BROADENED HORIZONS: NATURE WALKS AND REFLECTIVE THINKING IN THE CONTEXT OF SCARCITY

by

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ABSTRACT

PAISLEY RIVES AZRA-LEWIS. Broadened Horizons: Nature Walks and Reflective Thinking in the Context of Scarcity. (Under the direction of DR. AMY PETERMAN)

Walking in nature has been demonstrated to have a positive impact on cognitive and emotional wellbeing by restoring attention and increasing positive affect. Both of these factors are in turn linked to increases in flexible, reflective thinking ("broadened thinking"). Broadened thinking is contrasted to the narrowing of thoughts associated with scarcity, the experience of having less than one feels is necessary. This study proposed a new model outlining the process by which broadened thinking may occur during nature walks and, for the first time, incorporated the experience of scarcity into the nature walk literature. One hundred sixty-five college students reporting varying levels of perceived scarcity were randomly assigned to one of two conditions (natural or built) and took a 30-minute walk in an environment of their choosing. Structural equation modeling demonstrated that the proposed model was a good fit for the data. This supports the hypothesized process linking nature walks with restoration of attention, positive affect, and broadened thinking. Qualitative data corroborated these findings. Although scarcity did not moderate relationships in the model as expected, repeated measures ANOVA results showed that participants experiencing the highest time scarcity saw the greatest increases in restoration and broadened thinking. Those with the highest material scarcity saw the greatest increases in motivation to engage in subsequent walks. These findings provide some support for the hypothesis that those with more scarcity would derive greater benefit from nature walks. The study as a whole demonstrates the effectiveness of nature walks as a brief intervention for college students, especially those pressed for time, and highlights the importance of cultivating

and protecting natural walk environments that are safe and accessible for all. Implications for future research and clinical interventions at the individual and societal level are discussed.

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DEDICATION

I dedicate this dissertation to my family. To my parents and my sisters, Emily and Mollie: You have stepped in so many times to organize and execute ambitious school projects, most of which have involved elaborate costumes and too much glitter. Although this project took a different form, you were integral to its completion as well. Thank you for listening to me, for consulting with me, and of course for being the people who introduced me to nature walks in the first place. To my husband, Paul: When I needed a dissertation topic, you took me on a hike through mountain pastures belonging to the happiest cows on earth, and you told me how much it helped you to put things in perspective. Since then, you have continued to provide me with the unconditional support, inspiration, and accountability that I have needed to finish this project. Thank you.

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CHAPTER 1: INTRODUCTION

"Take a walk in the woods. Doctor's orders" (Kalaichandran, 2018). "How walking in nature shapes the brain" (Reynolds, 2015). "Want to be more creative? Take a walk" (Reynolds, 2014). These headlines, all from *The New York Times*, reflect modern society's growing awareness of, and interest in, the connection between nature walks and positive health outcomes.

It was not until the Industrial Revolution—after humans had spent the previous 350,000 generations in close communion with nature—that our lives began to shift away from the outside world (Pretty, 2002). Americans now spend up to 90% of their time indoors (Evans & McCoy, 1998), and more than half of the world's population lives in urban areas (Dye, 2008). Such a rapid shift in our species' relationship with the natural world does not come without a cost, however: The fast-paced and over-stimulating nature of modern life in urban centers can lead to increased levels of stress (e.g., Marrero & Carballeira, 2010). Spending less time in nature is also associated with greater mental fatigue, increased aggression and violence, and more depression (Greenleaf et al., 2014). Similarly, spending more time indoors, focused on sedentary pursuits, is associated with low rates of physical activity (Thompson Coon et al., 2011). In fact, it is estimated that 80% of American adults do not achieve sufficient levels of physical activity (Harris et al., 2013)—a fact contributing to rising rates of chronic illness (Thompson Coon et al., 2011). It is within this context that the nature prescription—"the therapy with no side effects" (Berman et al., 2008)—seems such a panacea.

Nature walks, which combine the advantages of physical activity with those of nature exposure, seem particularly attractive to many researchers. The promotion of nature walks takes a multi-pronged approach to improving health in a society that has largely deprived itself of two elements closely associated with wellbeing: physical activity and exposure to nature. In addition,

nature walks are a (theoretically) free and (relatively) accessible intervention for many people, and—as will be outlined in this paper—their benefits can be derived within just minutes. As an inexpensive and efficient intervention that directly targets cognitive and emotional depletion, nature walks seem to have great potential to mitigate the negative effects of stress, especially for those who may lack the time and material resources to seek out other forms of restoration. In other words, nature walks seem salient to the experience of *scarcity*.

Scarcity is described as the feeling of having fewer resources than one feels necessary in order to meet one's needs (DeSousa, 2015; Mullainathan & Shafir, 2013). These resources may be conceptualized in a variety of ways: Material scarcity refers to the experience of having insufficient material resources, such as basic necessities or money to cover daily expenses; time scarcity refers to having insufficient time to complete tasks; and psychological resource scarcity refers to having insufficient knowledge, social support, emotional resources, or cognitive abilities. The experience of scarcity may be objective or subjective (DeSousa, 2015). Scarcity directs attention to situations in which a given resource is limited, thereby drastically altering (and often limiting) the way that people engage in decision-making and problem-solving (Shah et al., 2012). For example, individuals might make decisions that prioritize short-term goals, resulting in unhelpful long-term consequences (DeSousa et al., 2018). In a sense, scarcity—out of necessity—seems to prompt a *narrowing* of thoughts and actions. What if this process could, in part, be reversed by behaviors that *broaden* thoughts and actions? What if nature walks could be used as a tool for improving one's ability to combat the stress and cognitive strain induced by scarcity?

Two main theories, attention restoration theory (Kaplan & Kaplan, 1989) and stress reduction theory (Ulrich et al., 1991), attempt to explain the salutogenic effects of spending time

in nature. This paper provides an overview of each theory, describes existing evidence supporting the benefits of nature walks, and attempts to integrate the two theories within the framework of positive psychology's upward spiral theory of lifestyle change. In addition, a new model is proposed to explain the role that nature walks may play in facilitating wellbeing, with a particular emphasis on developing the cognitive and emotional resources necessary to reflect upon and effectively manage personal projects and challenges. Broadly speaking, the model proposes that nature walks should induce restoration, as characterized by attention restoration and stress reduction, which should result in increases in positive affect. The experience of positive affect, in turn, should motivate individuals to continue engaging in future nature walks. Positive affect should also foster broadened thoughts and actions (e.g., creative, reflective thinking and problem-solving approaches), which over time lead to a build-up of psycho-emotional resources and allow individuals to more effectively cope with the challenges in their lives.

In addition, this paper outlines a study that attempted to test a portion of the model by examining the effectiveness of outdoor walks in facilitating restoration, positive affect, broadened thinking, and motivation to continue engaging in walks. Participants were divided into two conditions ("natural" and "built") and were asked to walk in an environment of their choosing that matched the criteria for the condition. Scarcity was also measured, and its relationship with the processes that occur during nature walks was examined. It was hypothesized that walking outdoors would be a restorative experience that promotes increased positive affect and broadened thinking, and that these effects would be stronger in more natural settings. Furthermore, it was hypothesized that the benefits should be particularly pronounced for individuals who report greater scarcity.

The following literature review will review the existing literature on attention restoration theory, stress reduction theory, nature walks, the upward spiral theory of lifestyle change, and scarcity to provide a rationale for the proposed model and accompanying study.

CHAPTER 2: LITERATURE REVIEW

Attention Restoration Theory

Many of our daily cognitive ills, such as loss of focus, failure of creativity, and lack of perspective, can be attributed to the depletion of directed attention—the effortful cognitive control required for everyday tasks (De Young, 2010; Kaplan & Kaplan, 1989). This highly controlled and goal-directed process is contrasted with its effortless, automatic, and stimulus-driven counterpart known as involuntary attention (Kaplan & Berman, 2010; Kaplan & Kaplan, 1989). These two components of attention complement each other in the sense that depleted levels of directed attention can be restored by allowing involuntary attention to "take over." Attention restoration theory (ART; Kaplan & Kaplan, 1989) describes the process by which one's directed attention capacities are replenished by interacting with nature. During such interactions, the mind—overtaken by involuntary attention—is engaged in effortless admiration of the interesting stimuli in its natural surroundings (Kaplan, 1995).

Even though the potential for attention restoration is not exclusive to nature, beautiful natural vistas are more likely than their built and urban counterparts to facilitate the process of restoration (Kaplan & Kaplan, 1989). Safe, inviting natural environments tend to be characterized by several traits that encourage restoration: extent (providing rich surroundings that can be experienced as worlds of their own); compatibility (offering demands consistent with one's goals); fascination (capturing attention effortlessly with inherently interesting stimuli); and a sense of being away (distancing oneself from attention-draining activities; Herzog et al., 2003; Kaplan, 1995). Urban environments, on the other hand, can be less restorative because they require directed attention to navigate traffic, ignore advertising, and otherwise manage demanding sensory stimuli (Berman et al., 2008).

Kaplan and Kaplan (1989) theorized a four-step process that identifies attention restoration as the catalyst for more profound cognitive benefits. In the first and second steps of this process, attention restoration occurs. The mind is cleared of the cognitive "noise" that accompanies mental exertion, and fatigued directed attention capabilities are recovered. In the third and fourth steps, reflective thinking can emerge. More immediate personal problems can be contemplated, followed by deeper reflections on "big picture" issues, such as one's values, priorities, and hopes for the future.

Evidence of Attention Restoration in Nature

Experimental studies have shown that college students who can see natural elements from their dormitory windows perform better on a task requiring directed attention than their counterparts without nature views (Tennessen & Cimprich, 1995). Similarly, participants who view photographs of natural scenes perform better on attention-based tasks than participants who view photographs of urban scenes (Berto, 2005). Several researchers have expanded on the findings of ART to include the effects of nature on constructs that are dependent upon attentional capacity, such as self-regulation and self-discipline. For example, Chow and Lau (2015) found that being exposed to scenes of nature can counteract ego-depletion—the diminishment of self-control and self-regulatory behaviors (Muraven & Baumeister, 2000). Participants in this study were "ego-depleted" by performing a cognitively demanding task. Participants who subsequently viewed nature scenes were more persistent while working on unsolvable anagrams than those who were given a period of rest without viewing nature scenes. Furthermore, those who viewed pleasant scenes of nature showed better logical reasoning performance than those who viewed pleasant scenes of urban areas (Chow & Lau, 2015). In a similar experiment, exposure to images of nature was associated with significantly lower rates of impulsive decision-making, with

participants choosing larger, delayed rewards over smaller, immediate rewards. Viewing images of built environments and geometric shapes, on the other hand, resulted in higher levels of impulsive decision-making (Berry et al., 2014).

Outside of laboratory settings, there is evidence that day-to-day exposure to natural images has implications for attention and the associated demands of self-regulation. Faber Taylor and colleagues (2002) studied a group of children living in a Chicago housing complex. The children shared similar living conditions and sociodemographic characteristics, but they differed in the views afforded by their apartment windows: Some looked over barren concrete, while others could view small green spaces. In their results, the researchers noted gender differences as well as differences attributed to apartment window views. The more "natural" a young girl's home views, the better she tended to perform on concentration tasks. Furthermore, girls with views of trees also performed better on tests of delayed gratification and impulse inhibition. Together, these measures were combined into an overall self-discipline score. The researchers surmised that the effect was not as apparent for young boys in the housing complex because they tended to spend more of their free time outside the home, and therefore would not be as dependent on views from home for exposure to nature (Faber Taylor et al., 2002).

In a related study, Kuo and Sullivan (2001) examined the link between attention and aggression. Housing complex residents living in buildings with more green space in the surrounding area (e.g., trees and grass) demonstrated higher levels of attentional functioning and lower levels of self-reported aggression and violence than those in buildings with less nearby nature. The authors were able to establish that attentional functioning fully mediated the relationship between green space and aggression.

Evidence of Reflection in Nature

Kaplan and Kaplan (1989) conceptualized reflection as one of the natural consequences of directed attention restoration. While empirical explorations of reflection in nature have been sparse, the existing evidence is promising. There is some evidence to suggest that participants prefer to be in more natural settings in order to engage in reflective thinking (Herzog et al., 1997), as well as some evidence that nature does provoke deep contemplation. Kaplan and Kaplan (1989) collected qualitative and quantitative data from individuals who had recently returned from 48-hour solo journeys in the wilderness. Participants endorsed high scores on items purportedly measuring reflection, such as "figuring out what kinds of things are important to you" and "thinking about who you are and who you want to be" (p. 138, Kaplan & Kaplan, 1989).

Nature-induced reflective thinking may also translate into better problem-solving and personal development. Kuo (2001) found that even low-dose exposure to nature can improve "major life-issues management" (e.g., handling major problems, goals, and decisions). In her study, low-SES urban dwellers living in buildings with more nearby nature were more effective in managing personal projects than their counterparts who had less nearby nature. According to the author, the participants who lived in greater proximity to natural elements were better able to reflect on potential solutions to the challenges facing them.

On a related note, there is some evidence to suggest that nature sparks creative thinking. Guilford's (1950) understanding of creativity speaks to a sense of curiosity, flexibility, and synthesis—the ability to explore new lines of thinking and to adopt alternative perspectives in the face of a challenge. Van Rompay and Jol (2016) found that viewing natural scenes rated highly in unpredictability and spaciousness significantly increased participants' creativity in a drawing task. In particular, spaciousness was noted to result in higher self-reported feelings of

creativity. Together, these studies show that nature exposure could be a powerful tool in promoting reflection and tackling everyday challenges.

Stress Reduction Theory

ART is not the only theory that has been proposed to explain the benefits of contact with nature. Stress reduction theory (SRT; Ulrich et al., 1991), as the name implies, addresses the potential of nature experiences to reduce stress. Stress can negatively impact one's emotional and physiological state, leading to a focus on negative emotions as well as a high-arousal fight-or-flight response (Selye, 1950; Ulrich et al., 1991). All too often, modern humans find that the fight-or-flight response is activated even in situations in which no physical response is required. Rumination over negative past events, or anxiety regarding future events, can also elicit intense, prolonged, and unnecessary physiological activation (Brosschot et al., 2005). In turn, the negative emotions and arousal associated with stress can decrease cognitive performance (Ellenbogen et al., 2002). Over time, as stress response activation accumulates and allostatic load grows, individuals are at higher risk for chronic illnesses such as cardiovascular disease and diabetes (e.g., Cohen et al., 2012). It is within this context that many researchers have turned to nature and its apparent stress-reducing benefits in the hopes of better understanding how best to use this resource—one that is highly accessible for many people—to increase wellbeing.

SRT (Ulrich et al., 1991) postulates that our positive response to nature stems from our species' innate connection with—and dependence on—elements of the natural world. Features such as water, vegetation, and expansive views have helped our species to survive and thrive over millennia. Accordingly, modern-day humans experience unconscious autonomic responses when faced with these advantageous natural elements (Ulrich et al., 1991). The parasympathetic

nervous system is activated, and feelings of stress are reduced. Negative affect diminishes, and positive affect increases (Ulrich et al., 1991).

Evidence of Stress Reduction in Nature

Ulrich (1981) found that ten-minute exposure to nature can lead to more efficient and effective recovery from stress, as measured by physiological responses such as skin conductivity, pulse transit time, electromyography, and cardiac response. Exposure to outdoor urban environments does not result in the same effects. Forest bathing—soaking in the atmosphere of a forest environment—has also been shown to increase parasympathetic nervous activity and to suppress sympathetic nervous activity (e.g., Park et al., 2010). Forest environments promote the lowering of cortisol levels, blood pressure, and pulse rate to a greater extent than urban environments (Lee et al., 2011; Park et al., 2010). Exposure to images and sounds of nature can facilitate recovery from sympathetic activation following experimentally induced stressors, whereas stimuli from urban or built environments do not show the same effects (Alvarsson et al., 2010; Brown et al., 2013).

The long-term effects of repeated exposure to nature are especially intriguing: Contact with nature over time has been associated with a significant reduction not only in chronic stress, but in the health problems that tend to accompany it (Hartig et al., 2014). Furthermore, adults who grew up in more rural areas show lower amygdala activation—indicating lower stress responsivity to laboratory-induced social stress—than those who grew up in more urban areas (Lederbogen et al., 2011). The study investigators explain that many factors related to city living (e.g., pollution, crowding, and noise) could be responsible for the higher observed amygdala activation in urban dwellers, and they cite previous research indicating that city life contributes

to greater instances of mental disorders (e.g., van Os et al., 2010) when interpreting their results (Lederbogen et al., 2011).

Consistent with the assertion of Ulrich and colleagues (1991) that decreased negative affect and increased positive affect accompany stress reduction in nature, many studies within the SRT literature include measures of self-reported mood or affect. A meta-analysis of thirty-two nature-themed studies indicated that contact with nature is associated with a small, but consistent, decrease in negative affect, as well as a moderate increase in positive affect compared to non-nature conditions. Effect sizes were larger for "real nature" than for laboratory simulations of nature through video or still images (McMahan & Estes, 2015). Nature-based outdoor recreation in particular has been linked with emotional well-being, as defined by self-reported mood or affect (e.g., Korpela et al., 2014). Overall, the evidence supporting SRT—from both physiological and self-report measures—is robust.

Nature Walks

Given the apparent power of nature to affect our cognitive abilities and stress levels, there is merit in learning how to harness that power for the purpose of interventions. Many researchers, including Kaplan and Berman (2010), have called for greater application of nature-based interventions. Nature walks, as previously mentioned, combine the benefits of nature exposure with those of physical activity, and they are a promising avenue for continued investigation. Although several studies have demonstrated the effectiveness of group walks on restoration and emotional wellbeing (e.g., Marselle et al., 2013; Marselle et al., 2014; Marselle et al., 2015; Marselle et al., 2016), the following review covers only individual walks in nature, as they are more relevant to the current study.

Evidence of Nature Walk Effects

Walking has long been linked with reflection and contemplation (Loehle, 1990). Lapkoff (2007) notes that "the physical action of walking, of moving through space, triggers the mental action of thinking, of moving through conceptual space. Our thoughts follow our feet" (p. 109). Because movement is at its most unhindered in wide open spaces, walking—and thinking—are often associated with the outdoors. Generations of philosophers and writers have turned to natural settings as a precipitant for better understanding themselves and the world around them. One elegant example can be found in Jean-Jacques Rousseau's (1782) *Reveries of a Solitary Walker*, in which the author describes a series of ten walks in the countryside. Each walk was an opportunity for the philosopher to reflect back on his life and the pivotal events that had forged his identity.

Venkataraman (2015) describes nature, for Rousseau, as a "catalyst" of self-reflection—an opportunity to escape into a sensorially appealing and thought-provoking environment, and a means of transcending the self and connecting to something larger. Interestingly, Rousseau was able to reflect upon and explore even the most painful of memories while on his walks. Perhaps this is because nature offered a safe, therapeutic environment in which to process distress (Venkataraman, 2015). Given the aforementioned stress-related benefits of nature, it seems intuitive that Rousseau—and the countless others whose writings lay anecdotal groundwork for this exploration—should have experienced both cognitive and stress-reducing benefits from nature walks.

Walking and other forms of physical activity have well-established links with well-being, regardless of the setting in which they take place. However, the benefits of nature walks and other forms of "green exercise"—a term used to describe movement through nature (Pretty, 2004)—have been shown to go above and beyond those of physical activity alone. As seen in a

meta-analysis comparing the psychosocial outcomes of indoor and outdoor physical activity, green exercise was associated with more significant increases in positive affect and more significant reductions in negative affect (Thompson Coon et al., 2011). Another study examining indoor exercise, outdoor exercise in "built" spaces, and green exercise demonstrated that all forms of physical activity were positively associated with general health. However, only green exercise showed a consistent positive correlation with emotional wellbeing (Pasanen et al., 2014). As seen in the following paragraphs, nearly every study that compares nature conditions to non-nature conditions finds that attention and stress-related improvements are significantly greater in nature.

Nature Walks and Directed Attention

For more details on the nature walk studies described in the following paragraphs, please refer to Table 1. Researchers have measured changes in directed attention after nature walks by implementing a variety of tests, including the backwards digit span test, in which participants are asked to repeat in backwards order a given series of digits (e.g., Berman et al., 2008; Bratman et al., 2015; Gidlow et al., 2016) and the Necker Cube Pattern Control test, in which participants are asked to observe the optical illusion Necker Cube without shifting perspectives on its angle (e.g., Hartig et al., 2003). Walking in nature has been shown to improve performance on these types of attention tasks (Berman et al., 2008). Additionally, when compared to outdoor walks in urban settings, the effects of nature walks tend to be more positive and more significant (Bratman et al., 2015; Gidlow et al., 2016; Hartig et al., 2003). There is limited evidence to suggest that the effects on attention are maintained for some time after the walk. Gidlow and colleagues (2016) found that the working memory improvements observed in their two natural conditions—both "green" (country park) and "blue" (canal footpath)—persisted for at least half

an hour after the end of the walk. Most other studies, unfortunately, did not collect any follow-up data.

The data are not without inconsistencies, however. Bratman and colleagues (2015) did not find consistent improvements in directed attention in their study: While verbal working memory increased after a nature walk, measures of visuospatial working memory and executive attention did not show significant differences pre- and post-walk. The authors stated that they were limited in the conclusions that could be drawn from these null results (Bratman et al., 2015). Furthermore, Johansson and colleagues (2011) actually found decreases in directed attention in both natural and urban conditions, with attention declining to a greater degree after the nature walk than after the urban walk. However, the authors argue that their results are inconclusive, as the mean scores for the cognitive performance task differed significantly between the two environmental conditions prior to the walk and were roughly the same afterwards. These results could simply reflect regression to the mean (Johansson et al., 2011).

Nature Walks, Reflection, and Problem-Solving

There is evidence that the observed improvements in directed attention may translate into improved abilities to reflect and problem-solve. A study by Mayer and colleagues (2009) suggests that walking in nature may facilitate reflection on personal problems. Participants were asked to "silently reflect on a loose end in their life that needs tying" (p. 615) before engaging in a short walk in either a nature preserve or an urban downtown area. Those in the natural setting reported a significantly greater ability to reflect on their "loose end" than those in the urban setting. Similarly, nature walks have been shown to facilitate reflection regarding personal projects, improving participants' sense of enjoyment, control, and efficacy related to a project as well as reducing their associated feelings of stress (Roe & Aspinall, 2011a). Overall, evidence

for the connection between nature walks and reflection is limited because of the small number of studies that have examined it. One of the main foci of the current study is to expand upon our understanding of the ways in which nature walks can contribute to broadened and reflective thinking.

Nature Walks, Stress, and Affect

Researchers have used both physiological measures (e.g., Gidlow et al., 2016; Hartig et al., 2003) and self-report questionnaires (e.g., Bratman et al., 2015; Duvall, 2011; Gidlow et al., 2016; Hartig et al., 2003; Pasanen et al., 2018; Roe & Aspinall, 2011a) to better understand the impact of nature walks on stress and affect. Existing physiological evidence within the walking literature is somewhat inconclusive, despite the well-established links with stress reduction in the forest bathing literature (e.g., Lee et al., 2011; Park et al., 2010). In a study by Gidlow and colleagues (2016), no significant differences in salivary cortisol levels or heart rate variability were observed between participants who took walks in natural settings and those who took walks in residential urban areas. Hartig and colleagues (2003) found that participants who walked in a wildlife preserve instead of an urban retail area showed lower blood pressure during the walk, but not afterwards.

In evidence from self-report measures, nature walks are associated with significant reductions in anxiety, stress, anger, and negative affect, with levels significantly lower than those found in non-nature walks (Bratman et al., 2015; Hartig et al., 2003; Roe & Aspinall, 2011a). In at least one case, urban walks even exacerbated symptoms of stress and negative affect (e.g., Hartig et al., 2003). In addition to reducing negative affect, nature walks have been associated with improvements in factors such as positive affect, contentment, enjoyment, revitalization, and tranquility (Duvall, 2011; Hartig et al., 2003; Roe & Aspinall, 2011a). In one study, positive

affect did not *improve* over the course of the walk, but it was maintained from pre- to post-walk measures in the nature condition, whereas it decreased in the urban condition (Bratman et al., 2015). Unlike the other researchers, Johansson and colleagues (2011) found no significant difference between urban and natural settings. Negative affect decreased and positive affect increased after both walk conditions.

Additional Considerations

The nature walks described in the studies above differ, sometimes significantly, in terms of location, length, and other important variables. A few researchers have attempted to narrow down some of the environmental characteristics, as well as characteristics of the walks themselves, that tend to lead to better outcomes.

Characteristics of the Environment

Past meta-analytic research has suggested that similar effects on emotional wellbeing are observed across natural environments, whether those locations would be described as "wild" (e.g., forests) or manicured (e.g., urban green spaces; McMahan & Estes, 2015). Barton and Pretty (2010) conducted a meta-analysis of green exercise (e.g., walking, cycling, gardening, and horseback riding) in several different types of environments: countryside, forest, farmland, urban green space, and waterside. They found that mood and self-esteem improved across all environments, though the presence of water seemed to generate greater benefits, leading the authors to recommend further study into the effects of water-based activities in nature.

Gatersleben and Andrews (2013) provide a nuanced perspective on restorative natural environments. They found that walking in natural settings with high levels of prospect (i.e., those conducive to having a clear field of vision) and low levels of refuge (i.e., those conducive to finding places in which to hide) is restorative, whereas walking in environments with low

prospect and high refuge may increase participants' attentional fatigue and stress. The authors surmised that low prospect/high refuge settings may elicit fears of becoming lost or being attacked, and individuals navigating such environments may in fact require higher levels of directed attention—thereby offsetting the potential restorative benefits of a nature walk. Similarly, Herzog and Rector (2009) found that as levels of perceived danger in natural environments increase, levels of anticipated restoration decrease. Natural settings must be perceived as safe in order to afford individuals a restorative experience.

Characteristics of the Walk

In a meta-analysis attempting to determine the ideal duration and intensity of green exercise for mood and self-esteem, Barton and Pretty (2010) found the greatest effect sizes for the shortest activities (those of five-minute duration), followed by activities that lasted a whole day. Effect sizes for activities that lasted 10-60 minutes and half a day fell in the middle. As for the ideal intensity of green exercise, effect sizes for self-esteem improvements declined as intensity increased. Mood improvements were greatest for activities that were either light or vigorous in nature (as compared to activities requiring moderate exertion). Overall, results from this meta-analysis indicate that even brief, light walks in nature could have significant positive effects on wellbeing (Barton & Pretty, 2010).

The social context in which individuals explore outdoor environments is also important to consider. Participants in a study by Staats and Hartig (2004) viewed a simulation of a walk through a forest or an urban area. They were asked to imagine being either alone or in the company a friend, and to estimate the effects of the walk on their sense of restoration. The results indicate that imagining the company of a friend increased the estimated restoration of an urban walk, but not that of a nature walk. Additionally, individuals expected to experience more

restoration in natural environments if they were alone—but only if safety was controlled for. Otherwise, the company of a friend improved the chances of restoration by increasing feelings of safety. Once more, as in the studies by Gatersleben and Andrews (2013) and Herzog and Rector (2009), safety seems to be an important factor influencing the potential for restoration in nature.

As a follow-up to their 2004 study, Johansson and colleagues (2011) conducted a study involving real walks in natural and urban settings. They discovered that physical exhaustion increased in both environments while walking alone, but not while walking with a friend—pointing to the potential for a companion to provide positive distraction during a walk. In addition, revitalization during nature walks increased more substantially while participants were alone, but revitalization during urban walks increased more substantially while they were walking with a friend. Although the company of a friend or companion can decrease safety concerns and increase enjoyment during a nature walk, there is also evidence that individuals may prefer solitude while seeking restoration in nature.

Finally, the extent to which individuals are engaged with the environment around them during their walk has an impact on the quality of the benefits they reap. Duvall (2011) examined the impact of engagement on restoration over the course of a two-week outdoor walking intervention. Participants in the engagement group were asked to implement an "awareness plan" with each walk, whereas their counterparts in the control group were not given instructions prior to their walks. Awareness plans included prompts to focus on the senses (e.g., "Focus on sounds. If the area is quiet, listen to the silence. If the area is full of sounds, focus on each one and notice how they differ"), to take on an imaginary role (e.g., "Imagine you are an artist looking for beauty in everyday things"), or to make inferences (e.g., "How would this area change if everyone had to grow their own food?"). At the end of the two-week period, participants in the

engagement group reported significantly greater restoration than those in the control group, as measured by improvements in attentional functioning and declines in frustration. Both groups, however, reported similar increases in contentment (Duvall, 2011).

Pasanen and colleagues (2018) also examined environmental engagement by asking some participants to engage with the environment through psychological tasks meant to enhance restoration. Prompts encouraged participants to observe the environment and relax (e.g., "[…] Keep looking around and let yourself be enchanted by your surroundings. Keep breathing peacefully."), to identify a favorite place (e.g., "Find your favorite place in this area […] Choose a detail by which you may remember this place, perhaps for years."), and to reflect on their own lives (e.g., "Look around for something representing you or your current situation in life […] Are you gaining new thoughts?"). Although self-reported restoration and mood improved throughout all walks, with no additional benefit found from greater environmental engagement, sustained attention did improve to a greater degree when participants were more engaged (Pasanen et al., 2018). Results from both engagement studies suggest that the simple act of walking in nature—regardless of the attention given to one's surroundings—can confer some benefits, but increasing engagement may result in additional restorative advantages.

Merging ART and SRT

Although they take different approaches to describing the effects of nature, ART and SRT agree that natural environments are more restorative than urban or built ones, and both theories address the potential of nature to facilitate wellbeing (Berto, 2014). However, there is no clear understanding of how the processes of ART and SRT may be related. Does stress reduction help clear one's mind, thus improving the ability to concentrate? Or does improved concentration and a clear mind lead to reduced stress? Likely, the two mechanisms are at work simultaneously,

and they may be inextricably intertwined (Bratman et al., 2012). For example, given that the ability to think clearly and cogently in order to address stress and its consequences is an important resource, directed attention fatigue may result from, or increase vulnerability to, physiological stress. Likewise, directed attention may provide the patience, empathy, and insight necessary to recovery from a stressful experience (Beute & de Kort, 2014; Hartig et al., 2003).

One of the most important common factors connecting ART and SRT seems to be the induction of positive affect (Bratman et al., 2012). Although affect is addressed more explicitly in the SRT literature (as evidenced by the review outlined above), both theories speak to the potential of nature to facilitate positive emotional states, either through the restoration of directed attention—which leads to mental relief and relaxation—or through the reduction of stress (Bratman et al., 2012). It is intuitive that a clear mind and an activated parasympathetic system should have the capacity to facilitate positive changes in one's emotional state. While directed attention fatigue increases irritability and negativity, engaging with natural environments and experiencing attention restoration may in fact block negative thoughts, allowing more positive ones to take root (Kaplan, 1995; Parsons, 1991). In turn, the experience of positive emotions can significantly improve one's ability to handle future stressors (Folkman, 2008)—leading to a possible connection between nature walks and the upward spiral theory of lifestyle change.

Upward Spiral Theory of Lifestyle Change

The upward spiral theory of lifestyle change (Fredrickson, 2013) may explain the benefits of nature walks while merging the theories of stress reduction and attention restoration under the unifying factor of positive affect. This model of behavioral change is based on the broaden-and-build hypothesis (Fredrickson, 1998, 2001), which suggests that positive emotions and "broadened mindsets" converge in an upward spiral, with each influencing the other. Negative

emotions often spur narrower and more restrictive thought-action repertoires: Anger may provoke an urge to fight, or fear an urge to flee. Positive emotions, however, tend to inspire a wider, more expansive set of mindsets and actions. For instance, joy may awaken the urge to play, and fascination may encourage exploration. In other words, broadening one's thoughts and actions increases the range of factors that can be considered when responding to a given situation, thereby improving one's flexibility and adaptiveness (Fredrickson, 2004).

The creative thinking and innovative problem solving associated with broadened thoughts (Fredrickson, 1998) are particularly salient to the current study. Prior to Fredrickson's work, other researchers had established a relationship between positive affect and flexible, creative thought processes (Isen, 2000). For example, the induction of positive affect has been shown to lead to greater success in solving problems that require innovative thinking and the use of everyday objects of accomplish a novel task (Isen et al., 1987). Experiencing positive affect has also been demonstrated to increase individuals' preference for variety, as well as their acceptance of a broader spectrum of behaviors (Kahn & Isen, 1993). Along these lines, Fredrickson and Branigan (2005) established that the induction of two different positive emotions—amusement and contentment—leads individuals to generate longer and more varied lists of behaviors in which they would like to engage. Participants reported more urges to be active, to spend time outdoors, and (in the case of amusement) to be playful and social (Fredrickson & Branigan, 2005).

The broaden-and-build hypothesis further states that the broadened thoughts and actions resulting from positive affect allow individuals an opportunity to "build up" physical, social, psychological, or intellectual resources. In turn, engaging with these resources—which may include physical health, social support networks, knowledge, executive control, resilience, and

creativity—can generate even more positive emotions (Fredrickson, 1998, 2001). Individuals experience greater wellbeing and find that they are better able to cope with life's difficulties (Fredrickson & Joiner, 2002). Crucially, the broaden-and-build hypothesis acknowledges that positive emotional states can be transient; however, it posits that the resources accumulated during even fleeting moments can be translated into long-lasting reserves to draw upon during future moments of difficulty (Fredrickson, 2004).

Fredrickson (2013) proposed the upward spiral theory of lifestyle change to link the broaden-and-build hypothesis to health behavior change. Experiencing positive affect during an enjoyable health behavior contributes to nonconscious motives to continue to engage with that activity in the future. The "incentive salience" of a health behavior increases, making it more likely to capture an individual's attention and trigger desire (Van Cappellen et al., 2018). In addition to prompting these nonconscious motives for continued engagement, positive affect also builds up psycho-emotional resources that can amplify and strengthen the relationship between future health behaviors and experiences of positive affect (Fredrickson, 2013).

Several studies offer support for the connection between positive affect and nonconscious motives. For example, participants who were randomly assigned to experience positive affect in an experimental setting showed more positive responses to words related to physical activity and expressed willingness to engage in future physical activity (Cameron et al., 2018). Even more compellingly, results from a diary study demonstrated that the experience of positive affect during exercise led participants to write more positively about physical activity in their diaries. In turn, these positive thoughts led participants to engage in longer and more frequent exercise in the future (Rice, 2016).

Model

The model seen in Figure 1 uses the upward spiral theory of lifestyle change as a framework to address the process by which individuals can benefit from engaging in nature walks. Nature walks are conceptualized not only as a coping skill for managing stress and attentional fatigue, but as a catalyst for the broadened mindsets and built-up resources that, over time, improve one's abilities to manage life's challenges. Attention restoration and stress reduction are conceptualized as intercorrelated variables which, together, contribute to the idea of "restoration." Not all nature walk studies have examined both cognitive and stress-reducing benefits, but those that have (e.g., Bratman et al., 2015; Duvall, 2011; Hartig et al., 2003; Johansson et al., 2011; Roe & Aspinall, 2011a) have found coexisting attention restoration and stress reduction. The combination of attention restoration and stress reduction into one variable speaks to their interconnected nature (e.g., Bratman et al., 2012). In fact, Korpela and colleagues (2008) created a scale that includes both ART- and SRT-based outcomes in one brief measure of restoration.

In keeping with Ulrich and colleagues' (1991) understanding of SRT, as well as Bratman and colleagues' (2012) assertion regarding attention restoration and positive affect, restoration is expected to lead to increased positive affect. According to the broaden-and-build hypothesis, the experience of positive emotions should in turn demonstrate a bidirectional relationship with broadened thoughts and actions. In other words, one should be able to engage in constructive, reflective thinking about one's more immediate personal problems, as well as larger life questions, much in the way that Kaplan and Kaplan (1989) theorized that individuals should be able to use higher-order cognitive abilities once their depleted levels of directed attention have been restored through nature. In fact, the "broadened thoughts" described in the upward spiral

theory could be seen as synonymous with ART-prompted reflection, and in this model, restoration is also hypothesized to induce broadened thinking directly.

Over time, with the accrual of positive emotional experiences and broadened thinking, healthy coping skills and other resources should accumulate. These resources, in turn, build resilience and equip individuals to more effectively manage the social, emotional, and material challenges they face. The spiraling arrows in the model indicate the passage of time. Last but not least, there is a second arrow leading from positive affect, pointing back towards nature walks and representing one of the main tenets of the upward spiral theory of lifestyle change—that positive affect produces nonconscious motives for continued engagement with a given health behavior. In this way, positive affect sparks a virtuous cycle.

Although non-nature walks are not included in this model, one would expect them to show comparatively poor fit. Walking in any context can confer health benefits—such as improved affect, decreased stress, and physiological improvements (e.g., Hanson & Jones, 2015)—but the nature walk literature makes it abundantly clear that the restorative potential of nature walks is more pronounced than that of their urban and indoor counterparts. Accordingly, the relationships with positive affect, broadened thoughts and actions, and resource build-up would be notably weaker.

Scarcity

The current study fills a gap in the nature literature through its incorporation of scarcity—which, as stated in the introduction, could be thought of as an experience characterized by the "narrowing" of one's thoughts and actions. This study explores the process by which theoretically "thought-broadening" activities, such as nature walks, could counteract some of the less helpful cognitive implications of scarcity. Scarcity is the feeling of being unable to meet

one's needs due to insufficient resources (DeSousa, 2015; Mullainathan & Shafir, 2013). Several themes, as outlined by Shah and colleagues (2018), have emerged in the scarcity literature: First, scarcity shifts attentional focus to one's most pressing needs—typically those associated with inadequate resources. Second, this increased focus can negatively impact cognitive function, often by limiting one's ability to see beyond the constraints set by the scarce resource. Third, different forms of scarcity (e.g., material scarcity, psychological resource scarcity, and time scarcity; DeSousa, 2015) share similar underlying mechanisms. The attentional and cognitive shifts induced by poverty are comparable to those prompted by being too busy or having inadequate social support (Shah et al., 2018).

There is ample evidence that living in a state of scarcity prompts certain cognitive shifts, thereby facilitating a "scarcity mind-set" (Shah et al., 2015) that influences the way individuals make decisions. For example, Mani and colleagues (2013) found that experimentally-induced reflection on financial problems impairs performance on cognitive tasks—but only for participants who experience material scarcity, and not for their more affluent counterparts. Outside of laboratory settings, the researchers uncovered similar results: Indian sugarcane farmers perform significantly better on cognitive tasks after a harvest, when they are well-off, than they do before a harvest, when they are poor (Mani et al., 2013). Furthermore, artificial simulations of financial scarcity have been shown to prompt a focus on the cost of buying food, to the neglect of other information such as calorie load. Those experiencing abundance, on the other hand, have the luxury of attending to other information about the food they are about to buy (Tomm & Zhao, 2016). Mani and colleagues (2013) explain these results by positing that poverty imposes a cumbersome cognitive burden, consuming all of one's mental resources and leaving little room for other considerations. The studies described in the following paragraphs

address the potential of nature exposure to counteract some of the cognitive burden of real-life scarcity.

Scarcity and Nature

Communities experiencing greater material scarcity are less likely to have access to nature and more likely to live in "nature-deprived" zones (referring to the extent to which natural areas have been lost to human activity; Landau et al., 2020). An examination of US census data showed that 70% of people in low income census tracts (those with median household incomes less than or equal to the 10^{th} percentile within their state) live in nature-deprived areas, as opposed to 50% of people in high income and 48% of people in moderate income tracts. When examining the intersection of income and race, the difference is even starker: 76% of non-white people in low income tracts live in nature-deprived areas (Landau et al., 2020).

Given these alarming statistics, it seems critical to take socioeconomic status into consideration in conversations about accessing nature and its myriad benefits. There is limited, but compelling, research that examines the impact of nature exposure on individuals experiencing scarcity. For example, studies by Kuo and colleagues (e.g., Faber Taylor et al., 2002; Kuo, 2001; Kuo & Sullivan, 2001) address the benefits of nature in the context of SES, focusing on the views that public housing residents see from their apartment windows. The same group of 145 Chicago residents was used in the Kuo (2001) and Kuo and Sullivan (2001) studies, and they were described as follows: "The composite participant profile is that of a 34-year-old African American single woman with a high school or equivalency diploma, raising three children on an annual household income less than $10,000" (p. 13, Kuo, 2001). Participants in the study by Faber Taylor and colleagues (2002) were children living in the same apartment buildings. Given the demographics described, scarcity—though not named explicitly—was

likely a significant factor in the lives of these participants. The research by Kuo and colleagues investigated the potential of nature views to assist participants in replenishing the mental and emotional resources most likely to be depleted by the experience of scarcity (Kuo, 2001).

Participants had been randomly assigned to public housing apartments with and without nearby nature. In accordance with researchers' hypotheses, having a view of nature from one's window was associated with significantly lower levels of mental fatigue and aggression (Kuo & Sullivan, 2001), as well as significantly greater abilities to concentrate, delay gratification, and control impusles (Faber Taylor et al., 2002). Furthermore, nature views were linked to better attentional performance and more effective management of major life issues (Kuo, 2001). It is fascinating to note that nature at such seemingly low doses can have such a marked impact on the mental and emotional wellbeing of these participants.

On a similar note, Mitchell and colleagues (2015) used data from a European quality of life survey to examine mental wellbeing and socioeconomic inequality of urban residents in the context of access to neighborhood green space. SES, in this survey, was assessed with participants' self-reported financial strain or "ability to make ends meet." The authors found that inequality in mental wellbeing between higher and lower SES participants was narrower when individuals had more access to green space and recreational areas. In fact, the gap was 40% narrower for participants who reported having the best access, as opposed to their counterparts who had the poorest access (Mitchell et al., 2015). The authors examined access to several other neighborhood services and amenities, such as public transport, cultural centers, and postal and banking services. Unlike green and recreational spaces, none of these features were associated with a narrowing of socioeconomic inequality in mental wellbeing (Mitchell et al., 2015).

Data from all of the studies described above lend credence to the idea that accessing even small patches of green space in one's urban environment can disrupt the typical process by which material scarcity yields negative mental and physical health repercussions (Mitchell et al., 2015). A review of the literature does not reveal any other studies to date that have examined nature walks in the context of scarcity. This study has the potential to uncover further pathways by which the health and wellbeing of disadvantaged populations can be promoted.

Current Study

The aims of the current study represent attempts to fill gaps in the existing literature—first, by proposing and testing a model that combines ART, SRT, and the upward spiral theory of lifestyle change; second, by incorporating a discussion of scarcity into the nature walk literature; and third, by further exploring the psychological processes that can occur during nature walks (and can theoretically lead to broadened thinking) with qualitative data.

The modified version of the model, which was used as a framework for the current study, can be seen in Figure 2. All longitudinal components of the model in Figure 1 were removed in the interests of time, meaning that this study tested the "broadening"—but not the "building"—potential of nature walks. However, the model still connects ART and SRT with the positive affect, broadened thoughts, and motivation for lifestyle change that is inherent in the upward spiral theory. Figure 3 shows a version of the model that incorporates scarcity. Here, the experience of scarcity is seen as a moderator that impacts the relationship between outdoor walks and restoration.

Hypotheses

It was hypothesized that the proposed model would be a good fit to the data from this study. Those who walked in more natural environments would report more restoration, greater

positive affect, more broadened thinking, and greater motivation to go on outdoor walks in the future.

It was also hypothesized that participants who experience more scarcity would score lower on the pre-walk measures of restoration, positive affect, and broadened thoughts; however, they would derive greater restorative, affective, and reflective benefits from nature than their counterparts who experience less scarcity. In other words, the experience of scarcity would moderate the relationship between nature exposure and restoration. This expectation stems from evidence that nature walk participants experiencing higher levels of stress see greater improvements in positive affect, restoration, and sustained attention (Pasanen et al., 2018). On a similar note, Roe and Aspinall (2011a, 2011b) found that adults with poorer mental health experienced greater restoration on nature walks than those with better mental health, and young people with poorer behavior experienced greater restoration in natural settings than young people with better behavior. Although scarcity cannot be equated with poor behavior or poor mental health, the same underlying mechanisms may be at work. Perhaps the cognitive and emotional restoration afforded by nature walks is all the more well-received in the minds of those who are feeling most overwhelmed by stressors. Furthermore, perhaps those who report more scarcity have fewer restorative experiences in their everyday lives—whether this is due to time constraints, environmental factors, or psychological fatigue. To be provided with a restorative opportunity in a research setting would therefore be more significant for these individuals than for their counterparts who experience less scarcity.

Finally, it was hypothesized that participants' post-walk writing samples would reflect the processes theorized in ART and SRT and corroborate the quantitative findings. In summary, this dissertation proposed to evaluate the following research objectives:

- Objective 1: Test a model that outlines the restorative benefits of nature walks, with an emphasis on broadened, reflective thinking as an outcome.
    - Hypothesis 2: The hypothesized model would fit the data and would support ART, SRT, and the upward spiral theory.
- Objective 2: Examine how the experience of scarcity can impact the relationship between nature walks and restorative benefits.
    - Hypothesis 3: Participants who report higher levels of scarcity would derive greater benefit (i.e., attention restoration, stress reduction, positive affect, and broadened thinking) from walking outdoors than those who report lower levels of scarcity.
- Objective 3: Explore the cognitive and emotional processes that occur during outdoor walks utilizing qualitative data analysis.
    - Hypothesis 1: Qualitative data would reveal themes that support ART and SRT.

CHAPTER 3: METHODOLOGY

Participants

This study passed the UNC Charlotte IRB review. Participants were recruited from the UNC Charlotte campus with an announcement posted in Sona, the online forum for UNC Charlotte's psychology research pool. In order to participate in the study, individuals had to be 18 years of age or older; be able to read and speak English proficiently; be able and willing to walk outdoors at their own pace for 30 minutes; and have a smartphone that they could use to download a free application prior to their participation in the study, access an online survey before and after the walk, and take photographs during the walk. Potential participants signed up for the study within the Sona system, and the researcher then randomly assigned each student to a condition (natural or built) using a virtual coin flip. The researcher sent out an email to each potential participant with instructions for choosing an appropriate environment, downloading and using a free smartphone application, and completing the study. These emails (one for each condition) can be found in Appendix B.

Basic Demographics

It was determined that at least 150 participants should be recruited for this study (E. Montanaro, personal communication, August 26, 2019). Of the 180 students who signed up for the study, 91 (50.56%) were randomly assigned to the natural condition, and 89 (49.44%) were randomly assigned to the built condition. After removing incomplete surveys, the resulting number of total participants was 165 (85 natural, 80 built). The average age was 19.51 (*SD* = 3.78), with ages ranging from 18 to 45 years old. About half identified as women, about half identified as men, and five participants (3.03%) identified with a different gender or preferred not to disclose their gender. Ninety-one participants (55.15%) identified as White, 26 (15.76%)

as Black, 15 (9.09%) as Hispanic/Latina(o), 12 (7.27%) as South Asian, 10 (6.06%) as East Asian, and one (0.61%) as Middle Eastern/North African. Ten participants (6.06%) identified as multi-racial, identified as a different race, or preferred not to disclose their race. The racial make-up of the sample was roughly consistent with the highly diverse UNC Charlotte undergraduate population as a whole (UNC Charlotte, 2019). There were no significant gender or race differences between conditions, except when dividing participants artificially into only two racial categories, White and non-White: There were significantly more White participants in the built condition than in the natural condition, as determined by an independent samples t-test; $t(163) = 1.53$, $p = .037$. A breakdown of gender and racial identity variables by condition can be found in Table 2.

Socioeconomic Status

Participants were also asked to report their annual household income and parental educational attainment. The median household income in the US for the 2020 fiscal year was $78,500, while the median household income in North Carolina was $70,000 (US Department of Housing and Urban Development, 2020). Income was measured somewhat imprecisely in this study, but one could very roughly divide participants into groups above and below the median income (about $75,000). More than half of all participants (56.36%) reported household incomes higher than this. Additionally, almost two-thirds of all participants (64.80%) identified that at least one of their parents had earned a bachelor's degree, and 116 of the 205 individual parents identified in this study (56.59%) had earned at least a bachelor's degree. Information about the median household income of UNC Charlotte students was unavailable. However, the statistics on parental educational attainment are once more consistent with the UNC Charlotte undergraduate population as a whole, given that in Fall 2020, 33% of the incoming undergraduates were first-

generation students (Haag, 2020). There were no significant socioeconomic differences between conditions, as determined by independent samples t-tests. More detailed information about income- and education-related demographics can be found in Table 3.

Smoking and Vaping Behaviors

Participants were asked to report the frequency of smoking and/or vaping of cannabis and/or tobacco products. Nearly three-fifths of all participants (57.00%) denied all smoking and vaping behaviors, and several participants (6.10%) declined to answer this question. The other 36.90% of participants endorsed smoking anywhere from once every few months, to a few times a day. Nearly two-fifths of the smokers and vapers (39.34%) reported daily use. Of the participants who endorsed smoking and/or vaping, 57.37% reported smoking cannabis products, 14.75% reported smoking tobacco products, 22.95% reported vaping cannabis products, and 45.90% reported vaping nicotine products. There were no significant differences in smoking behaviors between conditions. Further details, including a break-down of variables by study condition, can be found in Table 4.

Materials

Outdoor Walks

Outdoor walks took place in environments chosen by the participants themselves. Although a previous iteration of this study proposed that participants would walk in one of two standardized environments on the UNC Charlotte campus, conditions associated with the COVID-19 pandemic resulted in a change of procedure. The current study eliminated the need for in-person data collection by allowing participants to walk in environments of their own choosing. Participants were still assigned to a more natural or less natural (“built”) condition, and they were provided with descriptions and examples of their designated condition upon signing up

for the study (Appendix B). Most nature walk studies to date have involved standardized environments, with the exception of Duvall (2011), who allowed participants to select their own walk sites. Although participants were divided into two conditions, it was determined that the "naturalness" variable (based on ratings of the naturalness of the environment) would be continuous and not dichotomous.

Of the participants in the natural condition, 27.06% chose to walk in parks (mostly wooded, some with water features), 25.88% chose to walk in the UNC Charlotte Botanical Gardens, 21.18% chose to walk along greenways, and 12.94% chose to walk in neighborhoods. The others walked in a variety of environments, including the UNC Charlotte campus, athletic fields, and their own backyards. Of the participants in the built condition, 43.75% chose to walk in neighborhoods, 25.00% chose to walk around the UNC Charlotte campus, 12.50% chose to walk in parks, and 10.00% chose to walk around town or city streets. The others walked in environments that included shopping centers and greenways.

Many of the desired characteristics of the outdoor walks in this study are rooted in the nature walk literature. Participants were alone on their walks, in keeping with findings suggesting that individuals experience more restoration in solitude than in the company of others, as long as the safety of a natural environment is ensured (Johansson et al., 2011; Staats & Hartig, 2004). Participants were encouraged to prioritize safety when choosing a time and place to take their walk. They were also invited to bring a friend along with them to the walk site to wait nearby.

The length of the walks—roughly 30 minutes—is consistent with past nature walk research. The walks listed in Table 1 range from 10 minutes to one hour in duration, with significant changes in affect and reflective capabilities seen even at the low end of the spectrum.

Thirty minutes was seen as a compromise between the convenience of the briefest nature walk interventions and the more immersive experiences that participants may have as they spend longer periods of time in nature. In keeping with the broaden-and-build theory, which asserts that even fleeting states of positive affect can have a significant impact on wellbeing, it was not expected that a long walk would be required in order to derive psychological benefit from nature.

Finally, participants in this study were asked to take photographs of the landscape features that attracted them the most, in accordance with past research indicating that increasing one's environmental engagement can improve restoration during nature walks (Duvall, 2011; Pasanen et al., 2018).

Walk Materials

Participants carried a smartphone with them during the walk so that they could use MapMyWalk, a smartphone application that allows participants to log their walk route. Information gathered includes distance walked, steps walked, time of walk, and walk route. Participants were asked to take screenshots of their walk route and other walk statistics, and these screenshots were uploaded to Qualtrics. No personal or identifying information was included in these uploads. Although the process of downloading and using MapMyWalk may have been tedious, the tutorial provided by the researcher was designed to streamline the process. This tutorial included information on deleting the account and application after the walk had ended (Appendix B).

In addition to mapping the participants' walk routes, MapMyWalk also provides a camera and timer feature, so participants did not need to leave the application at any time during the walk. They used the camera to take photographs of the landscape features that were most pronounced or appreciable in their walk environment—the ones that "[stuck] out to [them] the

most." The timer feature of the app was also used to ensure that participants' walks were about 30 minutes long. Participants were informed that they should put their phones in "airplane mode" prior to the walk, and they should not use any other smartphone applications or features besides MapMyWalk while walking. Apart from the smartphone, no other materials were required.

Measures

All questionnaires were administered online, through the Qualtrics website. Participants received an email from the researcher with the link to the survey. The order of measures remained constant for all participants. All pre- and post-walk questionnaires can be found in Appendix A. In addition to the measures outlined here, participants completed several short scales related to stress and general health that were not used in the final analyses for this dissertation. These additional scales increase the amount of time between pre- and post-walk measures of variables that are relevant to this study.

Demographic Questions

Prior to the walk, participants were asked to share their age, gender, and race, as well as some information on household income and parental educational attainment. They were asked about their smoking and/or vaping behaviors, as a heavy smoking habit would be expected to impact their enjoyment of an outdoor walk. Participants were also asked to answer several questions about their outdoor habits in order to provide a baseline for later questions about motivation to engage in future outdoor walks.

Restoration Outcome Scale

The Restoration Outcome Scale (ROS; Korpela et al., 2008) is a six-item scale, grounded in both ART and SRT, that measures one's sense of cognitive and emotional restoration in a given setting. Originally, it was created to gauge feelings about a "favorite place" (which, for

many, was an outdoor environment). The items fall into three subscales: relaxation and calmness, attention restoration, and clearing one's thoughts. The wording of the ROS (e.g., "My thoughts are clear"; "I feel restored and relaxed") allows for it to be used as both a pre- and post-measure. Accordingly, it was administered both before and after the walk. Participants rate the extent to which each item describes their current experience, on a scale from 1 ("not at all") to 7 ("completely"). The ROS has previously been used in nature walk studies to measure participants' sense of restoration in the context of nature walks (e.g., Pasanen et al., 2018; Takayama et al., 2014). According to Korpela and colleagues (2008), the scale shows good internal reliability (α = .92) and adequate test-retest reliability (*r* = .60). In the current study, the ROS showed good internal reliability (α = .88 for both pre- and post-walk administrations).

International Positive and Negative Affect Schedule Short Form

The International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007) is a self-report questionnaire that measures positive and negative affect by asking participants to rate, on a scale of 1 ("very slightly or not at all") to 5 ("extremely") the extent to which they are experiencing a series of positively and negatively valenced affect words. It is a shortened version of the 20-item PANAS (Watson et al., 1988). The I-PANAS-SF has been reported to have adequate internal consistency (α = .75 for positive affect and .76 for negative affect) and good test-retest reliability over an eight-week period (*r* = .84 for both positive and negative affect (Thompson, 2007). In the current study, the I-PANAS-SF showed good internal reliability for positive affect (α = .81 pre-walk and α = .86 post-walk); however, it showed questionable to acceptable internal reliability for negative affect (α = .74 pre-walk and α = .64 post-walk). Although data on negative affect were collected in this study, they were not used in main analyses. The PANAS has been the affect measure of choice in many nature walk

studies (e.g., Berman et al., 2008; Bratman et al., 2015; Duvall, 2011; Mayer et al., 2009). Since affect was measured both before and after the walk, a shortened version of the PANAS was chosen for this study.

Perceived Scarcity Scale

The Perceived Scarcity Scale (PSS; DeSousa et al., 2020) is a 24-item self-report questionnaire that measures an individual's experience of scarcity. Participants respond to a series of statements on a scale of 1 ("strongly disagree") to 5 ("strongly agree"). The scale as a whole has been reported to have good internal consistency ($\alpha = .94$), as do the three subscales that compose it: time scarcity ($\alpha = .93$; e.g., "I have enough time to get done what needs to get done for my family"), psychological resource scarcity ($\alpha = .88$; e.g., "If there is something I need to know, I know who to ask for help or where to look up the information"), and material scarcity ($\alpha = .89$; e.g., "I have had to borrow money from family or friends to pay my bills"; DeSousa, 2015). In the current study, the PSS as a whole ($\alpha = .85$), the material scarcity subscale ($\alpha = .80$), and the time scarcity subscale ($\alpha = .81$) showed good internal consistency. The psychological resource subscale ($\alpha = .76$) showed acceptable internal consistency. The PSS was only administered before the walk.

Personal Project Analysis

Reflection on personal projects was chosen as one outcome measure representing "broadened thoughts." Personal projects, which range from quotidian tasks to lifetime aspirations, can provide a sense of coherence and meaning to our lives and are closely connected with emotional wellbeing (Little, 2014). Projects that have higher ratings in categories related to meaning, structure, community, and efficacy—and lower ratings of stress—are associated with human flourishing (Little, 1999).

The Personal Project Analysis (PPA) methodology was developed by Little (1983). Participants are asked to list their ongoing personal projects and to rate them on a variety of scales to express how they are currently thinking and feeling about those projects. Although the original PPA framework used 17 dimensions to explore each project (Little, 1983), the number of "standard" dimensions has increased over the years (Little & Gee, 2007). In a simplification of the PPA task, Roe and Aspinall (2011a, 2011b) identified five core affective and cognitive dimensions: positive affect (enjoyment), negative affect (stress), mastery (efficacy, or the extent to which one anticipates succeeding in the project), manageability (the degree to which one feels they have control over a project), and difficulty (the degree of challenge in working towards a project). A simplified version of the PPA task was used in this study, with participants answering five questions that measure the five aforementioned core affective and cognitive dimensions. They answered these questions for each of the two projects that they identified.

Tasks based on the PPA have been used in nature-based studies by Roe and Aspinall (2011a, 2011b) as a measure of reflection on personal goals and development. A measure based loosely on the PPA was also used by Kuo (2001) to capture management of major life issues. Both Roe and Aspinall (2011a, 2011b) and Kuo (2001) couched their use of the PPA or related measures in attention restoration theory. However, simply comparing scores on the PPA before and after an intervention is likely insufficient to capture true "reflection." For that reason, this study collected PPA task scores both before and after the walk, in addition to capturing process-related data through qualitative methods.

Writing Prompts

The two brief writing prompts—one before and one after the walk—were used in conjunction with the PPA task to measure the "broadening" of thoughts. These prompts, which

can be found in Appendix A, were meant to elicit responses on the general thoughts and feelings that participants may have been experiencing, as well as thoughts and feelings about their personal projects in particular. It was expected that the post-walk writing sample would demonstrate more reflection, insight, and flexible thinking.

Prior studies have collected qualitative data on participants' experiences in nature—for instance, by interviewing veterans who engage in outdoor activities to manage symptoms of posttraumatic distress (Westlund, 2015), and by examining the journal entries of individuals who participate in solo wilderness trips (Kaplan & Talbot, 1983). However, qualitative measures have not previously been used to gather information about ART outcomes, including reflection, in any of the nature walk studies included in Table 1. This study, therefore, aims to expand the nature walk literature by offering more substantial evidence for the changes that are hypothesized to occur as a result of attention restoration (Kaplan & Kaplan, 1989).

Two types of data were derived from the writing prompts. First, a second measure of "broadened thinking" was collected by analyzing the frequency of reflection-related words, using the Linguistic Inquiry and Word Count program (LIWC; Pennebaker, Booth, et al., 2015). Second, processes related to ART, SRT, personal projects, and scarcity were analyzed using thematic analysis. A more detailed description of the thematic analysis of qualitative data can be found in the data analysis section; what follows is an explanation of the LIWC variable.

LIWC. One aspect of broadened thinking was measured using the PPA task. Another was measured using LIWC, the most recent version of which (LIWC2015; Pennebaker, Booth, et al., 2015) evaluates text using a dictionary of almost 6,400 words. These words are sorted into more than 80 different categories based on both style and content, and LIWC calculates the percentage of a given text that is composed of each category (Pennebaker, Boyd, et al., 2015).

The creators of LIWC understand that words—as "the very stuff of psychology and communication" (p. 25, Tausczik & Pennebaker, 2010)—are the medium through which an individual's internal world is most easily translated and comprehended (Tausczik & Pennebaker, 2010).

LIWC defines two broad categories of words: content words, which are made up of the nouns, verbs, adjectives, and adverbs that convey meaning; and function (or style) words like pronouns, articles, and prepositions, which indicate the manner in which we are communicating with each other (Tausczik & Pennebaker, 2010). Within the broad category of content words, LIWC analyzes a variety of psychological (e.g., emotional and cognitive) processes (Pennebaker, Boyd, et al., 2015).

Elements of psychological functioning can also be measured by combining several pre-existing categories. For example, "complex thinking" has been measured using a combination of insight words (e.g., think, know, believe, meaning), causal words (e.g., because, cause, rationale, effect), negations (e.g., no, not, never), conjunctions (e.g., and, or, since), exclusives (e.g., but, without, exclude), and number of words per sentence (Pennebaker, 2011). The use of two of these categories—insight and causal words—can suggest that individuals are crafting a narrative (Pennebaker, 2017) or reappraising an event (Tausczik & Pennebaker, 2010). The reappraisal process underlying the use of these words is also associated with wellbeing: In an expressive writing intervention, participants who used more insight and causal words also experienced better health (as defined by fewer visits to the doctor) over the following months (Pennebaker et al., 1997).

This "reappraisal" metric—composed of the use of insight and causal words—was chosen to represent one aspect of broadened thinking in the current study. It was expected that

participants who exhibit greater reappraisal of their personal projects following the walk will have experienced a corresponding increase in flexible, reflective thinking as theorized by attention restoration theory. LIWC calculated the percentage of each writing prompt text composed of insight and causal words, and these data were used as one indicator of broadened thoughts in subsequent SEM analyses described below.

Post-Walk Measures

As mentioned above, participants completed post-walk iterations of the ROS, I-PANAS-SF, PPA, and writing prompt. Participants' nonconscious motives to re-engage with outdoor walks (a component of the upward spiral theory) were not measured in this study; however, following the walk, they completed face-valid questions about their *conscious* motivation to go on outdoor walks in the future. Conscious motivation, in this study, serves as a proxy for nonconscious motives. Participants also answered questions about their walk experience, including items related to sense of safety, degree of solitude, and extent to which they engaged in reflection on personal projects.

Naturalness. The naturalness of participants' walk environments was measured using two data points. First, participants rated their own perceptions about the naturalness of the environment, on a scale of one ("not at all natural; lots of man-made structures and no flora and fauna") to 10 ("completely natural; lots of flora and fauna and no man-made structures"). Second, the researcher rated her perception of the naturalness of the participants' environments on the same scale, using photograph and location data that participants had uploaded into Qualtrics. The researcher evaluated the naturalness of the photos and walk route without consulting the participants' own ratings. The participants' and researcher's ratings were then averaged together to create the naturalness scores. In the two cases of missing data, the average

for the condition was inputted. The mean naturalness rating in the natural condition (M = 6.75, SD = 1.26) was significantly higher than the naturalness rating in the built condition (M = 4.83, SD = 1.34), as demonstrated by an independent samples t-test; $t(160.54) = -9.47$, $p < .001$. Means, standard deviations, and ranges of the naturalness scores for both conditions and from both sources can be seen in Table 5.

Procedure

Recruitment materials—which include a study announcement in Sona, the UNC Charlotte psychology research pool forum—can be found in Appendix B. Interested individuals were directed to sign up in Sona. The researcher randomly assigned each student to one of two conditions ("natural" or "built") using a virtual coin flip. The researcher then contacted the participants by email with a description of their assigned condition, a detailed set of instructions for completing the study, a tutorial for downloading and using MapMyWalk, a preview of the informed consent document, and a link to the Qualtrics survey associated with their assigned condition (Appendix B).

Pre-Walk Data Collection

Once they had chosen their walk environment, had downloaded MapMyWalk, and were ready to begin the study, participants used their smartphones to access the Qualtrics survey via the link provided by the researcher. Within the online survey, participants read and agreed to the informed consent document (Appendix B). Participants then filled out pre-walk measures, which included questions about demographic characteristics, outdoor activity habits, and health, as well as the surveys listed above (ROS, I-PANAS-SF, PSS, and PPA task). Participants also completed the pre-walk writing prompt: "Please describe your state of mind today. How have you been feeling? What have you been thinking about? What thoughts about your personal projects are

coming up for you? Please write continuously for three to five minutes, and do not worry about spelling or grammar. Just share as much as you can about your thoughts and feelings right now." Upon the completion of all pre-walk measures, participants were reminded of the instructions for their outdoor walk. Their progress was automatically saved in Qualtrics.

Outdoor Walk

Participants were asked to begin their outdoor walk within five minutes of completing the pre-walk data collection. Participants took a 30-minute walk at a comfortable pace in the environment they had chosen. They were prompted to put their phone in airplane mode and open MapMyWalk to begin tracking their walk route. Throughout the next 30 minutes, they walked through their environment, taking a few photographs of the landscape features that attracted their attention or "[stuck] out to [them]" the most. They used the timer feature in MapMyWalk to ensure that their walk was about 30 minutes long.

Post-Walk Data Collection

After concluding the walk, participants were asked to begin the post-walk data collection within five minutes. They turned off airplane mode, returned to the saved Qualtrics survey, and completed the second writing prompt: "Please describe your experience on the walk: How did you feel? What did you think about? What thoughts about your personal projects came up for you? Please write continuously for three to five minutes, and do not worry about spelling or grammar. Just share as much as you can about your thoughts and feelings on the walk." Participants then continued to the rest of the post-walk questionnaires. They were also asked to upload one to three of the photographs taken during the walk, choosing ones that were most representative of their walk environment. Finally, participants were prompted to email the researcher stating that they had completed the study and indicating their incentive of choice

(entering the drawing or receiving research credit). All participants, with the exception of one, chose to receive research credit.

Data Analysis

This study includes both qualitative and quantitative components, all of which were collected and downloaded through the website Qualtrics. Qualitative data were analyzed using LIWC software (Pennebaker, Booth, et al., 2015), as well as a simplified version of thematic analysis. Quantitative data were analyzed using IBM SPSS Statistics for Windows, Version 27.0, and IBM SPSS Amos, Version 23.0. Data were cleaned and organized in SPSS. There were minimal missing data, as almost all questions in the Qualtrics survey had been required, including those associated with restoration, positive affect, reflection on personal projects, and motivation to go on walks in the future. In the rare case of missing data, means were inputted. This was the case for two naturalness ratings, as naturalness had inadvertently been marked as not required.

Within SPSS, descriptive statistics—including frequencies, means, and standard deviations—were calculated for all variables to describe the sample and to determine whether or not the variables fell within expected ranges. Internal consistency estimates were calculated for all scales and subscales, and bivariate correlations were calculated to gain an understanding of the relationships between all variables. One-way and repeated measures ANOVAs were run to better understand within- and between-subjects differences in study variables. The following sections describe how data were analyzed to address each identified objective. It is important to note that, although participants had been divided into two conditions for the purposes of choosing a walk environment, they were not divided into two groups for analyses. Rather, since participants rated the naturalness of their environments on a scale of 1-10, naturalness was

considered a continuous variable, with most "built" environments being rated lower than most "natural" environments.

Objective 1

The first objective of this study was to test the model in Figure 4 using Structural Equation Modeling (SEM) in Amos, with an emphasis on broadened, reflective thinking as an outcome. The difference between pre- and post-walk scores was calculated for ROS, PANAS, PPA task, LIWC, and motivation questions, and it was these difference scores that were inputted to the model. There are two variables measuring broadened thinking (PPA task scores and LIWC scores), and they are represented separately in the model because they capture slightly different aspects of broadened thinking—reflection on personal projects and reappraisal, respectively. The bidirectional relationship between positive affect and broadened thinking is represented through the covariance among the residuals of PPA task scores, LIWC scores, and PANAS scores. Naturalness was conceptualized as a continuous variable. Although participants had been divided into two conditions, they were not walking in identical sites within those conditions. Keeping "naturalness" as a continuous variable added some richness to the data.

This analysis followed the steps outlined by Kline (2011): First, the model was specified by representing the hypotheses in diagram form. Second, the model was identified—in other words, it was established that it would be theoretically possible to derive a unique set of model parameter estimates. Third, appropriate measures were selected, and data collected. Fourth, the model was estimated by using a program (i.e., Amos) to conduct the analysis. Since most of the data were not normally distributed, the bootstrapping method was used as a way of handling the non-normality of the data (Pek et al., 2018). Amos evaluated the fit of the model, interpreted the parameter estimates, and considered equivalent or near-equivalent models. Fifth, if the model

had shown poor fit, then it would be re-specified using a list of theoretically acceptable changes. A re-specified model would also be reidentified (Kline, 2011).

Several goodness-of-fit tests were used to determine model fit. These include chi-square, which requires the p-value to be greater than .05; the relative chi square, in which the chi-square index is divided by the degrees of freedom and should ideally be less than 2; the root mean square error of approximation (RMSEA), which should be less than .08 and ideally less than .05; the comparative fit index (CFI), which should be greater than or equal to .90; and the Tucker-Lewis Index (TLI), which should be greater than or equal to .95 (Schreiber et al., 2006).

Objective 2

The second objective of this study was to examine how the experience of scarcity can impact the relationship between outdoor walks and restoration. As can be seen in Figure 5, it was hypothesized that scarcity (a continuous variable represented by scores on the PSS) would moderate this relationship. In ordinary least squares (OLS) regression, the moderation/interaction effect is represented by the product of two variables—in this case, naturalness of the environment and scarcity (Little et al., 2006). The product term is often highly correlated with the predictors that compose it, leading to collinearity. The process of mean centering, in which the variable mean is subtracted from all observations, reduces collinearity (Little et al., 2006). For these analyses, the independent variable (naturalness) and interaction term (scarcity and its various subscales) were mean centered. Four separate interaction terms were created, using scores from the PSS as well as each of its individual subscales. Because the original model shows restoration mediating the relationship between naturalness and three different variables (positive affect and both broadened thinking variables, PPA task scores and LIWC) moderated

mediation was tested using all three paths separately. The analysis was, therefore, conducted several times.

Objective 3

The third objective of this study was to explore the psychological processes that occur during nature walks by using a simplified thematic analysis of the pre- and post-walk writing samples. Thematic analysis involves a process of identifying, analyzing, and reporting patterns in qualitative data (Terry, 2016). As it is not tied to any given theoretical perspective, thematic analysis is a particularly flexible qualitative method (Terry, 2016). Braun and Clarke (2006) developed a six-step process for thematic analysis: 1) becoming familiar with the texts by reading them and making some initial observations; 2) generating initial codes within the data; 3) searching for themes by sorting the codes into broad categories; 4) reviewing the themes to ensure that data within each theme are coherent and that distinctions between themes are clear; 5) defining and naming themes to identify the "story" that each tells about the data; and 6) reporting the results (Braun & Clarke, 2006).

Although the thematic analysis is first and foremost an exploration of themes present in the participants' writing samples, codes and themes were developed through the following lenses. In other words, these were the questions that the thematic analysis attempted to answer:

- What do participants' post-walk writing samples indicate about their experience of restoration (as theorized by ART and SRT)?
- What do participants' writing samples indicate about the manner in which personal projects are reflected upon before, during, and after the walk?
- What do participants' writing samples indicate about the manner in which scarcity is related to restoration and reflection on personal projects?

To conduct the thematic analysis, the researcher and two assistants independently generated initial codes and sorted them into broad categories, some of which were related to study variables and some of which were not. Because the researcher was the only one aware of all the research questions and the only one who specifically structured her codes and categories around those questions, research assistants went through afterwards, with relevant themes in mind, and identified writing samples in which those categories were present. The researcher and assistants talked through inconsistencies and reached agreements on the number of samples in which each given theme was present. Most themes were straightforward and easy to identify, but "broadened thinking" proved more difficult because its is a vaguer concept than positive affect, scarcity, and other themes based on the proposed model.

CHAPTER 4: RESULTS

Preliminary Analyses

Descriptive statistics, including means, standard deviations, and alpha values, can be seen in Table 6. Kolmogorov-Smirnov and Shapiro-Wilk tests of normality were run and skewness and kurtosis were calculated for all variables, including pre-walk scores, post-walk scores, and scores that were only measured once (e.g., naturalness ratings and PSS scores). Most variables were not normally distributed, but most were considered within normal bounds for skewness and kurtosis. The data were not transformed in any way, but subsequent analyses were considered robust against the normality assumption (i.e., ANOVA; Schmider et al., 2010) and/or were appropriate in cases of non-normality (i.e., bootstrapping in SEM; Pek et al., 2018)

Correlations

The correlations among variables in the model (i.e., change scores between pre- and post-walk), plus perceived scarcity, naturalness, and feelings of solitude and safety on the walk, can be found in Table 7. ROS, PANAS, and PPA change scores were all positively correlated with each other, with correlations greater than or equal to $r(163) = .48$, $p < .001$. Naturalness showed weaker positive correlations with PANAS and PPA change scores. The LIWC variable showed weaker positive correlations with PANAS and motivation change scores. Total scores on the PSS were positively correlated with ROS, PPA, and motivation change scores, with correlations greater than or equal to $r(163) = .18$, $p = .018$. Time scarcity showed positive correlations with ROS and PPA change scores, with correlations greater than or equal to $r(163) = .27$, $p < .001$. The other PSS subscales were correlated only with each other. Positive correlations among PSS subscales were all greater than or equal to $r(163) = .22$, $p = .004$, with time and material scarcity showing the weakest relationship among the three. Feelings of safety showed a positive

correlation with PANAS change scores and negative correlations with scores on the PSS and all of its subscales, with correlations greater than or equal to $r(163) = -.16$, $p < .001$. Safety and solitude also showed a negative correlation, $r(163) = -.21$, $p = .007$.

Differences Between Pre- and Post-Walk Scores

Although most of the study variables were not normally distributed, repeated measures ANOVAs were still used to examine differences between pre- and post-walk scores since they are considered robust against the normality assumption (Schmider et al., 2010). The results were encouraging: The walk elicited a statistically significant increase in restoration, positive affect, PPA scores, LIWC scores, and motivation to engage with outdoor walks in the future. Results from these ANOVAs can be seen in Table 8. Based on the means (which can be found in Table 6), all scores increased between pre- to post-walk measurement times.

Differences Between Natural and Built Conditions

Those in the natural condition ($M = 6.75$, $SD = 1.26$) rated their walk environments significantly higher than those in the built condition ($M = 4.83$, $SD = 1.34$), as would be expected ($F(1,163) = 90.09$, $p < .001$). However, there were no significant differences in feelings of safety or solitude, or the extent to which participants said that they reflected on their personal projects during the walk, between conditions. Most study variables, including scores of restoration, positive affect, personal project reflection, and motivation, did not differ between conditions. Apart from naturalness scores, the only other significant difference between conditions was the change in LIWC scores, which was significantly higher in the built condition ($M = 2.93$, $SD = 4.98$) than in the natural condition ($M = 1.36$, $SD = 4.97$); $F(1, 163) = 4.09$, $p = .045$.

Differences Among Groups of Participants

Most study variables are not normally distributed, but one-way ANOVAs—which are generally considered robust against the normality assumption (Schmider et al., 2010)—were implemented to examine differences among demographic groups of participants.

Gender

Significant gender differences were observed in scores of post-walk positive affect ($F(2,162) = 3.26$, $p = .041$) and scores on the time subscale of the PSS ($F(2,162) = 9.30$, $p < .001$). Tukey post hoc tests revealed that post-walk positive affect among women ($M = 19.00$, $SD = 4.52$) was significantly higher ($p = .040$) than it was among the five individuals who identified with a gender other than man or woman ($M = 14.20$, $SD = 2.49$). Time scarcity among women ($M = 24.20$, $SD = 5.50$) was significantly higher ($p < .001$) than among men ($M = 20.73$, $SD = 4.76$). Other gender differences in the data were not observed.

Race

There were no significant differences on any study variables based on reported racial identity. Only when participants were divided into two groups, White and non-White, did one difference emerge: White participants ($M = 15.74$, $SD = 3.92$) reported significantly higher pre-walk positive affect than participants of other races ($M = 14.31$, $SD = 4.03$); ($F(1,163) = 5.31$, $p = .022$).

Socioeconomic Status

There were no significant differences on any study variables based on household income. The same was true when participants were divided into two groups, one above and one below the US median household income. When a one-way ANOVA was performed to examine differences based on parental educational achievement, significant differences were observed in pre-walk LIWC scores ($F(1,163) = 4.67$, $p = .032$), PSS total scores ($F(1,163) = 6.09$, $p = .015$), and

scores on the material subscale of the PSS ($F(1,163) = 8.89$, $p = .003$). Tukey post hoc tests revealed that pre-walk LIWC scores among participants who had at least one parent with a bachelor's degree ($M = 5.32$, $SD = 3.26$) were significantly lower than participants whose parents had not earned a bachelor's degree ($M = 6.55$, $SD = 3.89$). PSS total scores were also lower among participants who had at least one parent with a bachelor's degree ($M = 49.92$, $SD = 9.89$) than among those who did not ($M = 54.26$, $SD = 12.30$), as were scores on the PSS material subscale ($M_{\text{bachelor's}} = 13.24$, $SD = 4.85$; $M_{\text{none}} = 15.76$, $SD = 5.73$).

Smoking and Vaping Behaviors

Significant differences based on smoking habits were observed in pre-walk restoration scores ($F(2,162) = 4.13$, $p = .018$) and PSS material scarcity scores ($F(2,162) = 4.28$, $p = .015$). Smokers scored significantly lower ($M = 17.28$, $SD = 5.02$) on pre-walk restoration than did the 10 participants who declined to answer the question about smoking ($M = 22.00$, $SD = 3.56$). Non-smokers ($M = 13.39$, $SD = 4.97$) reported significantly lower material scarcity ($p = .023$) than smokers ($M = 15.69$, $SD = 5.49$).

Personal Projects

Participants were each asked to identify two personal projects that they were currently working on. In addition to answering several Likert scale questions about these projects, participants identified barriers to completion. By far the most commonly cited personal projects were those related to academic progress or success, with nearly half of all projects related to academic goals such as "getting all As," "passing my sociology exam," and "doing all homework on time." Another quarter of projects were related to physical health (primarily diet and exercise), including "being consistent when working out," "eating healthy," and "[dropping] 10 pounds." Most of the remaining projects were related to interpersonal functioning (e.g.,

"[developing] better relationships with my friends"), mental and emotional health (e.g., "ultimately [getting] better coping mechanisms for stress"), employment (e.g, "getting my old job back"), immediate concerns (e.g., "transferring data to my new phone"), and seemingly long-term goals (e.g., "moving abroad").

Participants cited a wide variety of barriers to completing their personal projects, many of which seemed specific to individuals' personal situations. However, some broad themes did emerge. The most common barriers were ineffective time management or perceived lack of time (mentioned in more than 30% of responses), followed by lack of motivation, energy and/or focus (mentioned in about 20% of responses). To a lesser extent, the pandemic and virtual learning were identified as barriers (mentioned in nearly 10% of responses), as were mental health concerns such as stress, depression, and anxiety (mentioned in nearly 10% of responses).

The data on personal projects provide some additional context for participants' states of mind as they begin the walk. These responses paint a picture of students who are largely preoccupied with their academic obligations and feel that they may not have the time or the cognitive resources to adequately manage their responsibilities. The researcher would consider this to be an excellent starting point for a restorative intervention such as an outdoor walk.

Objective 1

Next, SEM was utilized to test the hypothesized impact of the walk on restoration, positive affect, broadened thinking and motivation for subsequent walks. The model with standardized estimates is shown in Figure 6, and the full results are outlined in Table 9.

The model shows acceptable fit, as demonstrated by chi-square (p = .403), relative chi-square (1.04), RMSEA (.02), CFI (1.00), and TLI (1.00). The covariance between the LIWC and PPA residuals was significant (p = .025), as was the covariance between the PPA and positive

affect residuals ($p < .001$). The covariance between LIWC and positive affect was not significant. Within this model, greater naturalness of the walk environment predicted an increase in restoration scores over the course of the walk. Increased restoration, in turn, predicted increased positive affect, as well as increased reflection on personal projects. Restoration did not predict a change in LIWC scores, nor did positive affect predict a change in motivation to engage in outdoor walks in the future. Several indirect effects were also hypothesized. Naturalness had significant indirect effects on positive affect and PPA task scores, with restoration as a mediator. The indirect effect of naturalness on LIWC scores was on the cusp of significance, with its standardized effect marked as significant but its unstandardized effect not marked as significant. Neither naturalness nor restoration had a significant indirect effect on motivation. About 39% of the variance in PANAS scores was accounted for by predictors in the model, while about 23% of the variance in PPA task scores was accounted for. Very little variance in ROS, LIWC, and motivation scores (i.e., 1 to 2%) was accounted for by predictors in the model.

Despite the fact that the LIWC and motivation variables do not fit the model very well, this seems to be an appropriate representation of the relationships between naturalness, restoration, positive affect, and reflection. The only modifications suggested in AMOS were related to the LIWC and motivation variables. It was suggested that there be a line drawn to show a direct effect from motivation to LIWC, and that the residuals for these two variables covary. As neither of these suggestions made theoretical sense for this model, they were both rejected.

Objective 2

Scarcity was hypothesized to impact the benefits that participants derived from the nature walk. Specifically, scarcity was expected to act as a moderator in the hypothesized model,

moderating the relationship between naturalness and restoration. Total scores on the PSS, as well as scores on each of the three subscales on the PSS, were each examined in turn as a moderating variable.

Total Perceived Scarcity as a Moderator

When the PSS total score was used as the moderator variable, the model showed barely acceptable fit, as demonstrated by chi-square (p = .171), relative chi-square (1.33), RMSEA (.05), CFI (.97), and TLI (.94). The effect of naturalness on restoration was significant (p = .044), as was the effect of scarcity on restoration (p = .004); however, the interaction term did not have a significant effect on restoration. The simple slopes for the medium (.55, 95% CI [.05, 1.03], p = .026) and high (.87, 95% CI [.17, 1.57], p = .016) scarcity groups were significant. The simple slope for the low scarcity group was not significant. There were conditional indirect effects on positive affect for the medium (.25, 95% CI [.02, .48], p = .026) and high (.40, 95% CI [.07, .74], p = .016) scarcity groups. However, the indicator of moderated mediation was not significant (.01, 95% CI [-.01, .04], p = .206), signifying that the interaction of naturalness and total scarcity on positive affect was not mediated by restoration. There were also conditional indirect effects on PPA task scores associated with the medium (.22, 95% CI [.02, .44], p = .026) and high (.35, 95% CI [.06, .67], p = .016) scarcity groups. Once more, the indicator of moderated mediation was not significant (.01, 95% CI [-.01, .03], p = .206). The conditional indirect effects on LIWC scores were not significant at any level of scarcity, and there was no evidence of moderated mediation (.00, 95% CI [.00, .01], p = .270).

Perceived Material Scarcity as a Moderator

When the PSS material scarcity subscale was used as the moderation variable, the model showed acceptable fit, as demonstrated by chi-square (p = .279), relative chi-square (1.18),

RMSEA (.03), CFI (.98), and TLI (.97). The effect of naturalness on restoration was significant (p = .035), but the effects of material scarcity and the interaction term on restoration were not significant. The simple slopes for the medium (.52, 95% CI [.03, 1.01], *p* = .035) and high (.80, 95% CI [.19, 1.46], *p* = .013) scarcity groups were significant. There were conditional indirect effects on positive affect for the medium (.24, 95% CI [.02, .46], *p* = .036) and high (.37, 95% CI [.08, .67], *p* = .013) scarcity groups. However, the indicator of moderated mediation was not significant (.02, 95% CI [-.02, .07], *p* = .238), signifying that the interaction of naturalness and material scarcity on positive affect was not mediated by restoration. There were also conditional indirect effects on PPA task scores associated with the medium (.21, 95% CI [.02, .43], *p* = .035) and high (.32, 95% CI [.07, .63], *p* = .013) scarcity groups. Once more, the indicator of moderated mediation was not significant (.021, 95% CI [-.02, .06], *p* = .238). The conditional indirect effects on LIWC scores were not significant at any level of scarcity, and there was no evidence of moderated mediation in regards to the LIWC variable (.01, 95% CI [-.01, .02], *p* = .285).

Perceived Psychological Resource Scarcity as a Moderator

When the PSS psychological resource scarcity subscale was used as the moderator variable, the model showed acceptable fit, as demonstrated by chi-square (*p* = .311), relative chi-square (1.14), RMSEA (.03), CFI (.99), and TLI (.98). The direct effect of naturalness on restoration was significant (p = .032), but neither psychological resource scarcity nor the interaction term had a significant effect on restoration. The simple slope for the medium scarcity group was significant (.60, 95% CI [.09, 1.11], *p* = .023). The simple slopes for the low and high scarcity groups were not significant. There were conditional indirect effects on positive affect for the medium scarcity group (.27, 95% CI [.04, .52], *p* = .023). However, the indicator of

moderated mediation was not significant (.01, 95% CI [-.05, .06], p = .845), signifying that the interaction of naturalness and psychological resource scarcity on positive affect was not mediated by restoration. There were also conditional indirect effects on PPA task scores associated with the medium scarcity group (.24, 95% CI [.03, .49], p = .023). Once more, the indicator of moderated mediation was not significant (.01, 95% CI [-.05, .06], p = .845). The conditional indirect effects on LIWC scores were not significant at any level of scarcity, and there was no evidence of moderated mediation in regards to the LIWC variable (.00, 95% CI [-.02, .02], p = .881).

Perceived Time Scarcity as a Moderator

When the PSS time scarcity subscale was used as the moderator variable, the model did not show acceptable fit, as demonstrated by chi-square (p = .028), relative chi-square (1.81), RMSEA (.07), CFI (.93), and TLI (.88). Because a model must have acceptable fit before its causal paths can be interpreted (Kenny, 2020), the rest of the results from this model will not be reported.

Post Hoc Analyses

Although the interaction terms were not significant, nor was moderated mediation present in any of these models, it does seem that there may be some differences in pre- to post-walk change scores among varying levels of scarcity in the data, given the variation among simple slopes. Post hoc two-way repeated measures ANOVAs were run to better understand the differences among participants reporting high scarcity (more than one standard deviation above the mean), low scarcity (more than one standard deviation below the mean) and medium scarcity (between the two). These are the same groups that were used in the analysis of simple slopes in the previous moderation analyses. For variables showing a significant interaction between time

and scarcity, one-way ANOVAs were also conducted using the change score to better understand this relationship. Overall, results signified that there is some limited support for the hypothesis that those experiencing greater scarcity would derive greater benefit from going on a nature walk than those experiencing lower scarcity.

Total Perceived Scarcity

Results from the two-way repeated measures ANOVA calculations can be seen in Table 10, and means and standard deviations for all variables (divided by level of scarcity) can be seen in Table 11. As previously established, there was a significant main effect of time, with participants' scores on all study measures increasing significantly after the walk. There was also a significant interaction between time and total perceived scarcity on restoration, personal project reflection, and motivation. Overall, these results suggest that those with higher levels of total scarcity derive greater benefit from the walk than those experiencing lower scarcity, at least in regards to the aforementioned variables.

Restoration. There was a significant interaction between time and perceived total scarcity for restoration scores. A one-way ANOVA showed that there was a significant difference in restoration changes among scarcity groups ($F(2,162) = 3.60$, $p = .029$). Although those in the high scarcity group had the lowest scores of restoration both before and after the walk, they saw a significantly higher *increase* in restoration compared to the low scarcity group ($p = .024$). The difference between the high and medium groups was not significant, nor was the difference between the medium and low groups. This relationship is visualized in Figure 7.

Reflection on personal projects. There was a significant interaction between time and perceived total scarcity for PPA task scores. A one-way ANOVA showed that there was a significant difference in PPA score changes among scarcity groups ($F(2,162) = 4.15$, $p = .018$).

Participants in the high (p = .044) and medium (p = .017) scarcity groups saw a greater increase in reflection on personal projects than those in the low scarcity group. The difference between high and medium groups was not significant. This relationship is visualized in Figure 8.

Motivation to go on walks in the future. There was a significant interaction between time and perceived total scarcity for motivation to go on walks in the future. A one-way ANOVA showed that there was a significant difference in motivation score changes among scarcity groups (F(2,162) = 5.01, p = .008). Participants in the high scarcity group saw a greater increase in motivation to go on outdoor walks in the future as compared to those in the medium (p = .007) and low (p = .038) scarcity groups. The difference between medium and low groups was not significant. This relationship is visualized in Figure 9.

Perceived Material Scarcity

Results from the two-way repeated measures ANOVA calculations can be seen in Table 12, and means and standard deviations for all variables (divided by level of material scarcity) can be seen in Table 13. There was a significant main effect of time, with participants' scores on all study measures increasing significantly after the walk. There was also a significant interaction between time and perceived time scarcity on motivation to go on outdoor walks in the future, but not on any other variables.

Motivation to go on walks in the future. A one-way ANOVA showed that there was a significant difference in motivation score changes among scarcity group (F(2,162) = 4.05, p = .019). Participants in the high material scarcity group saw a greater increase in motivation to go on outdoor walks in the future as compared to those in the medium scarcity group (p = .017). The difference between high and low, and medium and low, was not significant. This relationship is visualized in Figure 10.

Perceived Psychological Resource Scarcity

Results from the two-way repeated measures ANOVA calculations can be seen in Table 14, and means and standard deviations for all variables (divided by level of psychological resource scarcity) can be seen in Table 15. There was a significant main effect of time, with participants' scores on all study measures increasing significantly after the walk. There was not, however, any significant interaction between time and psychological resource scarcity for any variables in the model.

Perceived Time Scarcity

Results from the two-way repeated measures ANOVA calculations can be seen in Table 16, and means and standard deviations for all variables (divided by level of time scarcity) can be seen in Table 17. There was a significant main effect of time (i.e., pre- vs. post-walk measures), with participants' scores on all study measures increasing significantly after the walk. There was also a significant interaction between time and time scarcity on restoration, reflection on personal projects, and LIWC scores.

Restoration. There was a significant interaction between time and perceived time scarcity for restoration scores. A one-way ANOVA showed that there was a significant difference in restoration changes among scarcity groups ($F(2,162) = 5.26$, $p = .006$). Participants in the high time scarcity group saw a greater increase in restoration scores as compared to those in the low scarcity group ($p = .004$). The difference between high and low, and medium and low, was not significant. This relationship is visualized in Figure 11.

Reflection on personal projects. There was a significant interaction between time and perceived time scarcity for PPA task scores. A one-way ANOVA showed that there was a significant difference in PPA task score changes among scarcity groups ($F(2,162) = 5.81$, $p =$

.004). Participants in the high (p = .008) and medium (p = .005) time scarcity groups saw a significantly greater increase in personal project analysis task scores than those in the low time scarcity group. There was no significant difference between the high and medium groups. This relationship is visualized in Figure 12.

LIWC. There was a significant interaction between time and perceived time scarcity for LIWC scores. A one-way ANOVA showed that there was a significant difference in LIWC score changes among scarcity groups (F(2,162) = 3.61, p = .029). Participants in the high time scarcity group saw a significantly lower change in LIWC scores than those in the medium (p = .049) and low (p = .039) time scarcity groups. There was no significant difference between the medium and low groups. This relationship is visualized in Figure 13.

Objective 3

The third objective of this study was to explore the cognitive and emotional processes that occur during nature walks utilizing qualitative data analysis. It was hypothesized that qualitative data would reveal themes that support SRT and ART. Writing samples that exhibit each of the following themes can be found in Table 18.

SRT Themes

SRT posits that interacting with nature should reduce negative affect and increase positive affect. The writing samples provided by the participants offer robust support for this theory.

Decreased Negative Affect

Prior to the walk, 75.29% of participants in the natural condition and 71.25% of participants in the built condition had endorsed forms of negative affect, such as feeling "stressed," "overwhelmed," or "tired." Students described a variety of stressors, including

academic obligations, other responsibilities, relationship concerns, and current events (namely, the COVID-19 pandemic and the 2020 presidential election, both of which were happening as data collection took place). Examples of stress-related comments included, “I have been feeling very stressed out with a lot of school work while also trying to stay safe with everything happening in the world at the moment,” “I’ve been feeling a little overwhelmed with assignments and finals coming up,” and “I’m a little nervous and worried about my upcoming projects just because I feel like I won’t do good on my test, and I’ll have a hard time trying to relax until all my worries go away (school, work etc).” Schoolwork seemed to be the stressor at the forefront of most participants’ minds: 61.18% of participants in the natural condition and 67.50% in the built condition wrote about academic obligations, mostly in relation to stress.

Some negative affect was also endorsed after the walk, but it appeared in far fewer writing samples. Some of the participants (6.15% in the natural condition and 1.67% in the built condition) specifically mentioned fear or nervousness during the walk due to being alone and/or in an unfamiliar place. Examples included, “First I felt scared to be alone, and have my phone on airplane mode in case something happens. Once I got to the Botanical gardens, I felt relaxed,” and “I was little nervous about the walk considering I went to a nature trail. I was a little spooked.” Other forms of negative affect, such as boredom, fatigue, and stress, were endorsed in post-walk writing samples by 12.31% of participants in the natural condition and 18.33% of participants in the built condition. Examples include comments such as, “I felt very sad on my walk because of the memories I associate with my walking location,” and “I felt like I was going to die. I haven't walked that long for a very long time. It seemed like this walk was going to go on forever, it was the longest 30 minutes of my life.” More notably, *reductions* in stress or other forms of negative affect over the course of the walk were explicitly endorsed by 22.35% of

participants in the natural condition and 18.75% of participants in the built condition. Examples include comments such as, “I started my walk off with a little bit of stress going into it, but once I started walking it started to go away,” “I feel refreshed and like a little bit of my edge or the uncertainty I was feeling did fade as I feel I had to confront what was on my mind as there was little to nothing else I was able to spend my time,” and “I am a very on edge person, anything scares me. But going outside and walking around my neighborhood really helped.”

Increased Positive Affect

Prior to the walk, 45.88% of participants in the natural condition and 37.50% of participants in the built condition had endorsed forms of positive affect, such as feeling “good” or “relaxed.” Following the walk, mentions of positive affect increased, with 61.18% of participants in the natural condition endorsing feelings of peace and relaxation and 62.35% endorsing other forms of positive affect, such as happiness or enjoyment. In the built condition, 41.25% of participants endorsed feelings of peace and relaxation, while 52.50% endorsed other forms of positive affect. Participants wrote comments such as, “I was very relaxed and I had a truly peaceful time,” “During the walk I felt super refreshed and at peace. The weather was beautiful and the campus looks so nice when the sun is setting. I felt relaxed and rejuvenated while strolling around campus,” and “I felt amazing. The walk was everything I needed. I felt relaxed and happy and was very relaxed.”

SRT seems particularly well-supported by the content of these writing samples. Negative affect appeared to decrease substantially, while positive affect increased—albeit somewhat less dramatically. A good number of participants explicitly attributed the changes in affect to their experiences on the walk, which is all the more convincing because they were not asked directly to make the connection. Of course, we do not know exactly which elements were most helpful

for participants—the physical activity? the fresh air? the opportunity to get out of their dorm rooms and away from their computer screens? Regardless, this intervention seems to have been effective in reducing negative affect and increasing positive affect for many who engaged in the study. Although participants in both conditions endorsed patterns consistent with SRT, there seems to have been at least a nominal advantage to walking in the natural condition.

ART Themes

ART posits that interacting with nature should increase attentional capacity, increase ability to focus on immediate concerns, and increase ability to engage in broadened, "big picture" thinking. The writing samples provide support for this theory.

Attention Restoration

There was little direct mention of attentional fatigue prior to the walk, apart from some participants (2.35% in the natural condition and 3.75% in the built condition) who endorsed having trouble focusing on schoolwork or other projects. Participants shared comments such as "Focusing can also be hard because I have a lot going on in my personal life," and "I am struggling to focus on being productive and carrying out daily responsibilities." However, there was also little mention of attentional clarity prior to the walk. Only 2.35% of the participants in the natural condition (and no participants in the built condition) mentioned having a clear mind in pre-walk writing samples. These participants shared comments such as "My state of mind is clear," and "I feel good, clear mind." Following the walk, there was much more substantial mention of attentional clarity: 36.47% of participants in the natural condition and 30.00% in the built condition described having a clear mind or feeling focused. Many described their mental clarity as having increased as a result of the walk. Comments included "It helped clear my mind

and think to myself a little bit more then what I usually do when I'm stressed," and "I think the walk helped clear my head."

Broadened Thinking

ART would theorize that, following an increase in attentional clarity, participants would be better able to focus on immediate concerns as well as initiate reflection on bigger-picture issues—in other words, to engage in "broadened thinking." Ability to focus on immediate concerns will be more fully explored in the next section, through an examination of participants' reflection on personal projects. This section will address broadened thinking. No simple concept to operationalize, broadened thinking has been described in this paper as creative, flexible, and reflective thinking and problem-solving processes. There will be some overlap between the "broadened thinking" discussed in this section, and the reflection on personal projects discussed in the next section, since some participants who endorsed broadened thinking indicated that they were working through their personal projects and coming to conclusions about them.

Prior to the walk, 4.71% of participants in the natural condition and 5.00% of participants in the built condition had incorporated broadened thinking into their writing samples. Examples include "I've been feeling a little depression and have been really contemplating my decisions and life," and "I've been thinking a lot about what I want for myself and my career in the future and comparing it to what my family wants for me in the future a lot. Their wants are extremely different from mine and I am cool with that. I've been thinking a lot about whether college is for me or not." These comments speak to a certain level of self-reflection and active rumination. Following the walk, 21.18% of individuals in the natural condition and 16.25% in the built condition described having engaged in broadened thinking. Examples include "I thought about how I view myself versus how other people view me and how those viewpoints differ," "I

thought to myself and talked to myself a lot about how I want my future to go and how I want it to be," and "I talked about the stress that was bothering me with my parents divorce & said to myself that I won't and can not own that feeling." The participants who exhibit broadened thinking in their post-walk writing samples seemed to be grappling with "big picture" issues through self-reflection, and in many cases, they ultimately came to some sort of conclusion.

Reflection on Personal Projects

Participants were not explicitly asked to reflect on their personal projects during the walk. However, they were asked—both before and after the walk—to describe thoughts that were coming up for them about their personal projects. Many participants, therefore, wrote about their personal projects as well as other immediate concerns that seemed closely related.

One of the major themes to emerge was increased confidence and motivation to engage with personal projects and other immediate concerns following the walk. Prior to the walk, 11.76% in the natural condition and 10.00% in the built condition mentioned feeling motivated. On the other hand, 12.94% in the natural condition and 11.25% in the built condition described feeling unmotivated. After the walk, 25.88% of participants in the natural condition and 16.25% of participants in the built condition mentioned motivation or confidence for their personal projects and/or other immediate concerns, often acknowledging explicitly that the walk had assisted them in building up that confidence. Examples include, "When I thought about my projects honestly I felt more confident in my ability to complete them," and "I was able to actually take a step back and realize my projects, things I let stress me out so much, really weren't that big a deal. I feel encouraged and motivated to go home and complete some missing assignments and get my lesson plan finished for our last class tomorrow." There were no participants who explicitly mentioned ongoing lack of motivation following the walk.

Some participants, including 18.75% in the built condition and 16.47% in the natural condition, explicitly stated that they did not think about their personal projects during the walk. Many of these participants indicated that they had instead chosen to "be in the moment" and focus on their surroundings. They shared comments such as, "I didn't really think about any of my projects. I was mainly focused on my surroundings, and looking at the different things around me," and "I didn't really think about my personal projects at all. I just really thought about what came to my mind as I was walking and observing organisms." Despite having not focused on their projects during the walk, some of these participants acknowledged that they felt less stressed or more confident about their projects afterwards. Participants shared observations such as, "And to be honest I didn't really think about my personal projects. I just enjoyed the walk and just hearing nature and the water and stuff like that. I did feel like I could go back and figure out my projects now though with a clearer head," and "I tried not to think about my projects. Rather, I tried to clear my mind and to be in the moment…. and now feel like my projects aren't nearly as difficult as they feel sometimes. I have the tools I need to be successful and I just have to persevere."

Overall, qualitative data provide support for ART and suggest that outdoor walks facilitated cognitive wellbeing and contributed to participants feeling better about their personal projects and other immediate concerns. Some participants seem to have benefitted from the opportunity to contemplate their projects—to problem solve, to reflect on their priorities, or to come up with creative ways of prioritizing their projects. Other participants seem to have benefitted from the opportunity to set aside their projects and other cares, instead focusing on clearing their minds and being present in the moment. Once more, the same ART patterns were

identified in both conditions, but there was at least a nominal advantage to being in the natural condition.

Scarcity Themes

There were limited qualitative data related to scarcity.

Material Scarcity

In the pre-walk writing samples, only 1.17% of participants in the natural condition and 5.00% of participants in the built condition described stress related to money or other material resources. Examples include “Running low on personal funds which is unfortunate” and “I have been rather down lately because I don’t have a lot of money.” There was no mention of material scarcity after the walk.

Psychological Resource Scarcity

Psychological resource scarcity is characterized by not having enough knowledge, social support, emotional resources, or cognitive abilities. It was challenging to identify psychological resource scarcity in part because so many participants endorsed stress in their writing samples. Efforts were made to ensure that writing samples being marked for “psychological resource scarcity” were specifically focused on an inability to manage the stress that participants were experiencing. With this in mind, 15.29% of individuals in the natural condition and 12.50% in the built condition endorsed some psychological resource scarcity prior to the walk. Examples include “I need to make my school a priority because I am floundering. I am generally stressed, unmotivated, and my mental health is the worst it’s been in years,” and “I feel so overwhelmed that I can't even pay attention to just one emotion anymore. There's too much I need to do to make sure everything is in place that at times I can't relax when I'm supposed to be relaxing and I

can't work when I'm supposed to be working." In the post-walk writing samples, psychological resource scarcity was not mentioned.

Time Scarcity

In regards to time scarcity, 12.94% of participants in the natural condition and 6.25% of participants in the built condition described not having enough time to complete their responsibilities or to enjoy their leisure activities. Mentions of time scarcity include comments such as "I want to do fun activities, such as biking and working-out, but I struggle finding time for them" and "I also work 30 hours a week so finding time to relax can be hard so that's another reason to be excited for the semester to be over." In the post-walk writing samples, there was no mention of time scarcity, with the exception of one individual in the natural condition who seemed to come to the realization that time was not so scarce as it had felt before the walk: "I thought about Project 1 and realized that I was as wrong to think that I had no time for enough things and thought that I have plenty of time for all of my needs."

Overall, although qualitative data related to scarcity were relatively limited, it seems that there was a reduction in thoughts of scarcity over the course of the walk. As in the quantitative data, time scarcity was the most common experience of scarcity among participants.

CHAPTER 5: DISCUSSION

The intention of this study was to better understand the cognitive and emotional benefits of nature walks, while also gaining a better understanding of how the experience of scarcity might fit in to the existing nature walk literature. Overall, the 30-minute outdoor walks seemed to be a success: Restoration, positive affect, reflection on personal projects, and motivation to go on walks in the future all increased, and qualitative data backed up these findings. These increases were particularly notable within more natural environments. There were even some interesting patterns observed with scarcity, including the finding that those with the highest time scarcity see the highest increases in restoration and reflection on personal projects. The following sections will summarize and interpret study findings, as well as offer some implications and discuss future directions.

Assessing the Proposed Model

At the heart of this study is a proposed model that integrates ART, SRT, and the upward spiral theory to explain the process by which nature walks may lead to broadened thinking. Based on the results, this model seems to be an appropriate framework for conceptualizing the process. Bratman and colleagues (2012) proposed that ART and SRT may represent interconnected processes that promote cognitive and emotional wellbeing simultaneously. Indeed, in the current study, positive affect and broadened thinking seem to be closely connected and inextricably intertwined in participants' experiences of the walk (as seen in both quantitative and qualitative data). Unfortunately, as will be further expanded upon in later sections, positive affect did not seem to promote motivation to engage in subsequent walks. This is contrary to the expectations of the upward spiral theory. Given that "motivation" was captured exclusively with a couple of Likert-scale questions created by the researcher, it may not have been measured in a

helpful way. Other methods for capturing motivation may be appropriate in future studies, including measuring the actual behavioral changes that result from a walk or series of walks. Nevertheless, this model is a viable framework for ongoing research, and future studies will hopefully continue to refine its measurement.

Differences Among Participants

Before doing the main study analyses, some basic statistical analyses were run to compare groups of participants and attempt to understand any differences that might be based in gender or racial identity, socioeconomic status, or smoking behaviors. There were remarkably few differences among demographic groups. The fact that there were no gender differences for main study variables is unsurprising, as nothing in the literature would suggest that women, men, and people of other genders would experience the benefits of the walk in fundamentally different ways. However, given that there is some evidence to suggest that fear of outdoor walks is more prevalent among women (Roman & Chalfin, 2008), it was encouraging to see that there were no gender differences in perceived safety during the walk. The fact that participants were able to choose their own walk place and time may have fostered a sense of security. The only notable difference among genders was the fact that perceived time scarcity was higher among women than among men. Although the reasons for this difference cannot be ascertained with any great certainty, the finding speaks to gendered expectations for household and familial responsibilities—which may have been felt even more acutely at a time when many students were living at home due to the COVID-19 pandemic.

The fact that there were so few differences among racial groups was somewhat more surprising, as outdoor spaces and activities have often not been as welcoming to people of color as they have been to White people (Borunda, 2020). The only significant difference was in pre-

walk positive affect scores, with White participants reporting significantly higher positive affect than their counterparts of other races. This finding may be representative of the disproportionate levels of stress experienced by BIPOC individuals—especially at a moment in late 2020 when race-based trauma, a contentious election, and a pandemic that disproportionately affected communities of color, were all in the news. There were no differences in post-walk or change scores among different racial groups, signifying that something about going on a walk may have "evened the playing field" in regards to affect. When verifying the randomization of conditions, it was found that there were proportionally more White participants in the built condition as compared to the natural condition. However, given that different racial groups do not seem to have experienced the walk in fundamentally different ways, this is no cause for concern.

There were no significant differences for any study variables, including scarcity scores, based on household income. However, total perceived scarcity and material scarcity were higher among first-generation students. No other differences based on parental education were noted. This suggests that parental education—and not reported household income—may be a more appropriate indicator of SES and experiences of scarcity in the current study. One possible reason is that students in this study could have been poor estimators of their parents' income, whereas they were much more likely to be able to accurately report their parents' educational attainment.

It was expected that smoking behaviors would impact enjoyment of an outdoor walk, but interestingly there were no differences between smokers and non-smokers on main study variables. The only difference lay in levels of material scarcity, signifying perhaps that smoking was a way for those with greater material scarcity to cope with associated stress.

Process of Broadened Thinking

The first and third objectives of this study aimed to elucidate the process by which going on a nature walk can lead to broadened thinking. The proposed model combined ART, SRT, and the broaden-and-build hypothesis to describe this process. Quantitative data were utilized to attempt to validated the model, and qualitative data were used to attempt to corroborate it. Generally speaking, data indicate that the hypothesized model is a viable one. The original model showed acceptable fit, even though two of the variables (LIWC and motivation) did not seem to fit with the others as expected.

Naturalness

The first element of the model concerns the naturalness of the walk environment. As hypothesized, more natural environments led to greater increases in feelings of restoration, in keeping with previous nature walk studies that have utilized the ROS (e.g., Pasanen et al., 2018). Apart from the current research, no known studies up to this point have conceptualized naturalness as a continuous variable. Most researchers (including all of those listed in Table 1, with the exception of Duvall [2011], who did not compare the naturalness of conditions) have chosen two or more specific environments for their participants to walk in. Even though naturalness was conceptualized as a continuous variable in the current study, participants were still randomly assigned into two conditions in the current study, the hope being that this would result in a range of walk environments. The range of environments represented in the current study helps to support the generalizability of the findings, as well as the applicability of findings to "real life." Rather than interacting with one or two specific environments chosen by the researcher, participants found cognitive and emotional restoration in a wide variety of parks, neighborhoods, greenways, and sidewalks that are (hopefully) conveniently located in their everyday lives.

It was interesting that there were so few differences in study variables when comparing the natural to the built condition in a dichotomous manner—except, of course, on the "naturalness" ratings, which were significantly and reassuringly different between conditions. (The LIWC variable was also significantly different between conditions, but it did not follow any expected patterns, and its usefulness for the purposes of this study is questionable. See below for a further explanation of the LIWC variable.) Perhaps the relative similarities between conditions can be explained by the fact that most walk environments, across both conditions, were of average naturalness. The naturalness ratings for both conditions—while significantly different from each other—still hovered around the halfway point between 1 and 10, with the built condition slightly below and the natural condition slightly above. On the whole, participants chose environments of average naturalness, and there was some overlap between the types of environments that appeared in each condition (e.g., greenways, neighborhoods). Furthermore, as participants in both conditions were encouraged to seek out pleasant, pedestrian-friendly walk sites, all of the chosen environments should have been nice, safe places to walk. In some previous studies, participants in the built/urban condition had walked down busy city streets, resulting in decreased positive affect (Bratman et al., 2015; Hartig et al., 2003), as well as increased negative affect and heightened blood pressure (Hartig et al., 2003). The intention in this study was not to send participants in the built condition into stressful and unpleasant walk conditions; rather, the hope was that *all* participants would benefit to some degree from their walk—and benefit they did. Those in the more natural environments (with naturalness seen as a continuous variable) simply tended to benefit to a greater degree, consistent with past research showing that participants in natural conditions report greater improvements in directed

attention/reflection abilities as well as mood (e.g., Berman et al., 2008; Bratman et al., 2015; Hartig et al., 2003; and Mayer et al., 2009).

Emotional Benefits

Positive affect increased over the course of the walk, in keeping with the basic tenets of SRT and findings from past nature walk studies (e.g., Berman et al., 2008; Bratman et al., 2015; Mayer et al., 2009). The greater the increase in restoration, the greater the increase in positive affect. Qualitative data supported this finding, with fewer mentions of stress and negative affect—and more mentions of positive affect—after the walk than before the walk. In fact, perhaps the most notable theme from the qualitative data was the general sense that participants *felt better* after the walk than they had before. With data collection taking place during the latter half of a virtual semester, within the context of a global pandemic and in close proximity to the 2020 presidential election, participants endorsed relatively high levels of stress prior to the walk. Previous research has demonstrated that individuals experiencing more stress may derive greater benefit from nature walks (Pasanen et al., 2018; Roe & Aspinall, 2011a). The fact that so many participants endorsed stress and other forms of negative affect prior to going on the walk may have primed them to experience the emotional benefits that they did.

Despite notable increases in positive affect over the walk, these feelings did not have an effect on motivation to go on outdoor walks in the future. The upward spiral theory would argue that increased positive affect should lead to increased non-conscious motives—or, in the context of this study, increased conscious motivation—to go on outdoor walks in the future. On the whole, motivation scores did increase after the walk, but positive affect must not have had a major impact on that change. Other factors may have been at play: Going on a walk during this study, for example, may have rendered the idea of future walks more reasonable and appealing.

Participants with no regular outdoor walking habit may have realized that walking was an easy and accessible way to work towards a physical fitness goal or have an excuse to get out of the house. In other words, participants' increased motivation to go on walks in the future may have been less impacted by the emotional experience of the walk than it was by simple logistics.

Cognitive Benefits

Qualitative data demonstrated a pattern of increased mental clarity after the walk. In keeping with ART, further cognitive benefits—such as reflective, broadened thinking—seem to have followed.

Reflection on Personal Projects

Broadened thinking, as measured by the PPA task, increased over the course of the walk, consistent with findings from past nature walk studies (e.g., Mayer et al., 2008; Roe & Aspinall, 2011a). The greater the increase in restoration, the greater the increase in broadened thinking. Naturalness also had a small, but significant, indirect effect: The more natural the environment, the greater the increase in broadened thinking. Qualitative data supported the finding about increased reflection, with more evidence of broadened thinking in writing samples after the walk than before.

LIWC

The LIWC variable—the second quantitative variable measuring broadened thinking—is more challenging to understand than the variable measuring PPA task scores. Although it did increase over the course of the walk, this variable did not seem to follow expected patterns and may not have been a helpful measure of broadened thinking. The LIWC variable did not correlate significantly with PPA scores, as might be expected if they were measuring similar constructs, nor was it correlated with restoration or positive affect. There were some unexpected

relationships within the data: For example, first-generation students scored significantly higher on pre-walk LIWC scores than their non-first-generation counterparts.

The LIWC variable was created using LIWC software, which calculated the percentage of each sample consisting of insight and causal words, as defined by Pennebaker (2017). Some of the LIWC variable's inscrutability may have stemmed from inconsistencies in the word counts of these short writing samples. Most writing samples were several sentences in length, but there was a significant range in word count, between participants who wrote brief sentences ("I felt relaxed") and those who wrote long paragraphs to describe their experiences. A participant who wrote a very short response but happened to include an insight or causal word would have earned a higher LIWC score than one who encased the same insight or causal word within a lengthy paragraph—arguably showing a more thoughtful and reflective response. Furthermore, despite the occasional paragraph, writing samples as a whole were relatively short, perhaps even too short to support meaningful analysis. If LIWC is included in future studies, researchers may consider suggesting a minimum word count. Although there does not seem to be a standard word count recommendation for LIWC samples, one online LIWC project advised participants to write 200 words at minimum, keeping in mind that more is better (Pennebaker Conglomerates, Inc., n.d.).

The relative inutility of the LIWC variable was one of the limitations of the study, as it reduced the number of sources from which meaningful measures of broadened thinking could be derived. The PPA task measures a very specific type of reflection, and the intention in incorporating the LIWC variable was to capture at least one additional facet of broadened thinking. Unfortunately, if LIWC does represent an aspect of broadened thinking in this study, it is not an easily recognizable or comprehensible one.

Future Directions for Measuring Broadened Thinking

Future studies should work to clarify and operationalize broadened thinking in a clearer manner, for the purposes of both quantitative and qualitative data collection. Because this concept does not seem to have a precise definition in the literature, it was difficult to find appropriate ways to measure it. There is precedent for using the PPA task as a measure of reflection in nature walk studies (e.g., Roe & Aspinall, 2011a). As mentioned above, however, this task represents a specific type of broadened thinking—one that is bound to personal projects and is tied very closely to the emotional experience of reflection (as evidenced by the two items of the PPA task asking about the levels of stress and enjoyment associated with personal projects). The PPA task was an appropriate and adequate measure of broadened thinking in this study, but future studies may consider taking a different approach to measuring broadened thinking quantitatively—perhaps even one that does not depend on self-report data. One manifestation of broadened thinking is the ability to solve problems that require innovative thinking (e.g., Isen et al., 1987), and future research may incorporate such problem-solving tasks before and after the walk.

Qualitative data in this study were also limited by the vague and open-ended definition of broadened thinking. There was potential in the writing samples to capture multiple aspects of this elusive concept, including outside-the-box thinking, holistic reflection, and creative problem-solving. However, judging the presence of broadened thinking was a challenging and contentious process. Some writing samples may have paid homage to the *idea* of broadened thinking, without actually *demonstrating* broadened thinking, in the same way that the recitation of a platitude does not necessarily show one's own homegrown wisdom. Differentiating between the two within the context of a brief writing sample provided by a time-pressed 19-year-old, however, is

nearly impossible. For example, one participant wrote the following: “I thought about letting God take my fears away and take burdens off my shoulders. I told myself that I will not procrastinate and put in 100% effort into studying for finals. I will be determined and stick to my diet and cut out all of those junk foods.” Although contemplating one’s relationship with one’s faith or a higher power would certainly fall under the umbrella of broadened thinking, it is not clear from this writing sample that the participant actually was *reflecting* during or after the walk. Perhaps they grappled with their faith or meditated on what it means to trust God. Perhaps they simply repeated well-worn and comforting thoughts. Regardless, it seems to have been helpful for this participant—but we don’t know enough about the process to determine whether or not they were engaging in “broadened thinking.” Therein lies the challenge of identifying broadened thoughts within this study. The writing prompts were not explicit in their request for participants to describe the process of reflection or broadened thinking, and therefore most did not.

Interestingly, participants seem to have identified two separate paths towards cognitive restoration and broadened thinking in this study. Some participants engaged in deliberate contemplation of personal projects and other concerns on the walk; others intentionally set aside stressful thoughts to “be in the moment.” Individuals from both camps apparently were able to arrive at conclusions about their projects and/or feel more confident and motivated about the tasks at hand. Future studies should follow up on the divergence and convergence of these two paths and explore the differential effects they may have on cognitive and emotional wellbeing.

Scarcity

The second objective of this study was to examine how the experience of scarcity can impact the relationship between outdoor walks and restoration. It was hypothesized that

participants reporting higher levels of scarcity would derive greater benefit from the walk than those reporting lower levels of scarcity. Qualitative data on scarcity were limited, which may signify that scarcity was not weighing heavy on the minds of these participants before or during the walk. Even those who spoke about scarcity before the walk did not mention it following the walk, but the reasons for this change are unclear. Were participants temporarily distracted from thoughts of scarcity by their engagement in the study? Were they simply in a better mood after the walk, as data would suggest, and therefore less inclined to focus on the negative? Future studies may consider asking specifically about scarcity in qualitative follow-up questions.

For the purposes of quantitative analysis, it was hypothesized more specifically that scarcity would moderate the relationship between naturalness and restoration. Ultimately, the data did not support this hypothesis, but that does not mean that scarcity had no impact on the effects that participants experienced on the walk. When post hoc ANOVA tests were run on the data to better understand the relationships between scarcity and other study variables, some interesting patterns emerged—patterns that were, in fact, consistent with the general hypothesis that those with higher levels of scarcity would derive greater benefit from the walk. Those experiencing the highest levels of total scarcity demonstrated lower baseline levels of restoration, positive affect, personal project reflection, and motivation to go on walks in the future. This is consistent with the understanding of scarcity as an experience that contributes to stress and the narrowing of one's focus to the scarce resource at hand, thus making it more difficult to focus on bigger picture concerns such as one's personal projects. After the walk, however, those with the highest levels of scarcity actually saw the greatest increases in scores of restoration, motivation, and reflection on personal projects, suggesting a disproportionate benefit for these participants.

Each subscale of the PSS was also analyzed separately and will be explored in the following sections.

Perceived Time Scarcity

Time scarcity was by far the most common type of scarcity present among participants in this study. Those reporting the highest levels of time scarcity reported lower baseline levels of restoration, positive affect, and reflection on personal projects. However, they demonstrated the largest *increase* in scores of restoration and reflection. Although participants as a whole experienced restorative and reflective benefit from the walk, this effect was particularly strong for those who reported the greatest time scarcity. This finding highlights the value of outdoor walks as an effective intervention—especially for students feeling significant time pressure or burnout at the end of the academic semester.

There may be something about the stress of time scarcity (as compared to other forms of scarcity) that is more responsive to interventions like an outdoor walk. In the life of an otherwise well-resourced person, time scarcity may be a stressor that is more easily addressed through increasing relaxation, clearing one's mind, and shifting one's perspective with broadened thinking. On the other hand, the experiences of material and psychological resource scarcity likely stem from systemic factors that no amount of broadened thinking on the part of an individual can "fix."

Perceived Psychological Resource Scarcity

Those experiencing the highest levels of psychological resource scarcity presented with lower baseline levels of restoration, positive affect, personal project reflection, and motivation to go on walks in the future. There was no specific interaction, however, of psychological resource scarcity and time.

Those with significant psychological resource scarcity may not feel that they have the knowledge or tools to handle concerns in their daily lives, and one focus of future work could be to clarify the link between nature walks and their practical applications. More information could be gathered in future studies about the coping skills participants have at their disposal, the extent to which they recognize the walk as a potential coping skill, and their willingness to implement walks for coping in the future.

Perceived Material Scarcity

Those with the highest levels of material scarcity presented with lower baseline levels of restoration, positive affect, reflection on personal projects, and motivation to go on walks in the future. However, they demonstrated the highest increase in scores of motivation over the course of the walk. Participants with higher levels of perceived material scarcity may have grown up in areas with lower access to safe and pleasant walk environments, making them less likely to feel motivated to engage in recreational walking in their daily lives. Being exposed to the intervention in this study may have had a greater impact on students for whom outdoor walking was a relatively novel idea (i.e., those at the highest levels of scarcity), perhaps helping them to realize how accessible and appealing outdoor walks could be.

Considerations Regarding Material Scarcity

The scarcity component of this study was very much inspired by studies by Kuo and colleagues (e.g., Faber Taylor et al., 2002; Kuo, 2001; Kuo & Sullivan, 2001), whose work focused on marginalized communities experiencing high levels of material scarcity. These communities are also the most likely to be deprived of natural elements in their neighborhoods (Landau et al., 2020). It is important that we advocate for equitable access to nature, given the research showing that neighborhood green space can significantly reduce inequalities in mental

wellbeing between individuals of higher and lower SES (Mitchell et al., 2015). Policy change can be spurred by research, and it was hoped that this study would provide further evidence for the importance of maintaining and expanding green space in the communities that need it the most.

However, given the limited material scarcity among participants in this study, it was difficult to draw conclusions. Scores on the material scarcity subscale of the PSS ranged from 8 (the lowest possible score) to 31 (out of 40 possible), with a mean of 14.13, a median of 13, and a modal response of 8. Add to this the fact that the majority of participants reported household incomes above the national and state medians, and we must acknowledge that there was not enough material scarcity within this sample to be able to draw meaningful conclusions. This is somewhat surprising, as the researcher's anecdotal interactions with the UNC Charlotte undergraduate community would suggest a population that experiences more material scarcity than the level endorsed in this study. Such an observation begs the question: Was there something about this study that was less appealing to students of lower socioeconomic backgrounds? In the context of virtual learning during the 2020 – 2021 school year, students from lower-income households may have opted to live at home rather than pay expensive on-campus room and board fees or off-campus rents. They may, therefore, have had more limited access to safe, pleasant, and pedestrian-friendly walk environments compared to students living on campus or in more affluent neighborhoods, thus lessening the appeal of an outdoor walk study. Results show that, when exposed to this study, participants with the highest levels of material scarcity actually saw the greatest increase in motivation to go on walks in the future. This finding highlights the importance of interventions that can expose those with high material scarcity to safe and accessible walk environments.

This relative lack of material scarcity among participants is one of the main limitations of this study in regards to Objective 2. Future studies should expand the participant pool to include participants from a diverse array of socioeconomic backgrounds, including those who experience high levels of material scarcity. Care must be taken to understand and eliminate any barriers to participation for these participants, perhaps by incorporating pilot work to gather information on the accessibility of safe and pleasant walk sites.

Other Limitations

Limitations that have not yet been discussed are outlined below:

Pandemic Context

This study, occurring as it did in the midst of the COVID-19 pandemic—at a time when UNC Charlotte students were engaged in virtual learning in addition to their regular online activities—may have provided a particularly welcome break for students who would otherwise be staring at a screen. The encouraging results of this study must be seen within the context of the pandemic. It is unknown whether or not these participants would have experienced similar restoration during a "normal" semester when they had regularly scheduled activities outside the home or dorm room. Many participants described the power of "getting out of the house," sharing comments such as, "It was nice to just get out of the house and have a moment to myself," "It was so nice to get out of the house and just let my thoughts roam," "It was fun getting out of the house, during the weekdays especially and I feel like I will definitely come out again during the week since it has been a rather rejuvenating 30 minutes," and "It felt good to get the blood flowing and not just sulking in my room avoiding doing work. I enjoyed it [thoroughly]."

The context of the pandemic in no way diminishes the beneficial effects that many participants observed; however, it does call into question the extent to which nature alone can be credited with the cognitive and emotional improvements endorsed in this study. Nature may work in tandem with other restorative elements, such as fresh air, physical activity, and the novelty of getting outside the confines of one's quarantine environment. It would be fascinating to conduct future studies during a "normal" semester and observe the differences in participants' reactions.

Lack of Longitudinal Data

Post-walk measures, coming as they did immediately following the walk, were inadequate for capturing the durability of any stress-reducing, mood-enhancing, and reflection-inducing powers of the outdoor walk. Although many participants endorsed less stress and more motivation to complete necessary tasks after the walk, there is no certainty about how long those effects lasted—or whether or not they had any practical impact. Without having knowledge of participants' behavioral changes following the walk (if any), it is difficult to argue that the walk had a lasting impact. Furthermore, without any longitudinal data, it is difficult to argue for the applicability of the upward spiral theory to the proposed model—particularly in regards to the build-up of psychological resources over time.

There are a couple of ways in which longitudinal data might be gathered, provided that a researcher had access to adequate resources. One possibility would be to create an outdoor walk regimen in which participants were asked to take a certain number of walks over a certain period of time (e.g., six, thirty-minute walks spread over the course of two weeks, as in the study by Duvall [2011]), and to gather data both during and after the regimen. Another possibility would be to maintain the one-walk intervention but to follow up with participants at different intervals

following the study, similar to the 30-minute follow-up utilized in the nature walk study by Gidlow and colleagues (2016). Following up 30 minutes to several hours after the walk would provide some indication of the duration of stress relief and motivation to complete immediate tasks. Following up a few days, weeks, or months after the walk would provide some indication of whether or not participants continued utilizing outdoor walks as a way of building up resources that help them to cope with stress and managing their cognitive and emotional well-being.

Cell Phone Usage

Several participants noted that the (relative) freedom from screen time afforded to them during the walk was one factor contributing to restoration. Participants shared comments such as, "Putting the phone on airplane mode and shutting off all technology was really good [and] relaxing," "It was really nice to take a break from checking my electronics and let myself be," "Being off my phone and away from technology really opened my eyes up more to the nature surrounding me," and "It felt good to just walk around a bunch of shops and buildings without checking my phone every minute."

Unfortunately, however, participants were required to carry—and even interact with—their cell phones during this study. Cell phones provided the location and photo data that were important in verifying students' genuine participation and establishing the "naturalness" of their walk environments. Although many participants seemed to experience the walk as a welcome break from regular phone use, at least one participant expressed some annoyance at the need to use their cell phone during the study: "Constantly taking photos was a bit annoying though because I felt that it was taking away from the experience of merely exploring. I would've enjoyed the experience more if I wasn't stopping to take a photo." Had students been able to

leave their phones in their pockets for the duration of the walk, with no need to take photographs, check the time, or ensure that their app was still working, they may have experienced even more restoration. Future studies may explore the possibility of implementing an outdoor walk study with no need to engage with cell phones or other technology.

Demand Characteristics

Participants were aware of the general objectives of this study—understanding cognitive and emotional wellbeing following outdoor walks. It is possible that demand characteristics skewed the data, with participants feeling that they "should" endorse improvements following the walk and responding accordingly. Future studies may consider using measures of broadened thinking that are less dependent on participant self-report than the PPA task (e.g., finding ways to further elicit examples of broadened thinking through qualitative data collection).

Participants

The current study follows in the footsteps of other outdoor walk studies that have primarily recruited university students and young adults as participants (e.g., Berman et al., 2008; Bratman et al., 2015; Hartig et al., 2003; Johansson et al., 2011; and Mayer et al., 2009). The participants in this study, as previously mentioned, seem to be representative of the UNC Charlotte undergraduate population in terms of gender identity, racial and ethnic background, and first-generation status, but it is uncertain whether or not findings from this study would generalize to the wider population.

It is crucial to remember that participants who signed up for this study may have done so precisely because the idea of an outdoor walk appealed to them. Those for whom the idea of outdoor physical activity was disagreeable likely scrolled past to the next Sona study. Future studies may benefit from gaining an understanding of who would *not* typically sign up for an

"outdoor walk study," and targeting interventions to those who may need or desire to access nature differently. As previously mentioned, participants without easy access to safe walk environments may have avoided signing up for this study. Additionally, those with mobility or health-related concerns may have not have felt that this opportunity was accessible to them due to the requirement that they be able to walk outdoors for thirty minutes. Walking is an important element of this study—and the benefits of physical activity are indisputable—but an intervention could easily be tailored to suit those with physical limitations or personal preferences for a less physical exploration of nature (e.g., finding a "sit spot" in a park or garden and engaging in mindful interactions with one's surroundings).

Writing Prompts

One major limitation of the qualitative portion of the study was the vague and open-ended nature of the writing prompts, which had the effect of eliciting responses that were correspondingly vague (and short) from participants who may have been rushing through data collection. Other participants crafted thoughtful and detailed responses. Themes relevant to the study did emerge, but they could have been more thoroughly explored through the use of targeted questions asking participants to expand on their observations related to certain hypothesized processes (e.g., "Some people might engage in deliberate reflection during a walk. Others might let their thoughts wander. Describe your own thought process over the course of the walk, including any ways in which your thoughts may have shifted. What sorts of observations did you make about the connection between your mood and your thought process during the walk?"). Future studies should include more specific writing prompts such as these. Even better, they could implement a structured interview approach to more easily follow up on

interesting lines of thought and to better ensure both clarity and completeness in participants' responses.

Implications and Conclusions

In conclusion, this study provides evidence that nature walks can significantly increase cognitive and emotional wellbeing among college students. It supports the well-documented effects of ART and SRT, validates the proposed model, and represents a preliminary attempt to understand how the experience of scarcity may impact the benefits of a nature walk. After walking at their own pace for 30 minutes, in a natural or built environment of their own choosing, participants felt more restored and happier. Most importantly for the purposes of this study, they experienced "broadened thinking" in the form of increased reflection on personal projects. These effects were seen regardless of gender, race, and socioeconomic status, but they were particularly strong for those who were experiencing high time scarcity. Naturalness of the walk environment was also an important predictor of outcomes, with more natural walk environments leading to greater restoration, positive affect, and broadened thinking.

Defining "Nature"

Although participants who walked in more natural environments saw stronger effects from the walk, even those in the less natural environments still experienced some benefit. It is also notable that there were few significant differences between conditions when "naturalness" was conceptualized as a dichotomous variable instead of a continuous one. This finding may challenge us to broaden our perspective on what "nature" can be. Kaplan and Kaplan (1989), who first theorized about attention restoration, described nature as follows: "Nature connotes many settings….Nature includes parks and open spaces, meadows and abandoned fields, street trees and backyard gardens. We are referring to places near and far, common and unusual,

managed and unkempt, big, small, and in-between, where plants grow by human design or even despite it….Much of our discussion is about the nature that can be found in the urban *and* in the rural context" (pp. 2-3, emphasis added). "Nature," according to this definition, is an inclusive construct, rendered all the more beautiful and powerful by its very accessibility. Keeping in mind this inclusive definition, all participants interacted with nature on their walks. Many of the participants in the built condition provided photographs of trees, clouds, animals, and other natural elements that were apparent in their neighborhood and downtown environments.

Emphasizing (and nurturing) the nature that can be found even in built contexts is vital to making nature accessible for all, including those living in lower income communities. Immersing oneself in the wilderness, as may happen while forest bathing or hiking, is a uniquely engrossing experience whose benefit cannot be overestimated—but not everyone has regular access to verdant and expansive natural landscapes. In work by Kuo and colleagues, something as simple as having a view of trees outside one's window made a substantial difference for residents of a public housing building in Chicago. In the current study, participants who walked in less natural settings may not have seen as dramatic an effect as their counterparts in more natural settings, but they still experienced meaningful cognitive and emotional changes. These results suggest that we may benefit from broadening our definition of nature for the purposes of accessibility. Broadening the definition, however, in no way relieves us of our responsibility to protect nature in all its forms, nor does it permit us to become complacent with current levels of urban green space or discount the value of connecting with profound wilderness. Rather, broadening the definition of nature helps to remind us that nature is for everyone, and that even the smallest patches of flora and fauna within our built environments should be acknowledged, valued, and protected as precious commodities.

The previous paragraphs discussed limitations, while also suggesting a variety of ways in which future studies may refine and expand upon the existing body of work. Here, main suggestions for refining the current study will be summarized, and ways of expanding this work to benefit both individuals and the communities to which they belong will be discussed.

Refining the Current Study

Future research should work to refine and improve elements of the current study. Several suggestions have already been put forward, but it would be most important to focus on three main area. First, it would be helpful to improve the measurement of broadened thinking, perhaps through the use of longer and more specific writing samples and/or interviews. Second, it would be helpful to include some form of follow-up or collection of longitudinal data to better understand the longer-term effects of going on a walk or series of walks. Third, it would be helpful to recruit from a broader spectrum of society, hopefully capturing more participants who experience significant material scarcity.

Expanding to Individual-Level Interventions

A second aspect of future work would be to expand on the study, focusing on the transformation of empirical results into meaningful clinical interventions. Given the focus on college students in the current study (as well as many past studies), it may be helpful to begin by finding ways to intervene with this population. Nature walks are an affordable and accessible intervention for most students—especially those living on or near campus, which is likely to be filled with pleasant, pedestrian-friendly walk sites. Nature walks may also be appealing to college students, as evidenced by responses from the participants in this study. In addition to providing self-report data demonstrating increased positive affect following the walk, participants expressed their gratitude for the study in emails to the researcher: “Thank you for

giving me the opportunity to participate in your study! The experience was enjoyable and I had a great time learning more about my neighborhood"; "I really enjoyed this project and I feel like this could be a useful way to aid people with struggling circumstances in [their] life that feel overwhelming to them so they could ease their anxiety or worry"; and "I really enjoyed this study and I think I will start to go on more outdoor walks by myself!" Many participants seemed pleasantly surprised by their experiences during this research study, lending credence to the idea that college students would be willing to use nature walks as a coping tool if only they are provided with the opportunity and the motivation to engage with them.

Student services across university campuses may benefit from the incorporation of outdoor walks into their programming. In some cases, these programs may already exist. For example, an outdoor workshop (or "walkshop") focused on nature connectedness and mental and emotional wellbeing has been offered through the University of Florida Counseling and Wellness Center, and it was met with encouraging student interest and engagement prior to the COVID-19 pandemic (personal communication, E. Lenes, September 7, 2020). Given the reactions of students in this study, more "walkshop" offerings through counseling centers and/or student recreational services may be appreciated on college campuses. These offerings may be particularly important during moments when students are at their busiest and most stressed (e.g., during midterms and finals). Nature walks could be advertised as a particularly efficient and effective intervention for those who have limited time for self-care. Research could be incorporated into walkshops to better understand how these walks can shape students' perceptions of time scarcity and improve their cognitive and emotional wellbeing; to figure out whether or not participation in campus programming inspires students to engage in behavioral change and take walks on their own time; and to measure the impact of walking in a group

setting as opposed to individually. Of course, as more research is done with populations experiencing greater material scarcity, it would be important to also tailor interventions to those populations specifically.

Expanding to Societal-Level Interventions

A third and final aspect of future work involves expanding beyond the individual. Nature walk studies up to and including this one have largely emphasized personal benefits as outcomes. This paper presents an intervention that is individualistic in nature, but whose long-term impact has the potential to go much farther. The personal benefits of nature walks could be conceptualized as pleasant incentives for increasing our interconnectedness with other livings things and fostering relationships with the natural world. Cynically, but justifiably, one might argue that humans have a difficult time caring about something until it impacts us personally. If we are invited to view nature not only as a tool that helps us to cope more effectively, but also as a friend that provides comfort and protection to us, then maybe we will prioritize its protection in return. In the words of ecologist Aldo Leopold, "We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect" (p. viii, Leopold, 1949). There is some evidence that exposure to outdoor activities may increase pro-environmental attitudes and behaviors, but the relationship is complex and may depend heavily on the type of activity and the characteristics of the person engaging in it (Rosa & Collado, 2019).

Future studies may consider focusing on the larger-scale impact of nature walks: Does beginning a regular nature walk routine induce participants to begin advocating for the protection of biodiverse green space within their own neighborhoods, or perhaps even to advocate for equitable access to nature for all? In other words, future studies may explore the ways in which

nature walks can foster broadened thinking about the wider communities to which we belong, and thereby facilitate conscious decision-making to improve conditions for other living beings—both human and otherwise—in our surroundings. The ability of nature walks to broaden thinking even beyond one's personal wellbeing may be one of their greatest possibilities.

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Table 1

Summary of Nature Walk Studies

Authors	Sample characteristics	Walk characteristics	Study design	ART measures	ART outcomes	SRT measures	SRT outcomes
Berman, Jonides, & Kaplan (2008) Study 1	38 university students (23 female, 15 male; mean age = 22.62) Location: Michigan, USA	Two 50- to 55-minute walks, one in each environment; separated by one week Arboretum condition vs. urban downtown condition	Within-subjects design for environment and time Order of walks randomized and counterbalanced across participants Administration of measures immediately before/after walks	Backwards digit span task (directed attention)	Improvement in directed attention significantly greater for nature condition	Positive and Negative Affect Schedule (positive and negative affect)	Improvement in positive affect significantly greater for nature condition
Bratman, Daily, Levy, & Gross (2015)	60 adults with no current or past diagnosis of neurologic or psychiatric disorders (33 female, 27 male; mean age = 22.9) Location: California, USA	50-minute walk Grassland condition vs. urban downtown condition	Between-subjects design for environment and within-subjects for time Random assignment to nature or urban condition; sequence of tasks randomized Administration of measures immediately before/after walks	Operation span task (verbal working memory) Change detection task (visuo-spatial working memory) Attention Network Test (executive attention)	Significant improvements in verbal working memory (OSPAN) for nature condition, with no improvements for urban; other measures did not show significant changes	State-Trait Anxiety Inventory (anxiety) Rumination-Reflection Questionnaire (rumination) Positive and Negative Affect Schedule (positive and negative affect)	Decreases in anxiety, rumination, and negative affect significantly greater for nature condition; positive affect maintained in nature but decreased in urban

Authors	Sample characteristics	Walk characteristics	Study design	ART measures	ART outcomes	SRT measures	SRT outcomes
				Backwards digit span task (executive attention)			
Duvall (2011)	66 adults (predominantly female and predominantly between 40 and 69 years of age) Location: Michigan, USA	Six 30-minute walks, spread over the course of two weeks (natural environment of choice) Environmental engagement condition vs. control condition	Between-subjects design for engagement; within-subjects design for time Random assignment to engagement or control condition Administration of measures at the beginning and end of the two-week treatment period	Attentional Functioning Index (self-reported attentional functioning)	Significant increases in attentional functioning during treatment for engagement condition; no significant change for control group	Positive and Negative Affect Scale (positive and negative affect)	Significant increases in contentment and decreases in frustration during treatment for engagement condition; significant increases in contentment during treatment for standard condition but no significant change for frustration
Gidlow et al. (2016)	38 healthy adults who do not smoke and do not have chronic medical conditions (15 female, 23 male, mean age = 40.9) Location: West	Three 30-minute walks, one in each environment (and 30-minute follow-up); walks all occurred on different days Country park	Within-subjects design for environment and for time Order of walks randomized Administration of measures immediately before/after	Backwards digit span task (working memory)	Working memory improved in natural conditions and persisted through follow-up; reduced to below baseline levels in urban condition	Abbreviated Profile of Mood States (total mood disturbance) Salivary cortisol (stress reduction)	Mood improved in all environments with no significant differences; cortisol concentration decreased in all environments with

Authors	Sample characteristics	Walk characteristics	Study design	ART measures	ART outcomes	SRT measures	SRT outcomes
	Midlands, UK	condition vs. canal footpath condition vs. residential urban condition	walks, as well as 30 minutes after walk completion			Heart rate variability (stress reduction)	no significant differences; HRV showed no consistent patterns
Hartig, Evans, Jamner, Davis, & Gärling (2003)	112 healthy normotensive university students (56 female, 56 male; mean age = 20.8) Location: California, USA	50-minute walk Wildlife preserve condition vs. urban street condition	Between-subjects design for environment, task, and gender; within-subjects for time Random assignment to conditions Administration of measures immediately before/after walks	Necker Cube Pattern Control task (attention) Search and Memory test (attention)	NCPCT improved in natural environment but suffered in urban environment; SMT showed no significant change	Zuckerman's Inventory of Personal Reactions (positive and negative affect) Systolic and diastolic blood pressure (stress reduction)	Positive affect increased and negative affect decreased in nature walk, and opposite pattern was seen in urban walk; nature walk resulted in blood pressure reduction, and urban walk resulted in blood pressure increase
Johansson, Hartig, & Staats (2011)	20 university students (10 female, 10 male; mean age = 23.3) Location: Sweden	Four 40-minute walks, two in each environment; all walks separated by one week Park condition vs. urban street condition	Within-subjects design environment, time, presence of friend; between-subjects design for gender Order of walks randomized and counterbala	Symbol Substitution Test (directed attention)	Attention declined across all walks, more so for nature walks (no explanation for this)	Subscales from Exercise-Induced Feeling Inventory (revitalization, positive engagement, tranquility) Negative Mood Scale	Significant effects: In nature, revitalization increased to a greater degree while walking alone, but in the urban area, it increased while

Authors	Sample characteristics	Walk characteristics	Study design	ART measures	ART outcomes	SRT measures	SRT outcomes
		On two occasions (one park walk and one urban walk), participants brought a friend along	nced across participants Administration of measures immediately before/after walks			(negative affect)	walking with a friend but not while alone; exhaustion increased when walking alone but not with a friend; time pressure declined significantly more in nature than in urban
Mayer, Frantz, Bruehlman-Senecal, & Dolliver (2009) Study 1	76 university students (51 female, 22 male, 3 unidentified) Location: Ohio, USA	10-minute walk Nature preserve condition vs. urban downtown condition	Between-subjects design for environment; within-subjects design for time Random assignment to nature or urban condition Administration of measures immediately before/after walks	Self-reported ability to reflect on a loose end	Significantly greater ability to reflect on loose end in nature condition	Positive and Negative Affect Schedule (positive and negative affect)	Significantly greater positive affect in nature condition; no significant change for negative affect
Mayer, Frantz, Bruehlman-Senecal, & Dolliver (2009)	92 university students (61 female, 28 male, 3 unidentified)	10-minute walk (or 10-minute video) Nature preserve walk condition	Between-subjects design for environment; within subjects design for time	Self-reported ability to reflect on a loose end	Significantly poorer ability to reflect in virtual urban condition; other conditions	Positive and Negative Affect Schedule (positive and negative affect)	Significantly greater positive affect in nature condition; significantly greater negative

Authors	Sample characteristics	Walk characteristics	Study design	ART measures	ART outcomes	SRT measures	SRT outcomes
Study 2	Location: Ohio, USA	vs. virtual nature condition vs. virtual urban condition	Random assignment to condition Administration of measures immediately before/after walks		not significantly different		affect in virtual urban condition
Mayer, Frantz, Bruehlman-Senecal, & Dolliver (2009) Study 3	64 university students (33 female, 29 male, 2 unidentified) Location: Ohio, USA	10-minute walk (or 10-minute video) Nature preserve walk condition vs. virtual nature condition	Between-subjects design for environment; within subjects design for time Administration of measures immediately before/after walks	Self-reported ability to reflect on a loose end	Significantly greater ability to reflect in nature walk condition	Positive and Negative Affect Schedule (positive and negative affect)	Significantly greater positive affect in nature walk condition
Roe & Aspinall (2011a) Study 1	123 adults (83 female, 40 male); 83 with good mental health (mean age = 50) and 40 with poor mental health (mean age = 44) Location: Scotland	60-minute walk Woods and open countryside	Between-subjects design for health condition; within subjects for time Administration of measures immediately before/after walks	Five-item personal project scale (reflection)	Significant increase in reflection across both groups	Mood Adjective Checklist (mood—hedonic tone, energy, stress)	Significant increases in mood across both mental health groups; even more advantageous for poor mental health group
Roe & Aspinall (2011a) Study 2	24 adults (11 with good mental health, mean age = 46; 13 with poor mental	Two 60-minute walks, one in each environment; separated by one week	Between-subjects design for health condition; within-subjects design for	Five-item personal project scale (reflection)	Significant increase in reflection in both conditions for the poor	Mood Adjective Checklist (mood—hedonic tone, energy, stress)	Significant increase in mood in both conditions for the poor health

Authors	Sample characteristics	Walk characteristics	Study design	ART measures	ART outcomes	SRT measures	SRT outcomes
	health, mean age = 35) Location: Scotland	Country park condition vs. town center condition	environment and time Administration of measures immediately before/after walks		health group; significant increase only in nature for the good mental health group		group; significant increase only in nature for the good mental health group

Table 2

Participants' Gender and Racial Identities

	Condition		
Variable	Natural	Built	Total
Students who signed up for study	91	89	180
Participants who fully completed study	85	80	165
Gender			
Men	36	42	78
Women	48	34	82
Nonbinary	1	2	3
Gender nonconforming	0	1	1
Prefer not to disclose	0	1	1
Racial Identity			
White/European American	42	49	91
Black/African American/Afro-Caribbean	15	11	26
Hispanic/Latina(o)/Latinx	8	7	15
South Asian/South Asian American	6	6	12
East Asian/East Asian American	6	4	10
Middle Eastern/Arab American/North African	1	0	1
Other	2	0	2
Multi-racial	5	2	7
Prefer not to disclose	0	1	1

Table 3

Participants' Household Incomes and Parental Education

	Condition		
Variable	Natural	Built	Total
Household Income			
Less than $10,000	3	2	5
$10,000-14,999	3	2	5
$15,000-19,999	2	0	2
$20,000-24,999	1	6	7
$25,000-29,999	1	1	2
$30,000-39,999	5	4	9
$40,000-49,999	8	8	16
$50,000-74,999	14	11	25
$75,000-99,999	15	10	25
$100,000-149,999	18	20	38
$150,000 or more	14	16	30
Did not respond	1	0	1
Parental Education			
Less than high school	4	5	9
High school	16	23	39
High school, currently in college	10	10	20
Associate's degree	13	8	21
Bachelor's degree	29	35	64
Bachelor's, currently in grad school	4	1	5
Master's degree	20	15	35
Terminal degree	9	3	12
Total number of parents identified	105	100	205

Table 4

Participants' Smoking and Vaping Behaviors

	Condition		
Variable	Natural	Built	Total
Smoking/Vaping Behaviors			
Smoking (cannabis)	25	10	35
Smoking (tobacco)	3	6	9
Vaping (cannabis)	7	7	14
Vaping (nicotine)	18	10	28
Smoking/Vaping Frequency			
Never	45	49	94
Once every few months	7	3	10
Once a month	1	4	5
A few times a month	7	4	11
Once a week	3	0	3
A few times a week	3	5	8
Once a day	2	2	4
A few times a day	13	7	20
Did not respond	4	6	10

Table 5

Means, Standard Deviations, and Ranges of Naturalness Scores

	Natural			Built			All Participants		
	Ppt	Rsch	Tot	Ppt	Rsch	Tot	Ppt	Rsch	Tot
M	6.88	6.62	6.75	5.30	4.37	4.83	6.12	5.53	5.82
SD	1.92	.93	1.26	2.00	1.00	1.34	2.11	1.48	1.61
R	2 – 10	3 - 8	4 – 8.5	1 – 10	2 – 7	1.5 – 8.5	1 – 10	2 – 8	1.5 – 8.5

Note. Ppt = participant rating. Rsch = researcher rating. Tot = combined (average) rating. M = mean. SD = standard deviation. R = range.

Table 6

Means, Standard Deviations, Normality Statistics, and Cronbach's Alpha for Variables in the Model

Variable	M	SD	S-W	K-S	Skewness	Kurtosis	Alpha
Naturalness	5.82	1.61	.96***	.10***	-.03(.19)	-.93(.38)	-
ROS pre	18.58	5.42	.98*	.08*	-.08(.19)	-.69(.38)	.88
ROS post	23.38	4.61	.95***	.10***	-.71(.19)	.36(.38)	.88
ROS change	4.79	5.81	.99	.06	.06(.19)	.53(.38)	-
PANAS pre	14.95	4.03	.99	.08**	-.13(.19)	-.17(.38)	.81
PANAS post	18.51	4.30	.96***	.10***	-.57(.19)	-.18(.38)	.86
PANAS change	3.56	4.25	.98*	.10***	.23(.19)	.11(.38)	-
PPA pre	32.15	6.17	.99	.05	-.20(.19)	-.12(.38)	.71
PPA post	36.21	6.17	.99	.06	-.13(.19)	.00(.38)	.76
PPA change	4.07	4.91	.97**	.09**	.59(.19)	.52(.38)	-
LIWC pre	5.75	3.53	.95***	.08*	.89(.19)	1.68(.38)	-
LIWC post	7.88	4.26	.89***	.09**	1.71(.19)	7.52(.38)	-
LIWC change	2.12	5.02	.97**	.09**	.28(.19)	1.44(.38)	-
Motiv pre	9.25	2.09	.89***	.20***	-1.19(.19)	1.55(.38)	-
Motiv post	10.14	1.42	.90***	.20***	-.75(.19)	.54(.38)	-
Motiv change	.88	1.74	.86***	.21***	1.53(.19)	3.99(.38)	-
Scarcity	51.44	10.96	.98*	.07*	.41(.19)	.15(.38)	.85
Material	14.13	5.30	.92***	.14***	.78(.19)	-.12(.38)	.80
Psych	14.85	4.02	.97**	.09**	.39(.19)	.05(.38)	.76
Time	22.46	5.39	.99	.07*	.23(.19)	-.35(.38)	.81

Note. Standard errors in parentheses. M = mean. SD = standard deviation. S-W = Shapiro-Wilk. K-S = Kolmogorov-Smirnov. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Motiv = motivation to go on walks in the future.

*$p < .05$. **$p < .01$ ***$p < .001$.

Table 7

Correlations Among Variables

	1	2	3	4	5	6	7	8	9	10	11
1.Nat											
2.ROS	.15										
3.PANAS	.16*	.63***									
4. PPA	.15*	.48***	.53***								
5.LIWC	.04	.13	.17*	-.09							
6.Motiv	.04	.01	.10	.06	.16*						
7.PSS	-.04	.21**	.07	.19*	-.02	.18*					
8.Mat	-.02	.08	.06	.07	.06	.14	.74***				
9.Psych	-.11	.11	.00	.04	.07	.14	.76***	.41***			
10.Time	.03	.27***	.08	.28***	-.14	.13	.74***	.22**	.39***		
11.Solitude	.05	-.03	-.10	-.10	-.05	-.01	.04	.03	.06	.00	
12.Safety	.08	.05	.18*	.13	.07	-.08	-.26***	-.16*	-.24**	-.20*	-.21**

Note. ROS, PANAS, PPA, LIWC, and Motiv are change variables (i.e., difference between pre- and post-walk scores). Nat = naturalness. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Motiv = motivation to go on walks in the future. PSS = total perceived scarcity. Mat = perceived material scarcity. Psych = perceived psychological resource scarcity. Time = perceived time scarcity. Solitude = extent to which participants felt alone on the walk. Safety = extent to which participants felt safe on the walk. *$p < .05$. **$p < .01$ ***$p < .001$.

Table 8

Repeated Measures ANOVA by Study Condition

	Sum of Squares	*df*	Mean Square	*F*	*p*	Partial η^2
Restoration						
Time	1882.51	1	1882.51	111.84	<.001	.41
Time*Condition	19.92	1	19.92	1.18	.278	.01
Error (Time)	2743.58	163	16.83			
Positive Affect						
Time	1034.45	1	1034.45	115.54	<.001	.42
Time*Condition	20.00	1	20.00	2.23	.137	.01
Error (Time)	1459.35	163	8.95			
PPA Task						
Time	1349.51	1	1349.51	113.33	<.001	.41
Time*Condition	37.15	1	37.15	3.12	.079	.02
Error (Time)	1940.99	163	11.91			
LIWC						
Time	379.86	1	379.86	30.71	<.001	.16
Time*Condition	50.58	1	50.58	4.09	.045	.02
Error (Time)	2016.49	163	12.37			
Motivation						
Time	64.17	1	64.17	42.03	<.001	.21
Time*Condition	.56	1	.56	.37	.546	.00
Error (Time)	248.85	163	1.53			

Table 9

SEM Results from Objective 1

	B			B			
Effects	Nat	ROS	PANAS	Nat	ROS	PANAS	R^2
Direct							
ROS	.15*			.54*			.02
PANAS		.63**			.46**		.39
PPA		.48**			.40**		.23
LIWC		.13			.11		.02
Motiv			.10			.04	.01
Indirect							
ROS							
PANAS	.09*			.25*			
PPA	.07*			.22*			
LIWC	.02*			.06			
Motiv	.01	.07		.01	.02		
Total							
ROS	.15*			.54*			
PANAS	.09*	.63**		.25*	.46**		
PPA	.07*	.48**		.22*	.40**		
LIWC	.02*	.13		.06	.11		
Motiv	.01	.07	.10	.01	.02	.04	

Note. β = standardized regression weights. B = unstandardized regression weights. R^2 = variance accounted for. Nat = naturalness. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Motiv = motivation to go on walks in the future.

* $p < .05$. ** $p < .01$

Table 10

Two-Way Repeated Measures ANOVA for Total Perceived Scarcity

	Sum of Squares	*df*	Mean Square	*F*	*p*	Partial η^2
Restoration						
Time	1158.29	1	1158.29	70.92	<.001	.30
Time*Scarcity	117.67	2	58.83	3.60	.029	.04
Error (Time)	2645.83	162	16.33			
Positive Affect						
Time	617.80	1	617.80	68.40	<.001	.30
Time*Scarcity	16.06	2	8.03	.889	.413	.01
Error (Time)	1463.29	162	9.03			
PPA Task						
Time	708.66	1	708.66	61.01	<.001	.27
Time*Scarcity	96.33	2	48.17	4.15	.018	.05
Error (Time)	1881.80	162	11.62			
LIWC						
Time	294.21	1	294.21	23.13	<.001	.13
Time*Scarcity	6.46	2	3.23	.25	.776	.00
Error (Time)	2060.60	162	12.72			
Motivation						
Time	60.36	1	60.36	41.63	<.001	.20
Time*Scarcity	14.53	2	7.27	5.01	.008	.06
Error (Time)	234.87	162	1.45			

Table 11

Descriptive Statistics of Study Variables by Total Perceived Scarcity Group

Variable	M	SD	N
ROS pre			
Low	22.96	4.19	26
Medium	18.35	4.86	110
High	15.55	6.09	29
ROS post			
Low	25.35	4.12	26
Medium	23.26	4.52	110
High	22.03	4.96	29
PANAS pre			
Low	17.12	3.50	26
Medium	14.65	3.88	110
High	14.14	4.49	29
PANAS post			
Low	19.65	3.25	26
Medium	18.39	4.39	110
High	17.93	4.69	29
PPA pre			
Low	37.62	3.74	26
Medium	31.26	5.89	110
High	30.58	6.55	29
PPA post			
Low	39.19	5.37	26
Medium	35.75	6.12	110
High	35.31	6.44	29
LIWC pre			
Low	5.43	3.37	26
Medium	5.49	3.23	110
High	7.04	4.51	29
LIWC post			
Low	7.86	4.32	26
Medium	7.42	3.42	110
High	9.62	6.34	29
Motivation pre			
Low	9.58	1.96	26
Medium	9.30	1.91	110
High	8.79	2.74	29
Motivation post			
Low	10.23	1.48	26
Medium	10.00	1.46	110
High	10.59	1.15	29

Note. M = mean. SD = standard deviation. N = number of participants. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Low = total perceived scarcity score lower than 1 SD below the mean. Medium = total perceived scarcity score between 1 SD below and 1 SD above the mean. High = total perceive scarcity score higher than 1 SD above the mean.

Table 12

Two-Way Repeated Measures ANOVA for Perceived Material Scarcity

	Sum of Squares	*df*	Mean Square	*F*	*p*	Partial η^2
Restoration						
Time	1312.12	1	1312.12	78.03	<.001	.33
Time*Scarcity	39.18	2	19.59	1.17	.315	.01
Error (Time)	2724.32	162	16.82			
Positive Affect						
Time	734.08	1	734.08	80.88	<.001	.33
Time*Scarcity	8.99	2	4.50	.50	.610	.01
Error (Time)	1470.36	162	9.08			
PPA Task						
Time	1043.98	1	1043.98	86.42	<.001	.35
Time*Scarcity	21.05	2	10.52	.87	.420	.01
Error (Time)	1957.09	162	12.08			
LIWC						
Time	310.70	1	310.70	24.62	<.001	.13
Time*Scarcity	22.68	2	11.34	.90	.409	.01
Error (Time)	2044.39	162	12.62			
Motivation						
Time	66.58	1	66.58	45.40	<.001	.22
Time*Scarcity	11.87	2	5.93	4.05	.019	.05
Error (Time)	237.54	162	1.47			

Table 13

Descriptive Statistics of Study Variables by Perceived Material Scarcity Group

	M	SD	N
ROS pre			
Low	21.21	4.77	24
Medium	18.42	5.10	108
High	17.21	6.34	33
ROS post			
Low	25.13	3.90	24
Medium	23.01	4.74	108
High	23.30	4.52	33
PANAS pre			
Low	16.46	4.29	24
Medium	14.82	3.72	108
High	14.27	4.64	33
PANAS post			
Low	19.75	4.27	24
Medium	18.24	4.33	108
High	18.48	4.17	33
PPA pre			
Low	33.71	6.62	24
Medium	32.02	5.88	108
High	31.42	6.78	33
PPA post			
Low	38.00	6.28	24
Medium	35.75	6.35	108
High	36.42	5.37	33
LIWC pre			
Low	5.22	3.41	24
Medium	5.70	3.35	108
High	6.32	4.18	33
LIWC post			
Low	7.38	3.93	24
Medium	7.50	3.64	108
High	9.47	5.86	33
Motivation pre			
Low	9.38	2.08	24
Medium	9.39	1.71	108
High	8.73	3.01	33
Motivation post			
Low	10.46	1.53	24
Medium	10.02	1.33	108
High	10.30	1.63	33

Note. M = mean. SD = standard deviation. N = number of participants. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Low = perceived material scarcity score lower than 1 SD below the mean. Medium = perceived material scarcity score between 1 SD below and 1 SD above the mean. High = perceived material scarcity score higher than 1 SD above the mean.

Table 14

Two-Way Repeated Measures ANOVA for Perceived Psychological Resource Scarcity

	Sum of Squares	*df*	Mean Square	*F*	*p*	Partial η^2
Restoration						
Time	1154.37	1	1154.37	67.88	<.001	.30
Time*Scarcity	8.40	2	4.20	.25	.782	.00
Error (Time)	2755.10	162	17.01			
Positive Affect						
Time	684.00	1	684.00	75.33	<.001	.32
Time*Scarcity	8.35	2	4.17	.46	.632	.01
Error (Time)	1471.01	162	9.08			
PPA Task						
Time	788.33	1	788.33	64.65	<.001	.29
Time*Scarcity	2.77	2	1.38	.11	.893	.00
Error (Time)	1975.37	162	12.19			
LIWC						
Time	224.44	1	224.44	17.66	<.001	.10
Time*Scarcity	8.55	2	4.23	.34	.715	.00
Error (Time)	2058.51	162	12.71			
Motivation						
Time	51.37	1	51.37	33.89	<.001	.17
Time*Scarcity	3.85	2	1.92	1.27	.284	.02
Error (Time)	245.56	162	1.52			

Table 15

Descriptive Statistics of Study Variables by Perceived Psychological Resource Scarcity Group

	M	SD	N
ROS pre			
Low	20.92	4.96	26
Medium	18.62	5.07	119
High	15.30	6.53	20
ROS post			
Low	25.54	3.26	26
Medium	23.31	4.65	119
High	20.95	4.80	20
PANAS pre			
Low	17.19	3.71	26
Medium	15.02	3.75	119
High	11.65	4.07	20
PANAS post			
Low	21.19	2.83	26
Medium	18.38	4.30	119
High	15.80	4.01	20
PPA pre			
Low	35.46	6.08	26
Medium	32.19	5.82	119
High	27.55	5.70	20
PPA post			
Low	39.27	6.08	26
Medium	36.24	5.84	119
High	32.05	6.13	20
LIWC pre			
Low	6.49	3.34	26
Medium	5.38	3.37	119
High	7.04	4.35	20
LIWC post			
Low	8.12	4.10	26
Medium	7.48	3.67	119
High	9.89	6.75	20
Motivation pre			
Low	9.27	2.13	26
Medium	9.37	2.03	119
High	8.55	2.31	20
Motivation post			
Low	10.19	1.52	26
Medium	10.15	1.44	119
High	10.00	1.26	20

Note. M = mean. SD = standard deviation. N = number of participants. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Low = perceived psychological resource scarcity score lower than 1 SD below the mean. Medium = perceived psychological resource scarcity score between 1 SD below and 1 SD above the mean. High = perceived psychological resource scarcity score higher than 1 SD above the mean.

Table 16

Two-Way Repeated Measures ANOVA for Perceived Time Scarcity

	Sum of Squares	*df*	Mean Square	*F*	*p*	Partial η^2
Restoration						
Time	1257.70	1	1257.70	78.51	<.001	.33
Time*Scarcity	168.35	2	84.18	5.26	.006	.06
Error (Time)	2595.15	162	16.02			
Positive Affect						
Time	594.72	1	594.72	65.44	<.001	.29
Time*Scarcity	7.15	2	3.57	.39	.676	.01
Error (Time)	1472.21	162	9.09			
PPA Task						
Time	692.52	1	692.52	60.78	<.001	.27
Time*Scarcity	132.45	2	66.23	5.81	.004	.07
Error (Time)	1845.69	162	11.39			
LIWC						
Time	180.68	1	180.68	14.79	<.001	.08
Time*Scarcity	88.08	2	44.04	3.61	.029	.04
Error (Time)	1978.99	162	12.22			
Motivation						
Time	41.64	1	41.64	27.12	<.001	.14
Time*Scarcity	.62	2	.31	.20	.82	.00
Error (Time)	248.79	162	1.54			

Table 17

Descriptive Statistics of Study Variables by Perceived Time Scarcity Group

	M	SD	N
ROS pre			
Low	22.62	3.85	26
Medium	18.56	5.29	112
High	14.78	4.48	27
ROS post			
Low	25.04	4.30	26
Medium	23.27	4.59	112
High	22.22	4.71	27
PANAS pre			
Low	16.81	3.32	26
Medium	14.74	4.06	112
High	14.04	4.14	27
PANAS post			
Low	19.88	3.63	26
Medium	18.50	4.34	112
High	17.22	4.44	27
PPA pre			
Low	36.65	4.62	26
Medium	31.97	5.72	112
High	28.52	6.78	27
PPA post			
Low	37.85	5.27	26
Medium	36.45	6.21	112
High	33.67	6.24	27
LIWC pre			
Low	4.41	2.89	26
Medium	5.70	3.47	112
High	7.26	3.88	27
LIWC post			
Low	7.64	4.64	26
Medium	8.11	4.40	112
High	7.15	3.20	27
Motivation pre			
Low	9.73	1.64	26
Medium	9.12	2.21	112
High	9.37	1.92	27
Motivation post			
Low	10.46	1.42	26
Medium	10.00	1.48	112
High	10.41	1.12	27

Note. M = mean. SD = standard deviation. N = number of participants. ROS = restoration. PANAS = positive affect. PPA = broadened thinking. LIWC = broadened thinking. Low = perceived time scarcity score lower than 1 SD below the mean. Medium = perceived time scarcity score between 1 SD below and 1 SD above the mean. High = perceived time scarcity score higher than 1 SD above the mean.

Table 18

Examples of Writing Samples

Theme	Condition	Example
Pre-walk attention fatigue	Built	"i feel stuck/confined to a life in which i am not happy, and find little satisfaction in the activities that used to bring me a lot of fulfillment. connections with family and friends are becoming meaningless, **and i am struggling to focus on being productive and carrying out daily responsibilities**. i am not sad, but i am not happy, it seems like the prominent emotions i experience are frustration and a dull agony."
		"i have been feeling anxious and stressed today. i've been thinking about finals and getting my work done for today. finals are coming up and christmas shopping needs to get done. i'm worried that i'm not smart enough to complete my finals. **i'm worried i won't be able to focus enough to study and learn the material.** i want to be successful and get great grades. math is a struggle for me. i struggle with anxiety and it's been really hard for me lately. i have trouble letting it go and trying to not stress out. i'm anxious a lot and even right now i'm anxious. i cant control it. i'm nervous about moving onto campus nest semester too but i'm so excited to be in campus and not be in my house wall day. i'm excited to be able to be with friends and i feel that it'll make me less anxious."
		"I was active **but cannot focus well today**. I mood was down because I just started my period, so I feel lazy. Also, I feel sleepy and tired during lectures. For my personal project, I did a homework thoughtfully so I can get better grade than before."
	Natural	"I feel alright. Stressed about school and covid. I feel like I'm putting in a lot of work and not getting the results I want. **Focusing can also be hard because I have a lot going on in my personal life**."
		"I'm am tired and exhausted from all the schoolwork i've been doing. I feel relaxed at the moment but there's the **tiredness and exhaustion in the back of my mind**."
		"I am feeling very stressed these days. Every day I have a checklist that I try to get through and it seems like there is no end to the work I must complete. Today I am trying to get a lot done but I do not feel very motivated. All I want to do is relax or go outside but I feel like I have to continuously work. The pandemic means that social opportunities are nonexistent right now and that is frustrating. **The upcoming election is something I have to avoid thinking about or I will get so**

		stressed that I lose focus on my other things. The election feels so stressful because my boyfriend hasn't decided who he is going to vote for and I desperately want him to vote a certain way. I don't know what I'm going to do if he chooses the other candidate and it gives me a lot of anxiety to speculate about that. It generally feels like I'm going through the motions every day and not getting much joy out of life right now."
Pre-walk clear mind	Built	**"I'm feeling good, positive clear mind and thoughts.** I've been thinking a lot about money. I want to start myself on a daily routine so I can manage my time better and to make sure that I am completing my personal long and short term goals."
	Natural	**"I feel good, clear mind focused on finishing my research project** and this week's assignments."
		"My state of mind is clear , I been feeling good. I been thinking about school a lot. I feel a little stressed from it but still good. I feel I will continue feeling like this until I finish this semester."
Post-walk clear mind	Built	"I feel a little tired cause my toe was hurting for some reason. I feel cold because I forgot to wear a jacket. **My mind got clear** and I didn't even think about the projects. It made me less worried"
		"I felt relaxed and it gave me time to think about my problems and what to do with them and how to complete them **and it helped clear my mind and think to myself a little bit more then what I usually do when I'm stressed** and it made me happy in general"
		"i enjoyed my walk and though about alot of things during it. I thought alot about how much I could potentially benefit from going on a walk outside for atleast 30 minutes once a day. **it was really refreshing and helped calm and clear my mind."**
	Natural	"I felt very at ease and forgot about my stress for a bit. I just tried to think about the plants and took time to listen to all the different sounds. I didn't realize there was an Asian garden at uncc so that was a fun surprise. I really loved all the water features and all the different little places for me to sit down and think. I will be coming back here to do some homework. **The running water helped to clear my mind."**
		"I felt like I was able to relax for the first time today and not pressure myself to think about one specific thing. **It feels good to move my body and clear my head.** I enjoy seeing people on the greenway and getting a taste of the outside world. I thought about what I have to do the rest of the day but I also thought about fun plans for the weekend and how much I love being outside in nature. I'm ready for the weather to get

		cooler and for it to really feel like fall. I didn't think much about the election which was nice but I thought about my boyfriend and how we met which was nostalgic. I also listened to music which was relaxing."
		"On my walk, I felt more relaxed. I did think about my projects some but I was more focused on enjoying my surroundings**. I think the walk helped clear my head.** I was able to just wander around and take in the sights with no specific plan, but in a peaceful way. I didn't really think about much. I thought about the different plants I was seeing and the birds and squirrels around me. The worries that have been on my mind we're not at the forefront as they usually are. This walk was enjoyable as I took in the nature around me."
Pre-walk broadened thinking	Built	I have been pretty calm and relaxed lately and a little agitated. **I've been thinking a lot about what I want for myself and my career in the future and comparing it to what my family wants for me in the future a lot.** Their wants are extremely different from mine and I am cool with that. I've been thinking a lot about whether college is for me or not. And I have been thinking a lot about chasing my dream of creating something that is my own from the ground up.
		I've been pretty sad but I have to work later so I'm trying to get myself doing stuff. Recently I've been thinking a lot on my ex boyfriend and how he left me. We lived together for 6 months and then he just left me when we had to move. Like I don't know what I did. But I've also been thinking about how individuals think I'm intimidating and scary and maybe that's why people don't like me. I'm not sure if that's true but it's just been on my mind recently.
		Today I still feel like I'm trapped in a cycle. A downward spiral. Slowly getting more momentum until I might not be able to stop it. A little overdramatic. I still have hope for the future. **I know what I need to do but questions about God and how I operate have been plaguing my thoughts for sometime lately. I would be more interested in school and life in general if it wasn't for these questions. What is true? Does God exist? Or is evolution and all the seemingly infinite variables that come with it true?** Everyone thinks they have the answer but the truth is no one does they are all wrong! The folly and arrogance of all of us so sure of our own beliefs and able to find all the proof we want. Just my crazy thoughts.
	Natural	"I've been feeling a little depression **and have been really contemplating my decisions and life**."
		"**Well I've realized that I'm really good at isolating myself and not being around other people.** I guess I'm just the type

		of person to feel alone even when I'm surrounded by other people. Now is probably not the best time for me to be social what with the whole pandemic going on"
		"I feel alone, but I have friends. I feel stressed because I have so many things going on. **I'm realizing that I'm becoming an adult and it comes with responsibilities. I question myself all the time,** " am I doing the right thing?""
Post-walk broadened thinking	Built	"On my walk I was more focused specifically on the issues I previously discussed surrounding my projects because they were fresh in my mind. While I focused on specific issues and feeling down, **I also generally reflected on my past and decisions and events in my past that have brought me to this specific point.** My life is turned completely upside down from where it was two years ago, let alone just 6 months ago. So many things have changed and while I was overall happier two years ago, there was no way that happiness would have lasted and now I am more aware of the fact it was superficial. While my happiness right now and today specifically is much worse off than I probably have been in my entire life, this year has been tough, I know that I am on a better track to be happier and successful in the future even if I might not know what that means. I am doing things more for me now, and while that might not fly with my parents, it makes me happier and less stressed, which is overall better for my future because it is my life and not theirs. In accordance to school, this is by far my toughest semester, and I have reason for that. I am in 6 classes and at a new massive school and it is fully online during a time when I personally have little motivation to do anything, and online classes is purely my own motivation because I have to teach the material completely to myself because this semester professors are useless. So it is okay if this semester is a bust , it's not the end of the world and it's unprecedented times. At worst I waste a little money and have to repeat these classes but it's better than panicking daily about the amount of work I have and how far behind I am yet not having the mental and emotional capacity to actually do anything about it."
		"It felt good to move my body like it relieves some tension. I thought about a plethora of things such as friends and honestly where I wanted to go next. **I thought about what I wrote before the walk and self-reflected on a lot of those things**. I found that I needed to be outside more and I have to set time aside for that. However, I'm not a people person so I like to be completely alone outdoors or with a few close friends. I don't like worrying about other strangers near me. I'm unsure if that makes a lot of sense. I also think it would be nice to listen to a

		podcast while walking outside or maybe just calming music. I ultimately felt a bit relieved, but I know it's only temporary. Walking outside could be a handy tool if I need a break and I'm overly stressed."
		"I felt great when walking and after I got back home. I feel as if walking is different than working out because it gives you time to think about what's important and how to prioritize. When I workout, I feel good as well but most of my energy is focused on the weights. **I thought about how I view myself versus how other people view me and how those viewpoints differ.** Among other things, I believe this was the most important thought that I had while walking."
	Natural	"At first I was really admiring the garden and the wooden bridges and natural**. I then started thinking about biology and religion a lot,** looking at the plants and different types of plants was a nice change of scenery. I woke up today and didn't feel like my day started but now I feel as if it did really start. I started dozing off after a while and **just started reflecting on myself and what I did recently and that led to me thinking about my childhood and home country. I thought about how happy and simple my childhood was.** I didn't think much about my personal objectives, **instead I mostly reflected throughout the walk**. I pooped around the garden trails since they are not very long and noticed things I didn't the first time. I enjoyed the different plants and took notice to pretty and weird looking ones."
		"The experience on my walk was pleasant. I was able to relax & talk my thoughts out. I felt good about my walk, walking alone was a + because I was able to walk at my own pace without having to keep up with someone else. I cleared my head of many thoughts that were stressing me. **I talked about the stress that was bothering me with my parents divorce & said to myself that I won't and can not own that feeling**. I talked about my exam & how I can fit time into my schedule along with personal time. I feel energized & refreshed. I also feel lighter and more optimistic about the things I'm dealing with. I wasn't focused on the time limit, I was just thinking and talking to myself and it felt good and somehow I ended back at my starting point right at 30 minutes!"
		"I felt really refreshing. I think we about how wonderful it was to take a walk in such natural areas and I should do more of it. **I thought about Project 2 and thought that I still have time to think about it later so I thought about Project 1 and realized that I was as wrong to think that I had no time for enough things and thought that I have plenty of time for all of my needs.** Most of the time I was not thinking

		of my projects though. I was just enjoying the walk, thinking of how beautiful the nature is and how we have affected in a bad way. I feel very peaceful. Also have grown confidence to achieve my daily goals and coming projects."
Pre-walk lack of motivation	Built	"Today I have been feeling down, been pretty stressed about life and things going on and **it feels like the list of things I need to get done is never ending, yet I have no motivation to do anything productive to get it done**. Everyday I have class work to do and it reminds me about how I have so many classes and as the semester goes on my grades are slowly dropping with each assignment I miss or test I do poorly on. I'm constantly reminded of that fact I don't have friends when I go on my phone for a break and I have no new notifications or a notification from my best friend who lives across the country and is busy living her own life and doesn't have time for my meaningless small talk that I wish to have with someone. I don't like talking to my parents about what goes on in my life because they like to push for more details than I'm willing to share and think it's no big deal and but I just want to share what I want so I find it easier to not talk to them at all then deal with their pushing conversations. They don't like to give praise and since I've always done well in school they're going to be very disappointed in this semester with me because I've never gotten lower than a 3.7 gpa ever. They give me crap for being in my room all day but I don't want to leave because I don't have the energy to carry on a conversation with them for more than 5 minutes because it's just draining to deal with their constant jokes and pushing for more personal information I don't want to share."
		"**Felt very unenergized and unmotivated to do my tasks of the day.** I want to do fun activities, such as biking and working-out, but I struggle finding time for them. I'm usually stressed and anxious, though my workload is not a lot compared to my peers. I want to be better in every way I can be, but maybe I just lack the motivation to do it, or perhaps I am just lazy. Insecure a lot which may be a reason. Not sure about a lot of things anymore."
		"I've been overthinking about a lot of things today. Thanksgiving break is now over and I feel upset about starting up classes again, but I hope the excess of assignments can allow me to stay distracted from my anxious thoughts. **I have no motivation to finish any artwork lately.** My professor for Drawing II has really high standards and my classmates and I are all struggling to live up to them. **It's really causing me to burn out and feel unenthusiastic about drawing in general.**"

	Natural	"I have a slight cold, so I'm irritated. I have been really lonely living off-campus in an apartment during covid and I really wish I had some friends to relate too. My roommate I have had a complete different personality than me and we just don't vibe so I feel completely alone. Apart of me wants to go home but I do like being independent, I just hate being lonely. This isn't the college experience I thought I would have, being a freshmen. Also I've been falling back into old bad habits that I worked so hard to overcome. Apart of me wants to get involved in talking to someone on campus, like a specialist but I haven't gotten around to doing it. **I feel so unmotivated to do anything and lately** I feel like everyday is the same and I'm just apart of a routine."
		"Right now I'm a little worried about my grades and my life in general. **I've been losing my passion and motivation to do things. I have missing assignments in classes and I need to get those done but I can't find the motivation to do it.** My days are super long and they start really early and end really late. I'm up by 4:45 to go workout and then I work from 7-6:30 and then I either go to the gym again or I go home and make dinner and try to get assignments done. The thing for me is my parents are really strict and hard on me. I know they love me but the push me sometimes I think more than I can handle. I'm glad for this walk because I believe o need to take my mind off of everything and get a break from my phone. I've feel like I've been isolated from my friends for so long and I'm looking forward to the end of the semester so that I can just be done and just relax with no worries."
		"I feel alright overall, although the best way to put it is that I'm stressed about inevitable stress. Finals are coming up, I had a tough heart to heart with my mom recently. There are some very personal things on my mind right now. I'm talking to someone new and I don't know where it will go or what the point of it will be. **Lately I've been struggling to find a drive to finish the things I need to get done. I know it'll eventually go away and I'll feel motivated again.** Hopefully this research project will give me an idea of something I can do to achieve some respite."
Post-walk motivation	Built	"On my walk, I was mostly focused on taking in the scenery around me. I admittedly haven't gotten the chance to explore the Campus besides in small bursts whenever I'm walking to and from classes or to the Student Union. It was nice to not only have that chance to feel connected with my campus a little better, but also the nature that surrounds it. I think a lot of my inactivity stemmed from my idleness, as **the walk sort of woke me up and helped me start thinking through what**

		I could accomplish today while also motivating me to do so. It was a positive experience overall, and I'm thankful that this study gave me this chance to reconnect with myself and make all new connections to my environment."
		"The walk was very relaxing I feel as though I was able to actually take a step back and realize my projects, things I let stress me out so much, really weren't that big a deal**. I feel encouraged and motivated to go home and complete some missing assignments and get my lesson plan finished for our last class tomorrow.** I have a few ideas in mind for it now. I even came up with a Christmas gift idea for my boyfriend who I've been trying to think of the perfect one for. My body feels light and I'm glad I walked off some calories."
		"I felt more energized as I walked, and thought about some of the things that bother me with my anxiety, like rejection and other issues in my love life. I also thought about how I have been doing better with these issues lately by using self healing methods like meditation and reading, as well as my connection to the earth. I also thought about how I only have about a month until I move back into campus, which I am excited about as well as my grandparents moving into their new house. **Overall I felt less anxious and more energetic and motivated."**
	Natural	"The walk was calming and for sure woke me up. I was alone as was able to submerge my self in the surroundings. **I was able to plan my day out in my head and feel way more motivated."**
		"I felt amazing. The walk was everything I needed. I felt relaxed and happy and was very relaxed. I was enjoying the sun and the breeze and the beautiful surroundings. **When I thought about my projects honestly I felt more confident in my ability to complete them.** I definitely think I need to do this more often. I think that walking alone is good for the soul. It was very peaceful and it allowed me to just think. I was able to just enjoy the moment and feel good. Most of the time I'm uncomfortable with silence. For example I always play music when I workout or I walk with a buddy or my dog but I think I might start going on walks alone more often."
		"At first all I could think about was how cold it was...lol. And how I wanted to just be home. But after about 10 mins I embraced it and just started thinking about this past year and how I put some of my goals on hold because the world put just normal life on hold. Then I thought about what I'm gonna do to help achieve my goals next year, and how I'm going to better myself and those around me. **I realized maybe I haven't been the best I can, but that didn't bring me**

		down, rather, *it* *inspired me.* I also just thought about how nice it was to be to myself, and without any distractions. It was rather nice.”
Pre-walk negative affect	Built	“**i have been feeling anxious and stressed today**. i’ve been thinking about finals and getting my work done for today. finals are coming up and christmas shopping needs to get done**. i’m worried that i’m not smart enough to complete my finals. i’m worried i won’t be able to focus enough to study and learn the material**. i want to be successful and get great grades. math is a struggle for me**. i struggle with anxiety and it’s been really hard for me lately. i have trouble letting it go and trying to not stress out. i’m anxious a lot and even right now i’m anxious.** i cant control it. i’m nervous about moving onto campus nest semester too but i’m so excited to be in campus and not be in my house wall day. i’m excited to be able to be with friends and i feel that it’ll make me less anxious.”
		“Today I have been feeling quite groggy, I woke up at a decent time but then decided to go back to bed as a way to avoid the things I have to do. **I am extremely stressed out as well as disappointed in myself** when it comes to the projects I have that need to be completed.”
		“**I'm pretty annoyed and feeling hectic and cooped up.** I have a shit ton of math homework and lectures I don't want to do. I want one day without anyone bothering me; without my mother saying "yeah you can do whatever you want-OH WAIT, you have to vacuum the house" without my dad getting on my back about being in my room, without the continuous pile of homework and responsibilities. I want to wake up at a decent time; I want to sit down and just work on all my passion projects goddamnit”
	Natural	“I woke up feeling very tired. **I do not feel well pertaining to my physical health as well as my mental health. I have been stressing over all of my assignments I have due today, and I am very nervous about them.** I also feel like I have no motivation to carry on my school. I have no appetite which is unusual as well.”
		“**Lately have been feeling very stressed and worrying about my future**. I just want to do my best but under the circumstances we’re in now, it’s been hard to put my best out there. So I feel like I’m just going through the motions and feel less than. I just want to finish this semester as best as I can with as much as my mental health in tact. It sure has declined over the semester, so I’m looking forward to a nice walk.”

		"**I've been feeling down.** Thinking about life in general, school, work and anything within those lines"
Pre-walk positive affect	Built	"**i am in a good mood today.** i slept in, took a shower, ate a good breakfast and finished my school work for the day. **i'm relaxed and content** with all that i have done for the day. i'm looking forward to having a day of the week where i don't have to go into work and can just do what i want and get extra school work done. **i am at peace and very happy w life and i'm excited to go on this walk.** i love walking and try to go on walks when i have free time."
		"**I feel very relaxed and present right now.** The lord woke me up for another day and I want to live to my fullest, love to my fullest, and enjoy my family and friends to the fullest. I'm blessed to have every little thing in my life. My dog makes me supper happy if I didn't have her idk what my life would be like.. she keeps me happy and she's so hyper it keeps me busy. Although it is Election Day and how the world is right now terrifies me **I'm trying to see the best in everything**."
		"**I feel good and full of energy.** I have been thinking about how to plan my day. Thoughts I'm getting is that I have to carefully plan for both of those projects so that I can succeed in them."
	Natural	"**I am feeling good,** I had a very good night sleep. **So I'm very excited** to go on this walk right now"
		"I'm feeling really good. I've fixed my sleep schedule after the start of college and been very productive. I've been thinking a lot about if I'm seeing my parents enough because I'm finding the time management of college courses tough. Also somewhat apprehensive to see them in fear of possibly spreading the coronavirus to them. **I'm proud of how productive I've been in college,** I'm procrastinating far less than in high school. I've been getting nervous before every in-person college class I have this year, I think because I haven't been in a school environment for about 7 months."
		"I mean I just woke up about 2 hours ago. **I feel relaxed**, no assignment is daunting over me right this second although an exam is lurking, so a bit of stress that I can push aside until tomorrow. Other than that I feel ahead of every other assignment for this week so **I feel calm relaxed and ready to win this day** after this walk and lunch. I would like to workout after lunch, which usually helps me a lot mentally and keeps me healthy as I am not in any high school sports anymore. I am sad about that but that's life, so I get over it after reminiscing a bit."
	Built	"**I felt relaxed on my walk**, it was a good time for me to feel connected with nature. I thought about wildlife. **Personally I**

Post-walk positive affect		**felt satisfied with myself** I was not super stressed. I walked with my dog and I thought about her and what she was feeling. The air was cool and felt good."
		"**I felt great!** The cold weather and sunshine helped me wake up and **feel more alert yet more relaxed.** What I was thinking about were some songs I had stuck in my head and what I was going to choose to do today in order to find out how to be more productive. As far as thinking about the projects I am working on right now, I feel confident that I can make it happen. I know the only reason why I struggle with achieving goals sometimes is because I don't take initiative to make the right choices so I can make other things happen. I feel like my phone has been the largest distraction, and hope to find joy in the things I do to the point I don't care about my phone. As I was walking by some nice houses, I thought about my life goal of having a wife and kids and a nice house that they can live in. To be in a place where I can provide for my family and have enough left over to share with others and be generous to the less fortunate. I thought about the community and how it is made of different types of people, and how a community like the one I was in can be united and caring for their neighbor."
		"**I felt great it was very relaxing to go on the walk** I thought about how beautiful the world was and everything outside was so nice. I thought about how I can do whatever I set my mind to and I'll be able to be always achieve the things I set out to do"
	Natural	"**I feel great. I feel relaxed and refreshed, and very calm**. The squirrels gave me looks that I didn't like and sometimes their burrowing made me uneasy. Other than that the birds were neat and so were all the plants."
		"I felt very relaxed and calm. I thought about letting God take my fears away and take burdens off my shoulders. I told myself that I will not procrastinate and put in 100% effort into studying for finals. I will be determined and stick to my diet and cut out all of those junk foods. T**he walk made me feel very good."**
		"The walk felt amazing. Putting the phone on airplane mode and **shutting off all technology was really good relaxing**. It is amazing to see how beautiful the world really is. Sometimes we get caught up on our phones and we fail to look at the little things in the world. It is crazy to realize how many small things I have missed in my neighborhood! There are so many aspects of my neighborhood that are beautiful, from the trees, the small flowers, to the birds flying in on their nests to feed their young ones. There are so many things to that occur

		simultaneously in nature while we go about our daily lives. I think it is important to take some time to step back and observe our beautiful surroundings and appreciate it while we can. As I walked I began to realize how stunning the world around me really is. I get so caught up on my phone and doing all my assignments for school and I eventually stress myself out. **Taking this walk helped me calm down my stressors** and showed me that it is okay to take a break and take in everything around you."

Figure 1

Original Model Combining Stress Reduction, Attention Restoration, and Upward Spiral Theories

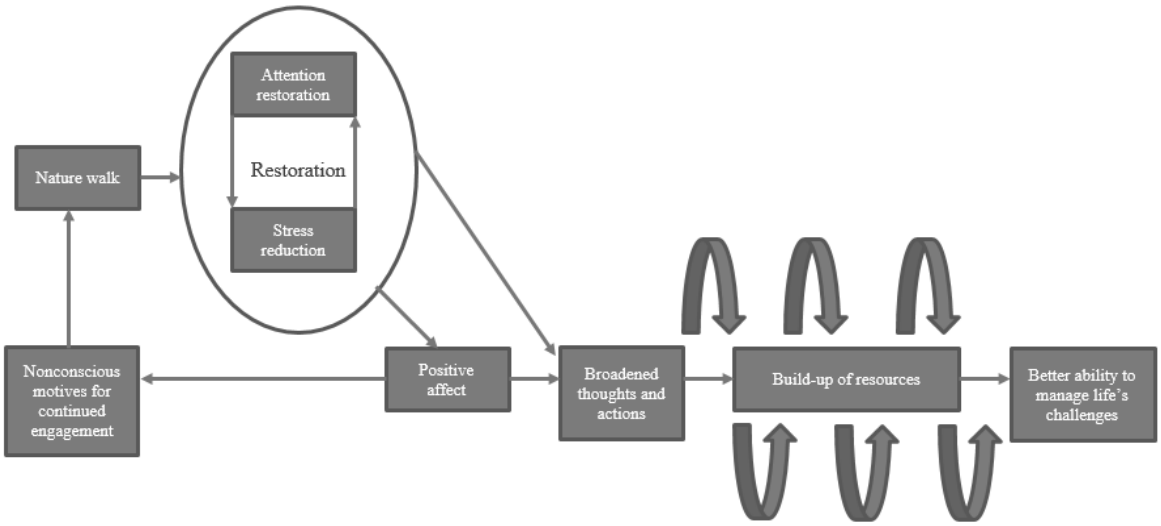


Figure 2

Model Tested in the Current Study

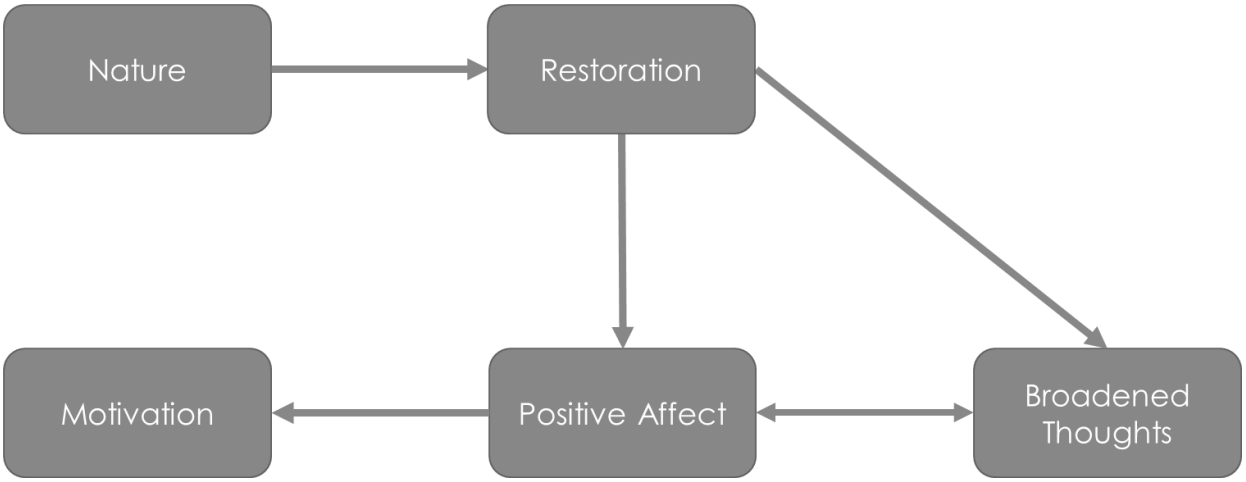


Figure 3

Model Tested in the Current Study, with Scarcity as a Moderator

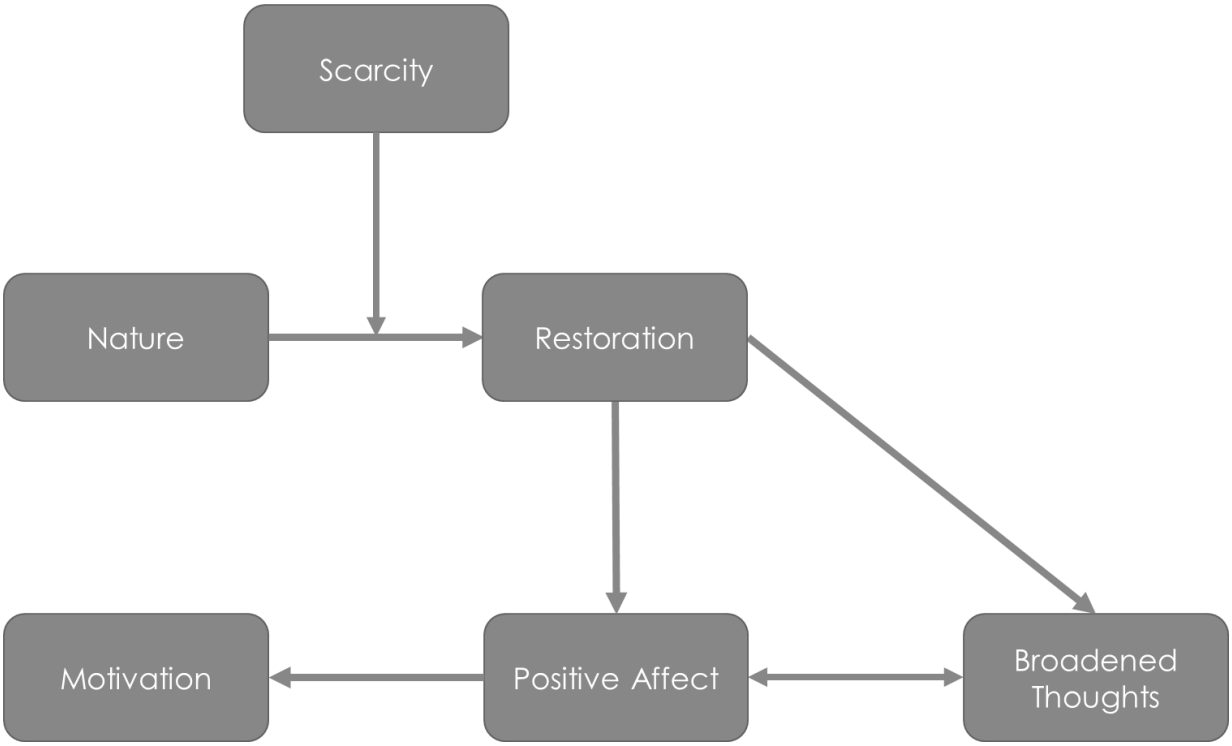
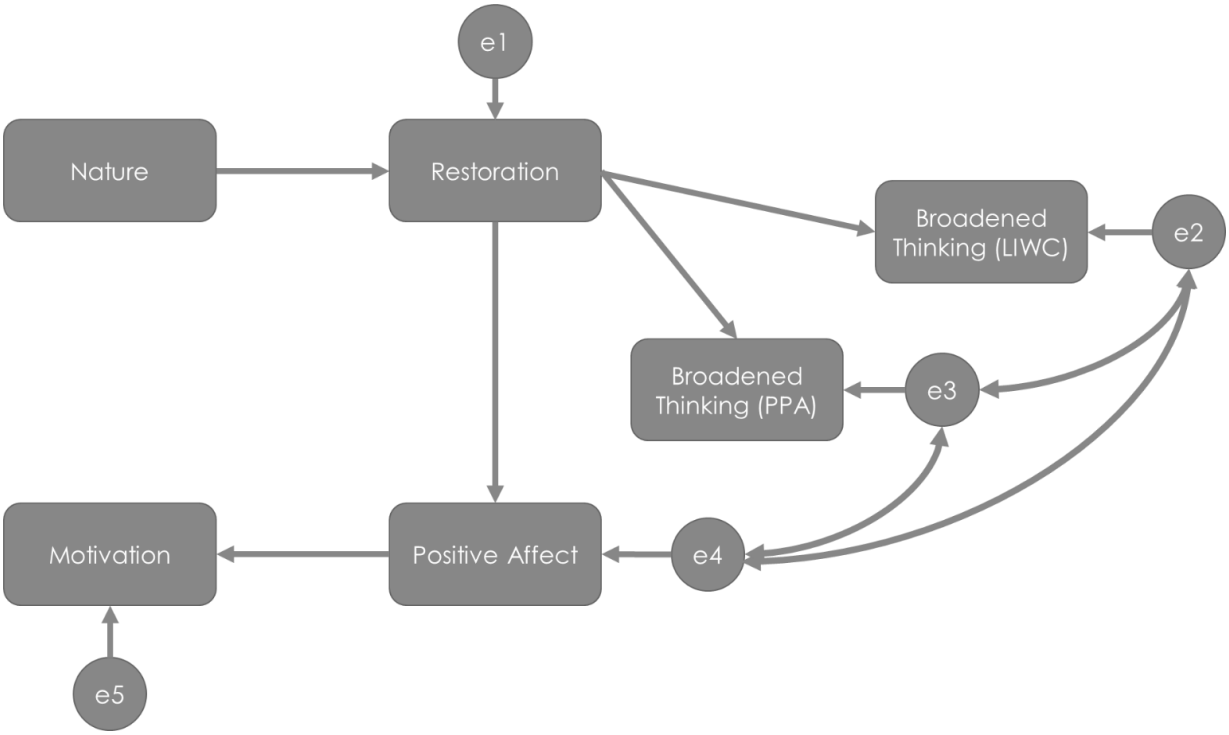


Figure 4

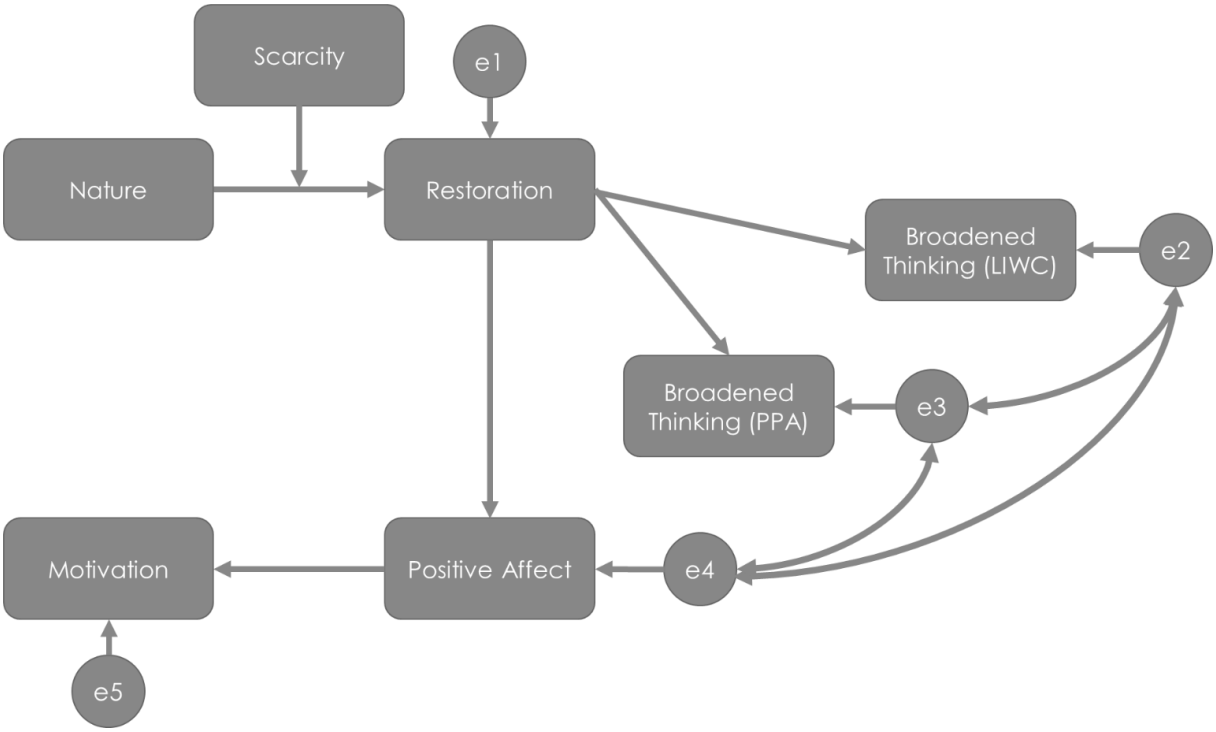
Model as Tested in Amos for Objective 1



Note. e = residuals.

Figure 5

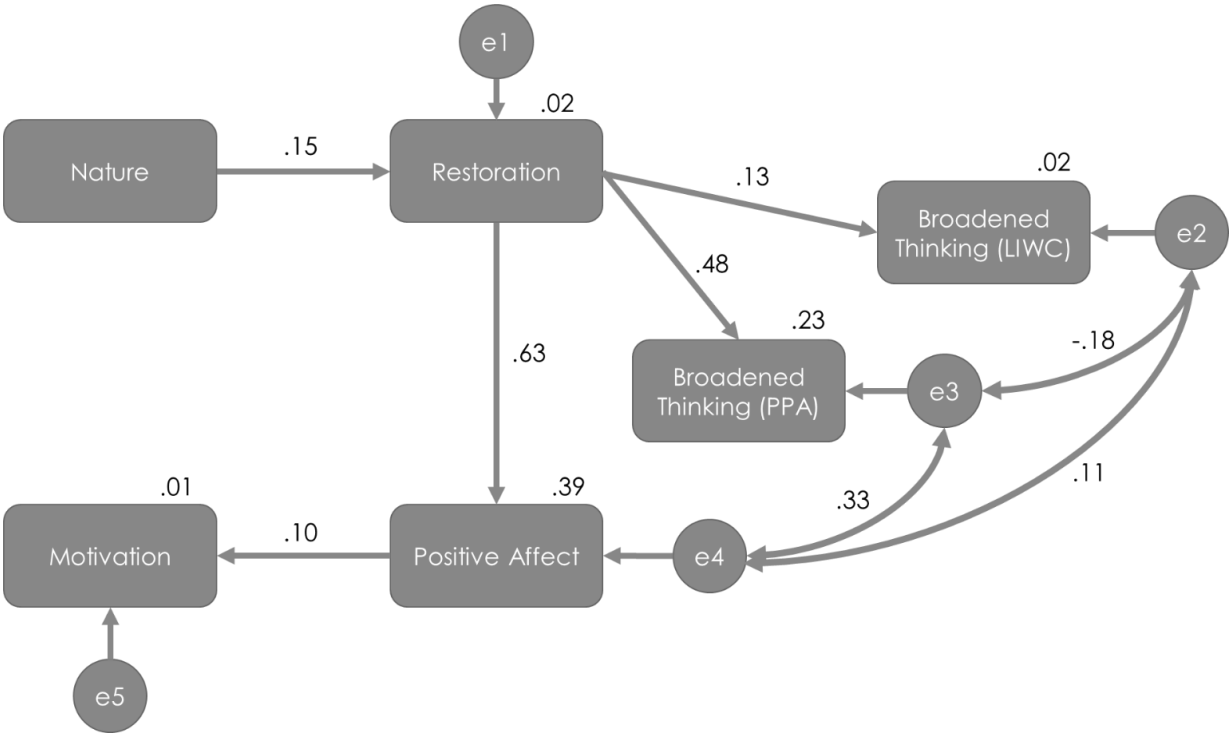
Model as Tested in Amos for Objective 2



Note. e = residuals.

Figure 6

Model with Objective 1 Results



Note. All estimates are standardized. e = residuals.

Figure 7

Estimated Marginal Means of Restoration by Scarcity Group

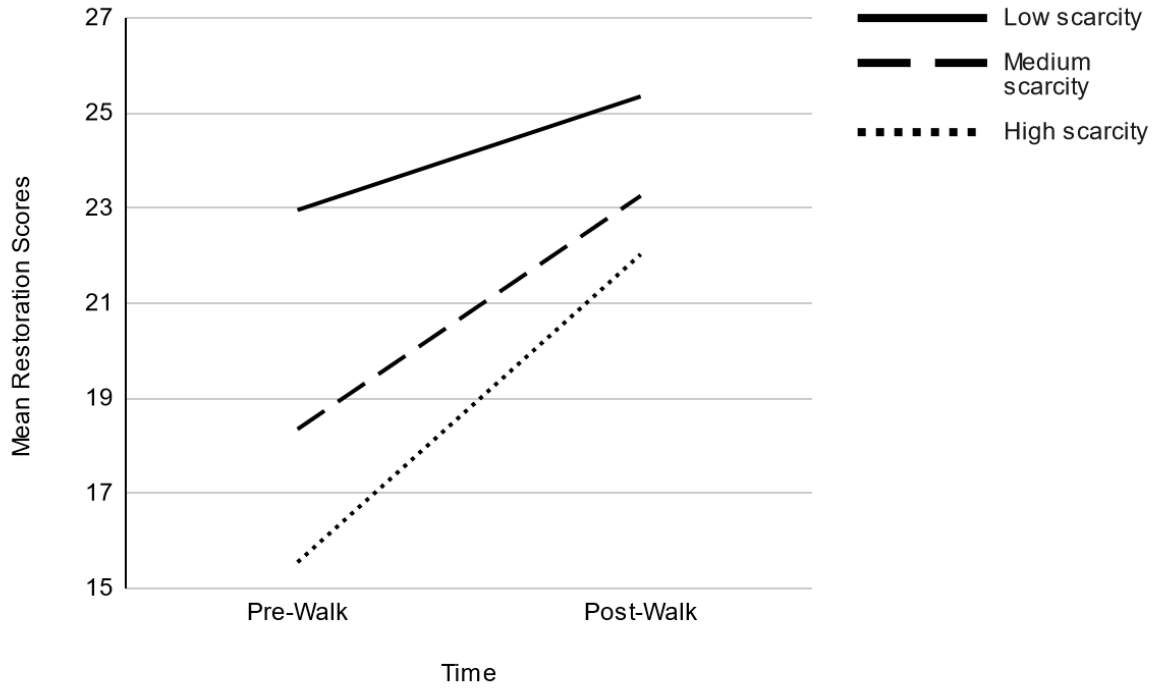


Figure 8

Estimated Marginal Means of PPA Task Scores by Scarcity Group

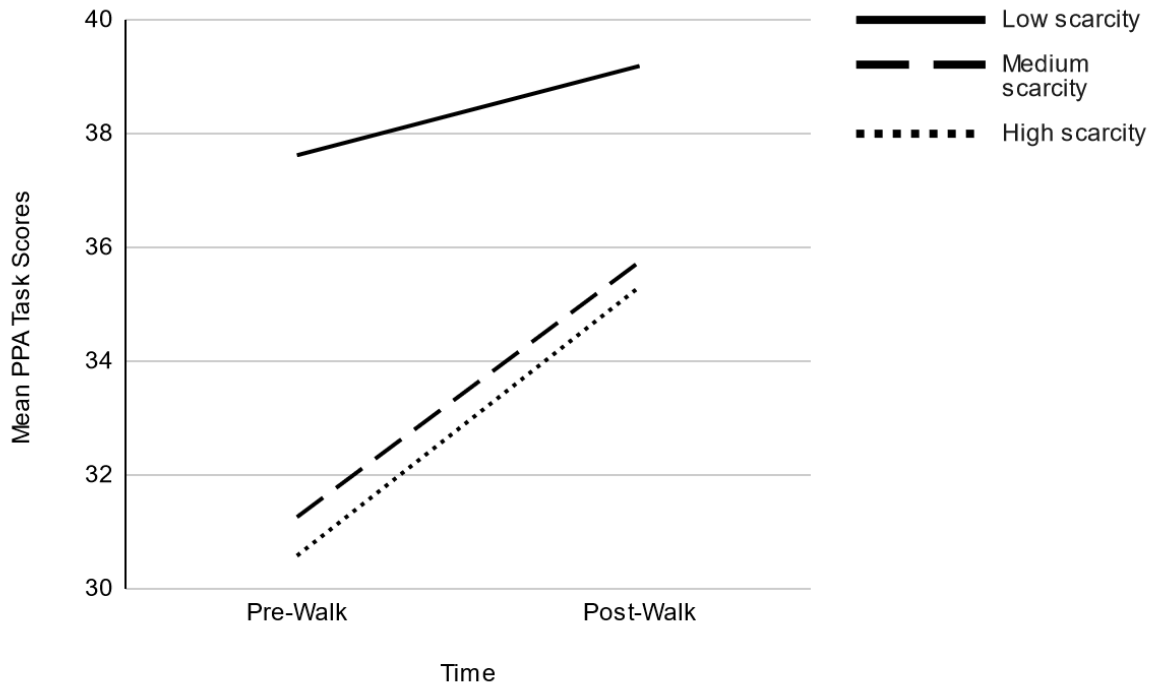


Figure 9

Estimated Marginal Means of Motivation by Scarcity Group

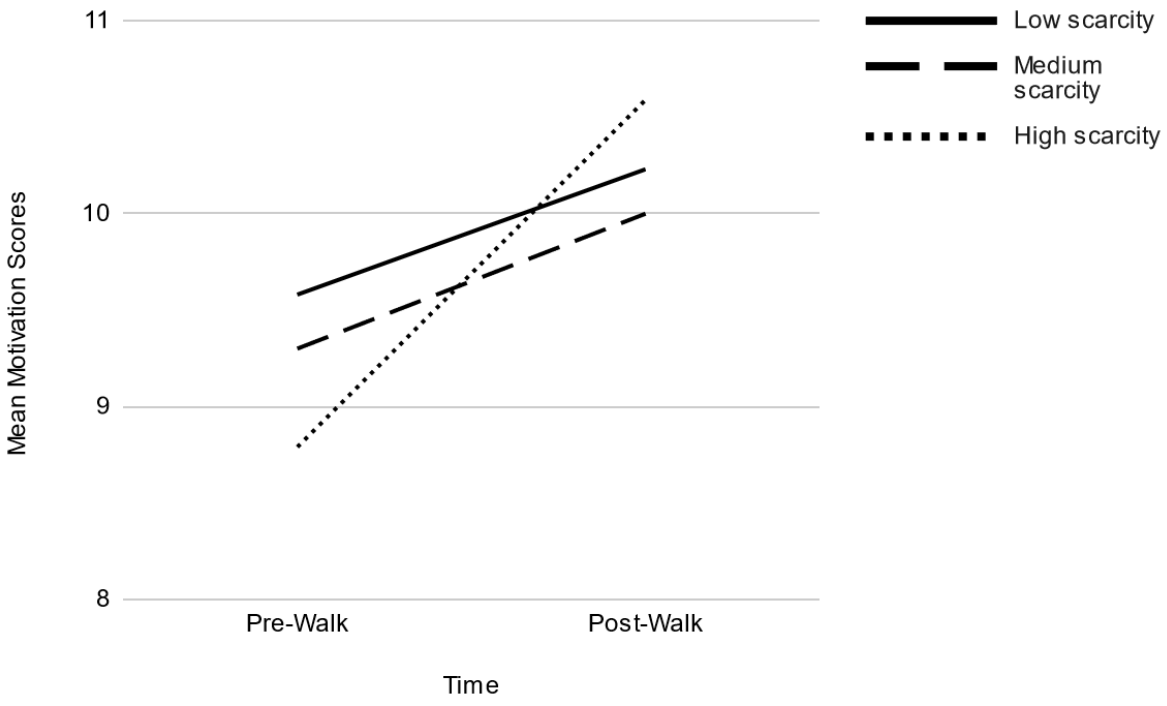


Figure 10

Estimated Marginal Means of Motivation by Material Scarcity Group

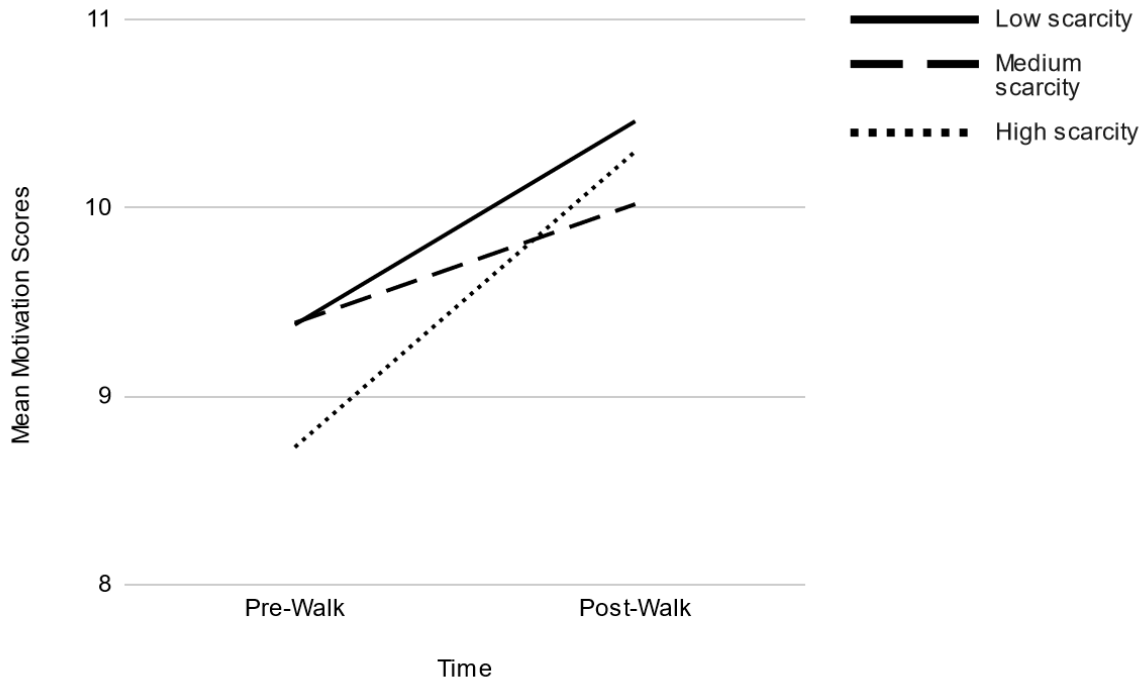


Figure 11

Estimated Marginal Means of Restoration by Time Scarcity Group

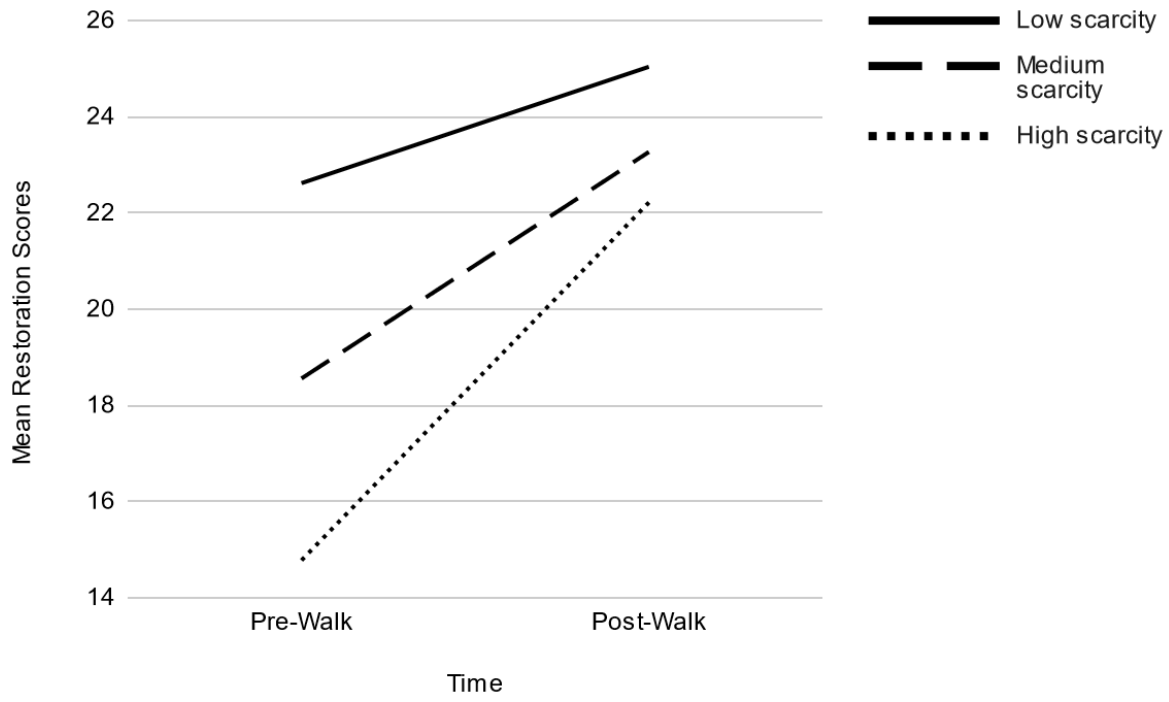


Figure 12

Estimated Marginal Means of PPA Task Scores by Time Scarcity Group

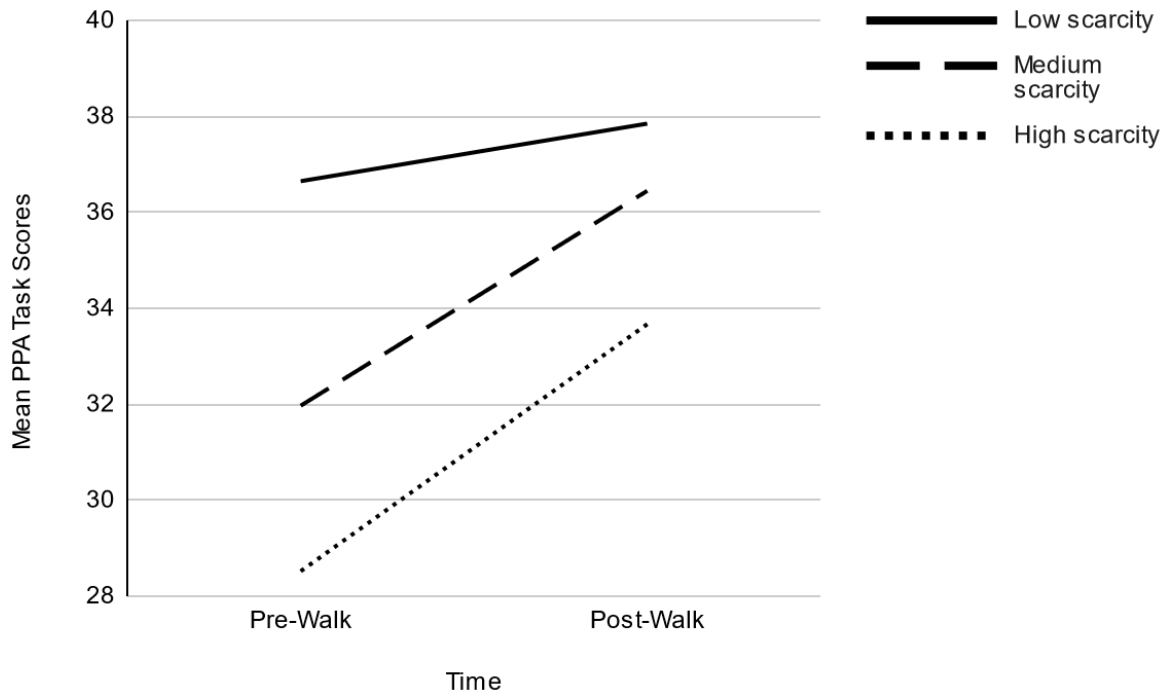
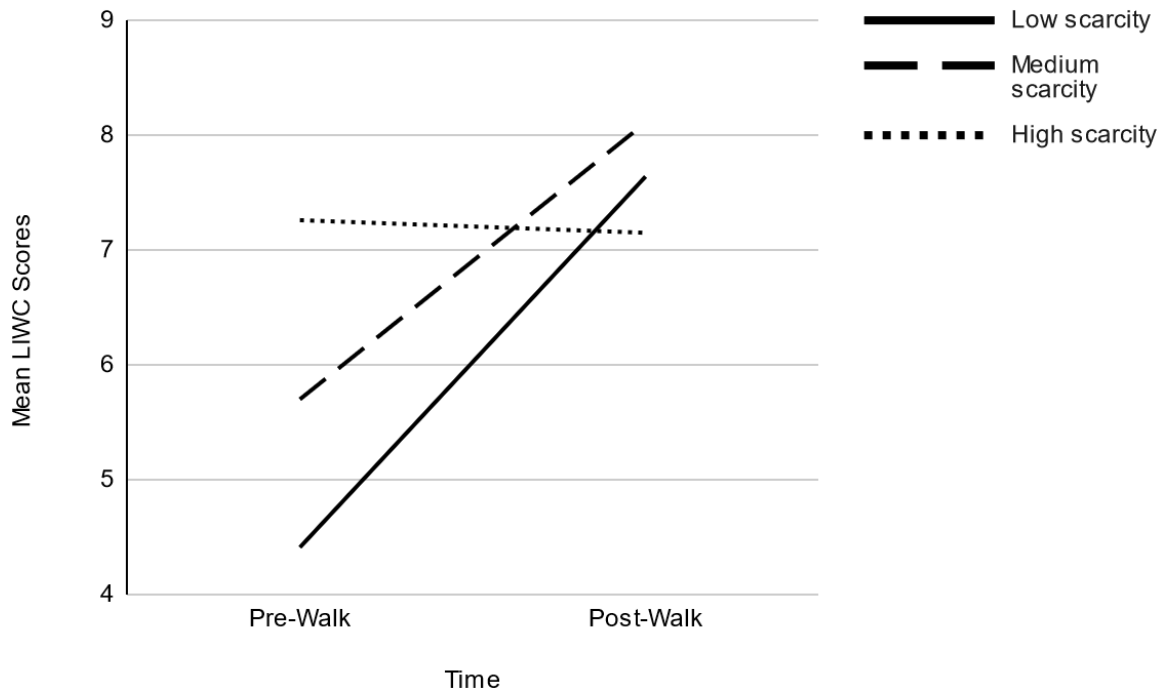


Figure 13

Estimated Marginal Means of LIWC Scores by Time Scarcity Group



APPENDIX A: QUESTIONNAIRE

Qualtrics Survey

Pre-Walk Data Collection

Restoration Outcome Scale (ROS): Korpela et al., 2008

Please answer the following questions.

1	2	3	4	5
Not at all	Slightly	Moderately	Mostly	Completely

[The ROS contains six items relating to cognitive and emotional restoration; however, permission to reproduce this scale in ProQuest was not obtained.]

International Positive and Negative Affect Schedule Short Form (I-PANAS-SF): Thompson (2007)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you feel this way right now—that is, at the present moment.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

1. Upset
2. Hostile
3. Alert
4. Ashamed
5. Inspired
6. Nervous
7. Determined
8. Attentive
9. Afraid
10. Active

Personal Project Analysis (PPA) Task: Based on Little & Gee (2007)

We are interested in studying the kinds of activities and concerns that people have over the course of their lives. We call these personal projects. All of us have a number of personal projects at any given time that we think about, plan for, carry out, and sometimes (though not always) complete.

Some projects may be focused on achievement ("Getting my degree"), others on the process ("Enjoying a night out with friends"); they may be things we choose to do, or things we have to do; they may be things we are working towards, or things we are trying to avoid. Projects may be related to any aspect of your daily life: university, work, home, self, relationships, and leisure, among others. Please think of projects in this broad way.

Some examples:

- Pass my psychology course
- Cut down on junk food
- Clean my apartment
- Clarify my religious beliefs
- Exercise more often
- Be a better parent
- Break up with my partner
- Travel to Europe this summer
- Understand my sister better
- Find a part-time job
- Stop putting off studying until the last minute

Please write down two personal projects that are **important to you at this time**. Remember these need not be formal projects or even important ones; we would prefer you to give us more of the everyday kinds of activities or concerns that characterize **your life at present.** If you have more than two such projects, please choose those that you expect to be actively working on in the next few weeks. Please be mindful of which one you are designating as "Project 1," and which one you are designating as "Project 2." You will be asked to answer questions about each project separately.

Project 1: _____
Project 2: _____

Please answer the following questions about Project 1.

1	2	3	4	5
Not at all	A little	Moderately	Quite a bit	Very

1. How difficult do you find it to carry out this project?
2. How much do you feel that you are in control of this project?
3. How successful do you believe this project will be?
4. How much stress do you feel while engaged in or thinking about this project?
5. How much enjoyment do you feel while engaged in or thinking about this project?

Please list any barriers or challenges to completing Project 1.

_____
_____
_____

Please answer the following questions about Project 2.

1. How difficult do you find it to carry out this project?
2. How much do you feel that you are in control of this project?
3. How successful do you believe this project will be?
4. How much stress do you feel while engaged in or thinking about this project?
5. How much enjoyment do you feel while engaged in or thinking about this project?

Please list any barriers or challenges to completing Project 2.

_____
_____
_____

Writing Prompt

Please describe your state of mind today. How have you been feeling? What have you been thinking about? What thoughts about your personal projects are coming up for you? Please write continuously for three to five minutes. Do not worry about spelling or grammar. Just share as much as you can about your thoughts and feelings right now.

_____
_____
_____

Perceived Scarcity Scale (PSS): DeSousa, Reeve, & Peterman (2020)

Please choose the response that best corresponds with how much you agree or disagree with each statement.

1	2	3	4	5
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

1. I have had to move in with friends/family because I could not afford to live on my own.
2. I have enough time to meet all of my responsibilities.
3. I do not have health insurance because it is not offered, I am unemployed, and/or I cannot afford to purchase it.
4. There are people I can talk to when I have a problem.
5. If I were unable to provide for myself, there are people in my life who would help me make ends meet.
6. I have had to borrow money from family or friends to pay my bills.
7. I have enough time to exercise.
8. I have enough knowledge to succeed in my profession/classes.

9. Even though I am able to get done what needs to get done, I often feel like I do not have enough time.
10. I go hungry because I cannot afford to buy more food.
11. I have more to do than I have time to do it in.
12. I have had my utilities (e.g., heat, water, etc.) turned off because I could not pay my bill.
13. I am confident in my ability to make good choices for myself.
14. I have not sought the health/medical care I needed because I could not afford it.
15. I have enough time to cook healthy meals.
16. I have meaningful relationships in my life.
17. I have enough time to engage in hobbies or engage in activities I enjoy.
18. I have had my phone turned off because I could not pay my bill on time.
19. I have the knowledge and/or skills to achieve my goals.
20. I have enough time to get done what needs to get done for work/school.
21. I buy less nutritious foods because I cannot afford healthier options.
22. I have enough time to spend with family/friends.
23. There are people in my life I can go to for support when I need it.
24. If there is something I need to know, I know who to ask for help or where to look up the information.

Demographic Questions

1. Which best describes your gender identity?
    a. Woman
    b. Man
    c. Trans Woman
    d. Trans Man
    e. Gender Queer
    f. Gender Nonconforming
    g. Gender Fluid
    h. Non-Binary
    i. Self-identify
    j. Prefer not to disclose

2. What is your age? _____

3. Which of the following groups would you say best represent(s) your race? Please check all that apply.
    a. African American/Black/Afro-Caribbean
    b. American Indian/Alaskan/Native/First Nations
    c. East Asian/East Asian American
    d. Hispanic/Latina(o)/Latinx
    e. Middle Eastern/Arab/North African
    f. Native Hawaiian/Pacific Islander
    g. South Asian/South Asian American
    h. White/European American

   i. Other

4. What is the highest level of education your parent(s)/guardian(s) have completed? Please check one per parent/guardian, as applicable.
   a. Less than high school
   b. High school, not currently enrolled in college or tech school
   c. High school, currently in college or tech school
   d. Associate's degree (or other two-year degree)
   e. Bachelor's degree, not currently in grad school
   f. Bachelor's degree, currently in grad school
   g. Master's degree
   h. Terminal degree (e.g., PhD, MD, JD, etc.)

5. What is the highest level of education you have completed?
   a. Less than high school
   b. High school, not currently enrolled in college or tech school
   c. High school, currently in college or tech school
   d. Associate's degree (or other two-year degree)
   e. Bachelor's degree, not currently in grad school
   f. Bachelor's degree, currently in grad school
   g. Master's degree
   h. Terminal degree (e.g., PhD, MD, JD, etc.)

6. Which of the following categories best describes your pre-tax household income (USD) in the last year? If you are claimed as a dependent on parent/guardian tax returns, please list their income.
   a. Less than $10,000
   b. $10,000 - $14,999
   c. $15,000 - $19,999
   d. $20,000 - $24,999
   e. $25,000 - $29,999
   f. $30,000 - $39,999
   g. $40,000 - $49,999
   h. $50,000 - $74,999
   i. $75,000 - $99,999
   j. $100,000 - $149,999
   k. $150,000 or more

7. What is your current zip code? If you are claimed as a dependent on parent/guardian tax returns, please list their zip code. _____

8. What is your childhood zip code? Please enter the zip code of the location in which you lived for the longest period of time during childhood. _____

9. Which of the following do you engage in? Please check all that apply.
   a. Smoking (tobacco)

b. Smoking (cannabis)
c. Vaping (nicotine)
d. Vaping (cannabis)

10. How often do you smoke and/or vape?
    a. A few times a day
    b. Once a day
    c. A few times a week
    d. Once a week
    e. A few times a month
    f. Once a month
    g. Once every few months
    h. Never

Motivation

Please answer the following questions.

1	2	3	4	5	6
Never	Very rarely (once or twice a year)	Rarely (a few times a year)	Sometimes (once or twice a month)	Often (once or twice a week)	Very often (nearly every day)

1. How often would you *like* to walk outdoors for recreational purposes?
2. How often do you *actually* walk outdoors for recreational purposes?
3. How often would you *like* to engage in other (non-walking) outdoor activities?
4. How often do you *actually* engage in other (non-walking) outdoor activities?

Post-Walk Data Collection

Writing Prompt

Please describe your experience on the walk: How did you feel? What did you think about? What thoughts about your personal projects came up for you? Please write continuously for three to five minutes. Do not worry about spelling or grammar. Just share as much as you can about your thoughts and feelings on the walk.

_____
_____
_____

Restoration Outcome Scale (ROS): Korpela et al., 2008

Please answer the following questions.

1	2	3	4	5

Not at all	Slightly	Moderately	Mostly	Completely

[The ROS contains six items relating to cognitive and emotional restoration; however, permission to reproduce this scale in ProQuest was not obtained.]

International Positive and Negative Affect Schedule Short Form (I-PANAS-SF): Thompson (2007)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer. Indicate to what extent you feel this way right now—that is, at the present moment.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

1. Upset
2. Hostile
3. Alert
4. Ashamed
5. Inspired
6. Nervous
7. Determined
8. Attentive
9. Afraid
10. Active

Personal Project Analysis (PPA) Task: Based on Little & Gee (2007)

Please answer the following questions about Project 1, which you identified prior to going on the walk.

1	2	3	4	5
Not at all	A little	Moderately	Quite a bit	Very

1. How difficult do you find it to carry out this project?
2. How much do you feel that you are in control of this project?
3. How successful do you believe this project will be?
4. How much stress do you feel while engaged in or thinking about this project?
5. How much enjoyment do you feel while engaged in or thinking about this project?

Please list any barriers or challenges to completing Project 1.

_____

_____

_____

Please answer the following questions about Project 2, which you identified prior to going on the walk.

1. How difficult do you find it to carry out this project?
2. How much do you feel that you are in control of this project?
3. How successful do you believe this project will be?
4. How much stress do you feel while engaged in or thinking about this project?
5. How much enjoyment do you feel while engaged in or thinking about this project?

Please list any barriers or challenges to completing Project 2.

_____
_____
_____

Impressions of the Walk

Please answer the following questions about your walk.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

1. To what extent did you feel alone during this walk?
2. To what extent did you feel safe during this walk?
3. To what extent did you reflect on Project 1 during this walk?
4. To what extent did you reflect on Project 2 during this walk?

Naturalness

1. Please rate the "naturalness" of your walk environment on a scale of 1 (not at all natural; lots of man-made structures and no flora and fauna) to 10 (completely natural; lots of flora and fauna and no man-made structures)

Motivation

1	2	3	4	5	6
Never	Very rarely (once or twice a year)	Rarely (a few times a year)	Sometimes (once or twice a month)	Often (once or twice a week)	Very often (nearly every day)

1. In the future, how often would you like to walk outdoors for recreational purposes?
2. In the future, how often would you like to engage in other (non-walking) outdoor activities?

MapMyWalk

1. Please upload one to three of the photographs that you took during the walk. Please share image(s) that are most representative of your walk environment. Although you took these photographs using MapMyWalk, they should appear in your phone's camera roll.
2. Please upload screenshots from MapMyWalk. Make sure to include both your walk route and your walk stats.

APPENDIX B: OTHER STUDY MATERIALS

Email Sent to Potential Participants

Hello,

I am a doctoral student in the Health Psychology program at UNCC, and I am seeking participants for a study examining some of the emotional and cognitive processes associated with outdoor walking. This study has been approved the UNCC IRB (xxxxx).

Qualifications

1) You must be at least 18 years of age.
2) You must be able to read and write English proficiently.
3) You must be able and willing to walk outdoors at your own pace for 30 minutes.
4) You must have a smartphone that you can use to 1) download the application MapMyWalk, 2) access an online survey, and 3) take photographs during the walk.

Procedure

Participants will be asked to take a 30-minute walk in an outdoor environment. Before and after the walk, they will complete online questionnaires on their smartphones. Participants will also log their walk route in the app MapMyWalk and take photographs of their surroundings within the app. Participants may be compensated in one of two ways: They may choose for their name to be entered in a drawing for one $20 gift card, or they may choose to receive three research credits for a participating psychology course at UNCC.

For More Information

To sign up for this study or to request further information, please contact Paisley Azra-Lewis at plewis19@uncc.edu. You may also contact my faculty advisor, Dr. Amy Peterman, at amy.peterman@uncc.edu, with any questions or concerns.

Thank you for your consideration!

Email Sent to Interested Students Assigned to Natural Condition

Dear _____,

Thank you for your interest in my study on outdoor walks and well-being! During this study, you will take a 30-minute outdoor walk in a natural area of your own choosing. Before and after the walk, you will complete online questionnaires in a survey that is linked below. This email provides you with information that you will need to know before beginning the study. Two documents are attached to this email: One outlines the process by which you will download and use the smartphone application MapMyWalk. The other is the informed consent document. Feel free to read through the informed consent and ask questions prior to beginning the study. You will see the informed consent document again when you click on the survey link below, and you will "agree" to it prior to beginning the survey.

Choosing a "natural" walk environment: We are looking for walk sites that are full of flora and fauna, and have few buildings or other man-made structures. Think of parks, nature preserves, arboretums, and wooded trails. Examples of natural walk environments near UNC Charlotte include UNC Charlotte Botanical Gardens, Reedy Creek Nature Center and Preserve, and Clarks Creek Nature Preserve—but feel free to choose any natural environment that is convenient to you. Please keep in mind that you will need to begin your walk within five minutes of completing the pre-walk online survey, so in some cases you may need to choose a walk environment where you will have a place to sit and answer questions on your phone (e.g., bench, picnic shelter, grassy area, or even your car). Please contact the researcher if you have any questions or concerns about choosing an appropriate walk site.

Downloading the application MapMyWalk: You will be using the smartphone application MapMyWalk to map your walk route. This information will be used to give us a better idea of the type of environment you choose to walk in. The app should be downloaded prior to the walk. Instructions for downloading and using the app are attached to this email, and it is recommended that you read through everything and familiarize yourself with the app before beginning the study. Please contact the researcher if you have any questions or concerns about using this app.

Study instructions: Once you have chosen your environment, have downloaded MapMyWalk, and are ready to go on the walk, you will use your own smartphone to complete online questionnaires. After completing the pre-walk portion of data collection, you will be prompted to save your progress within the survey. Within five minutes of completing the questionnaires, you should put your phone in airplane mode and begin your 30-minute walk, starting MapMyWalk at the same time to map your walk route. You will walk alone, and at your own pace. During the walk, you will take photographs within the app of the landscape features that stick out to you the most. You will also use the app to time yourself, ensuring that you walk for about 30 minutes. Please do not use any other smartphone applications or features during the walk. Within five minutes of completing the walk, you will turn off airplane mode, return to the saved survey, and complete additional questionnaires. You will upload a screenshot of your walk summary from MapMyWalk. You will also upload one to three of the photographs that you took. Your time commitment will be about 90 minutes.

Staying safe: Your health and well-being are very important to us. In addition to following all public health guidelines in regards to COVID-19, please prioritize safety when choosing the time and place of your outdoor walk, and be aware of your surroundings at all times. Although you must take the 30-minute walk by yourself, feel free to ask a friend to accompany you to the walk site and wait nearby.

Link to the survey: Please do not click on this link and begin the survey until you have chosen your walk environment, have downloaded the app, and are ready to go on your walk. [Link]

Thank you once more for your interest in this study! Please do not hesitate to reach out to me or my faculty advisor, Dr. Amy Peterman (amy.peterman@uncc.edu), with any questions or concerns.

Warm regards,

Paisley Azra-Lewis

Email Sent to Interested Students Assigned to Built Condition

Dear _____,

Thank you for your interest in my study on outdoor walks and well-being! During this study, you will take a 30-minute outdoor walk in a "built" environment of your own choosing. Before and after the walk, you will complete online questionnaires in a survey that is linked below. This email provides you with information that you will need to know before beginning the study. Two documents are attached to this email: One outlines the process by which you will download and use the smartphone application MapMyWalk. The other is the informed consent document. Feel free to read through the informed consent and ask questions prior to beginning the study. You will see the informed consent document again when you click on the survey link below, and you will "agree" to it prior to beginning the survey.

How to choose a "built" walk environment: We are looking for walk sites that are situated in pleasant urban or suburban areas. The environment should be characterized primarily by man-made structures such as buildings and sidewalks, although it may include "natural" landscaping features such as trees, flowers, and ponds. Think of neighborhood streets, pedestrian downtown areas, and other man-made sites that are appropriate for foot traffic. The UNC Charlotte campus is a good example of a "built" walk environment (with the exception of its Botanical Gardens, which are NOT characterized primarily by man-made structures), but feel free to choose any built environment that is convenient to you. Please keep in mind that you will need to begin your walk within five minutes of completing the pre-walk online survey, so in some cases you may need to choose a walk environment where you will have a place to sit and answer questions on your phone (e.g., bench, table, or even your car). Please contact the researcher if you have any questions or concerns about choosing an appropriate walk site.

Downloading the application MapMyWalk: You will be using the smartphone application MapMyWalk to map your walk route. This information will be used to give us a better idea of the type of environment you choose to walk in. The app should be downloaded prior to the walk. Instructions for downloading and using the app are attached to this email, and it is recommended that you read through everything and familiarize yourself with the app before beginning the study. Please contact the researcher if you have any questions or concerns about using this app.

Study instructions: Once you have chosen your environment, have downloaded MapMyWalk, and are ready to go on the walk, you will use your own smartphone to complete online questionnaires. After completing the pre-walk portion of data collection, you will be prompted to save your progress within the survey. Within five minutes of completing the questionnaires, you should put your phone in airplane mode and begin your 30-minute walk, starting MapMyWalk at the same time to map your walk route. You will walk alone, and at your own pace. During the walk, you will take photographs within the app of the landscape features that stick out to you the most. You will also use the app to time yourself, ensuring that you walk for about 30 minutes. Please do not use any other smartphone applications or features during the walk. Within five minutes of completing the walk, you will turn off airplane mode, return to the saved survey, and complete additional questionnaires. You will upload a screenshot of your walk summary from

MapMyWalk. You will also upload one to three of the photographs that you took. Your time commitment will be about 90 minutes.

Staying safe: Your health and well-being are very important to us. In addition to following all public health guidelines in regards to COVID-19, please prioritize safety when choosing the time and place of your outdoor walk, and be aware of your surroundings at all times. Although you must take the 30-minute walk by yourself, feel free to ask a friend to accompany you to the walk site and wait nearby.

Link to the survey: Please do not click on this link and begin the survey until you have chosen your walk environment, have downloaded the app, and are ready to go on your walk. [Link]

Thank you once more for your interest in this study! Please do not hesitate to reach out to me or my faculty advisor, Dr. Amy Peterman (amy.peterman@uncc.edu), with any questions or concerns.

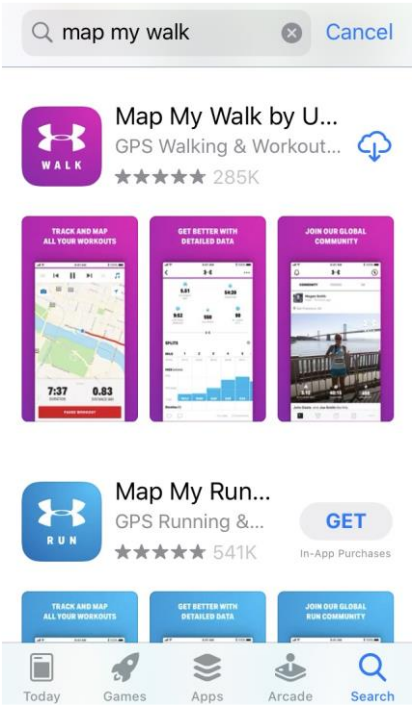
Warm regards,

Paisley Azra-Lewis

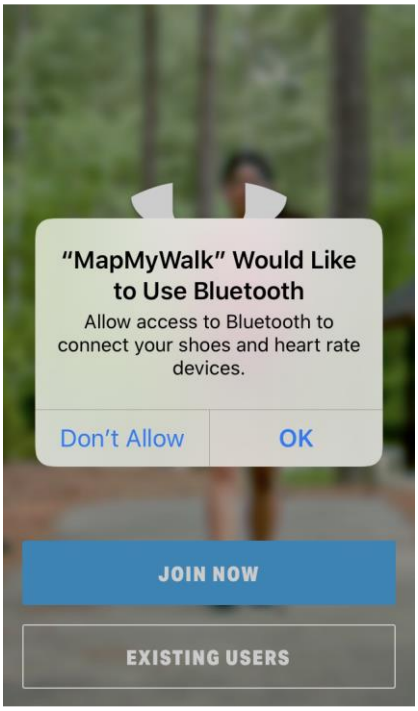
Instructions for MapMyWalk

In order to participate in this study, you must download and use the free application MapMyWalk, which you can find for both Apple and Android phones. The following instructions detail how to install the app, how to use it during the study, and how to delete your account when you are finished with the study.

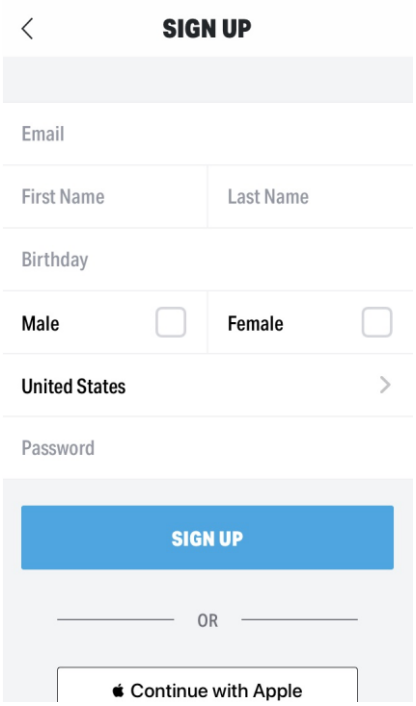
Download MapMyWalk from the App Store, Google Play, or wherever you find your smartphone apps. MapMyWalk is free.



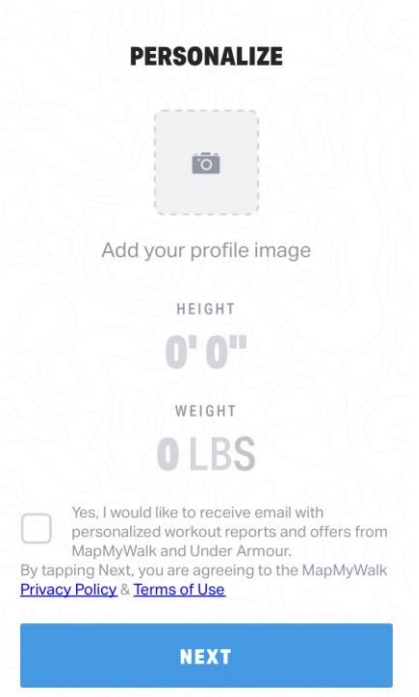
Open the app on your smartphone. There is no need to allow Bluetooth access. Click "Don't allow," then "Join now."



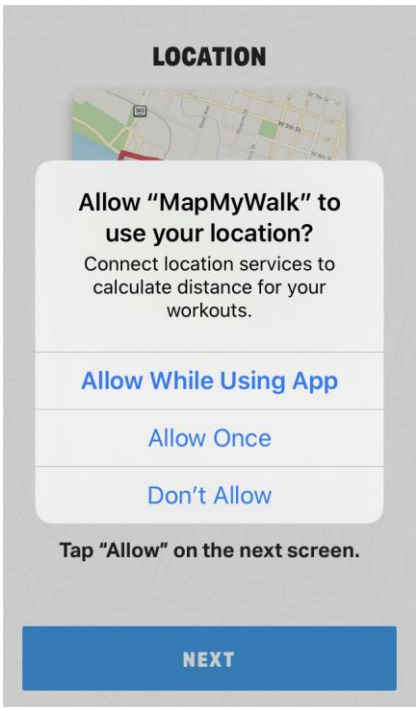
Sign up for an account. There is no need to use your real name, real birthdate, or university-affiliated email account. Any information you include here will NOT be sent to the researcher, and it will NOT be linked to your research data. The researcher has been able to use MapMyWalk without ever verifying the email address used to sign up. Please remember your password, because it will be required for account deletion.



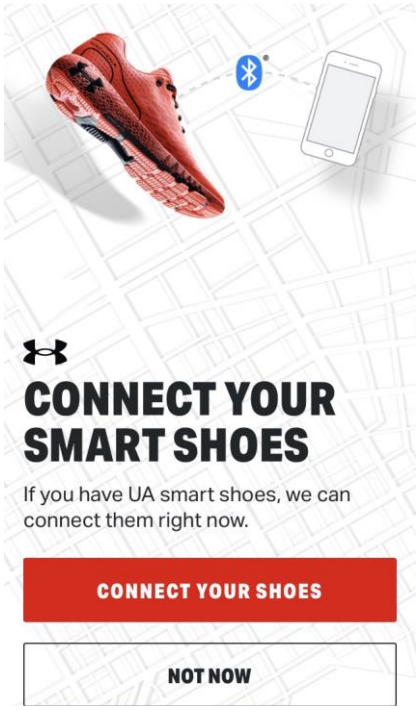
There is no need to personalize your account by adding height and weight. There is no need to receive emails from MapMyWalk. Click "Next."



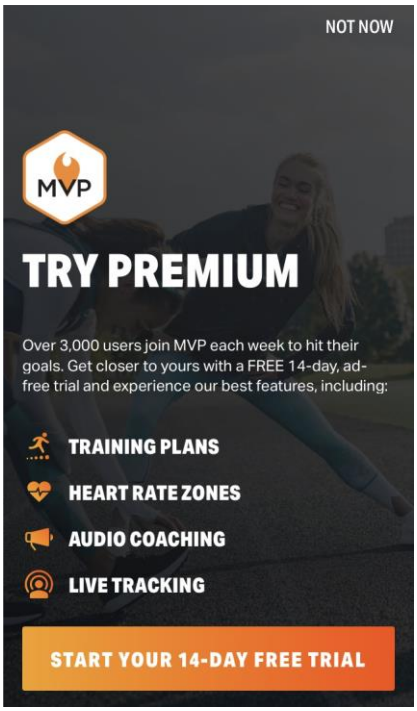
You will need to allow MapMyWalk to access your location while using the app. Click "Allow while using app," then click "Next."



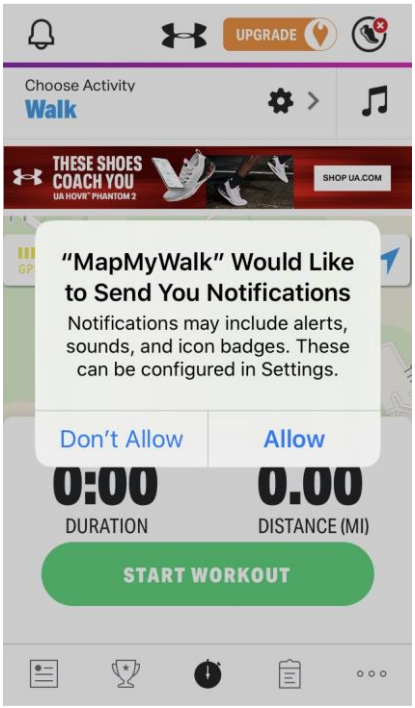
There is no need to connect your smart shoes. Click "Not now."



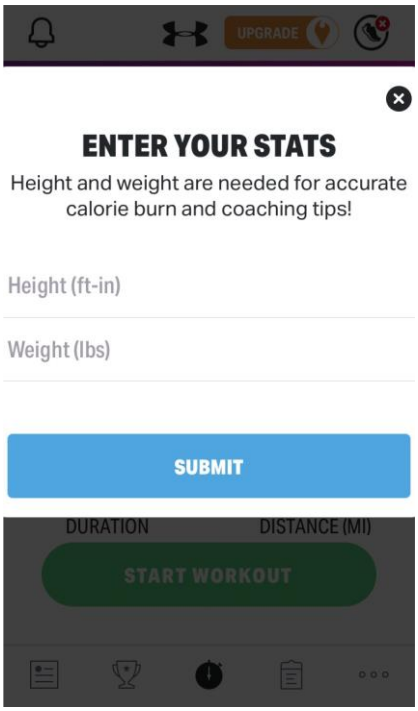
There is no need to try Premium. Click "Not now."



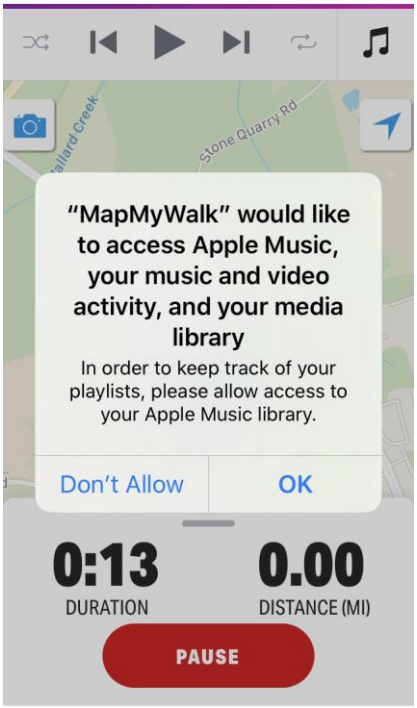
There is no need to receive notifications from MapMyWalk. Click "Don't allow."



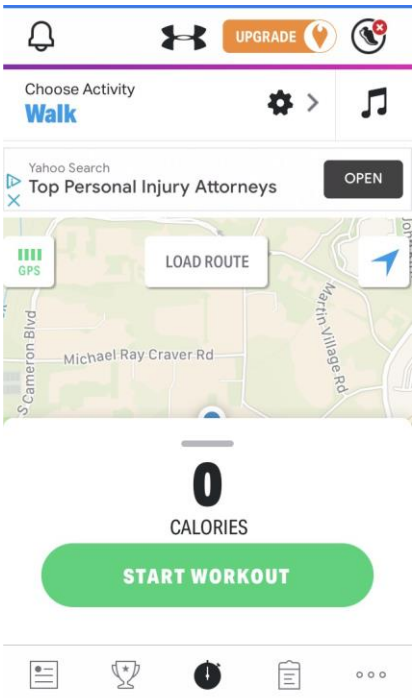
MapMyWalk may prompt you to enter your stats. There is no need to do this. Click the "x" to remove this prompt.



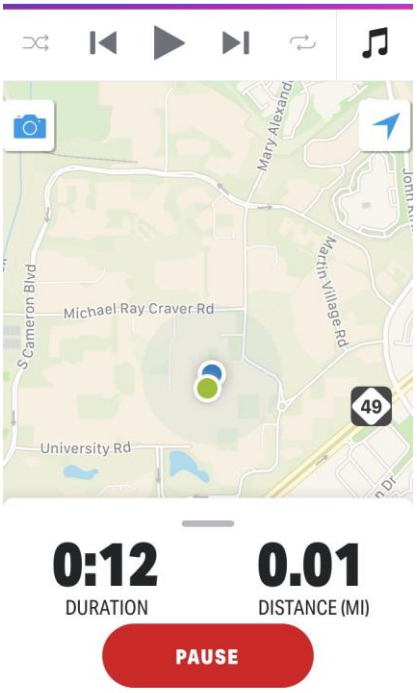
MapMyWalk may prompt you to provide access to your music and video activity. There is no need for this. Click "Don't allow."



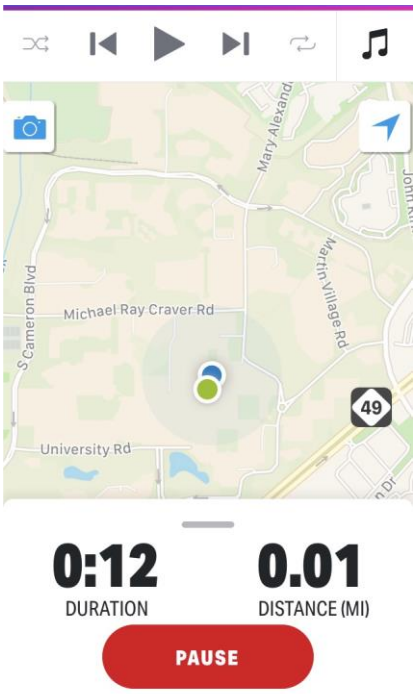
When you are ready to begin the walk, pull up the app and click "Start workout."



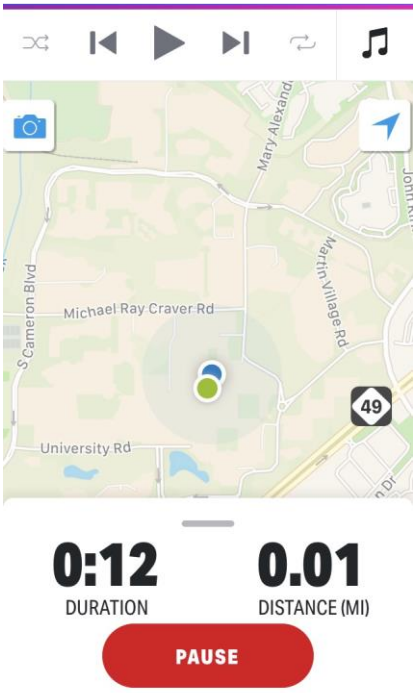
You will see that the app timer is running in the bottom left corner. This will help you to ensure that your walk is about 30 minutes long.



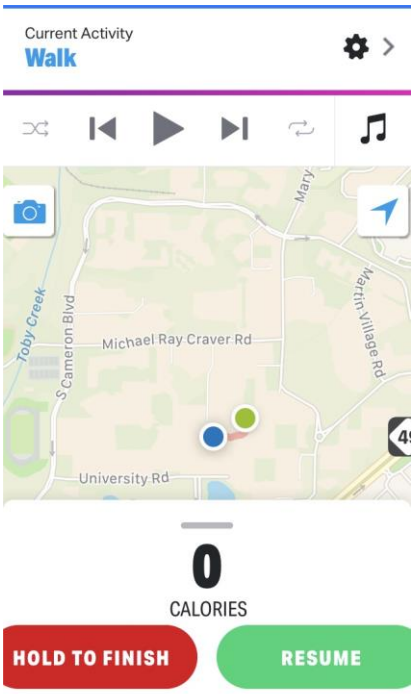
During the walk, take photographs by clicking on the camera in the upper left corner of the screen.



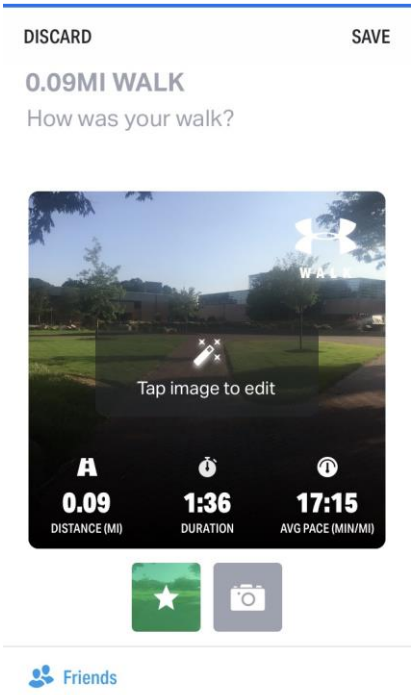
When you are ready to end your walk, click "Pause."



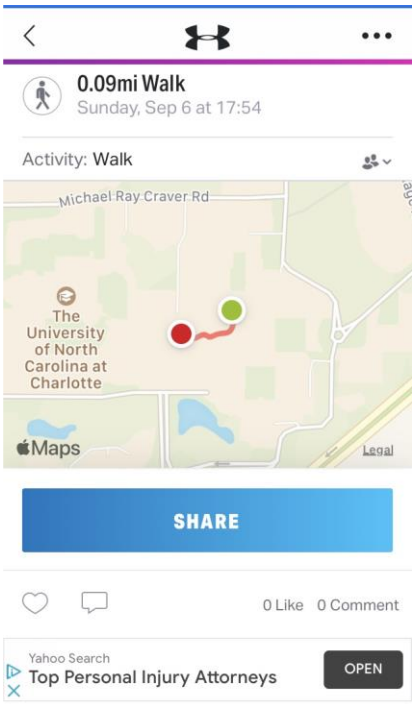
Hold the "Hold to finish" button to confirm that you are ending your walk.



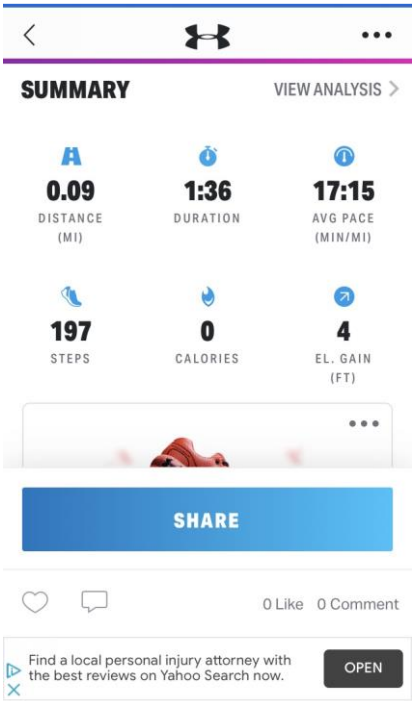
Click "Save" to save your walk data within the app.



Take screenshots of the walk data that appear on your screen. You will likely need to take two screenshots: At the top of the screen, screenshot your walk route.

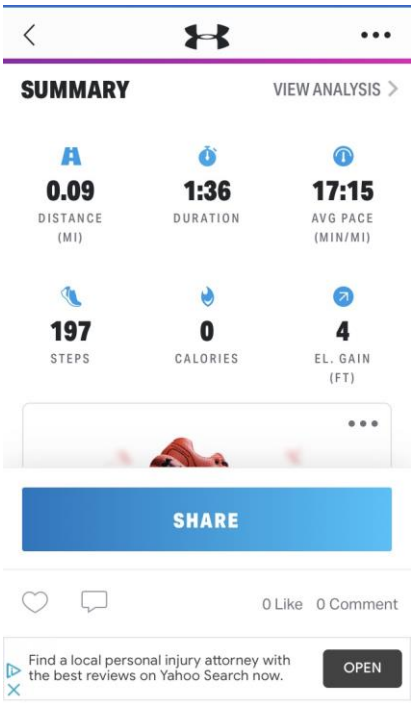


Scroll down to take a second screenshot, this time of the walk summary. There is no need to use the "Share" button; you will upload screenshots into Qualtrics instead of sharing directly from the app.

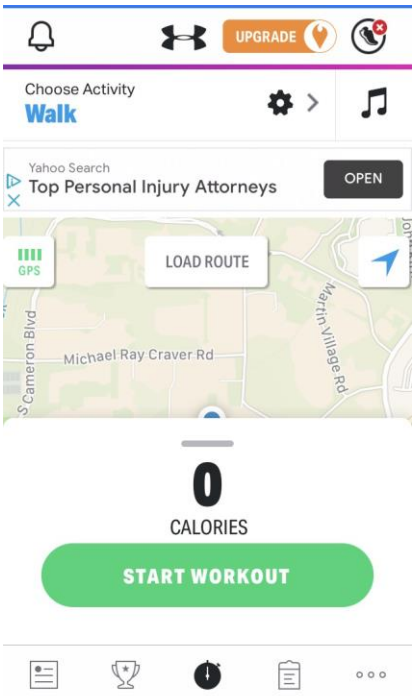


After the conclusion of your participation in this study, there is no need to keep your MapMyWalk account or app. However, make sure that you have taken screenshots of your walk route and your walk stats before proceeding to account deletion.

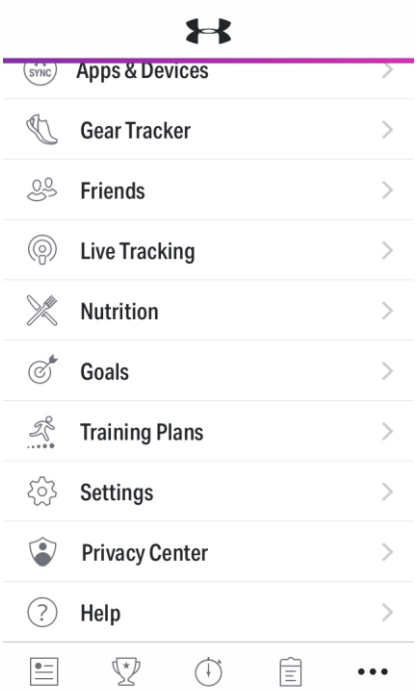
If you are on the workout summary page, hit the "back" arrow on the top left to get to a page with three dots in the bottom right corner of the screen.



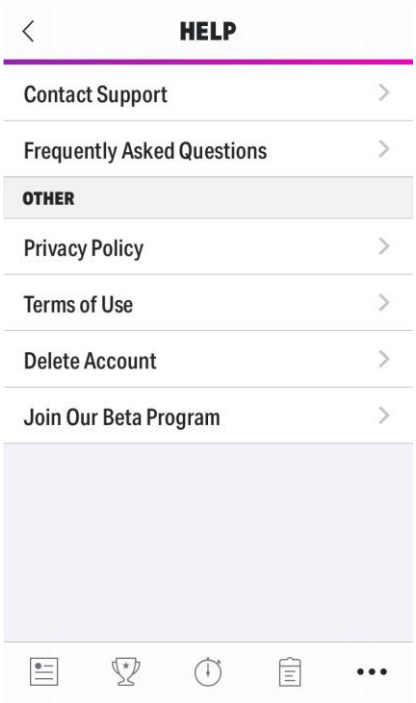
If you have closed the app and are reopening to delete your account, you will also see a page with three dots at the bottom right of the screen. Click those three dots.



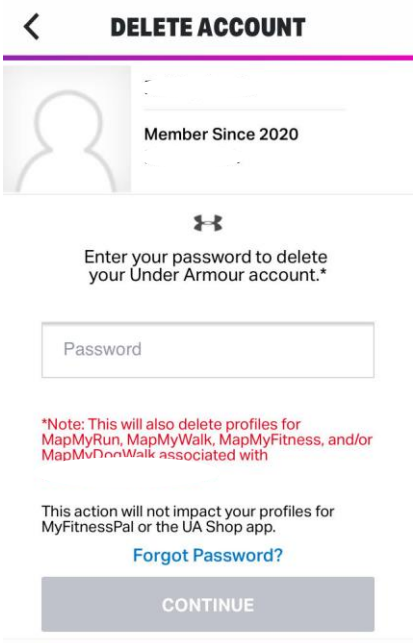
Scroll down to the bottom of the screen. Click "Help."



Click “Delete account.”

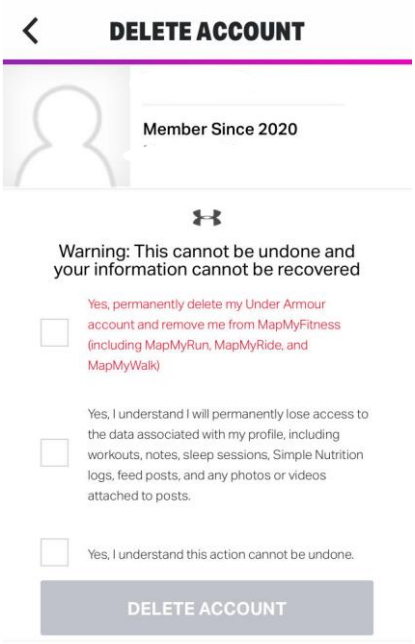


Enter your password and click “Continue.”



Check all three boxes and click "Delete account."

Congratulations! Now you just need to delete the app from your phone, and you will be completely finished with your MapMyWalk experience.



UNC CHARLOTTE
Department of Psychological Science
9201 University City Boulevard, Charlotte, NC 28223-0001

Consent to be Part of a Research Study

Title of the Project: Outdoor Walks and Wellbeing
Principal Investigator: Paisley Azra-Lewis, BS (UNCC Department of Psychological Science)
Faculty Advisor: Amy Peterman, PhD (UNCC Department of Psychological Science)

You are invited to participate in a research study. Participation in this research study is voluntary. The information provided is to help you decide whether or not to participate.

Important Information You Need to Know

- The purpose of this study is to examine some of the emotional and cognitive processes associated with outdoor walking.
- You will be asked to choose an outdoor environment and engage in a 30-minute walk, at your own pace, in that environment. Before and after the walk, you will complete online questionnaires. During the walk, you will map your route and take photographs using the free smartphone application MapMyWalk.
- If you choose to participate it will require about 90 minutes of your time.
- Risks or discomforts from this research include possible psychological discomfort while answering survey questions, and possible (though unlikely) injury during the outdoor walk.
- Benefits may include those associated with walking outdoors.
- You may choose not to participate, or to end your participation at any time. In this case, your data will not be included for analysis and you will not be eligible for any incentives.

Please read this form before you decide whether to participate in this research study.

Why are we doing this study?

The purpose of this study is to examine some of the emotional and cognitive processes associated with outdoor walking, and to better understand how personal characteristics may affect a person's walking experience.

Why are you being asked to be in this research study?

You are being asked to be in this study because you are aged 18 or older; you are able to read and write English fluently; you are able and willing to walk outdoors at your own pace for 30 minutes; and you have a smartphone that you can use to download the application MapMyWalk, access an online survey, and take photographs during the walk.

What will happen if I take part in this study?

If you choose to participate in this study, you will first choose an outdoor environment in which to take a walk. This environment should adhere to the guidelines outlined by the researcher. You

will also need to download the smartphone application MapMyWalk, using the tutorial provided by the researcher. Once you have chosen your environment, have downloaded MapMyWalk, and are ready to go on the walk, you will use your own smartphone to complete online questionnaires. After completing the pre-walk portion of data collection, you will be prompted to save your progress within the survey. Within five minutes of completing the questionnaires, you should put your phone in airplane mode and begin your 30-minute walk, starting MapMyWalk at the same time to map your walk route. You will walk alone, and at your own pace. During the walk, you will take photographs within the app of the landscape features that stick out to you the most. You will also use the app to time yourself, ensuring that you walk for about 30 minutes. Please do not use any other smartphone applications or features during the walk. Within five minutes of completing the walk, you will turn off airplane mode, return to the saved survey, and complete additional questionnaires. You will upload screenshots of your walk summary from MapMyWalk. You will also upload one to three of the photographs that you took. Your time commitment will be about 90 minutes.

What benefits might I experience?

Potential benefits include those associated with walking and other light exercise in outdoor settings. Even if you do not personally benefit from this study, your participation will help further our understanding of the emotional and cognitive processes associated with outdoor walking, thereby helping to create more effective walking interventions for others.

What risks might I experience?

It is possible that you may become distressed while completing the online survey. If this happens, you will be able to take a break or to end participation in the study. Please be aware that you are able to skip questions within the survey. Risks to your emotional, social, professional, and financial wellbeing throughout the course of this study are considered less than minimal.

We do not believe that you will experience any physical risk from participating in this study, above and beyond what you might experience while walking outdoors on your own time. However, walking in outdoor spaces does involve some chance of personal injury. In spite of all safety measures, you might develop a reaction or injury from walking outdoors in this study. If such problems occur, any costs for medical care will be billed to you and/or your insurance company. UNC Charlotte has not set aside funds to pay you for any such reactions or injuries, or for the related medical care. Please be aware of your surroundings and do not walk in an environment that feels unsafe to you. If, at any time, you feel that you are in danger during the walk, cease participation and take action as needed. You do not give up any of your legal rights by signing this form.

How will my information be protected?

We plan to publish the results of this study. To protect your privacy, we will not include any information that could identify you. We will protect the confidentiality of the research data by keeping them in a password-protected file on a password-protected device. Your name and email address, which will be available to the researcher when you sign up for the study, will not be associated with the research data. You will also provide the researcher with your email address if you would like to enter the drawing for the chance to win a gift card. This information will be stored separately and will be destroyed after the drawing. Incentive payments such as gift cards

are considered taxable income. Therefore, we are required to give the University's Financial Services division the name of the individual who receives a gift card. This information is for tax purposes only and is separate from the research data, which means the name of the winner will not be linked to survey responses.

How will my information be used after the study is over?
After this study is complete, study data may be shared with other researchers for use in other studies without asking for your consent again or as may be needed as part of publishing our results. The data we share will NOT include information that could identify you.

Will I receive an incentive for taking part in this study?
As a token of gratitude for your participation in this study, you will be eligible to receive one of two incentives: First, you may choose to enter your name in a drawing for one, $20 gift card. Second, if you are participating in this study for research credit, you may choose to receive three Sona credits in lieu of entering the drawing. Only participants who complete the study (i.e., do not withdraw before the end of data collection) will be eligible for these incentives.

What are my rights if I take part in this study?
It is up to you to decide to be in this research study. Participating in this study is voluntary. Even if you decide to be part of the study now, you may change your mind and cease participation at any time. You do not have to answer any questions you do not want to answer. If you withdraw from the study, your data will not be included for analysis.

Who can answer my questions about this study and my rights as a participant?
For questions about this research, you may contact Paisley Azra-Lewis (plewis19@uncc.edu) or Dr. Amy Peterman (amy.peterman@uncc.edu).

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Office of Research Compliance at 704-687-1871 or uncc-irb@uncc.edu.

Crisis Resources
If you find yourself in distress, please reach out for help.
(UNCC students only) UNCC Counseling and Psychological Services: 704-687-0311
National Suicide Prevention Lifeline: 1-800-273-8255
Mecklenburg County Mobile Crisis Team: 704-566-3410

Consent to Participate
You have already received a copy of this document by email for your own records. If you are 18 years of age or older, have read and understand the information provided, freely consent to participate in the study, and are ready to begin, you may proceed to the survey. Click "Continue" below.