (none at all) to 5 (a great deal). Third, previous video game experience was also controlled (Balakrishnan & Sundar, 2011). Specifically, participants that frequently played video games could have found some controllers more natural than other controllers (Seibert, 2014). Therefore, previous video game experience was measured using the question, "On average, over the past month, how often did you play console video games (i.e., Xbox One, PlayStation 4, etc.)?" with a five-point response options ranging from 1 (none at all) to 5 (a great deal). Fourth, due to the nature of using two motion controls with distinct functionality, participants' dominant hand was also controlled with the question, “With which hand do you normally use to write?” with three response options (left, right, both).

Fifth, participants’ already established general environmental attitudes were controlled. Specifically, participants’ baseline general environmental attitudes via their pretest responses to the NEP were controlled. Sixth, given that conservatives are more likely to deny climate change, a control for political ideology was also included (Funk & Kennedy, 2016). The measure for Ideological Self-Placement asks participants “Do you consider yourself to be…” with response options ranging from 1 (very liberal) to 5 (very conservative) (Bishin, 2004).

Finally, the participants’ potential feelings of motion sickness were controlled. Some early experiments found motion sickness had a negative impact on treatment efficacy (Gregg & Tarrier, 2007; Nichols & Patel, 2002). The problem of nausea induced by VR has been labeled “cybersickness” (McCauley & Sharkey, 1992). Research related to VR induced cybersickness still indicates that VR nausea/sickness should be controlled in any VR related study (Munafo, Diedrick, & Stoffregen, 2017; Nichols & Patel, 2002). Participants’ level of motion sickness was measured using four nausea related items ($\alpha = 0.83$) selected from the Simulator Sickness Questionnaire (SSQ) (Kennedy, Lane, Berbaum, & Lilienthal, 1993). The SSQ response options ranged from 1 (none) to 4 (severe). The participants’ SSQ responses were totaled and averaged, resulting in an overall cybersickness score. Participants’ initial general environmental attitudes and demographics were measured during the pretest (time 1). The remaining control variables were measured during the posttest (time 2).

3.8. Manipulation Checks

There were four manipulation checks included in the present study in order to explore potential differences in the levels of perceived natural mapping and the levels of perceived narrative interactivity. First, participants' level of perceived natural mapping was measured using two questions based off of the definition of natural mapping used in this study and other similar studies which also used single-item measures of locomotion naturalness (Appel, Gnambs, Richter, & Green, 2015; Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013). The first natural mapping manipulation check question taped into the naturalness dimension of natural mapping by asking "The way I walked through the environment was similar to walking in real life." The second natural mapping manipulation check question taped into the intuitiveness dimension of natural mapping by asking "I felt like the controls allowed me to move around the environment in an intuitive way." The two questions were analyzed separately to gain a more nuanced understanding of the potential impacts of both dimensions of natural mapping.

Manipulation Check 1 (MC1): There will be a difference in participants' perceived controller naturalness when comparing those in the high natural mapping condition (realistic) with those in the low (directional) and medium (incomplete) natural mapping conditions.

Manipulation Check 2 (MC2): There will be a difference in participants' perceived controller intuitiveness when comparing those in the high natural mapping condition (realistic) with those in the low (directional) and medium (incomplete) natural mapping conditions.

Second, participants' level of perceived narrative interactivity was measured using two questions based off of the definition of narrative interactivity used in this study (Steuer, 1992). The first narrative interactivity manipulation check question was "I feel like I was able to modify and change the virtual environment." The second narrative interactivity manipulation check question was "I feel like I was able to make an impact on the lives of the wildlife in the virtual environment." The response options for all of the above manipulation check questions were measured using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Initially, the two questions were analyzed separately to gain a more nuanced understanding of the potential impacts of both dimensions of perceived narrative interactivity and natural mapping. All of the manipulation check variables were measured during the posttest (time 2).

Manipulation Check 3 (MC3): Those in the high narrative interactivity condition will report greater technological interactivity than those in low narrative interactivity condition.

Manipulation Check 4 (MC4): Those in the high narrative interactivity condition will report greater content interactivity than those in low narrative interactivity condition.

3.9. Pilot Test

Before beginning full data collection of the main study, a pilot test was conducted. The pilot test consisted of 18 participants (i.e., 3 for each condition). A pilot test sample size of 18 was selected because it represented 10% of the larger sample, which is considered ideal for a pilot test (Connelly, 2008; Treece & Treece Jr, 1977). The participants were recruited using the College of Communication Arts and Sciences (CAS) SONA system. SONA was used to make sure that the pilot test participants were comparable to the full study participants. The pilot test participants were also offered the same amount of extra credit (1.25% of their final grade) as an incentive. The pilot test was conducted to evaluate the efficacy of both of the manipulations included in the present study using a series of nonparametric statistics. First, in order to evaluate the effectiveness of the perceived narrative interactivity manipulation a Mann-Whitney U test was conducted. The Mann Whitney U test was used successfully in the past to analyze small samples in psychological studies (Nachar, 2008). Second, in order to evaluate the effectiveness of the perceived natural mapping manipulations a Kruskal-Wallis H test was conducted. The Kruskal-Wallis H test is a generalization of the Mann Whitney U test which can compare more than two groups (Swinscow & Campbell, 2002).

The Mann-Whitney U test indicated that the level of perceived technical interactivity was greater for those in the interactivity condition (Mdn = 13) than for those in the non-interactive condition (Mdn = 10), U=8.0, p = .003. Likewise, a Mann-Whitney U test also indicated that the level of content interactivity was greater for those in the interactivity condition (Mdn = 12) than for those in the non-interactivity condition (Mdn = 11), U= 14.5, p = .018. Therefore, the pilot test indicated that there was a successful manipulation of the narrative interactivity independent variable across both dimensions.

A preliminary Kruskal-Wallis H test indicated that the differences in perceived controller naturalness between the three levels of natural mapping were not significant (H(2) = 2.06, p = .36. Meanwhile, the Kruskal-Wallis H test indicated that the differences in perceived controller intuitiveness between the three levels of natural mapping were approaching significance (H2) = 3.42, p = .18. These preliminary results indicated that the manipulation of natural mapping was not as strong as narrative interactivity. A possible explanation or this finding could be the lack of adequate sample size (n=14) due to some missing data related to the natural mapping in the pilot. Therefore, the sample size (i.e., participants) was doubled (n=28) and the Kruskal-Wallis H analysis was conducted again. In this case, The Kruskal-Wallis H test indicated that the differences in perceived controller naturalness between the three levels of natural mapping were approaching significance (H(2) = 4.28, p = .12. Meanwhile, the Kruskal-Wallis H test indicated that the differences in perceived controller intuitiveness between the three levels of natural mapping were significant (H2) = 7.10, $p = .03$. Therefore, it was concluded that the weak initial pilot test results for the natural mapping manipulation were due to the small sample size. The pilot test using double the participants indicated that there was a successful manipulation of the natural mapping independent variable across both dimensions. Therefore, full data collection was carried out.

3.10. Analytical Design

The data collected from this experiment was used to explore the differences between participants across multiple levels of naturally mapped movement and narrative interactivity conditions. This study also explored the impacts of perceived differences in natural mapping and narrative interactivity across two dimensions on various outcome variables of interest. Lastly, the data was also used to examine any potential spreading activation effects across environmental types. Therefore, a number of different analytic techniques were implemented in this study. First, descriptive statistics were estimated for each of the variables. The descriptive statistics were not used to draw conclusions from the data, but rather to gain a better contextual understanding of the data. Furthermore, both frequencies and one-way ANOVA analyses were used to check for any potential violations of statistical assumptions.

Second, a series of independent-samples t-tests and one-way ANOVAs were used to establish the successful manipulation of natural mapping and narrative interactivity across all four dimensions. Specifically, two independent-samples t-tests were used to check for successful manipulation of perceived narrative interactivity across both technical and content interactivity dimensions (MC3 & MC4). The one-way ANOVAs were used to check for successful manipulation of perceived natural mapping across both perceived controller naturalness and intuitiveness dimensions (MC1 & MC2).

Third, a series of ordinary least squares (OLS) regressions were conducted to test for potential relationships between participants' perceived levels of natural mapping and narrative interactivity and their subsequent feelings of spatial presence (H1) and narrative transportation (H4). OLS regressions were also employed to examine the relationships between participants' feelings of spatial presence (H2), narrative transportation (H6), and narrative interactivity (H5) and their subsequent environmental attitudes and behavioral intentions. All of the OLS regression models controlled for participants' demographics, video game experience, VR experience, and motions sickness.

Finally, I also conducted a series of PROCESS path-analyses (Hayes, 2013). The PROCESS path-analysis uses a regression-based framework to test mediator-moderator models with multiple mediators (Hayes, 2016). The PROCESS analysis results were used to test hypotheses three (H3), seven (H7), and eight (H8) in which the spatial presence and narrative transportation were considered potential mediators/moderators between perceived natural mapping and narrative interactivity and the environmental attitudes outcome variables. The PROCESS analysis was also used to help answer the sole research question (RQ1). All of the PROCESS models controlled for participants' demographics, general environmental attitudes, previous video game and VR experience, and motions sickness.

The PROCESS analyses were conducted using version 3.2. During the PROCESS analysis Model 1 was employed to examine potential moderating relationships. Meanwhile, Model 4 was employed to examine potential mediating relationships. All of the above analyses were conducted using the statistical software package SPSS 22. For a complete summary of all the hypotheses, analytic techniques, variables, and time periods measured see Appendix B. The results for the above analysis are examined in the following chapter.

CHAPTER 4: RESULTS

4.1. Descriptive Statistics

A total of 183 undergraduate students participated in the present study. Ten students were eliminated due to incomplete or outlier data, leaving 173 total participants in the present analyses. See Table 2 in the previous chapter for a detailed breakdown of participant distributions across conditions. The majority of participants were female (57%), white (56%), and the average age was approximately 21 years old. Most participants (51%) considered themselves to be "moderate" on the political spectrum. The vast majority of participants (90%) favored their right hand. The average level of reported motion sickness was only 1.39 (out of 3) indicating that motion sickness was not a prevalent problem for participants. Finally, most participants (84%) did not have any previous VR experience in the past month. However, most participants did at least have some video game experience (58%) in the past month. See Table 3 below for more detailed information control variable characteristics.

Table 3: Descriptive Statistics of Control Variables

	Mean	**S. D.**	**Min**	**Max**
Gender (1=Male)	0.43	0.50	0.00	1.00
Race (1=White)	0.56	0.50	0.00	1.00
Age	20.82	1.57	18.00	29.00
Hand Dominance	1.91	0.30	1.00	3.00
VR Experience	1.17	0.42	1.00	3.00
VG Experience	2.09	1.17	1.00	5.00
Political Ideology	2.72	0.79	1.00	5.00
Motion Sickness	1.39	0.53	1.00	3.00

N=173

Regarding the independent variables in this study, participants, on average, reported high levels of perceived technical interactivity (M = 4.58; SD = 1.80). Meanwhile, on average, participants reported relatively high levels of perceived content interactivity (*M* = 4.25; *SD* = 1.78). Likewise, on average, participants also reported moderate levels of perceived controller naturalness (*M* = 3.93; *SD* = 1.66) and relatively high levels of perceived controller intuitiveness (*M* = 5.16; *SD* = 1.28). Finally, on average, participants reported high levels of spatial presence (*M* = 5.45; *SD* = 0.99) and moderate levels of narrative transportation (*M* = 3.85; *SD* = 1.23). The independent variables were measured during the posttest. See Table 4 below for more detailed information regarding the independent variable characteristics.

Table 4: Descriptive Statistics of Independent Variables

	Mean	**S. D.**	**Min**	**Max**
Perceived Technical Interactivity	4.58	1.80	1.00	7.00
Perceived Content Interactivity	4.25	1.78	1.00	7.00
Perceived Controller Naturalness	3.93	1.66	1.00	7.00
Perceived Controller Intuitiveness	5.16	1.28	2.00	7.00
Spatial Presence	5.45	0.99	1.25	7.00
Narrative Transportation	3.85	1.23	1.00	7.00

N=173

Regarding the dependent variables in this study, participants on average reported relatively high levels of general environmental attitudes (*M* = 5.06; *SD* = 0.75). On average participants reported high elephant-related attitudes (*M* = 5.85; *SD* = 0.82) and ocean-related attitudes (*M* = 5.29; *SD* = 0.79). Participants reported moderate levels of feeling connected to nature (*M* = 4.92; *SD* = 0.75). Finally, on average participants reported high levels of support for conservation (*M* = 5.53; *SD* = 0.91) and relatively high levels of activism intentions (*M* = 5.23; *SD* = 0.86). Descriptive statistics for the dependent variables were analyzed using the posttest responses. See Table 5 below for more detailed information regarding the dependent variable characteristics.

Table 5: Descriptive Statistics of Dependent Variables				
	Mean	**S. D.**	**Min**	**Max**
Environmental Attitudes (pre)	4.82	0.66	2.71	6.57
Environmental Attitudes (post)	5.06	0.75	3.07	6.86
Elephant Attitudes	5.85	0.82	3.00	7.00
Ocean Attitudes (pre)	5.60	0.89	1.90	7.00
Ocean Attitudes (post)	5.29	0.79	1.91	6.36
Connection to Nature	4.92	0.75	3.00	6.79
Support for Conservation	5.53	0.91	2.00	7.00
Activism Intentions	5.23	0.86	2.80	7.00
N=173				

4.2. Manipulation Check Results (MC1-MC4)

Two independent samples t-tests were conducted to confirm the effective manipulation of narrative interactivity across two dimensions (i.e., perceived technical interactivity and content interactivity) during the experiment. The results of the first t-test compared the mean scores for perceived technical interactivity between the high interactive and low interactive conditions. A statistically significant difference ($t(171) = 9.50$, $p < .001$) existed between these two conditions. The mean scores for the high interactive condition were significantly higher ($M = 5.61$, $SD = 1.27$) than the mean scores for the low interactive condition ($M = 3.51$, $SD = 1.63$). In other words, the high interactive condition was perceived as being more technically interactive (i.e., participants felt able to modify the virtual environment) than the low interactive condition. **Therefore, MC3 was confirmed.** See table 6 below for more detailed information regarding the t-test results.

The second t-test compared the means scores for the content interactivity between the high interactive and low interactive conditions. There was a statistically significant difference between the high and low interactive conditions ($t(171) = 5.90$, $p < .000$). The mean scores for the high interactive condition were significantly higher ($M = 4.97$, $SD = 1.52$) than the mean scores for the low interactive condition (*M* = 3.51, *SD* = 1.73). The high interactive condition was perceived as being more content interactive (i.e., participants felt like they were able to impact the lives of the wildlife) than the low interactive condition. **Therefore, MC4 was confirmed.** The results confirm that narrative interactivity was successfully manipulated across both perceived technical and content dimensions. See table 6 below for more detailed information regarding the t-test results.

Table 6: Independent Samples t-test Results: Comparing Narrative Interactivity Conditions

Condition/Group	**N**	**Mean**	**SD**	**SE**	**t**	**p**
Perceived Technical Interactivity						
High Interactive	88	5.61	1.27	0.14	9.50	<.000
Low Interactive	85	3.51	1.63	0.18		
Perceived Content Interactivity						
High Interactivity	88	4.97	1.52	0.16	5.90	<.000
Low Interactivity	85	3.51	1.73	0.19		

N=173

Two one-way ANOVAs were also conducted to confirm the effective manipulation of natural mapping across two dimensions (i.e., perceived controller naturalness and controller intuitiveness) during the experiment. The first ANOVA compared the mean scores for perceived controller naturalness between the high (arm-swinging), medium (teleportation), and low (directional) natural mapping conditions. A statistically significant difference existed between these three conditions (*F*(172) = 4.51, p = .01). The mean scores for the high natural mapping condition were significantly higher (*M* = 4.24, *SD* = 1.51) than the mean scores for the medium (*M* = 3.40, *SD* = 1.62) and low natural mapping conditions (*M* = 4.14, *SD* = 1.74). In other words, the high natural mapping condition was perceived to be more natural (i.e., similar to walking in real life) than the medium and low natural mapping conditions. **Therefore, the MC1**

was confirmed with arm-swinging being the most natural locomotion method. See Table 7 below for more detailed information regarding the ANOVA results.

The second ANOVA compared the means scores for the perceived controller intuitiveness between the high (arm-swinging), medium (teleportation), and low (directional) natural mapping conditions. There was a statistically significant difference between these three conditions ($F(172) = 3.79$, $p = .02$). In this case, the mean scores for the medium natural mapping condition were significantly higher ($M = 5.53$, $SD = 1.07$) than the mean scores for the low ($M = 5.03$, $SD = 1.45$) and high natural mapping condition ($M = 4.91$, $SD = 1.23$). In other words, the high natural mapping condition (i.e., arm-swinging) was actually perceived to be the least intuitive when compared to the medium natural mapping condition (i.e., teleportation) and the low condition (i.e., directional). **Therefore, MC2 was confirmed with teleportation being the most intuitive locomotion method.** The ANOVA analyses confirm successful manipulation of natural mapping across both a naturalness and intuitiveness dimensions. The ANOVA results indicate that natural mapping is a more nuanced concept than originally posited in the literature as controller naturalness and intuitiveness were perceived differently across conditions. See Table 7 below for more detailed information regarding the ANOVA results.

Table 7: One-way ANOVA Results: Comparing Natural Mapping Conditions

Condition/Group	**N**	**Mean**	**SD**	**SE**	**F**	**p**
Perceived Controller Naturalness						
High Mapping	58	4.24	1.51	0.199	4.51	.01
Medium Mapping	57	3.40	1.62	0.22		
Low Mapping	58	4.14	1.74	0.23		
Perceived Controller Intuitiveness						
High Mapping	58	4.91	1.23	0.16	3.79	.02
Medium Mapping	57	5.53	1.07	0.14		
Low Mapping	58	5.03	1.45	0.19		

N=173

4.3. Predicting Spatial Presence and Narrative Transportation (H1 & H4)

Two OLS regressions were used to examine the relationships between perceived natural mapping (i.e., perceived naturalness and intuitiveness) and narrative interactivity (i.e., perceived technical and content interactivity) and the outcome variables of spatial presence and narrative transportation. In the models, the standardized Beta coefficients are reported. Furthermore, participants' race, gender, age, hand dominance, video game experience, VR experience, and level of motion sickness were controlled. First, spatial presence was regressed on both dimensions of natural mapping. Perceived controller naturalness was not a statistically significant predictor of spatial presence ($\beta = .117$, $p = .118$). However, perceived controller intuitiveness was a positive predictor ($\beta = .353$, $p < .000$). In other words, when the method for moving around the virtual environment was more predictable or intuitive, participants reported greater feelings of spatial presence. The above regression model explained a statistically significant proportion of variance in spatial presence scores ($F(9, 163) = 6.22$, $p < .001$), with an adjusted R^2 of .214. **Therefore, H1 was supported.** Interestingly, the "naturalness" of the locomotion method was not as important as the "intuitiveness" of the locomotion method during the formation of spatial presence feelings. Due to the finding that perceived controller naturalness was not a statistically significant predictor in the above model, it was eliminated from future analyses. See Table 8 below for more detailed regression results.

Second, narrative transportation was regressed on both dimensions of narrative interactivity. Perceived content interactivity was a positive predictor of narrative transportation ($\beta = .432$, $p < .000$). However, perceived technical interactivity was not a statistically significant predictor of narrative transportation ($\beta = -0.103$, $p = .237$). In essence, when participants felt like they were able to make an impact on the narrative (i.e., the lives of the wildlife) they reported greater feelings of narrative transportation. Approximately 16% of the variation in the narrative transportation was explain by the variables in the model ($F(9, 163) = 4.687$, $p < .001$), with an adjusted R^2 of .162. **Therefore, H4 was supported.** The technical aspect of interactivity (i.e., altering the environment) was not as important as interacting with the story when feeling transported into the narrative. Perceived technical interactivity was eliminated from future analyses due to the finding that it was not a statistically significant predictor in the above model. See Table 8 below for more detailed regression results.

Table 8: Regression Results: Predicting Spatial Presence and Narrative Transportation

Variables	**Spatial Presence**		**Narrative Transportation**	
Perceived Controller Naturalness	0.117		NA	
Perceived Controller Intuitiveness	0.353	***	NA	
Perceived Technical Interactivity	NA		-0.103	
Perceived Content Interactivity	NA		0.432	***
Race	0.020		-0.087	
Gender	-0.214	*	-0.101	
Age	0.001		0.022	
Hand Dominance	0.125		0.052	
VG Experience	0.187	*	0.111	
VR Experience	0.038		0.068	
F	6.216	***	4.687	***
Adjusted R^2	0.214		0.162	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

4.4. Spatial Presence Predicting Environmental Outcomes (H2)

The relationships between the independent variable spatial presence and participants' environmental attitudes (i.e., elephant attitudes, general environmental attitudes, connection to nature) and behavioral intentions (i.e., activism intentions and support for conservation) were explored using a series of OLS regressions. In the below models the standardized Beta coefficients are reported. Numerous controls were included in the models such as: race, gender, age, hand dominance, political ideology, general environmental attitudes, video game experience, VR experience, and level of motion sickness. See Table 9 and Table 10 below for detailed regression results.

First, a series of regression models were conducted to examine the relationship between spatial presence and participants' environmental attitudes. In the first model, participants' elephant attitudes were regressed on spatial presence. Participants' feeling of spatial presence in the virtual savannah environment was a statistically significant predictor of their elephant attitudes ($\beta = .262$, $p < .001$). The above regression model explained a statistically significant proportion of variance in elephant attitude scores ($F(10, 162) = 14.726$, $p < .001$), with an adjusted R^2 of .444.

In the second model, participants' general environmental attitudes were examined. The results once again indicated that participants' feeling of spatial presence was a statistically significant predictor of general environmental attitudes ($\beta = .110$, $p = .003$). Approximately 80% of the variation in general environmental attitudes was explained by the variables in the model ($F(10, 162) = 68.366$, $p < .001$), with an adjusted R^2 of .797. In this case, participants' environmental attitudes on the pretest were the strongest predictor and accounted for most of the variation explained by the model.

Finally, in the third model, participants' feelings of being connected to nature were regressed on spatial presence. Participants' feeling of spatial presence in the virtual savannah environment was a statistically significant predictor of their connection to nature ($\beta = .438$, $p < .001$). A statistically significant regression equation was found ($F(10, 162) = 9.806$, $p < .001$), with an adjusted R^2 of .339. Overall, participants' feeling of being spatially present in the virtual environment increased their pro-environmental attitudes. **Therefore, H2a was supported.** See Table 9 below for more detailed regression results.

Table 9: Regression Results: Environmental Attitudes Regressed on Spatial Presence

Variables	**Elephant Attitudes**		**Environmental Attitudes**		**Connection to Nature**	
Spatial Presence	0.262	***	0.110	**	0.438	***
Race	0.039		-0.015		-0.003	
Gender	-0.141		-0.054		-0.059	
Age	-0.003		-0.034		0.054	
Hand Dominance	0.015		-0.039		-0.085	
Political Ideology	-0.011		-0.003		-0.070	
Environmental Attitudes (pretest)	0.533	***	0.876	***	0.347	***
VG Experience	0.061		-0.011		-0.027	
VR Experience	-0.115		-0.004		0.050	
Motion Sickness	0.002		0.009		0.004	
F	14.726	***	68.366	***	9.806	***
Adjusted R^2	0.444		0.797		0.339	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

Second, a series of regression models were used to examine the relationship between spatial presence and participants' pro-environmental behavioral intentions. In the first model, participants' activism intentions were examined. Participants' feeling of spatial presence in VR was a statistically significant predictor of activism intentions ($\beta = .253$, $p < .001$). A statistically significant portion of the variance in activism intention was explained by the model ($F(10, 162) = 11.152$, $p < .001$), with an adjusted R^2 of .371. In the second model, participants' support for conservation was regressed on spatial presence. Participants' feeling of spatial presence was not a statistically significant predictor of support for conservation ($\beta = .052$, $p = .393$). In this case, participants' general environmental attitudes was the strongest predictor of support for conservation ($\beta = .549$, $p < .001$). Approximately 43% (R^2 of .426) of the variation in support for conservation was explained by the variables in this model ($F(10, 162) = 13.787$, $p < .001$).

Overall, as participants' feeling of being spatially present in VR increased their activism intentions also increased; however, their support for conservation remained unchanged. **Therefore, H2b was partially supported.** See Table 10 below for more detailed regression results.

Table 10: Regression Results: Behavioral Intentions Regressed on Spatial Presence

Variables	**Activism Intensions**		**Support for Conservation**	
Spatial Presence	0.253	***	0.052	
Race	-0.005		0.097	
Gender	-0.176	*	-0.122	
Age	-0.008		0.041	
Hand Dominance	0.029		0.138	*
Political Ideology	-0.107		-0.096	
Environmental Attitudes (pretest)	0.437	***	0.549	***
VG Experience	-0.043		0.025	
VR Experience	0.098		-0.015	
Motion Sickness	0.008		-0.058	
F	11.152	***	13.787	***
Adjusted R^2	0.371		0.426	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

4.5. Narrative Transportation Predicting Environmental Outcomes (H6)

OLS regressions were conducted to examine the relationships between the independent variable narrative transportation and participants' environmental attitudes (i.e., elephant attitudes, general environmental attitudes, connection to nature) and behavioral intentions (i.e., support for conservation and activism intentions). In the below models, the standardized Beta coefficients are once again reported. Controls included participants' race, gender, age, hand dominance, political ideology, general environmental attitudes, video game experience, VR experience, and level of motion sickness. See Table 11 and Table 12 below for more detailed regression results.

First, a series of regression models examined the relationship between narrative transportation and participants' environmental attitudes. In the first model, participants' elephant attitudes were regressed on narrative transportation. Participants' feeling of narrative transportation was a statistically significant predictor of elephant attitudes ($\beta = .258$, $p < .001$). The above regression model explained a statistically significant proportion of variance in elephant attitude scores ($F(10, 162) = 14.737$, $p < .001$), with an adjusted R^2 of .444.

In the second model, participants' general environmental attitudes were examined. Participants' general environmental attitudes were predicted by their feeling of narrative transportation ($\beta = .099$, $p = .006$). Approximately 80% of the variation in general environmental attitudes were explained by the variables in the model ($F(10, 162) = 67.574$, $p < .001$), with an adjusted R^2 of .795. Most of the variation in general environmental attitudes was explained by participants' general environmental attitudes on the pretest.

In the third model, participants' feelings of being connected to nature were regressed on narrative transportation. Participants' feeling of narrative transportation was a statistically significant predictor of their connection to nature ($\beta = .450$, $p < .001$). Approximately 36% of the variation in the outcome was explained by this model. Overall, when participants' reported feeling transported into the narrative of the VR experience they also reported an increase in pro-environmental attitudes. **Therefore, H6a was supported.** See Table 11 below for more detailed regression results.

Table 11: Regression Results: Environmental Attitudes Regressed on Narrative Transportation

Variables	**Elephant Attitudes**		**Environmental Attitudes**		**Connection to Nature**	
Narrative Transportation	0.258	***	0.099	**	0.450	***
Race	0.072		-0.003		0.054	
Gender	-0.182	*	-0.072		-0.127	
Age	-0.013		-0.038		0.036	

Table 11 (cont'd)

Hand Dominance	0.032		-0.031		-0.058	
Political Ideology	0.005		0.009		-0.043	
Environmental Attitudes (pretest)	0.531	***	0.875	***	0.342	***
VG Experience	0.071		-0.005		-0.012	
VR Experience	-0.136	*	-0.004		0.014	
Motion Sickness	-0.022		-0.001		-0.036	
F	14.737	***	67.574	***	10.491	***
Adjusted R^2	0.444		0.795		0.356	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

Second, two regression models were conducted to examine the relationship between narrative transportation and participants' pro-environmental behavioral intentions. In the first model, participants' activism intentions were examined. Participants' activism intentions were predicted by their feeling of narrative transportation (β = .327, p < .001). A statistically significant proportion of variance in activism intention scores (F(10, 162) = 13.225, p < .001) was explained by the variables in the regression model, with an adjusted R^2 of .415. In the second model, participants' support for conservation was regressed on narrative transportation. Participants' feeling of narrative transportation was not a statistically significant predictor of their support for conservation (β = .070, p = .247). In this case, participants' general environmental attitudes were the strongest predictor of support for conservation (β = .548, p < .001). Approximately 43% of the variation in support for conservation was explained by the statistically significant regression equation (F(10, 162) = 13.901, p < .001). Overall, when participants' reported feeling transported into the narrative of their VR experience they also reported an increase in activism intentions; however, their support for conservation did not change. **Therefore, H6b was partially supported.** See Table 12 below for more detailed regression results.

Table 12: Regression Results: Behavioral Intentions Regressed on Narrative Transportation

Variables	**Activism Intensions**		**Support for Conservation**	
Narrative Transportation	0.327	***	0.070	
Race	0.035		0.105	
Gender	-0.207	*	-0.129	
Age	-0.020		0.039	
Hand Dominance	0.039		0.140	*
Political Ideology	-0.088		-0.092	
Environmental Attitudes (pretest)	0.433	***	0.548	***
VG Experience	-0.043		0.025	
VR Experience	0.069		-0.021	
Motion Sickness	-0.012		-0.062	
F	13.225	***	13.901	***
Adjusted R^2	0.415		0.429	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

4.6. Perceived Content Interactivity Predicting Environmental Outcomes (H5)

A series of OLS regressions were also used to examine the relationships between the independent variable perceived content interactivity and participants' environmental attitudes (i.e., elephant attitudes, general environmental attitudes, connection to nature) and behavioral intentions (i.e., support for conservation and activism intentions). The standardized Beta coefficients are once again reported. Likewise, participants' race, gender, age, hand dominance, political ideology, general environmental attitudes, video game experience, VR experience, and level of motion sickness were controlled. See Table 13 and Table 14 below for more detailed regression results.

First, regression models were conducted to examine the relationship between perceived content interactivity and participants' environmental attitudes. In the first model, participants' elephant attitudes were examined. Participants' perception of content interactivity was a statistically significant predictor of their elephant attitudes ($\beta = .174$, $p = .003$). The above regression model explained a statistically significant proportion of variance in elephant attitude scores ($F(10, 162) = 12.907$, $p < .001$), with an adjusted R^2 of .409.

In the second model, participants' general environmental attitudes were regressed on perceived content interactivity. Participants' perception of content interactivity was not a statistically significant predictor of their general environmental attitudes ($\beta = .052$, $p = .145$). In this case, participants' general environmental attitudes controlled at the pretest were the strongest predictor ($\beta = .878$, $p < .000$). Approximately 79% of the variation in general environmental attitude scores was explained by the variables in the model ($F(10, 162) = 64.866$, $p < .001$), with an adjusted R^2 of .788.

In the third model, participants' feelings of being connected to nature were examined. Participants' connection to nature was predicted by participants' perception of content interactivity ($\beta = .406$, $p < .001$). Overall, when participants perceived high levels of content interactivity they reported an increase in elephant attitudes and connection to nature but not their general environmental attitudes. This is most likely due to the strength of general environmental attitudes on the pretest as a predictor. **Therefore, H5a was partially supported.** See Table 13 below for more detailed regression results.

Table 13: Regression Results: Environmental Attitudes Regressed on Content Interactivity

Variables	**Elephant Attitudes**		**Environmental Attitudes**		**Connection to Nature**	
Perceived Content Interactivity	0.174	**	0.052		0.406	***
Race	0.054		-0.010		0.028	
Gender	-0.207	**	-0.082		-0.168	*
Age	-0.011		-0.037		0.038	
Hand Dominance	0.039		-0.027		-0.055	
Political Ideology	-0.007		-0.005		-0.063	
Environmental Attitudes (pretest)	0.539	***	0.878	***	0.358	***
VG Experience	0.102		0.007		0.042	
VR Experience	-0.127		-0.002		0.016	
Motion Sickness	-0.024		-0.003		-0.032	

Table 13 (cont'd)

F	12.907	***	64.866	***	9.240	***
Adjusted R^2	0.409		0.788		0.324	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

Second, two additional regression models were used to examine the relationship between perceived content interactivity and participants' pro-environmental behavioral intentions. In the first model, participants' activism intention was regressed on perceived content interactivity. Participants' perception of content interactivity was a statistically significant predictor of activism intentions ($\beta = .142$, $p = .026$). A statistically significant portion of the variance in activism intention was explained by the variables in the regression model ($F(10, 162) = 9.509$, $p < .001$), with an adjusted R^2 of .331. In the second model, participants' support for conservation was examined. Participants' perception of content interactivity was not a statistically significant predictor of their support for conservation ($\beta = -.073$, $p = .214$). In this case, participants' general environmental attitudes were the strongest predictor of support for conservation ($\beta = .550$, $p < .001$). Approximately 43% (R^2 of .429) of the variation in support for conservation was explained by the variables in the model ($F(10, 162) = 13.938$, $p < .001$). Overall, when participants perceived high levels of content interactivity they reported an increase in their activism intentions but not their support for conservation. **Therefore, H5b was partially supported.** See Table 14 below for more detailed regression results.

Table 14: Regression Results: Behavioral Intentions Regressed on Content Interactivity

Variables	**Activism Intensions**		**Support for Conservation**	
Perceived Content Interactivity	0.142	*	-0.073	
Race	0.008		0.094	
Gender	-0.241	**	-0.138	
Age	-0.014		0.043	
Hand Dominance	0.055		0.152	*

Table 14 (cont'd)

Political Ideology	-0.103		-0.097	
Environmental Attitudes (pretest)	0.444	***	0.550	***
VG Experience	-0.003		0.035	
VR Experience	0.090		-0.004	
Motion Sickness	-0.018		-0.069	
F	9.509	***	13.938	***
Adjusted R^2	0.331		0.429	

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Note: standardized Beta coefficients are reported

4.7. Spatial Presence as a Mediator (H3)

In order to explore the potential mediating relationship between spatial presence and the environmental outcome variables, a series of PROCESS path-analyses were conducted using an SPSS macro (Hayes, 2013). The following PROCESS path-analyses were conducted using Model 4 (mediation). Furthermore, a boot-strapping method of 5000 samples was employed. In keeping with the above analyses, participants' race, gender, age, hand dominance, political ideology, general environmental attitudes, video game experience, VR experience, and level of motion sickness were controlled. However, in this case, the unstandardized Beta coefficients are reported. See Table 15 and Table 16 below for more detailed regression results.

First, a series of path-analyses were conducted to examine if spatial presence was a mediator between natural mapping (i.e., perceived controller intuitiveness) and participants' environmental attitudes (i.e., elephant attitudes, general environmental attitudes, and connection to nature). In the first model, participants' elephant attitudes were regressed on perceived controller intuitiveness and spatial presence. Participants' feeling of spatial presence was a statistically significant predictor of their elephant attitudes (B = 0.206, p < .001) while perceived controller intuitiveness was not (B = 0.023, p = .587). The indirect effect from perceived controller intuitiveness to spatial presence and then to elephant attitudes was statistically significant (95% CI [0.028, 0.105]). In other words, spatial presence was indeed a mediator between natural mapping (i.e., perceived controller intuitiveness) and elephant attitudes. The above mediation model explained a statistically significant proportion of variance in elephant attitude scores ($R^2 = .48, F(12, 160) = 12.322, p < .001$).

Next, the participants' general environmental attitudes were regressed on perceived controller intuitiveness and spatial presence. Again, participants' general environmental attitudes were predicted by their feeling of spatial presence ($B = 0.079, p = .010$) while perceived controller intuitiveness was not a predictor ($B = 0.008, p = .723$). Support for mediation was found as the indirect effect from perceived controller intuitiveness to spatial presence and then to environmental attitudes was statistically significant (95% CI [0. 007, 0. 046]). Approximately 81% of the variation in general environmental attitudes was explained by the variables in the model ($R^2 = .809, F(12, 160) = 56.573, p < .001$). Overall, spatial presence was a mediator between natural mapping (i.e., perceived controller intuitiveness) and general environmental attitudes.

Finally, the participants' feelings of being connected to nature were regressed on controller intuitiveness and spatial presence. In this case, both participants' feeling of spatial presence ($B = 0.286, p < .001$) and their perceived controller intuitiveness were statistically significant predictors of connectedness to nature ($B = 0.091, p = .028$). The indirect effect from perceived controller intuitiveness to spatial presence and then to connection to nature was statistically significant (95% CI [0.048, 0.139]). The PROCESS mediation model explained a statistically significant proportion of variance in connection to nature scores ($R^2 = .405, F(12, 160) = 9.080, p < .001$). In this case, spatial presence was a partial mediator between natural mapping (i.e., perceived controller intuitiveness) and participants' connection to nature. Overall, spatial presence was a mediator between naturally mapping locomotion and participants' environmental attitudes. **Therefore, H3a was supported.** See Table 15 below for more detailed PROCESS results. See Figure 4 below for a visual representation of the mediating relationship.

Table 15: PROCESS Results: Direct and Indirect Effects of Natural Mapping and Spatial Presence on Environmental Attitudes

			Bootstrap 95% CI	
	Coefficients	**SE**	**Lower**	**Upper**
Direct Effects				
NM → Elephant	0.023	0.042	-0.597	0.105
SP → Elephant ***	0.206	0.054	0.098	0.313
NM → Environment	0.008	0.023	-0.038	0.054
SP → Environment**	0.079	0.030	0.020	0.139
NM → Connection*	0.091	0.041	0.010	0.171
SP → Connection***	0.286	0.053	0.181	0.391
			Bootstrap 95% CI	
	Effect size	**Bootstrap SE**	**Lower**	**Upper**
Indirect Effects				
NM → SP → Elephant*	0.063	0.020	0.028	0.105
NM → SP → Environment*	0.024	0.010	0.007	0.046
NM → SP → Connection*	0.088	0.023	0.048	0.139

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Notes: Bootstrap sampling = 5000, CI = Confidence interval, NM = Natural mapping, SP = Spatial presence, controls included race, gender, age, hand dominance, political ideology, general environmental attitudes (pretest), video game experience, and virtual reality experience, unstandardized Beta coefficients are reported

Second, two additional path-analyses were conducted to examine if spatial presence was a mediator between natural mapping (i.e., perceived controller intuitiveness) and participants' behavioral intentions (i.e., activism intentions and support for conservation). In the first model activism intention was regressed on perceived controller intuitiveness and spatial presence. Participants' activism intentions were predicted by their feeling of spatial presence ($B = 0.218$, $p < .001$). However, perceived controller intuitiveness was not a statistically significant predictor of activism intentions ($B = 0.004$, $p = .938$). A mediating relationship was found as the indirect effect from perceived controller intuitiveness to spatial presence and then to activism intentions was statistically significant (95% CI [0.025, 0.128]). In other words, spatial presence was a mediator between natural mapping (i.e., perceived controller intuitiveness) and participants' activism intentions. A statistically significant portion of the variance in activism intention scores was explained by the variables in the PROCESS model ($R^2 = .408$, $F(12, 160) = 9.184$, $p < .001$).

In the second model participants' support for conservation was examined. Neither participants' feelings of spatial presence ($B = 0.021$, $p = .739$) nor perceptions of perceived controller intuitiveness ($B = 0.053$, $p = .267$) were a statistically significant predictors of their support for conservation. Furthermore, the indirect effect from perceived controller intuitiveness to spatial presence and then to support for conservation was also not statistically significant (95% CI [-0.032, 0.053]). Overall, these findings indicate that spatial presence was only a mediator between naturally mapping locomotion and some of the participants' behavioral intentions (i.e., activism intentions). The above mediation model still explained a statistically significant proportion of variance in support for conservation scores ($R^2 = .465$, $F(12, 160) = 11.585$, $p < .001$). In this case, neither naturally mapped locomotion nor spatial presence were related to participants' support for conservation. **Therefore, H3b was partially supported.** See Table 16 below for more detailed PROCESS results. Again, see Figure 4 below for a visual representation of the mediation results.

Table 16: PROCESS Results: Direct and Indirect Effects of Natural Mapping and Spatial Presence on Behavioral Intentions

			Bootstrap 95% CI	
	Coefficients	**SE**	**Lower**	**Upper**
Direct Effects				
NM → Activism	0.004	0.047	-0.089	0.096
SP → Activism***	0.218	0.061	0.098	0.339
NM → Conservation	0.053	0.047	-0.041	0.146
SP → Conservation	0.021	0.061	-0.101	0.142
			Bootstrap 95% CI	

Table 16 (cont'd)

	Effect size	Bootstrap SE	Lower	Upper
Indirect Effects				
NM → SP → Activism*	0.067	0.026	0.025	0.128
NM → SP → Conservation	0.006	0.021	-0.032	0.053

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Notes: Bootstrap sampling = 5000, CI = Confidence interval, NM = Natural mapping, SP = Spatial presence, controls included race, gender, age, hand dominance, political ideology, general environmental attitudes (pretest), video game experience, and virtual reality experience, unstandardized Beta coefficients are reported

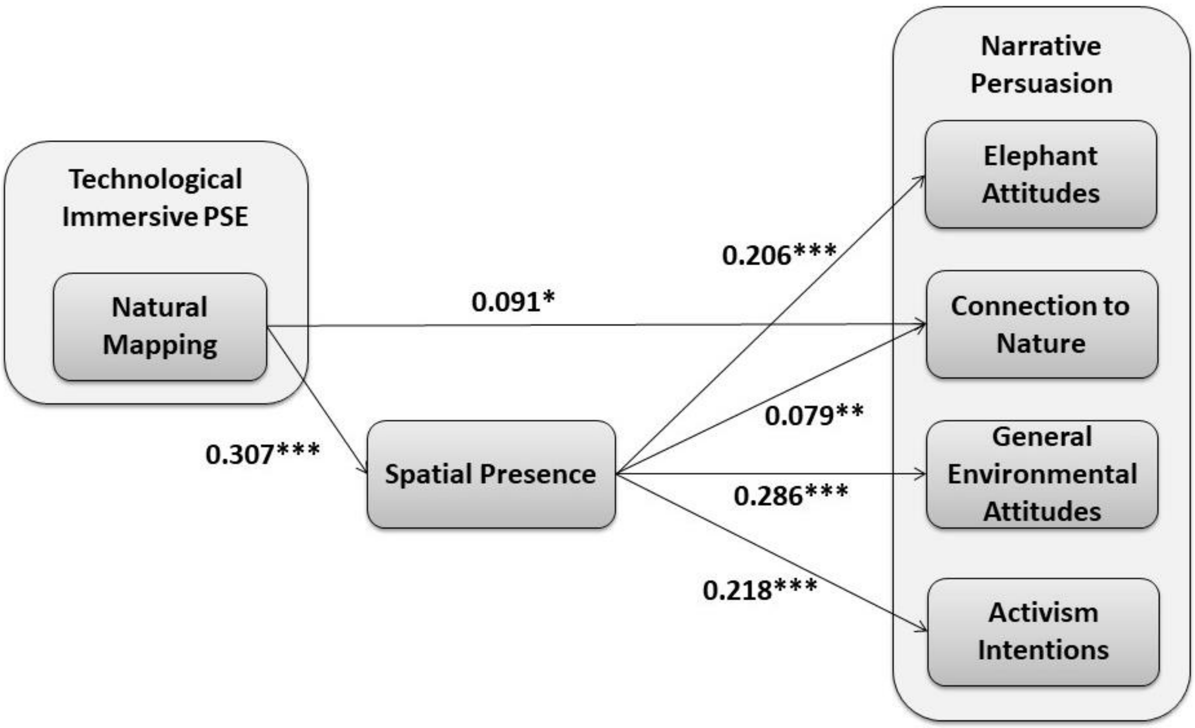

Figure 4: Spatial Presence Partial Mediation

4.8. Narrative Transportation as a Moderator (H7)

In order to explore the potential moderating relationship between narrative transportation and the spatial presence, a single PROCESS path-analysis was conducted. The following PROCESS path-analysis was conducted using Model 1 (moderation). A boot-strapping method of 5000 samples was employed. In this model, controls included participants' race, gender, age, hand dominance, video game experience, VR experience, and level of motion sickness. The unstandardized Beta coefficients are reported. See Table 17 below for more detailed regression results.

In the model, participants' feeling of spatial presence was regressed on natural mapping (i.e., perceived controller intuitiveness) and narrative transportation. Narrative transportation did not have a moderating effect on the relationship between natural mapping and spatial presence (95% CI [-0.156, 0.002]). However, both participants' perception of perceived controller intuitiveness (*B* = 0.430, p = .004) and their feeling of narrative transportation (*B* = 0.774, p < .000) were statistically significant predictors of spatial presence. Therefore, narrative transportation does not have the hypothesized moderating effect on the relationship between natural mappings and spatial presence; however, there is a positive relationship between narrative transportation and spatial presence. Approximately 42% of the variation in spatial presence was explained by the PROCESS model ($R^2 = .418$, $F(12, 160) = 9.557$, $p < .001$). **Regardless, H7 was not supported.** See Table 17 below for more detailed PROCESS results. See Figure 5 below for a visual representation of the relationship between narrative transportation and spatial presence.

Table 17: PROCESS Results: Moderating Effects of Narrative Transportation

	Coefficients	SE	Bootstrap 95% CI Lower	Bootstrap 95% CI Upper
Direct Effects				
NM → Spatial **	0.430	0.145	0.144	0.717
NT → Spatial ***	0.774	0.220	0.340	1.208
Moderating Effect				
NM × NT → Spatial	-0.077	0.040	-0.156	0.002

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Notes: Bootstrap sampling = 5000, CI = Confidence interval, NM = Natural mapping, NT = Narrative transportation, controls included race, gender, age, hand dominance, video game experience, and virtual reality experience, unstandardized Beta coefficients are reported

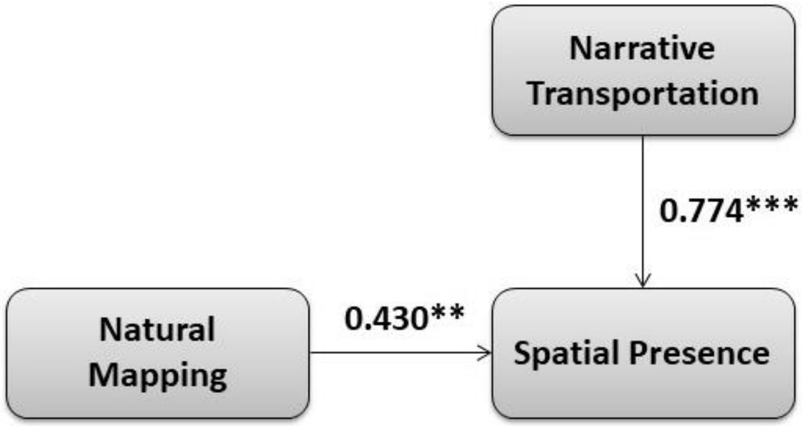

Figure 5: Variables Predicting Spatial Presence

4.9. Narrative Transportation as a Partial Mediator (H8)

A series of PROCESS path-analyses were also conducted to explore the potential mediating relationship between narrative transportation and the outcome variables. The following PROCESS path-analyses were conducted using Model 4 (mediation) with a boot-strapping method of 5000 samples. In keeping with the above analyses, participants' race, gender, age, hand dominance, political ideology, general environmental attitudes, video game experience, VR experience, and level of motion sickness were controlled. The unstandardized Beta coefficients are reported. See Table 18 and Table 19 below for more detailed regression results.

First, a series of path-analyses were conducted to examine if narrative transportation was a partial mediator between narrative interactivity (i.e., perceived content interactivity) and participants' environmental attitudes (i.e., elephant attitudes, general environmental attitudes, and connection to nature). In the first model, participants' elephant attitudes were regressed on perceived content interactivity and narrative transportation. Narrative transportation ($B = 0.147$, $p < .001$) was a statistically significant predictor or elephant attitudes while perceived content interactivity was not ($B = 0.042$, $p = .145$). However, the indirect effect from perceived content interactivity to narrative transportation and then to elephant attitudes was statistically significant (95% CI [0.013, 0.069]). In other words, narrative transportation was a mediator between narrative interactivity (i.e., perceived content interactivity) and elephant attitudes. A statistically significant proportion of variance in elephant attitude scores was explained by the model (R^2 = .484, *F*(12, 160) = 12.501, p < .001).

Next, the participants' general environmental attitudes were examined. Again, participants' general environmental attitudes were predicted by narrative transportation (*B* = 0.059, p = .014) while perceived content interactivity was not a predictor (*B* = 0.008, p = .642). Mediation was found as the indirect effect from perceived content interactivity to narrative transportation and then to environmental attitudes was statistically significant (95% CI [0. 004, 0. 029]). Therefore, narrative transportation was a mediator between narrative interactivity (i.e., perceived content interactivity) and general environmental attitudes. The mediation model was statistically significant (R^2 = .808, *F*(12, 160) = 56.245, p < .001).

Finally, the participants' feelings of being connected to nature were regressed on perceived content interactivity and narrative transportation. Both participants' perception of content interactivity (*B* = 0.118, p < .001) and narrative transportation were statistically significant predictors of connectedness to nature (*B* = 0.207, p < .001). Narrative transportation was found to be a mediator as the indirect effect was statistically significant (95% CI [0.026, 0.084]). In this case, narrative transportation was a partial mediator between narrative interactivity (i.e., perceived content interactivity) and connectedness to nature. Approximately 46% of the variation in connection to nature was explained by the variables in the model (R^2 = .460, *F*(12, 160) = 11.341, p < .001). Overall, these findings indicate that narrative transportation was a mediator between narrative interactivity and participants' environmental attitudes. **Therefore, H8a was supported.** See Table 18 below for more detailed PROCESS results. Also, see Figure 6 below for a visual representation of the results.

Table 18: PROCESS Results: Direct and Indirect Effects of Narrative Interactivity and Narrative Transportation on Environmental Attitudes

			Bootstrap 95% CI	
	Coefficients	**SE**	**Lower**	**Upper**
Direct Effects				
NI → Elephant	0.042	0.029	-0.015	0.099
NT → Elephant***	0.147	0.042	0.063	0.232
NI → Environment	0.008	0.016	-0.024	0.039
NT → Environment**	0.059	0.024	0.012	0.107
NI → Connection***	0.118	0.027	0.065	0.172
NT → Connection***	0.207	0.040	0.127	0.286
			Bootstrap 95% CI	
	Effect size	**Bootstrap SE**	**Lower**	**Upper**
Indirect Effects				
NI → NT → Elephant*	0.037	0.014	0.013	0.069
NI → NT → Environment*	0.015	0.007	0.004	0.029
NI → NT → Connection*	0.052	0.015	0.026	0.084

N=173. *$p < 0.05$. **$p < 0.01$. *** $p < 0.001$.
Notes: Bootstrap sampling = 5000, CI = Confidence interval, NI = Narrative interactivity, NT = Narrative transportation, controls included race, gender, age, hand dominance, political ideology, general environmental attitudes (pretest), video game experience, and virtual reality experience, unstandardized Beta coefficients are reported

Second, two additional path-analyses were conducted to examine if narrative transportation was a mediator between narrative interactivity (i.e., perceived content interactivity) and participants' behavioral intentions (i.e., activism intentions and support for conservation). In the first model participants' activism intentions were examined. Narrative transportation was a statistically significant predictor of their activism intentions ($B = 0.228$, $p < .001$) while perceived content interactivity was not a predictor ($B = 0.012$, $p = .708$). The indirect effect from perceived content interactivity to narrative transportation and then to activism intentions was statistically significant (95% CI [0.027, 0.094]). In other words, narrative transportation was a mediator between narrative interactivity (i.e., perceived content interactivity) and activism intentions. The above mediation model explained a statistically significant proportion of variance in activism intention scores ($R^2 = .452, F(12, 160) = 11.017, p < .001$).

In the second model participants' support for conservation was regressed on perceived content interactivity and narrative transportation. Neither participants' perception of content interactivity ($B = -0.060, p = .675$) nor narrative transportation ($B = 0.089, p = .067$) were statistically significant predictors of their support for conservation. The indirect effect from perceived controller intuitiveness to spatial presence and then to support for conservation was also not statistically significant (95% CI [-0.002, 0.052]). In this case, neither narrative interactivity nor narrative transportation were related to participants' support for conservation. However, the mediation model still explained a statistically significant proportion of variance in support for conservation scores ($R^2 = .475, F(12, 160) = 12.042, p < .001$). Overall, these findings indicate that narrative transportation was only a mediator between narrative interactivity and some of the participants' behavioral intentions (i.e., activism intentions). **Therefore, H8b was partially supported.** See Table 19 below for more detailed PROCESS results. See Figure 6 below for a visual representation of the mediating relationship between narrative interactivity, narrative transportation, and the outcome variables.

Table 19: PROCESS Results: Direct and Indirect Effects of Narrative Interactivity and Narrative Transportation on Behavioral Intentions

			Bootstrap 95% CI	
	Coefficients	**SE**	**Lower**	**Upper**
Direct Effects				
NI → Activism	0.012	0.031	-0.050	0.074
NT → Activism***	0.228	0.047	0.136	0.320
NI → Conservation	-0.060	0.032	-0.124	0.004
NT → Conservation	0.089	0.048	-0.006	0.184
			Bootstrap 95% CI	

Table 19 (cont'd)

	Effect size	Bootstrap SE	Lower	Upper
Indirect Effects				
NI → NT → Activism*	0.058	0.017	0.027	0.094
NI → NT → Conservation	0.023	0.014	-0.002	0.052

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Notes: Bootstrap sampling = 5000, CI = Confidence interval, NM = Natural mapping, SP = Spatial presence, controls included race, gender, age, hand dominance, political ideology, general environmental attitudes (pretest), video game experience, and virtual reality experience, unstandardized Beta coefficients are reported

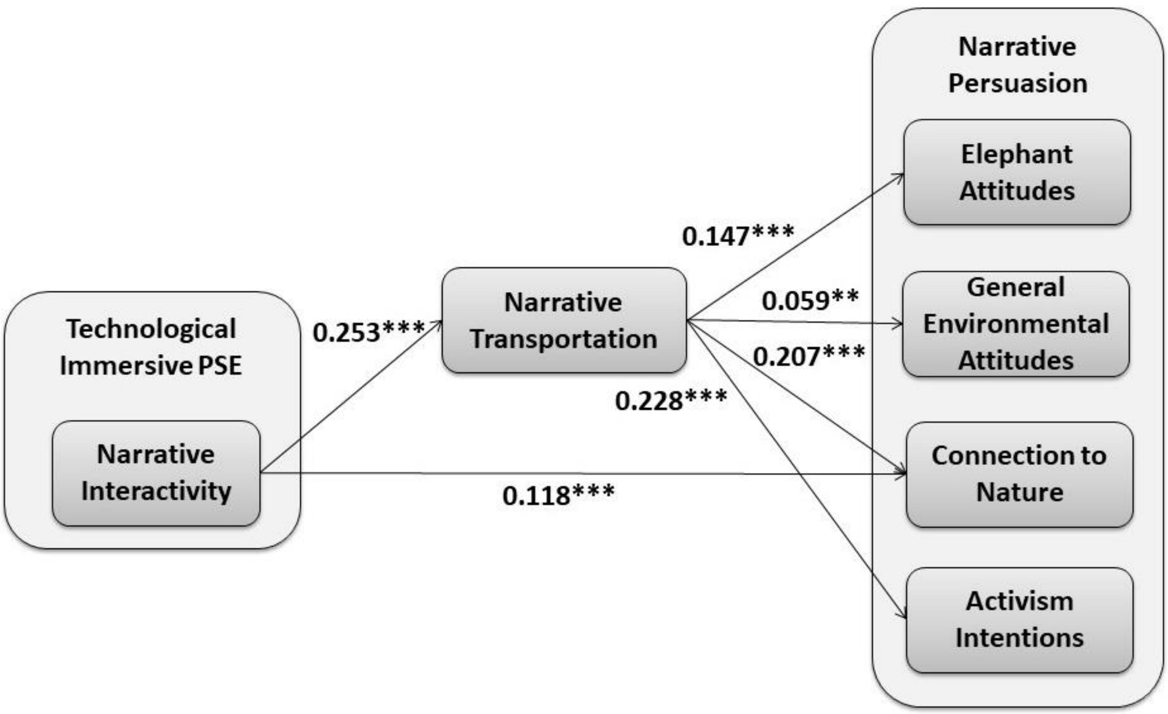

Figure 6: Narrative Transportation Partial Mediation

4.10. Spreading Activation Results (RQ1)

Finally, this study also explores the possibility of spreading activation effects from one natural environment (i.e., the savannah) to another environment (i.e., the ocean). In order to explore this possibility, another series of PROCESS path-analyses were conducted with participants' oceanic attitudes as the dependent variable. The following PROCESS path-analyses were conducted using Model 4 (mediation). A boot-strapping method of 5000 samples was employed. Controls included participants' race, gender, age, hand dominance, political ideology, oceanic attitudes from the pretest, video game experience, VR experience, and level of motion sickness. The unstandardized Beta coefficients are reported. See Table 20 below for more detailed PROCESS results.

First, the participants' oceanic attitudes were regressed on perceived content interactivity and narrative transportation. Participants' perception of content interactivity (*B* = 0.018, p = .259) was not a statistically significant predictor of oceanic attitudes. However, narrative transportation was a statistically significant predictor of oceanic attitudes (*B* = 0.081, $p < .001$). The indirect effect from perceived content interactivity to narrative transportation and then to oceanic attitudes was statistically significant (95% CI [0.007, 0.035]). In other words, both narrative interactivity and narrative transportation within the savannah environment were positively associated with participants' oceanic attitudes after the experience, though the effect of narrative interactivity was indirect via narrative transportation. Approximately 83% of the variation in oceanic attitudes was explained by the variables in the mediation model ($R^2 = .831$, $F(12, 160) = 65.497$, $p < .001$). See Figure 7 below for a visual representation of the partial mediation relationship.

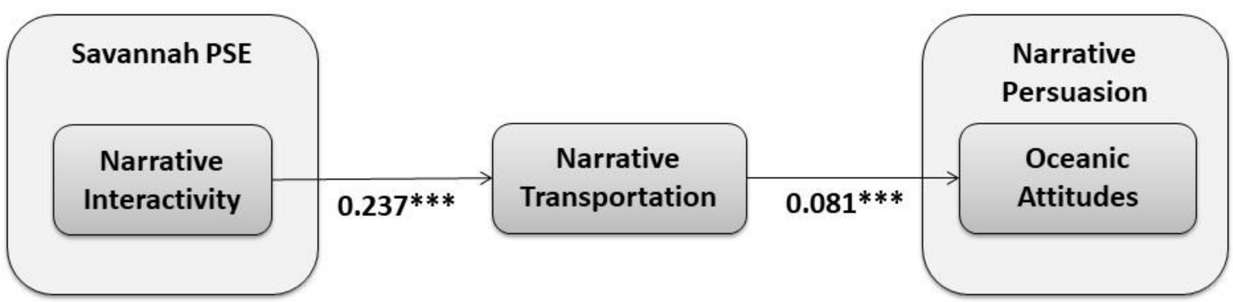

Figure 7: Model of Partial Mediation

Second, participants' oceanic attitudes were regressed on perceived controller intuitiveness and spatial presence. Spatial presence was a statistically significant predictor of ocean attitudes (B = 0.130, p < .001) while perceived controller intuitiveness was not (B = 0.001, p = .962). A mediating relationship was found as the indirect effect from perceived controller intuitiveness to spatial presence and then to ocean attitudes was statistically significant (95% CI [0.0190, 0.064]). In other words, spatial presence, and, indirectly, naturally mapped locomotion within the savannah environment were positively associated with participants' oceanic attitudes after the experience. The PROCESS mediation model explained a statistically significant proportion of variance in oceanic attitudes scores (R^2 = .836, F(12, 160) = 67.954, p < .001). **Therefore, it would appear that there is a spreading activation effect from the savannah environment experience to ocean-related attitudes, thus answering the proposed research question (RQ1).** See Figure 8 below for a visual representation of the mediation relationship.

Table 20: PROCESS Results: Direct and Indirect Effects on Oceanic Attitudes

			Bootstrap 95% CI	
	Coefficients	**SE**	**Lower**	**Upper**
Direct Effects				
NI → Ocean	0.018	0.016	-0.013	0.049
NT → Ocean***	0.081	0.024	0.034	0.129
NM → Ocean	0.001	0.023	-0.044	0.046
SP → Ocean***	0.130	0.029	0.072	0.188
			Bootstrap 95% CI	
	Effect size	**Bootstrap SE**	**Lower**	**Upper**
Indirect Effects				
NI → NT → Ocean*	0.019	0.007	0.007	0.035
NM → SP → Ocean*	0.039	0.012	0.019	0.064

N=173. *p < 0.05. **p < 0.01. *** p < 0.001.
Notes: Bootstrap sampling = 5000, CI = Confidence interval, NI = Narrative interactivity, NT = Narrative transportation, NM = Natural mapping, SP = Spatial presence, controls included race, gender, age, hand dominance, political ideology, oceanic attitudes (pretest), video game experience, and virtual reality experience, unstandardized Beta coefficients are reported

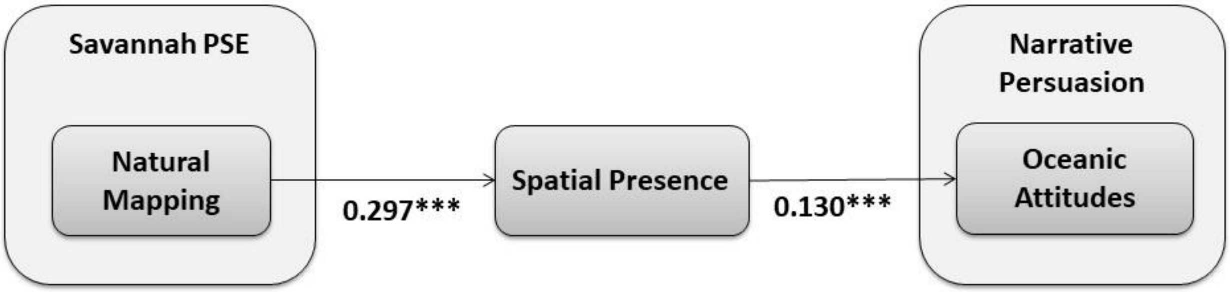

Figure 8: Model of Complete Mediation

CHAPTER 5: DISCUSSION

5.1. Overview of Findings and Revised Conceptual Frameworks

The present chapter begins with a brief overview of the findings derived from the analysis and a revised conceptual model. See Table 21 below for a summary of the hypotheses and the results of this study. First, this study sought to examine participants' perceptions of narrative interactivity and naturally mapped movement across multiple dimensions. As hypothesized, participants in the interactivity condition reported greater perceptions of narrative interactivity across both technical and content dimensions. Meanwhile, arm-swinging was considered to be the most natural locomotion system while teleportation was reported to be the most intuitive.

Table 21: Results of Hypotheses

Hypothesis #	Hypothesis	Results
Hypothesis 1 (H1)	Participants' perceived natural mapping will be positively associated with participants' reported feelings of spatial presence.	H1: Supported
Hypothesis 2 (H2)	Spatial presence will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.	H2a: Supported H2b: Partially Supported
Hypothesis 3 (H3)	Spatial presence will mediate the relationship between perceived natural mapping and participants' (a) environmental attitudes and (b) behavioral intentions.	H3a: Supported H3b: Partially Supported
Hypothesis 4 (H4)	Participants' perceived narrative interactivity will be positively associated with participants' reported feelings of narrative transportation.	H4: Supported
Hypothesis 5 (H5)	Participants' perceived narrative interactivity will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.	H5a: Partially Supported H5b: Partially Supported
Hypothesis 6 (H6)	Narrative transportation will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.	H6a: Supported H6b: Partially Supported

Table 21 (cont'd)

Hypothesis 7 (H7)	Narrative transportation will moderate the relationship between perceived controller naturalness and spatial presence.	H7: Rejected
Hypothesis 8 (H8)	Narrative transportation will partially mediate the relationship between narrative interactivity and participants' (a) environmental attitudes and (b) behavioral intentions.	H8a: Supported H8b: Partially Supported

The first hypothesis predicted that participants' perceptions of natural mapping would be associated with their subsequent feeling of being spatially present in the virtual environment. Perceived controller intuitiveness was a positive predictor of participants' reported feelings of spatial presence. Therefore, the first hypothesis was supported.

The second hypothesis posited that participants' feelings of being spatially present in the virtual environment would be positively associated with their subsequent (a) environmental attitudes and (b) behavioral intentions. Spatial presence was a positive predictor of all three of the environmental attitude dimensions (i.e., elephant attitudes, general environmental attitudes, and connectedness to nature) and some behavioral intentions (i.e., activism intentions). Possible explanations for the lack of support for conservation change are discussed in subsequent sections. Therefore, H2a was supported by these findings and H2b was partially supported.

The third hypothesis predicted that spatial presence would mediate the relationship between participants' perceived naturally mapped movement and their subsequent (a) environmental attitudes and (b) behavioral intentions. Spatial presence was a complete mediator between natural mapping (i.e., perceived controller intuitiveness) and most of the participants' environmental attitudes (i.e., elephant attitudes and general environmental attitudes) while it was a partial mediator for connectedness to nature. Spatial presence was a complete mediator (i.e., the entirety of the effect of natural mapping was transmitted indirectly via spatial presence) of the relationship between natural mapping and participants' activism intentions. Therefore, H3a was supported based on these findings and H3b was partially supported.

The fourth hypothesis posited that narrative interactivity would positively predict participants' feelings of narrative transportation during the virtual experience. Perceived content interactivity was a positive predictor of participants' reported feelings of narrative transportation. Therefore, the fourth hypothesis was supported.

The fifth hypothesis predicted that participants' perceived narrative interactivity would be positively associated with their (a) environmental attitudes and (b) behavioral intentions. Narrative interactivity (i.e., perceived content interactivity) was a positive predictor of participants' elephant attitudes and connectedness to nature. However, narrative interactivity was not a statistically significant predictor of general environmental attitudes. This is most likely due to controlling participants' general environmental attitudes from the pretest. Perceived narrative interactivity was a positive predictor of participants' activism intentions but not their support for conservation, which is discussed later in this chapter. Therefore, H5a and H5b were both partially supported.

The sixth hypothesis posited that participants' feelings of narrative transportation during the virtual experience would be positively associated with their subsequent (a) environmental attitudes and (b) behavioral intentions. Narrative transportation was a positive predictor of all three of the environmental attitude dimensions (i.e., elephant attitudes, general environmental attitudes, and connectedness to nature). Narrative transportation was also a positive predictor of some behavioral intentions (i.e., activism intentions), but not others (i.e., support for conservation). Reasons for the lack of an association between narrative transportation and support for conservation are discussed in the following sections. Therefore, H6a was supported and H6b was partially supported.

The seventh hypothesis predicted narrative transportation would moderate the relationship between perceived controller naturalness and spatial presence. Narrative transportation did not have a moderating effect on the relationship between natural mapping and spatial presence. However, narrative transportation did positively predict participants' feelings of spatial presence. So while the narrative transportation is not a moderator, it is still related to spatial presence. Nevertheless, H7 was not supported based on these findings.

The eighth hypothesis posited that narrative transportation would partially mediate the relationship between participants' perceived narrative interactivity and their subsequent (a) environmental attitudes and (b) behavioral intentions. Narrative transportation was a complete mediator between narrative interactivity (i.e., perceived content interactivity) and participants' elephant attitudes and general environmental attitudes while it was a partial mediator for connectedness to nature. Narrative transportation was a complete mediator (i.e., the entirety of the effect of narrative interactivity was transmitted indirectly via narrative transportation) between narrative transportation and participants' activism intentions. Therefore, H8a was supported and H8b was partially supported. Based on the above findings I proposed a revised conceptual framework.

In chapter 2, I proposed a possible conceptual framework for PSEs based on the literature (See Figure 2). I am now able to propose a revised conceptual framework for PSEs (see Figure 9). There are three primary differences between the two proposed conceptual frameworks. First, spatial presence was originally hypothesized to completely mediate the relationship between natural mapping and environmental attitudes. Spatial presence was found to be a partial mediator. Specifically, natural mapping both directly and indirectly predicted participants' connection to nature. This finding is most likely due to an underestimation of the power of controller intuitiveness for creating connections with virtual environments. In other words, it is possible that by focusing less on controls and more on the virtual world, participants were able to foster greater feelings of connection to nature.

Second, narrative transportation was hypothesized to moderate the relationship between natural mapping and spatial presence. Narrative transportation did not moderate this relationship; rather it positively predicted spatial presence. A possible explanation for this finding is that the relationship between narrative transportation and spatial presence is more direct than anticipated. The feeling of being transported into a virtual narrative appears to be positively associated with the feeling of being transported into the virtual environment (i.e., spatial presence). In other words, stories in VR may help us to connect with places in VR.

Third, the original conceptual model hypothesized that the immersive PSE would impact both participants' environmental attitudes (i.e., elephant attitudes, general environmental attitudes, and connection to nature) and behavioral intentions (i.e., support for conservation and activism intentions). These hypotheses were largely supported; however, none of the models were able to predict statistically significant changes in participants' support for conservation. Therefore, this variable was removed from the final proposed conceptual framework. Possible reasons for this lack of support are discussed in subsequent sections. Finally, it should be noted that the revised conceptual framework was based on separate PROCESS path-analyses because analyzing the full model was outside the scope of the present study. Future studies may wish to conduct a structural equation model (SEM) path-analysis to delve deeper into potential interrelationships between these variables.

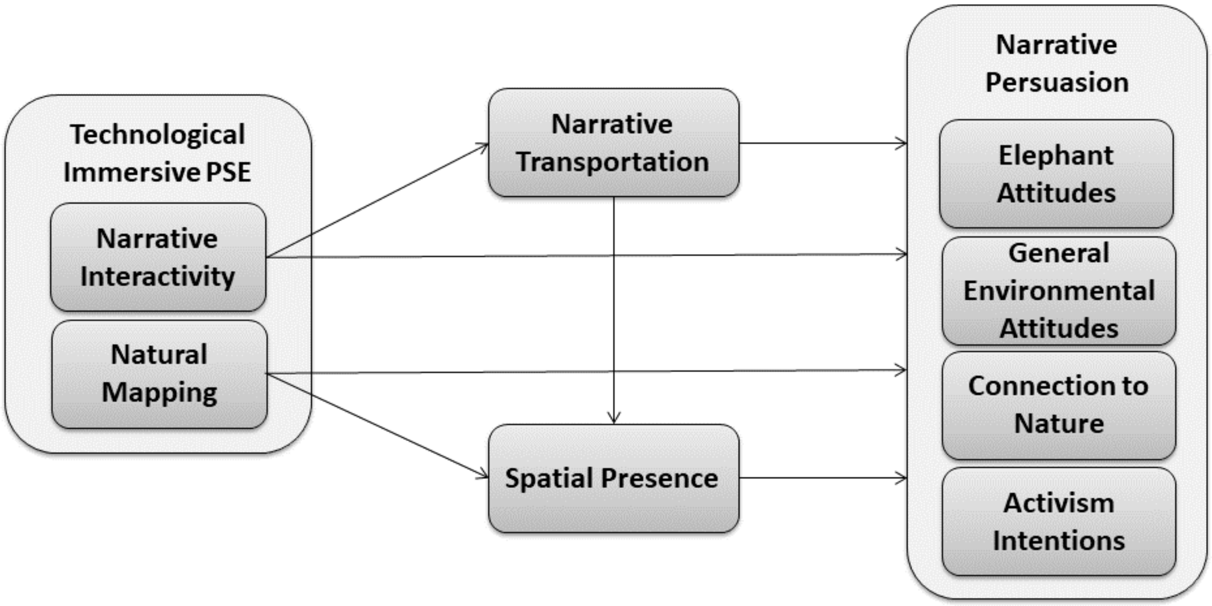

Figure 9: Revised Conceptual Framework

Finally, the only exploratory research question in this study examined the possibility that the experiences in one virtual environment (i.e., the savannah) might have a spreading activation effect to other environments (i.e., the ocean). Both narrative interactivity (i.e., perceived content interactivity) and narrative transportation within the savannah environment positively predicted participants' oceanic attitudes. Likewise, both spatial presence, and, indirectly naturally mapped locomotion within the savannah environment were positively associated with participants' oceanic attitudes. Therefore, based on these findings it would appear that experiences in one kind of virtual environment can have a spreading activation effect on other environments. See Figure 10 below for a representation of the proposed combined mediating model. Once again, the proposed conceptual framework was based on separate PROCESS path-analyses because analyzing the full model was outside the scope of the present study.

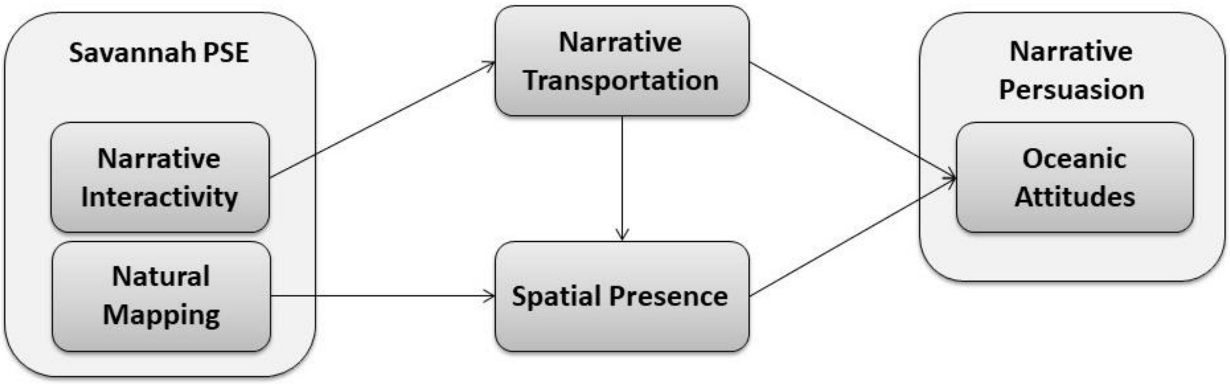

Figure 10: Proposed Combined Mediating Model

5.2. Summary of Natural Mapping and Spatial Presence Findings

One of the practical challenges which may hinder the adoption of VR technology, and the subsequent viability of PSEs, is the conflict between *limitless* virtual worlds and *limited* real-world spaces (Multon & Olivier, 2013; Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013). One possible option to remedy this conflict has been cost-prohibitive treadmills (Nilsson, Serafin, Laursen, et al., 2013; Virtuix, 2017). In this study, I posited that we may be able to address this issue via a better understanding of “natural locomotion” in VR via the natural mapping literature (Dannatt et al., 2016; Norman, 1988; Skalski et al., 2011). Using a definition of natural mapping which included the ability of a system to map its controls in both a “natural” and “predictable” manner, I conceptualized perceived controller naturalness across two dimensions (i.e., naturalness and intuitiveness) (Steuer, 1992).

One of the contributions of this study is a more nuanced understanding of the importance of naturally mapped controls and their perceived gradient differences. Naturally mapped locomotion is actually a multidimensional concept in which naturalness and intuitiveness are perceived differently, with different effects, based on technological affordances (Skalski et al., 2011). Specifically, in line with previous studies, this study found that participants reported the greatest locomotion *naturalness* in the arm-swinging condition (i.e., the realistic natural mapping condition) (Nilsson, Serafin, & Nordahl, 2013; Skalski et al., 2011). In this case, participants reported that the arm-swinging controller input method was the most similar to walking in real life followed by directional movement and teleportation respectively. However, interestingly, participants reported the greatest locomotion *intuitiveness* in the teleportation condition (i.e., the incomplete natural mapping condition). In other words, participants reported that using the teleportation controller input method was the most intuitive to use followed by directional and arm-swinging respectively. This finding may be due to the simplicity of the teleportation control scheme when compared to the arm-swinging control scheme. Specifically, the arm-swinging control scheme required that buttons where held on both controllers while participants swung their arms. Meanwhile, the teleportation control scheme simply required the use of one button on one controller while pointing in the desired direction. These two distinct dimensions of natural locomotion had different effects on participants' subsequent feelings of spatial presence.

There is a great deal of literature which has examined the relationship between perceived controller naturalness and its positive relationship with the concept of spatial presence in video games (Huang, 2017; Kim & Sundar, 2013; McGloin et al., 2015; Schmierbach et al., 2012; Skalski et al., 2011; Tamborini & Bowman, 2010; Williams, 2014). However, far fewer studies have examined naturally mapped locomotion in the context of VR (i.e., Dannatt et al., 2016; Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013). The concept of spatial presence is important because it has been linked to both naturally mapped controls and experiential outcomes such as enjoyment (McGloin et al., 2011; Shafer et al., 2011). The feeling of being spatially present in VR is also particularly important because it has been linked to immersive PSE effects across multiple studies (Ahn et al., 2016; Ball, 2018).

The results of this study support the above findings by indicating that naturally mapped controls positively predicted spatial presence. However, this study adds to our understanding of this relationship by exploring naturally mapped controls across two dimensions. In this case, perceived controller intuitiveness was actually found to be a predictor of spatial presence while perceived controller naturalness was not. In other words, perceived controller/locomotion intuitiveness was positively related to participants' reported feelings of being spatially present in the virtual environment. Meanwhile, perceived controller/locomotion naturalness was not related to participants' feelings of being spatially present in the virtual environment.

One possible explanation for this finding is that natural mapping is linked to spatial presence via mental models (Roskos-Ewoldsen et al., 2002). Naturally mapped controls contribute to greater feelings of spatial presence because they reduce players focus on the controller inputs which allows for greater focus on the virtual environment (Huang, 2017; Tamborini & Skalski, 2006). Therefore, the ”naturalness” may be less important than the "intuitiveness" of the control scheme, because intuitive controls free more cognitive resources to focus on the virtual environment. This finding contributes to the literature by adding validation to the previous studies that have found a connection between natural mapping and spatial presence (Huang, 2017; McGloin et al., 2011; Seibert & Shafer, 2018; Skalski et al., 2011; Tamborini & Skalski, 2006). Furthermore, to my knowledge, this is the first study which conceptualizes natural mapping as a multi-dimensional concept which in turn has different effects on the formation of spatial presence.

The results of this study also contribute to the literature surrounding PSE effects. Previous studies related to PSEs found that virtual experiences could have a positive effect on various pro-environmental attitudes and behavioral intentions (Ahn et al., 2016; Ball, 2018). The findings from this study support these findings while adding natural mapping to the conceptual model of PSE effects. In this study, both naturally mapped controls (i.e., perceived controller intuitiveness) and spatial presence were positively related to participants' pro-environmental attitudes and behavioral intentions. Specifically, spatial presence was a complete mediator (i.e., the entirety of the effect of natural mapping was transmitted indirectly via spatial presence) between perceived controller intuitiveness and participants' elephant attitudes, general environmental attitudes, and activism intentions. Meanwhile, spatial presence was a partial mediator between perceived controller intuitiveness and participants' feelings of being connected to nature. Lastly, neither perceived controller intuitiveness nor spatial presence was related to participants' support for conservation. This finding is counter to previous studies that found that spatial presence was positively related to support for conservation (Ball, 2018).

One potential reason for this contrary finding is the possibility of history effects. There is currently a growing political divide related to environmental conservation issues such as climate change (Dunlap, McCright, & Yarosh, 2016). I attempted to control for this threat to internal validity by measuring participants' political affiliations. However, this growing political divide might make people less likely to support conversation related tax increases. Therefore, future PSEs may need to be stronger (i.e., longer duration, repeated exposures, etc.) to shift people's increasingly politically entrenched conservational voting habits.

In general, the PSE appeared to have a positive effect on participants' environmental attitudes and behavioral intentions. However, the effect was apparently not strong enough to shift participants' intentions to support conservational efforts on a global/governmental scale. Regardless, these results show promise for the potential of PSEs to serve the community interest via immersive virtual experiences while also demonstrating the importance of both perceived controller/locomotion intuitiveness and spatial presence.

5.3. Summary of Narrative Interactivity and Transportation Findings

Narrative persuasion is a field dedicated to studying and harnessing the persuasive power of stories to disseminate messages (Bilandzic & Busselle, 2013). The study of narrative persuasion is important because it is capable of inciting strong attitudinal and behavioral change (Bandura, 2004; Bilandzic & Busselle, 2013). As a result, the concept of narrative persuasion has been used across numerous fields of study (Durkin & Wakefield, 2008; Escalas, 2007; Moyer-Gusé, 2008). Narrative persuasion has also been examined across numerous traditional technological contexts, such as books and television (Moyer-Gusé et al., 2011; Strange, 2002). One of the contributions of this study is the exploration of VR as a potential vehicle for narrative persuasion. In order to do so, this study examined the importance of narrative interactivity and transportation, which are two potential strengths of VR.

Definitions and conceptualizations of narrative interactivity change based on the medium in question (Green & Jenkins, 2014). As a result, some scholars have examined narrative interactivity as a technological affordance while others have examined it as an affordance of content (Green & Jenkins, 2014; Sundar et al., 2003). Interactivity in the context of VR is defined in this study as the users' perception that they can modify the "form and content of a mediated environment" (Steuer, 1992, p. 14). One of the contributions of this study is that it examines narrative interactivity as a multidimensional concept across both conceptualizations (i.e., both a technological and content related affordance).

Giving participants the ability to alter the virtual environment in positive ways in the context of a personal PSE narrative resulted in greater perceived technological interactivity and greater perceived content interactivity. In other words, participants in the narrative interactivity condition reported greater feelings of being able to alter the virtual environment as well as greater feelings of being able to impact the lives of the wildlife in that virtual environment. This finding is important because it indicates that VR is capable of instilling feelings of narrative interactivity across both dimensions. Furthermore, narrative interactivity should be positively associated with participants' subsequent feelings of narrative transportation, which is another important component of narrative persuasion.

Being transported into a narrative is a psychological state of becoming emotionally and cognitively involved in a story (Green & Jenkins, 2014). Narrative transportation is an important factor which has been shown to contribute to narrative persuasion (Appel & Richter, 2010; Busselle & Bilandzic, 2009; Murphy et al., 2011). Immersive and interactive experiences such as those provided by video games have been found to increase narrative transportation or other similar constructs (Gorini et al., 2011; Sundar et al., 2013). Furthermore, a previous PSE study found that immersive VR was positively associated with narrative engagement, which is a similar concept (Ball, 2018). The two dimensions of narrative interactivity appear to have different impacts on the formation of narrative transportation. Specifically, perceived content interactivity was positively associated with narrative transportation while perceived technical interactivity was not. In other words, participants that felt like they were able to alter the lives of the wildlife in the virtual environment subsequently reported greater feelings of being emotionally and cognitively transported into their personal PSE narrative. However, participants' who reported simply being able to alter the virtual environment did not report greater feelings of being transported into their personal PSE narrative.

This finding may be due to subtle but important differences in our conceptualizations of narrative interactivity, which changes between mediums (Green & Jenkins, 2014). Narrative interactivity in the context of the PSE experience was the ability to alter the virtual environment in positive ways in order to improve the lives of the wildlife inhabitants. Insights may be gleaned by comparing the PSE experience to more traditional media such as “choose your own adventure” stories (Green & Jenkins, 2014). The technical aspect of changing the virtual environment was perhaps akin to turning to the desired page in a choose your own adventure book. The technical ability to turn the page is an essentially meaningless act unto itself. Meanwhile, the ability to positively impact the wildlife was perhaps akin to choosing a narrative path in the same book. The participatory ability to make choices that impact the story appears to be the more meaningful affordance when compared to the simple technical act necessary to make choices.

Therefore, this study contributes to the literature by adding validation to the previous studies which posited a connection between narrative interactivity and narrative transportation (Balakrishnan & Sundar, 2011; Green et al., 2004). Furthermore, this study also contributes to the literature by examining narrative interactivity as a multi-dimensional concept. The two dimensions of narrative interactivity (technical and content) appear to have different effects on the formation of narrative transportation feelings.

Based on previous literature, the narrative interactivity provided by VR should allow users to engage with the message of the PSE experience and bring about positive attitudinal change (Ahn & Bailenson, 2011; Ahn et al., 2015; Green & Jenkins, 2014; Sundar et al., 2013). Furthermore, narrative interactivity should also facilitate narrative transportation (Green et al., 2004) which should, in turn, impact narrative persuasion (Appel & Richter, 2010; Murphy et al., 2011). This study supports the above literature by demonstrating that both narrative interactivity and narrative transportation were positively associated with participants' pro-environmental attitudes and behavioral intentions. Specifically, this study found that narrative transportation was a complete mediator (i.e., the entirety of the effect of narrative interactivity was transmitted indirectly via narrative transportation) of the relationship between perceived content interactivity and participants' elephant attitudes, general environmental attitudes, and activism intentions. Meanwhile, narrative transportation was a partial mediator of the relationship between perceived content interactivity and participants' feelings of being connected to nature. Finally, once again, neither perceived content interactivity nor narrative transportation were related to participants' support for conservation.

As noted in the previous section, a possible explanation for the lack of support for conservation change could be the presence of history effects. Another potential explanation is that the PSE experience may not have perceptible impact on college students' support for conservation until later in their lives when tax contributions are more salient. When younger people have experiences in nature, such as hiking, their support for conservation increases (Zaradic, Pergams, & Kareiva, 2009). However, their support for conservation doesn't occur until 11 to 12 years after the experience when they are older (Zaradic et al., 2009). It would be interesting for future PSE studies to have a longitudinal component to investigate such a possibility.

Narrative transportation may function as a moderator of perceived controller naturalness and spatial presence (Carassa et al., 2004, 2005). However, in other studies, the results indicated a negative relationship between narrative and spatial presence. (Balakrishnan & Sundar, 2011). The results of this study are contrary to both sets of findings. In this study, narrative transportation did not moderate the relationship between perceived controller naturalness and spatial presence. Instead, there was a positive relationship between narrative transportation and spatial presence. In other words, as participants felt more emotionally and cognitively engaged in their personal PSE narrative they reported greater feelings of being spatially present in the virtual environment. The relationships between users' VR experiences and the formation of both narrative transportation and spatial presence are mixed and require further research.

Once again, the PSE experience appeared to have an overall positive effect on participants' environmental attitudes and behavioral intentions. However, the effect was still not strong enough to shift participants' intentions to support conservational efforts on a global/governmental scale. Regardless, these results reveal the potential of PSEs to serve the community interest via demonstrating the importance of both perceived content interactivity, narrative transportation, and ultimately narrative persuasion.

5.4. Summary of Spreading Activation Findings

Previous studies have found that pro-environmental experiences, such as PSEs, can have positive effects on participants' environmental attitudes and behavioral intentions (Ahn et al., 2014; Ahn et al., 2016; Ball, 2018). In these studies, the effects of the PSEs were only measured related to the environment in question. For example, one study demonstrated that an ocean-based PSE had a positive impact on participants' ocean-related attitudes and behavioral intentions (Ball, 2018). One of the contributions of the current study is the exploration of the possibility that attitudinal shifts from one virtual environment/topic might translate/transfer to other environments/topics. In other words, this study explored the possibility of spreading activation effects.

Spreading activation theory posits that we store information/memories in conceptual nodes which exist at intersections with other similar information/memories (Quillian, 1962). In this case, individuals' attitudes and behavioral intentions are stored in their neural network of related information which could be primed by activating other related concepts (Collins & Loftus, 1975). When a person develops an attitude about a specific concept through an experience, it may then become intertwined with other related concepts (Anderson, 1983; Bohner & Dickel, 2011). The concept of spreading activation effects has been applied successfully to avatar and video game research. For example, one study found that avatars in a video game primed both positive and negative attitudes and behaviors (Peña et al., 2009). However, to my knowledge, there have not yet been any studies examining at the capability of VR to prime/activate related nodes. Therefore, this study examined the possibility that attitudes primed during a virtual savannah experience, which included endangered elephants, might activate positive attitudes related to the ocean and endangered whales.

Both spatial presence and narrative transportation during the savannah experience had a positive impact on participants' oceanic attitudes and behavioral intentions, with both narrative transportation and spatial presence serving as a complete mediators. Based on these findings, it would appear that when participants' felt present in the savannah environment and they felt emotionally involved in their personal wildlife narrative, this activated positive attitudes and behavioral intentions related to the ocean and whales. In other words, it would appear that when participants' perceived the locomotion controls as being intuitive, this increased their feelings of being spatially present in the savannah environment which subsequently activated positive oceanic attitudes and behavioral intentions. Likewise, when participants felt like they could impact the lives of the wildlife they then felt more transported into the narrative which subsequently activated their oceanic attitudes and behavioral intentions.

This study adds to the literature by demonstrating that PSEs in particular, and VR technologies in general, have the capability to activate adjacent attitudes and behavioral intentions related to the environment and endangered wildlife. This finding supports other studies that have found that positive experiences and perceptions can become intertwined with other related concepts (Anderson, 1983; Bohner & Dickel, 2011; Peña et al., 2009). However, this finding that VR experiences may prime other related attitudes and behavioral intentions should also be cautionary as researchers and developers should take care that they don't unintentionally prime negative attitudes or behavioral intentions (Peña et al., 2009). In the end, it would appear that PSEs may have the capability to have positive effects outside of the subject matter directly at hand via spreading activation effects.

5.5. Summary of Discussion

One of the goals of this study was to fill a gap in the literature related to gradient differences in immersive factors (Cummings et al., 2012). In this case, the medium level natural mapping condition was found to be the most intuitive compared to the high and low conditions. The results of this study demonstrate that natural mapping should be considered a multidimensional concept in which naturalness and intuitiveness are perceived differently and with different effects. Specifically, I found that arm-swinging locomotion was perceived to be the most natural by participants while teleportation was the least natural. However, I also found that teleportation was perceived to be the most intuitive by participants while arm-swinging was the least intuitive. Furthermore, perceived controller/locomotion intuitiveness was more important than perceived controller/locomotion naturalness during the formation of spatial presence. This finding is particularly important because, in support of the literature, spatial presence was found to be a mediator between natural mapping and participants' pro-environmental attitudes and behavioral intentions (Ahn et al., 2016; Ball, 2018). These results show promise for the potential of PSEs to serve the community via immersive virtual experiences while also demonstrating the importance of both perceived controller/locomotion intuitiveness and spatial presence.

Another goal of this study was to explore the impacts of perceived narrative interactivity in VR on narrative transportation and persuasion (Ahn & Bailenson, 2011; Ahn et al., 2015; Green & Jenkins, 2014; Sundar et al., 2013). Narrative interactivity should also be considered a multidimensional concept in which technical interactivity and content interactivity are distinct with different impacts. Specifically, this study found that those in the narrative interactivity condition reported greater perceived technical as well as content interactivity. However, this study also found that only content interactivity was a predictor of participants' feelings of narrative transportation. This finding is important because, in support of the literature, narrative transportation was found to be a mediator between narrative interactivity and participants' pro-environmental attitudes and behavioral intentions (Appel & Richter, 2010; Murphy et al., 2011). Furthermore, this study contributes to the mixed results of narrative transportation as a mediator/moderator of spatial presence (Balakrishnan & Sundar, 2011; Carassa et al., 2004, 2005). In this study, narrative transportation was not a moderator between perceived controller intuitiveness and spatial presence; however, it was a positive predictor. These results reveal the potential of PSEs to serve the community via demonstrating the importance of both perceived content interactivity, narrative transportation, and ultimately narrative persuasion.

Finally, this study also set out to explore the possibility that VR-based PSE experiences related to one environment (i.e., the savannah) might have a spreading activation effect on other related environments (i.e., the ocean) (Collins & Loftus, 1975; Quillian, 1962). Perceived content interactivity, narrative transportation, perceived controller intuitiveness, and spatial presence during the virtual savannah experience were all related to participants' subsequent oceanic attitudes and behavioral intentions. This finding supports the research related to the priming effects of avatars in video games (Peña et al., 2009). In the end, it would appear that PSEs (and VR in general) are capable of priming associated pro-environmental attitudes and behavioral intentions. This finding is encouraging because it indicates that PSEs may be able to be tailored to have impacts beyond the scope of singular experiences.

5.6. Limitations and Future Directions

While the above findings provide valuable insights into the effects of PSEs, there are still a number of limitations that must be considered. First, college students were the population of interest in this study for reasons related to their lack of awareness related to environmental issues, political engagement, and the potential lack of traditional PSA efficacy (Boyle et al., 2014; Parsons et al., 2010). As a result, the focus on college students limits the generalizability of these findings. Further still, the sample of college students that participated in this study were drawn from a single Midwestern university, thus potentially limiting the generalizability of these findings even more. Future studies should explore the potential impacts of PSEs on other demographics such as children, older adults, and/or other racial and ethnic groups.

Second, while consumer-grade VR equipment has become more much common in recent years, we still cannot ignore the potential for novelty effects. In other words, it is possible that some of the positive effects of the PSE on participants' environmental attitudes and behavioral intentions might be due to the exciting prospect of experiencing VR for the first time. However, this limitation is common among studies that explore the impacts of new and emerging media technologies (Peng et al., 2010). In an attempt to mitigate this limitation, participants' previous VR experience was controlled in all of the relevant analyses. Future studies should continue to strive to control for the possibility of novelty effects while VR continues along its adoption trajectory.

Third, a potential threat to the internal validity of this study is that the pretest may have primed participants for the posttest. In order to limit this possibility, only a small sample of questions (such as participants' general environmental attitudes) were included on both the pretest and the posttest. Relatedly, there is also a possibility that there may have been a response bias present for some of the questions/scales. In other words, participants may have responded in a socially desirable way regarding some of the questions related to their environmental attitudes and behavioral intentions. However, the lack of statistically significant change related to participants' support for conservation may indicate that this was not a consistent problem in this study.

Finally, another limitation of the present study is the use of single-item measures for perceived controller naturalness, perceived controller intuitiveness, perceived technical interactivity, and perceived content interactivity. These questions were created based off of the conceptual definitions used in this study as well as questions used in other similar studies (Skalski et al., 2011; Steuer, 1992). While published scales exist to measure perceived controller naturalness (Seibert, 2014; Skalski et al., 2011), there are no currently published scales that measure perceived *locomotion* naturalness as this is a relatively new concept. As a result, the use of single-item measures for perceived locomotion naturalness is currently a common limitation

(Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013). Future studies should consider validating a "locomotion naturalness scale" which should be comprised of two sub-constructs (i.e., locomotion naturalness and locomotion intuitiveness).

CHAPTER 6: CONCLUSION

Traditional PSAs may be becoming less effective with millennial viewers in a modern multi-media context (Boyle et al., 2014; Paek et al., 2011; Walther et al., 2010). The present study examined the potential of modern consumer-grade VR to disseminate a PSE related to environmental conservation to millennial college students. Overall, the results of this study indicate that the PSE was effective at improving participants' pro-environmental attitudes across a number of important dimensions. Furthermore, the PSE was effective at improving some pro-environmental behavioral intentions. Finally, the results also demonstrated that the chosen PSE had a positive spreading activation effect on participants' pro-environmental attitudes and behavioral intentions related to an environment which was not the subject of the present PSE. Therefore, the present study has both theoretical and practical implications for the literature.

Theoretically, this study builds and expands upon the VR and PSE literature by successfully exploring some of the mechanisms that help to explain VR and PSE effects. First, this study contributes to the literature surrounding natural mapping in a number of ways. The definition of natural mapping which was used in this study posited that natural controls should be both natural and predictable (Steuer, 1992). Participants' perceived naturalness of movement was not as important as the perceived intuitiveness of the movement in this sample. Therefore, natural mapping should be considered a multi-dimensional construct which includes both natural and intuitive dimensions.

Furthermore, the natural mapping literature primarily examines controller naturalness. However, VR provides a new layer of abstraction as the method of movement is often different/distinct from the method of manipulation. In other words, in traditional video games players move and interact using the same system of controls, but in VR participants may interact with the experience using one control scheme while using a completely different method to move. Therefore, these findings support an emerging area of literature which establishes the importance of naturally mapped locomotion in addition to naturally mapped controls (Dannatt et al., 2016; Nilsson, Serafin, Laursen, et al., 2013; Nilsson, Serafin, & Nordahl, 2013).

Finally, this study also filled a gap in the literature by examining gradient differences in naturally mapped locomotion (Cummings et al., 2012). Arm-swinging locomotion was perceived to be the most natural by participants' but it was also the least intuitive. Likewise, teleportation was perceived to be the most intuitive while it was also perceived to be the least natural. Meanwhile, directional movement was consistently perceived as being in the middle. These findings indicate that naturally mapped movement in VR is a very nuanced concept which requires further study and perhaps better user interfaces.

Natural mapping is particularly important because previous studies found that it is often positively related to the formation of spatial presence (Huang, 2017; Kim & Sundar, 2013; McGloin et al., 2015; Schmierbach et al., 2012; Skalski et al., 2011; Tamborini & Bowman, 2010; Williams, 2014). This study supports those studies while examining the importance of natural locomotion in VR. Controller intuitiveness, a dimension of natural locomotion, was a positive predictor of participants' feelings of spatial presence. Furthermore, spatial presence was a mediator between natural mapping and participants' pro-environmental attitudes and behavioral intentions. This finding supports another PSE study which also found that spatial presence served a mediating role (Ball, 2018).

Second, this study also contributes to the literature surrounding narrative persuasion in two ways. The narrative persuasion literature typically examines the persuasive effects of narratives in traditional media contexts such as books or television (Moyer-Gusé et al., 2011; Strange, 2002). This study expands our understanding of narrative persuasion by examining narrative persuasion in the context of VR and PSEs. In particular, this study establishes the importance of narrative interactivity as a contributing factor of persuasion in VR (Green & Jenkins, 2014; Sundar et al., 2003). This study also demonstrates the importance of conceptualizing narrative interactivity as a multi-dimensional construct in which it is both an affordance of technology and content (Steuer, 1992). In other words, in VR, narrative interactivity is both the perceived ability to alter the world (i.e., technical) as well as the perceived ability to impact the story (i.e., content).

This contribution is particularly important when examining the impact of narrative interactivity on narrative transportation, and subsequently participants' environmental attitudes and behavioral intentions. Narrative transportation is an important mechanism which contributes to narrative persuasion (Appel & Richter, 2010; Busselle & Bilandzic, 2009; Murphy et al., 2011). In this study, the perceived ability to impact the narrative was more important than the perceived ability to modify the virtual environment during the formation of narrative transportation. Narrative transportation was then a mediator between narrative interactivity and participants' pro-environmental attitudes and behavioral intentions. These results establish the importance of first-person interactive narrative experiences/narratives in the context of VR as a means to positively influence peoples' environmental attitudes and behavioral intentions.

This study also provides a number of practical implications for the design of VR experiences more broadly, and PSEs more specifically. First, naturally mapped movement in VR is a nuanced multi-dimensional concept which has various implications for the design and development of VR experiences. In particular, findings from this study demonstrate that the naturalness of movement may not be as important as the intuitiveness of movement during VR experiences. While arm-swing locomotion was perceived as being the most natural, it was not intuitive, which reduced its potential impact on spatial presence. Meanwhile, teleportation was not perceived as being natural, but it was intuitive, which increased its potential impact on spatial presence. Therefore, designers and developers should carefully consider which form of locomotion best suits their design objectives because the choice of movement system can have implications for players feelings of spatial presence and ultimately their persuasion.

Second, this study also demonstrates that narrative interactivity is a multi-dimensional concept which has design implications. In this case, the perceived ability to impact the story being told in VR may be more important than the perceived ability to impact the virtual environment. Specifically, the ability to alter the virtual environment was not a predictor of participants' reported feelings of narrative transportation which mediated their environmental attitudes and behavioral intentions. The implication for design is that developers should perhaps focus more on crafting consequences into their VR experiences rather than solely focusing on environmental interactions. In other words, if designers wish to increase narrative transportation and persuasion than it may be more important to show how players can impact the story or the lives of characters rather than how they can impact the immediate environment.

In essence, both narrative interactivity and naturally mapped movement were important factors which impacted participants' subsequent feelings of narrative transportation, spatial presence, and ultimately, their pro-environmental attitudes and behavioral intentions. Building off previous literature, the present study takes important steps towards crafting a new conceptual framework which improves our theoretical understanding of persuasion in VR. The PSE experience of spending time with virtual wildlife in a savannah environment had positive effects on college students' environmental attitudes and behavioral intentions, even across environmental types. These findings are encouraging, as they demonstrate the potential for VR to effectively disseminate pro-social messages via experience. In the end, with the persuasive power of VR, we now have the ability to illustrate life via experience in new and exciting ways.

APPENDICES

APPENDIX A. Inventory of Scale Items

Spatial Presence (Hartmann et al., 2016) (α= 0.87)

1. I felt like I was actually there in the environment.[M]
2. It seemed as though I actually took part in meeting the animals.[M]
3. It was as though my true location had shifted to the environment.[M]
4. I felt as though I was physically present in the environment.[M]
5. The animals gave me the feeling that I could do things with them.[M]
6. I had the impression that I could be active in the environment.[M]
7. I felt like I could move around among the animals in the environment.[M]
8. It seemed to me that I could do whatever I wanted in the environment.[M]

Narrative Transportation (Green & Brock, 2000) (α= 0.75)

1. The narrative experience affected me emotionally[M]
2. The events in the narrative experience are relevant to my everyday life[M]
3. The events in the narrative experience have changed my life[M]

General Environmental Attitudes (Dunlap et al., 2000) (α= 0.81)

1. We are approaching the limit of the number of people the earth can support
2. Humans have the right to modify the natural environmental to suit their needs[R]
3. When humans interfere with nature it often produces disastrous consequences
4. Humans are severely abusing the environment
5. The earth has plenty of natural resources if we just learn how to develop them[R]
6. Plants and animals have as much right as humans to exist
7. The balance of nature is strong enough to cope with the impacts of modern industrial nations[R]
8. Despite our special abilities humans are still subject to the laws of nature
9. The so-called "ecological crisis" facing humankind has been greatly exaggerated[R]
10. The earth is like a spaceship with very limited room and resources
11. Humans were meant to rule over the rest of nature[R]
12. The balance of nature is very delicate and easily upset
13. Humans will eventually learn enough about how nature works to be able to control it[R]
14. If things continue on their present course, we will soon experience a major ecological catastrophe

Elephant Attitudes (Hacker & Miller, 2016) (α= 0.85)

1. Humans have the right to modify nature even if it impacts elephants.[R]
2. I am troubled by the well-being of elephants.
3. It is important to have elephants in the wild.
4. I am concerned about elephants being killed.
5. Elephants in the wild cause more harm than good.
6. Elephants are an important part of nature.
7. It is important to protect elephants.

Oceanic Attitudes (The Ocean Project, 2009) (α= 0.88)

1. Protecting the ocean should be a priority for the government.

2. Protecting the ocean is an important part of protecting the environment.
3. The world's ocean is endangered.
4. The world's ocean is fragile.
5. I worry about the health of the world's ocean.
6. I am worried about the future health of the ocean.
7. I would pay more for seafood at a restaurant to positively impact ocean health.
8. I would change my seafood eating habits to protect and/or preserve an endangered species.
9. Pollution poses a serious risk to the health of the world's ocean.
10. I would donate money to help conserve the world's ocean.

Connectedness to Nature (Mayer & Frantz, 2004) (α= 0.82)

1. I often feel a sense of oneness with the natural world around me.
2. I think of the natural world as a community to which I belong.
3. I recognize and appreciate the intelligence of other living organisms.
4. I often feel disconnected from nature. [R]
5. When I think of my life, I imagine myself to be part of a larger cyclical process of living.
6. I often feel a kinship with animals and plants.
7. I feel as though I belong to the Earth as equally as it belongs to me.
8. I have a deep understanding of how my actions affect the natural world.
9. I often feel part of the web of life.
10. I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.
11. Like a tree can be part of a forest, I feel embedded within the broader natural world.
12. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature. [R]
13. 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.
14. My personal welfare is independent of the welfare of the natural world.

Activism Intentions (Milfont & Duckitt, 2010) (α= 0.87)

1. If I ever get extra income I will donate some money to an environmental organization.
2. I would like to join and actively participate in an environmentalist group.
3. I don't think I would help to raise funds for environmental protection.[R]
4. I would NOT get involved in an environmentalist organization.[R]
5. Environmental protection costs a lot of money. I am prepared to help out in a fund-raising effort.
6. I would not want to donate money to support an environmentalist cause.[R]
7. I would NOT go out of my way to help recycling campaigns.[R]
8. I often try to persuade others that the environment is important.
9. I would like to support an environmental organization.
10. I would never try to persuade others that environmental protection is important.[R]

Support for Conservation (Milfont & Duckitt, 2010) (α= 0.87)

1. Industry should be required to use recycled materials even when this costs more than making the same products from new raw materials.

2. Governments should control the rate at which raw materials are used to ensure that they last as long as possible.
3. Controls should be placed on industry to protect the environment from pollution, even if it means things will cost more.
4. People in developed societies are going to have to adopt a more conserving life-style in the future.
5. The government should give generous financial support to research related to the development of alternative energy sources, such as solar energy.
6. I don't think people in developed societies are going to have to adopt a more conserving life-style in the future.[R]
7. Industries should be able to use raw materials rather than recycled ones if this leads to lower prices and costs, even if it means the raw materials will eventually be used up.[R]
8. It is wrong for governments to try and compel business and industry to put conservation[R] before producing goods in the most efficient and cost effective manner.[R]
9. I am completely opposed to measures that would force industry to use recycled materials if this would make products more expensive.[R]
10. I am opposed to governments controlling and regulating the way raw materials are used in order to try and make them last longer.[R]

Narrative Interactivity

1. I feel like I was able to modify and change the virtual environment.
2. I feel like I was able to make an impact on the lives of the wildlife in the virtual environment.

Natural Mapping

1. The way I walked through the environment was similar to walking in real life.
2. I felt like the controls allowed me to move around the environment in an intuitive way.

Motion Sickness (Kennedy et al., 1993) ($\alpha = 0.83$)

1. General discomfort
2. Nausea
3. Dizziness with eyes open
4. Dizziness with eyes closed

VR Experience

1. On average, over the past month, how often did you use virtual reality (i.e., Oculus Rift, PSVR, HTC Vive, Samsung Gear VR)?

Game Console Experience

1. On average, over the past month, how often did you play console video games (i.e., Xbox One, PlayStation 4, etc.)?

Ideological Self-Placement

1. Do you consider yourself to be…(1=Very liberal, 5=Very conservative)

Hand Dominance

1. With which hand do you normally use to write?

Gender
1. Your Gender

Age
1. How old are you?

Class
1. What year of college are you in?

Race
1. How do you identify yourself (please check all that apply)

Note 1: ^{R} indicates an item that is reverse coded
Note 2: ^{M} indicates an item that was modified to fit the subject matter

APPENDIX B. Summary of Hypotheses, Analyses, and Variables

Appendix B: Summary of Hypotheses, Analyses, and Variables

Hypothesis #	Hypothesis	Analytic Technique	Variables	Time Period
Hypothesis 1	Participants' perceived natural mapping will be positively associated with participants' reported feelings of spatial presence.	OLS Regression	Perceived Natural Mapping, Spatial Presence, Controls	Time 2 (posttest)
Hypothesis 2	Spatial presence will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.	OLS Regression	Spatial Presence, Connectedness to Nature, General Environmental Attitudes, Support for Conservation, Activism Intentions, Elephant Attitudes, Controls	Time 1 (pretest) Time 2 (posttest)
Hypothesis 3	Spatial presence will mediate the relationship between perceived natural mapping and participants' (a) environmental attitudes and (b) behavioral intentions.	PROCESS path-analyses (Model 4)	Spatial Presence, Perceived Natural Mapping, Connectedness to Nature, General Environmental Attitudes, Support for Conservation, Activism Intentions, Elephant Attitudes, Controls	Time 1 (pretest) Time 2 (posttest)

Appendix B (cont'd)				
Hypothesis 4	Participants' perceived narrative interactivity will be positively associated with participants' reported feelings of narrative transportation.	OLS Regression	Perceived Narrative Interactivity, Narrative Transportation, Controls	Time 2 (posttest)
Hypothesis 5	Participants' perceived narrative interactivity will be positively associated with participants' (a) environmental attitudes and (b) behavioral intentions.	OLS Regression	Perceived Narrative Interactivity, Connectedness to Nature, General Environmental Attitudes, Support for Conservation, Activism Intentions, Elephant Attitudes, Controls	Time 1 (pretest) Time 2 (posttest)
Hypothesis 6	Narrative transportation will be positively predict associated with participants' (a) environmental attitudes and (b) behavioral intentions.	OLS Regression	Narrative Transportation, Connectedness to Nature, General Environmental Attitudes, Support for Conservation, Activism Intentions, Elephant Attitudes, Controls	Time 1 (pretest) Time 2 (posttest)
Hypothesis 7	Narrative transportation will moderate the relationship between perceived controller naturalness and spatial presence.	PROCESS path-analyses (Model 1)	Narrative Transportation, Perceived Controller Naturalness, Spatial Presence, Controls	Time 2 (posttest)

Appendix B (cont’d)				
Hypothesis 8	Narrative transportation will partially mediate the relationship between narrative interactivity and participants’ (a) environmental attitudes and (b) behavioral intentions.	PROCESS path-analyses (Model 4)	Narrative Transportation, Perceived Narrative Interactivity, Connectedness to Nature, General Environmental Attitudes, Support for Conservation, Activism Intentions, Elephant Attitudes, Controls	Time 2 (posttest)

APPENDIX C. Narrative Interactivity Prompts

Introduction Prompts

Before we move onto the virtual reality portion of this study, please take a moment to carefully read the following information.

The world needs your help. Environmental issues such as deforestation and pollution destroy the natural habitats of wondrous and majestic creatures from around the world every day. You have the power to heal the environment. Explore the virtual environment around you, spend time with the elephants and other wildlife, and try to make the world a better place.

Conclusion Prompts

After completing the virtual reality portion of this study, please take a moment to carefully read the following information.

Thank you for exploring the environment. Many of the animals you met today, such as elephants, are under threat from various human related environmental issues such as poaching and habitat encroachment. Remember, you can help preserve the natural world, and the animals that inhabit it, in small ways every day.

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