Understanding the Beneficial Relationship between Nature and Well-Being in Daily Life— a Multi-Method Mediational Investigation

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ABSTRACT

Nature is thought to enrich well-being: The more time people spend in nature, the happier they feel. But how consistent is this link, and what mechanisms might account for the salutogenic effects of nature on well-being? The aim of this thesis was to investigate the beneficial effects of nature on emotional well-being in people’s daily lives and to deepen the scientific understanding of the mechanism(s) linking nature to emotional well-being. Following a brief overview of this thesis (Chapter 1- Introduction), I discuss the current literature on nature and well-being, focusing on theories of biophilia and attentional theories that might account for the nature and well-being relationship (Chapter 2- Literature Review). In the literature review, I identify several gaps in current research and discuss one possible mediator of the link between nature and well-being - the concept of fascination (defined as the extent to which attention is drawn effortlessly by objects in the environment). Next, I present a series of five empirical studies (Study 1-5) consisting of one correlational daily diary study and four field experiments that collectively sought to test the relationship between nature and two markers of well-being – increased positive affect and decreased negative affect. Study 1-2 explored and established fascination as a reliable mediator of the relationship between nature and positive affect (PA). Study 3-4 replicated fascination as a mediator of the nature-PA link and also eliminated two other potential mediators - mindfulness (Study 3) and heart rate variability as a physiological indicator (Study 4). After establishing fascination as the standard mediator which explains how nature may influence positive affect (PA), Study 5 investigated several other potential factors which together mediated the nature and PA link (fascination, fluency, and savoring).
Path analyses in Study 5 using multi-level structural equation modeling (MSEM) suggested that daily fascination, fluency, and savoring collectively mediated the link between nature and PA: experiencing more fascination in nature contributed to greater fluency in nature, and this fascination-fluency circuit enhanced the experience of savoring, contributing to increases in daily PA. Overall, the results across all five studies confirmed the positive relationship between nature and PA in daily life, and suggested that the cognitive quality of experiences in nature (fascination and fluency) and emotion regulation following nature (savoring) may explain why people feel happier after spending time in nature. In the General Discussion, I discuss these findings and the contribution made by this thesis to the literature on nature and emotional well-being.
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1. CHAPTER 1: INTRODUCTION

Since ancient times, humans have co-lived with nature. Nature is the environment in which various kinds of flora and fauna reside, with the presence of trees, plants, flowers (“green features”) and/or rivers, streams, and the sea (“water features”). Human urbanization has cut down our symbiotic relationships with nature, leading to what Louv (2005) has termed “nature deficit disorder.” For many modern humans, nature has become little more than an occasional plant, flower, or shrub that may line the busy streets in which humans navigate their everyday lives. This disconnect between humans and nature is thought to underlie many problems including higher crime, air pollution, and the deterioration of mental health (Frumkin, 2001). This thesis concerns the relationship between nature and psychological functioning, focusing on the causal links between nature and well-being in young adults’ everyday lives, and identification of the underlying mechanism(s) that link nature to well-being. I define well-being as an individual’s positive evaluation of his or her physical and mental (emotional) condition.

For the past few decades, there has been a growing literature on the relationship between contact with nature and mental health. Emerging evidence suggests that nature has an especially beneficial effect on the emotional aspects of mental health, such as positive and negative affect (e.g., Barton & Pretty, 2010; Bowler, Buyung-Ali, Knight, & Pullin, 2010; Bratman, Daily, Levy, & Gross, 2015; Frumkin, 2001; Hartig, Evans, Jamner, Davis, & Garling, 2003; Kuo, 2015; Maller, Townsend, Pryor, Brown, & St
Leger, 2006). It is important to note that this beneficial effect seems to still hold even after statistically controlling for the influence of outdoor physical activity and social interaction (Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagne, 2010). This unique salutogenic effect of nature suggests that nature may have special restorative effects on how people feel in their daily lives.

An important question is how does nature restore well-being? What are the potential mechanisms that explain the salutogenic effect of nature? This thesis will investigate a range of mechanisms starting with a mechanism derived from attention restoration theory (ART) (Kaplan & Kaplan, 1989; Kaplan, 1995). Attention restoration theory (ART) posits that natural environments possess certain visual and acoustic features that evoke feelings of “fascination” whereby our attention is drawn to interesting stimuli that engage attention without overloading attentional capability (Berto, 2005; Kaplan, 1995). In a normal everyday life, conscious effort is required to attend to many stimuli and tasks at once, which can eventually tax attentional resources. Fascinating stimuli in nature can provide the mental opportunity to restore depleted attentional resources, and make people feel better as a result (Berto, 2014; Berto, 2005; Kaplan & Kaplan, 1989).

Other mechanisms will also be explored in this thesis, including mechanisms related to emotion regulation and information processing. From an emotion regulation perspective, possible mediators included mindfulness, heart rate variability, and savoring, all of which could be increased in nature and are known to enhance emotional well-being
(e.g., Appelhans & Luecken, 2006; Keng, Smoski, & Robins, 2011; Quoidbach, Berry, Hansenne, & Mikolajczak, 2010; Quoidbach, Mikolajczak, & Gross, 2015). From an information processing perspective, I also tested the role of “processing fluency”, as another potential mediator of the relationship between nature and emotional well-being. Processing fluency is defined as the subjective feelings of ease with which one processes incoming information including visual stimuli (Reber, Schwarz, & Winkielman, 2004). Fluency plays an important role in the cognitive process related to perception and memory, and higher fluency is known to be associated with greater positive affect (e.g., Alter & Oppenheimer, 2009; Winkielman, Halberstadt, Fazendeiro, & Catty, 2006; Winkielman, Schwarz, Fazendeiro, & Reber, 2003).
The aim of thesis

The present thesis aimed to identify the potential mechanisms that underlie the relationship between nature and well-being in young adults’ daily lives. The various mechanisms tested in this thesis are shown in Figure 1. Firstly, I present a literature review on the restorative effects of nature on well-being, and the current theories explaining this link. I introduce the concept of biophilia and pay a special focus on attention restoration theory and the construct of ‘fascination’ which derives from a biophilic orientation. In Study 1, I used attention restoration theory as the starting point for identifying how experiences of fascination account for (and potentially modulate) the...
relationship between nature and emotional well-being. Study 1 employed an intensive
daily diary correlational design, using multi-level modeling to investigate associations
between variables in everyday life. Studies 2 – 5 were all experimental designs. In Study
2, I investigated the possibility of manipulating fascination (and alternatively,
mindfulness in Study 3) while people took a walk in nature (versus an urban
environment) as an intervention tool. In Study 4, I examined a potential physiological
mediator – heart rate variability – that might account for the nature-emotional well-being
link. Studies 2, 3, and 4 employed a field experimental design which addressed the
limitation of the cross-sectional design in Study 1. In Study 5, I tested the role of fluency
and savoring (using fascination as the benchmark) to shed new light on the overall
process linking nature to emotional well-being. Study 5 was the capstone study that
combined a one-week daily diary design with an experimental design using multi-level
structural equation modeling. From a methodological perspective, this thesis combined
intensive daily diary designs with a series of field experiments to examine how specific
subjective experiences in nature can influence the nature-well-being relationship.
Specifically, it aimed to investigate the hypothesis that perceived fascination,
mindfulness, heart rate variability, fluency, and savoring may mediate the link between
nature and emotional well-being.
2. CHAPTER 2: LITERATURE REVIEW

Historical Background and Early Research on Nature and Well-being

From the concept of evolutionary adaptation, Edward O. Wilson proposed that there is an innate dispositional tendency for humans to have affiliative feelings toward all living forms—flora and fauna—and he named this human tendency ‘biophilia’ (Wilson, 1984). The genetic affiliative tendency towards fauna and flora has evolved because it led human ancestors to seek out environments favorable to their survival and well-being (i.e., because these environments contain survival resources such as food sources, fresh water, etc.). While in the modern-day world nature may not hold the same evolutionary value for human adaptation, these evolutionary scripts may still guide our perception, attention, emotion, and behavior (Kellert & Wilson, 1995). Moreover, a human affinity towards nature might extend far beyond the surviving issues of material and physical sustenance: nature might also satisfy humans’ genetic craving for aesthetic, cognitive, emotional, and even spiritual meaning and satisfaction (Ulrich, 1986). According to the ‘biophilia hypothesis’ (Kellert, 1993), humans’ contact with the natural landscape with its associated fauna and flora should foster their psychological and physical well-being by signaling to humans that the surrounding natural environments are optimal environments for their survival and satisfaction.

In some of the earliest research on nature on well-being, Roger Ulrich demonstrated that visual stimuli from nature can accelerate the recovery from surgery and suggested that the restorative responses from natural stimuli might be based on the
human tendency for nature (Ulrich, 1984). In this seminal study, patients who had undergone cholecystectomy (a common type of gall bladder surgery) were randomly assigned to rooms with either a tree-view or a brick wall-view through windows. Patients in the tree-view groups \((n = 23)\) required significantly lower doses of medication (i.e., potent pain killers), and required significantly shorter hospital stays than patients in the wall-view group \((n = 23)\) (Ulrich, 1984). A similar study used ceiling mounted pictures shown to patients who were lying on gurneys (Coss, 1990; summarized in Ulrich, 1993). While the patients were waiting for surgery, different pictures were displayed for up to six minutes. Participants were randomly assigned to three groups that viewed either “serene” pictures (e.g., nature with water), “exciting” pictures (e.g., a sailboard rider into the wind), or a no picture control. The results showed that participants in the nature group had 10 – 15 points’ lower systolic blood pressure than the other two groups after just three to six minutes of exposure. It is important to note that the “exciting” pictures (which were supposed to tap high arousal content) had some nature elements in it, which could have led to an underestimation of possible group differences. Nevertheless, these two studies were among the earliest to show that exposure to nature can have beneficial physiological effects in a semi-uncontrolled environment of a hospital setting.

As the biophilia hypothesis implies, humans may possess an inner drive to seek out natural environments, which, in turn, provide an evolutionary advantage for their survival and well-being (Wilson, 1984). Yet as a hypothesis, biophilia has been criticized for being too broad, too loosely defined, and not specific enough for empirical
disconfirmation (Haybron, 2011; Joye, 2011; Kaplan, 1995; Ulrich, 1993). For example, the counterpoint to biophilia is the concept of biophobia, which reflects humans’ innate fear of snakes, spiders, etc. This biophobia tendency can be more powerful and persistent than biophilia (Ulrich, 1993) and it may be difficult to reconcile the concept of biophobia with that of biophilia (Kaplan, 1995). Another issue concerns humans’ preference for water features. Empirical evidence has shown that humans have preferences for nature with water features and exposure to water features in nature positively impacts their well-being (Korpela, Ylen, Tyrvainen, & Silvennoinen, 2010; Volker & Kistemann, 2011). However, biophilia is about humans’ feelings toward all living forms (fauna and flora), which does not necessarily include water per se. Therefore, it is difficult for the biophilia hypothesis to explain humans’ interest in water features (Joye, 2011) or other non-living things (e.g., the sky, stars) (Haybron, 2011). However, the concept of biophilia has helped to generate empirically testable hypotheses that have contributed to better scientific understanding of the person-nature interaction. One emerging theory is Attention Restoration Theory.

**Attention Restoration Theory**

Attention restoration theory (Kaplan & Kaplan, 1989) posits a cognitive interpretation of the biophilia hypothesis. Specifically, this theory suggests that natural environments are cognitively restorative, and they allow people to recover from mental fatigue. In normal everyday life, individuals have to make a conscious effort directing their attention to various tasks at hand. They also need to inhibit unwanted distractions,
so that they can concentrate on engaged tasks more efficiently (Kaplan, 1995). The need to inhibit unwanted distractions is particularly true in modern urban environments which provide very little relief from distraction. However, the continuous use of voluntary directed attention comes at a price, which is mental fatigue (Kaplan & Kaplan, 1989). The symptoms of mental fatigue include irritability, lack of energy, and more negative (and less positive) feelings (Kaplan, 1995).

According to attention restoration theory (ART), recovery from mental fatigue requires replenishing the once depleted inner attentional resources. Sleep, for example, can help restore depleted attention capacity (Kaplan & Kaplan, 1989; Kaplan, 1995). However, sleep requires waiting until the next day to feel better. It is important to recover from mental fatigue when individuals are awake and engaging in daily routines. Such recovery is more likely to occur in “restorative environments”. In restorative environments, like nature, attention is easily drawn to surroundings without any effort. During this period, the depleted attentional capacity can rest and be replenished to its full capacity again (Kaplan & Kaplan, 1989; Lee, Williams, Sargent, Williams, & Johnson, 2015). According to ART, replenishment of attentional resources has a positive cascading effect on emotional states such as positive affect (PA) (e.g., Berman, Jonides, & Kaplan, 2008; Berman et al., 2012; Kaplan & Berman, 2010).

But what is it about nature environments that is cognitively restoring? According to ART, nature or green spaces possess four qualities that make them restorative environments (Kaplan & Kaplan, 1989). The first quality is that natural environments
contain stimuli that easily and automatically evoke feelings of “fascination” in the perceiver. Stimuli that evoke fascination do not require voluntary efforts to keep attention focused; few cognitive resources are wasted within individuals and as a result, attentional resources can rest and be replenished (Kaplan, 1995). The second quality is that natural environments foster the experience of “being away”, which is the feeling of greater psychological distance from everyday routines. The third quality is “extent”, which gives individuals the sense of scope and coherence in the surroundings they are in. The fourth is “compatibility”, which indicates the match between personal needs and intended nature-based activities (e.g., the match between going on a fishing trip and visiting a park with a river). It is important to note that some urban environments like monasteries, museums, or historical buildings can be as restorative as natural ones (Herzog, Ouellette, Rolens, & Koenigs, 2010; Kaplan, Bardwell, & Slakter, 1993; Karmanov & Hamel, 2008; Ouellette, Kaplan, & Kaplan, 2005).

Of all these qualities of nature, “fascination” might be the most important. ART posits that fascination plays a key role as the restorative factor from mental fatigue (Kaplan & Kaplan, 1989; Kaplan, 1995). Based on this assumption, the present thesis focused on fascination and aimed to explore the role of fascination in mediating the link between nature and emotional well-being. Prior research has focused mainly on the cognitive benefits of fascination as a quality of nature (e.g., Berto, 2005; Berto, Baroni, Zainaghi, & Bettella, 2010). However, it is largely unknown how fascination might affect emotional well-being. The paucity of research on fascination as a mechanism linking
nature and emotion formed the initial basis for this PhD thesis. The main theme of the present thesis was to address the relationship between nature and emotional well-being, focusing on the possible mechanisms including fascination. However, before discussing these specific research questions, I will present a general overview of the literature on nature and its impact on well-being.

**Evidence for Nature’s Impact on Well-being**

In this section, I review the evidence for nature’s impact on well-being. Here, my literature review is guided by the World Health Organization definition of well-being which defines well-being as a complete state of physical, mental, and social health, which is more than the absence of sickness or disease (World Health Organization, 2013). Accordingly, within this review, I discuss the links between nature and both physical and mental well-being, although I prioritize the research literature on mental well-being. Moreover, in discussing mental well-being, I present research linking nature to reductions in the negative aspects of mental health – lower stress, anxiety, depression, negative affect (NA) – and to improvements in the positive aspects of mental health – higher happiness and positive affect (PA). Coverage of both the NA and PA elements recognizes a fundamental principle in the science of well-being – namely, that the absence of NA does not necessarily indicate the presence of PA (Myers & Diener, 1995; Watson & Tellegen, 1985).

My literature review is grouped by the type of research design. First, I review correlational research showing how living in proximity or visiting natural environments...
is related to emotional and physical well-being. Second, I present experimental research – both laboratory and field studies (including interventions with clinical populations) – that have shown how contact with nature can positively influence well-being in a causal fashion. Then, I will review several diary studies that track the dynamic co-occurrence between nature and well-being in daily life.

**Correlational studies**

Many cross-sectional studies using questionnaires have shown that there is an association between the availability of green space and emotional well-being. It is well established that the availability of green space is associated with reduced stress (Grahn & Stigsdotter, 2003), lower fatigue (e.g., Korpela et al., 2010; Stigsdotter et al., 2010), and lower noise annoyance (Gidlof-Gunnarsson & Ohrstrom, 2007). For example, using a sample of 953 respondents in nine Swedish cities, Grahn and Stigsdotter (2003) conducted a questionnaire survey to investigate the relationship between the use of green spaces and stress-related complaints (i.e., stress, irritation, and fatigue). They found that both the number of visits and total amount of time spent in urban open green spaces were inversely related to self-reported experiences of stress after controlling for age, sex and socio-economic status. These findings supported their hypothesis that the more frequently individuals visit urban green spaces, the less stress they would experience. In another study using a Danish representative survey ($n = 11,238$), Stigsdotter and colleagues investigated the relationships between the availability of green spaces, health, and stress (Stigsdotter et al., 2010). The results showed that individuals who lived more than 1km
away from a green space tended to experience more stress than individuals who lived less
than 300m from a green space, and those with more stress reported poorer health and
health-related quality of life measured by the 36-Item Short-Form Health Survey; SF-36
(Ware & Sherbourne, 1992), which assesses eight dimensions of health (bodily pain;
general health; mental health; physical functioning; role limitations due to emotional
problems; role limitations due to physical health; social functioning; and vitality). Similar
to the results of their earlier study, the more stressed individuals were, the more
motivated they were to visit green spaces for restoration, and visiting green spaces was
negatively related to stress (measured by Perceived Stress Scale; Cohen, Kamarck, &
Mermelstein, 1983). These results held after controlling for socio-economic and
demographic characteristics.

To examine how the availability of green spaces is associated with noise-related
psychosocial symptoms, Gidlof-Gunnarsson and Ohrstrom conducted a cross-sectional
questionnaire study in Sweden (Gidlof-Gunnarsson & Ohrstrom, 2007). Using a sample
of 500 residents exposed to high road traffic noise exposures (60–68 dB at the most
exposed facade of their home), the authors investigated whether the availability of green
spaces might buffer the residents’ responses to road traffic noise. After controlling for
demographic characteristics, personal attributes, and residential features of the sample,
the results showed that the availability of green spaces was inversely associated with
psychosocial symptoms (“very tired”, “irritated and angry”, and “stressed”) which could
result from noise annoyances. This indicates that the availability of green spaces could
potentially moderate the impact of road traffic noise exposures on psychosocial symptoms.

Correlational research also suggests that the availability of green space has a moderating effect on the relationship between stress and emotional well-being. For example, using a large sample of Finnish people \((n = 1273)\), Korpela and colleagues investigated how visiting favorite places (mostly natural environments) was related to restorative experiences and perceived mental and physical health using a cross sectional design (Korpela et al., 2010). The result showed that favorite places were mostly natural and waterside environments and exercise areas, and the use of these areas was positively related to restoration (relaxation and calmness, attentiveness, and clearing one’s mind). It also showed that the more stressed/worried the individuals were, the more restoration they received from the visit. This result suggests that nature might have a moderating effect on the relationship between stress and negative affect, and a beneficial effect on relaxation and calmness. It is interesting to note that the use of exercise areas was as restorative as the use of natural ones, suggesting that physical activity could confound the effect of nature on emotional outcomes.

In fact, a recent study addressed that very issue of physical activity (Pasanen, Tyrväinen, & Korpela, 2014). Using a large sample of data \((n = 2070)\), Pasanen and colleagues examined the relationship between exposure to nature and perceived general health (a single question; “In general, would you say your health is” with the options “good” (1), “fairly good” (2), “average” (3), “fairly poor” (4) and “poor” (5).) and
emotional well-being (the Emotional Well-Being subscale in the RAND 36-item health survey; Hays, Sherbourne, & Mazel, 1993), controlling for physical activity (Pasanen et al., 2014). The results of regression analyses showed that even when controlling for physical activity, exposure to nature was positively related to the both outcomes over and above the influence of physical activity.

Nature might be important in reducing the influence of life-stress on negative emotion. Wells and Evans tested the hypothesis that the availability of nearby-nature might have a moderating effect on negative affect (Wells & Evans, 2003). Using a sample of children \((n = 337)\) living in rural areas, they demonstrated that living close to nature moderated the relationship between children’s stressful life events and their psychological distress. They found that both the availability of green spaces and stressful life events had significant main effects on distress even after controlling for children’s socioeconomic status, and that green spaces significantly interacted with stressful life events to predict distress. The harmful link between stressful life events and distress was mitigated for children with access to green spaces. This pattern suggests that the availability of green spaces may reduce the impact of stressful life events on negative affect among children.

A recent study also demonstrated this life stress-buffering effect of nature (Van den Berg, Maas, Verheij, & Groenewegen, 2010). Using a representative sample of 4,529 respondents to the Dutch National Survey, Van den Berg and colleagues investigated how the availability of green spaces (calculated by percentages of green space in a 3-km
radius around the home) could moderate the relationship between negative life events and mental/physical health (Van den Berg et al., 2010). Results showed that the availability of green spaces had a significant interaction effect with negative life events on physical health as measured by the number of health complaints in the last 14 days. There was a marginally significant interaction for mental health as measured by the Dutch 12-item version of the General Health Questionnaire (GHQ-12) (Goldberg & Hillier, 1979). These results held even after controlling for socio-economic and demographic characteristics. However, it is interesting to note that the availability of green spaces had no significant main effect on mental and physical health. The result might be due to the specific nature of the questionnaire used in the study, which mainly focused on medical complaints. It would be interesting to use a different measure in future research, possibly a broader one that captures negative affect (NA) or positive affect (PA).

However, there are three limitations of correlational research linking nature to well-being. Firstly, the availability of green spaces does not always reflect the actual usages of those spaces. It might be better to use data based on the actual usages (e.g., time spent in nature). Secondly, the effect of nature on emotional well-being may vary within-individuals as well as between-individuals. For example, one individual’s interactions with nature could fluctuate considerably between days, and the magnitude of the differences within this individual might be larger than the differences between individuals. Moreover, affective states could fluctuate considerably between days, showing within-individual variation. It would be important to know whether the well-
being of an individual varies within that individual depending upon whether they interacted in nature that day or not. Such questions can only be answered using designs that track the same individuals repeatedly over time, as with daily diary designs (see Gunthert & Wenze, 2012). Finally, these correlational studies do not establish the causal relationship between nature and well-being. Longitudinal or experimental studies are needed to address this limitation.

**Experimental studies – Lab experiments**

Various types of laboratory experiments have been conducted and most of them involve having participants view slides or videos of nature scenes and testing the effects on psychological outcomes (e.g., Ulrich et al., 1991; Van den Berg, Koole, & van der Wulp, 2003). For example, Ulrich and colleagues used a laboratory experiment to test the restorative effects of nature images on stress reduction (Ulrich et al., 1991). After having participants ($n = 120$) experience stress by watching a disturbing film, participants were randomly assigned to a condition in which they watched a video clip of six different everyday outdoor settings. Psychophysiological and psychological states were measured throughout the experiment. Results showed that viewing natural images, compared to urban images, was associated with faster cardiovascular recovery from stressful events measured by an electrocardiogram (EKG) and pulse transit time (PTT), as well as better autonomic recovery measured by skin conductance responding (SCR) and frontalis muscle tension (EMG). Participants in the natural image group also showed faster psychological recovery as measured through less fear, anger and aggression (but not
sadness) than the urban image group. These findings suggest that nature had a restorative effect on physiological and psychological arousal.

The results of similar studies have confirmed the validity of the stress reduction theory. For example, Parsons and colleagues tested whether different roadside views (nature or urban) had different effects on stress recovery from mildly induced stressors in the lab (Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998). Participants ($n = 160$) were randomly assigned to watch each one of four simulated videos: driving through forest scenes, alongside golf courses, driving through urban scenes, and alongside mixed roadside scenes, immediately following and preceding mildly induced stressors. Findings demonstrated that participants who viewed the nature-dominated drives (forest, golf, or mixed) experienced quicker cardiovascular recovery from stressful events measured by the inter-beat interval (IBI), diastolic blood pressure (DBP), and systolic blood pressure (SBP) as well as better autonomic recovery measured by skin conductance responding (SCR) and frontalis muscle tension (EMG) than participants who viewed the urban-dominated drive. It is interesting to note that there was no such effect on sadness.

Another lab experimental study showed cognitive benefits of nature (Lee et al., 2015). In their study, participants ($n = 150$) were asked to complete the Sustained Attention to Response Task (Johnson et al., 2008) to assess attentional capacity. Then half of them were randomly assigned to view a city scene with a concrete roof; the other half ($n = 75$) were randomly assigned to view a city scene with a green roof (covered
with grass and flowers). After a brief viewing (40 seconds), participants were again asked to complete the Sustained Attention to Response Task, followed by a questionnaire which assessed their state of restorativeness (combining the four factors: being away, fascination, extent, and compatibility) using the Perceived Restorativeness Scale (Hartig, Korpela, Evans, & Garling, 1997). The results showed that participants who viewed the nature scene felt more restored after the viewing than participants who viewed the city scene. Importantly, the performance of Sustained Attention to Response Task indicated that nature condition was better at sustaining attention capacity compared to city condition. It is interesting to note that even a brief view of urban environments (with a green roof) can give some attentional benefits. The results are encouraging for city planners who try to make their urban environments greener and healthier.

**Experimental studies – Field experiments**

As mentioned previously, one of the earliest field experiments was the classic study by Ulrich who found that hospital patients randomly assigned to a room with a tree view recovered more quickly from surgery than participants assigned to a wall view (Ulrich, 1984). Since then, a range of other creative field experiments have been conducted that suggest exposure to nature outside lab can lead to better well-being compared to urban exposures. For example, in an early test of the emotional effects of nature, Hartig and colleagues tested a field experiment to investigate the effect of nature on self-reported affect and physiological measures of affect (Hartig, Mang, & Evans, 1991). Using a sample of student volunteers ($n = 34$), participants were randomly
assigned to three conditions: a walk in a park area, a walk in a city area, or to sit and relax in an indoor setting. After inducing mental fatigue by having participants undergo mental tasks, each participant completed their walking or sitting assignment. The Zuckerman Inventory of Personal Reactions (Zuckerman, 1977) was administered to assess positive affect, fear arousal, sadness, and anger/aggression before and after the walk/sit. Physiological measures (blood pressure and heart rate) were taken the same way. Results showed lower anger and aggression in the natural walk group than in the other groups. However, fear and sadness showed no significant differences between the groups. An important feature of their study is that they also included measures of happiness and positive affect. In fact, happiness and positive affect were significantly higher for people in the nature walk group after the treatment period compared to participants in the urban walk or indoor relaxation groups. However, the physiological measures (blood pressure and heart rate) also showed no significant differences between the groups. This could have been because all measures were taken 50 minutes after the treatment when any physiological effects had already dissipated. This observation suggests a need to employ ambulatory monitoring during the experiment (or immediately after with little delay) when assessing various physiological measures. It is worthy to note that this study was the first one to introduce positive affect among many other studies which were more focused on stress/negative affect.

The walking paradigm is quite a useful paradigm in the nature literature. For example, one recent field experiment (Bratman et al., 2015) randomly assigned 60 young
adult participants to walk either 50 minutes in a natural environment or 50 minutes in an urban environment. Before and after the walk, participants were asked to answer questionnaires to assess PA/NA (using the Positive and Negative Affect Schedule, PANAS; (Watson, Clark, & Tellegen, 1988; Watson & Tellegen, 1985), anxiety (the State-Trait Anxiety Inventory; Spielberger, 1983), and rumination (the Rumination-Reflection Questionnaire; Trapnell & Campbell, 1999). Participants were also asked to complete the Operation Span Task (Unsworth, Heitz, Schrock, & Engle, 2005) to assess working memory, and the attention network test (Fan, McCandliss, Fossella, Flombaum, & Posner, 2005) to assess executive attention functioning (pre/post walk). The results showed that the nature walk condition yielded significantly improved PA compared to the urban walk condition, which actually showed decreased PA. The nature walk condition also yielded significantly decreased NA, anxiety, and rumination. As for cognitive functioning, participants in the nature walk condition experienced significantly increased working memory compared to participants in the urban walk condition. However, the nature walk condition did not yield better executive attention functioning than the urban walk condition. These results demonstrate the direct effect of nature on some elements of cognition and emotion. Moreover, the results also suggest that cognitive and emotional changes might be interlinked to explain the connection between nature and emotional well-being.

Other field studies have shed light on how cognitive functioning mediates the link between nature and emotional well-being. Hartig and colleagues conducted a field
experiment on 112 university students who were randomly assigned to a 60-minute walk in a natural environment (a natural reserve) or in an urban one (along city streets) (Hartig et al., 2003). Participants were asked to complete the Zuckerman Inventory of Personal Reactions (Zuckerman, 1977) to assess PA, fear arousal, sadness, and anger/aggression before and after the walk. Participants completed the Necker Cube Pattern Control task which measured the capacity of directed attention (Tennessen & Cimprich, 1995) before, during, and after the walk. Using ambulatory blood pressure monitoring, Hartig and colleagues measured participants’ systolic and diastolic blood pressure (SBP; DBP) at frequent intervals. The result showed that PA significantly improved in the nature condition compared to the urban condition (and again, the urban walk actually decreased positive affect). These results also showed that the natural walk condition significantly improved attentional performance during the walk compared to the walk in the urban environment, and this difference was maintained after the walk. The natural walk condition also significantly lowered SBP and DBP immediately after starting the walk, whereas the urban walk initially raised blood pressure. Then, toward the end of walk, the physiological differences gradually narrowed and dissipated. It is interesting to note that the physiological restoration (lower blood pressure) kicked in immediately at the start and dissipated at the end, while the attentional restoration (improved attentional performance) came later and still held after the walk. The results imply that physiological/cognitive restoration might play an important role in the relationship between nature and PA.
Other than cognitive functioning, another field experiment demonstrated that personal feelings toward nature may also play a role between nature and emotional well-being (Capaldi, Dopko, & Zelenski, 2014; Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2009). In a study by Mayer and colleagues (Mayer et al., 2009), seventy-six university students were asked to take a 10 minute walk and observe their surroundings for another 5 minutes either in nature or an urban environment. Following the walk and observation period, they rated their feelings using the 10 item PA measure from the PANAS and the state version of the Connectedness to Nature Scale (CNS) questionnaires (Mayer et al., 2009). Typically, CNS measures an individual’s sense of oneness with nature and sense of affinity with plants/animals; it has two versions (trait and state) (Mayer & Frantz, 2004). The result showed that the state CNS mediated the link between nature (vs. urban condition) and PA. There was no moderating effect (Mayer et al., 2009). Thus, this research showed an indirect effect of nature on PA via CNS. Overall, this research suggests that more studies would benefit from studying indirect effects involving the nature–emotion link; not just nature’s direct effects though nature’s direct effects are still important as one meta-analysis has indicated (Capaldi A et al., 2014).

Some nature interventions have targeted clinical populations. For example, using the framework of attention restoration theory (ART), Gonzalez and colleagues investigated perceived attentional capacity during a nature intervention and the change in depression severity following intervention among clinically depressed individuals (Gonzalez, Hartig, Patil, Martinsen, & Kirkevold, 2010). Moreover, they also examined
whether the change in attentional capacity and depression was mediated by restorative experiences of being away and fascination. Using a convenience sample of clinically depressed individuals \( n = 28 \) with no control group (a single group design), participants engaged in 24 sessions which included ordinary and easy gardening activities in nature. Self-reported measures of the Attentional Function Index (Cimprich, 1993) to assess perceived effectiveness of directed attention (attentional capacity), the Beck Depression Inventory (Beck, 1967) to assess depression severity, and being away/fascination (taken from the Perceived Restorativeness Scale) to assess restorativeness were taken at the start, 4 times during the 12-week intervention, and at the 3-month follow-up. The results showed that depression severity decreased and perceived attentional capacity increased significantly 4 weeks after the start of intervention. The change held throughout the intervention and remained stable at the 3-month follow-up. Similarly, the change of restorative experiences (“being away” and “fascination”) increased significantly at 4 weeks after the start of intervention and held throughout the intervention. However, the change had dissipated at the 3-month follow-up. The study also indicated that depression severity and perceived attentional capacity were mediated by changes in both “being away” and “fascination” whereas depression severity was mediated by perceived attentional capacity. However, this study did not use an objective measure to assess attentional capacity (as other previous studies mentioned above). The limited research design needs to be taken into consideration and a bigger sample size would also be needed. The inclusion of control group could make it easier to clarify the issue of causal pathways.
A similar intervention study, using a sample of breast cancer patients \((n = 157)\), investigated whether a randomly assigned intervention (in which participants asked to expose themselves to a natural environment at least 120 minutes per week) could show the greater recovery of attentional capacity (restoration from mental fatigue) (Cimprich & Ronis, 2003). The Necker Cube Pattern Control task (which measured the capacity of directed attention) was taken at before and after surgery. The results showed that the intervention group showed significantly greater recovery of attentional capacity than the non-intervention group. However, no other outcome measures were tested so it is unclear whether the benefits of attentional capacity would translate into better emotional outcomes or objective cancer outcomes.

These experimental studies are stronger in their designs, and so they are better positioned to test the causal effects of nature and well-being. Overall, the results suggest that nature had some cognitive benefits (e.g., attentional capacity, working memory, etc.) and physiological benefits (e.g., blood pressure, heart rate, etc.) as well as emotional benefits (especially for PA) compared to urban environments. However, research is still lacking in understanding the mechanisms linking nature to emotional well-being. Moreover, most of the experimental studies are done over a very short time period either in the lab or in the field, both typically using between-person designs (the study of Gonzalez and colleagues (2010) is an exception- this is the gardening study). It would be interesting to know if the benefits of nature could be tracked over time using within-
person designs, such as daily diary research. Applying within-person designs could give researchers a deeper understanding of the nature–emotion mechanisms.

**Diary studies**

The benefits of nature have been tested in some daily diary research which track people’s experiences of nature and psychological outcomes over time in daily life (e.g., Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagné, 2010). These within-person designs have better ecological validity over laboratory experiments (which use artificial stimuli) that may not reflect the actual everyday experience of nature accurately. There are three studies to my knowledge using a daily diary method or experience sampling method to test the benefits of nature experiences. They have demonstrated that daily nature experiences are related to more daily subjective vitality, awareness, and lower systolic blood pressure (e.g., MacKerron & Mourato, 2013; Orsega-Smith, Mowen, Payne, & Godbey, 2004; Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagne, 2010).

From the leisure literature, Orsega-Smith and colleagues investigated the relationship between park-based leisure activities and health (Orsega-Smith et al., 2004). For five consecutive days using a paper diary method with interval contingent recording, participants \((n = 100)\) were provided with a blood pressure cuff and asked to record their blood pressure at various times (upon waking, just before lunch/dinner/going to bed, and before/after leisure activities). They were also asked to report their subjective stress levels and to measure their body mass index (BMI) at the end of each day. Researchers also measured the participants’ park-based leisure activities (the number of visits, time
spent, activity level, and social interactions in the past 12 months) as well as their overall physical/mental health using the Rand Medical Outcomes Study Health Survey (MOS SF-20; McDowell & Newell, 1996). The results showed that highly stressed individuals who engaged park activities with a companion had significantly lower BMI than stressed individuals without a companion. There was no relationship between average park-based leisure activities and average daily stress, but there was a relationship between average park-based leisure activities and average blood pressure/physical health (but not mental health). Because the data were aggregated, the study did not take full advantage of the within-person data. Application of statistical techniques like multilevel modeling can address this issue. It is also possible that nature’s effects (within these leisure activities) might become more salient by controlling for physical activities.

Another micro-longitudinal study took advantage of their within-person design to understand the link between nature and another element of emotional well-being called “vitality” (Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagne, 2010). Young adult participants \( n = 51 \) underwent an experience sampling procedure for 4 consecutive days (Csikszentmihalyi & Larson, 1987) during which they were paged six times between the hours of 10 am and 10 pm at random intervals to report whether they had done certain activities. Specifically, they answered questions (with yes or no) to assess whether they had spent time in social interactions and doing outdoor physical activities, both lasting at least 20 minutes. Participants were also asked to complete an online survey at the end of each day indicating whether their outdoor environments that day included natural
elements (e.g., trees, plants, flowers, grass), and to report their current feelings of vitality using the Subjective Vitality Scale (Ryan & Frederick, 1997). For statistical analysis, hierarchical linear modeling (HLM) was used to model within-person patterns with nested data (i.e., multiple observations per person; Nezlek, 2012). The results showed that on days with at least 20 minutes spent outdoors and in nature, individuals experienced a greater sense of vitality at the end of day. Additional analyses indicated that nature mediated the relationship between outdoor settings and vitality; the relationship between outdoor settings and vitality was no longer present after controlling for nature. The results imply that being in nature, not just being outdoors, is crucial to vitality. Moreover, this study is one of the few studies to link nature to positive aspects of emotion. However, the study did not include a corresponding measure of negative emotion, so it’s hard to isolate any effects of PA from NA. Emotional well-being can be better understood including NA in addition to PA (vitality in this case). It is yet to be seen whether the same results can be obtained with the inclusion of NA.

It is interesting to note that some studies have started to take advantage of newly developed mobile technology. For example, one recent study applying a within-person design of nearly 22,000 UK residents, examined how people experienced momentary happiness when they were near nature (MacKerron & Mourato, 2013). In their seminal study, MacKerron and Mourato used Mappiness technology, which can track the state of happiness over a period of time. Using the Mappiness application for iPhones, participants’ proximity to natural environments was identified with the help of GPS
location features, and at the same time, participants were asked to indicate how happy they were feeling at random moments twice a day between 8am and 22pm. The data of participants’ responses were collected over six months. The results showed that proximity to natural environments was positively associated with happiness; people felt happier the closer they were to natural environments, and they felt less happy the further they were to natural environments. Their use of emerging mobile technology with smartphones is impressive and economical. By using participants’ own smartphones, researchers were able to collect data from more than 20,000 people, without providing equipment. This approach can also reduce the burden to participants by letting them use their own devices that they are familiar with (easy-to-operate). However, the exclusion of NA from the Mappiness application may limit the full understanding of the nature’s effects on emotional well-being.

In summary, intensive longitudinal designs like daily diaries and experience sampling provide a unique set of tools for investigating the nature–well-being relationship. With the advancement of newly emerging technology utilizing participants’ own smartphones (e.g., De Vos, Gandras, & Debener, 2014; MacKerron & Mourato, 2013), these designs are becoming easier to conduct than ever before. The inclusion of within-person designs can also provide a richer dataset of information to understand nature’s effect on well-being. Therefore, this thesis will incorporate features of diary studies into the programme of research.
Limitations and Gaps in the Literature

From this literature review, some benefits of nature are well understood. For example, the cognitive literature has consistently demonstrated that nature can restore attentional capacity (e.g., Bratman et al., 2015; Lee et al., 2015). These results support attention restoration theory (ART), which posits that nature can restore attention required in completing everyday tasks.

The emotional benefits of nature are not entirely consistent, however. Some studies find that nature has a main effect on reducing stress (e.g., Grahn & Stigsdotter, 2003; Parsons et al., 1998); while others show a stress buffering effect (e.g., Van den Berg, Maas, Verheij, & Groenewegen, 2010) with a few exceptions (e.g., Orsega-Smith et al., 2004). In fact, while most of the research has focused on the negative aspects of emotional functioning, there are plenty of inconsistent findings with respect to these states. For example, many previous studies failed to detect the nature’s effect on depression/sadness (e.g., Hartig et al., 2003; Hartig et al., 1991; Herzog & Strevey, 2008; Korpela & Ylen, 2009; Korpela et al., 2010) whereas other studies have found effects (e.g., Bratman, Hamilton, & Daily, 2012; Wells & Evans, 2003). These inconsistent results for negative affect (especially on depression/sadness) might be due to an exclusive focus on nature’s direct effect on these outcomes. One possibility is that nature might have some influence on negative aspects of emotion not directly, but via indirect effects. An indirect effect is defined as the product of the independent variable to mediation path and the mediation path to dependent variable path, and is expressed by all possible effects.
of independent variable on dependent through intervening (mediation) variables. For example, one previous study already demonstrated an indirect effect of fascination on nature and depression (i.e., fascination mediated the link between nature/depression) (Gonzalez et al., 2010).

Relatively less research has tested the relationship between nature and the positive aspects of emotional functioning. However, among these few studies including measures of positive functioning, they consistently find that nature is linked to improved PA (e.g., Bratman et al., 2015; Hartig et al., 2003; Hartig et al., 1991), vitality (Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagné, 2010), and happiness (MacKerron & Mourato, 2013). This could suggest that nature has differentially stronger effects on positive psychological functioning and relatively weaker effects on negative functioning; however, few studies have tested both NA and PA together in the same study to directly compare the two. Therefore, all studies in the present thesis use both PA and NA. If nature has a stronger effect on PA, and a weaker or inconsistent effect on NA, this could suggest that the existence of important intermediate agents from nature; these intermediate agents might be exclusively associated with PA.

The mechanisms linking nature to various indicators of emotional well-being is still not understood. One thing is clear – nature affects cognition via attention restoration via heightened “fascination” in natural environments. Given that fascination is a key factor in attention restoration theory (Kaplan & Kaplan, 1989; Kaplan, 1995), fascination might be a good starting point for exploring mechanisms linking nature to well-being.
Perceived fascination was shown to mediate between nature and depression (Gonzalez et al., 2010). Perceived fascination is also known to indicate objectively measured attention restoration (Berto, 2005; Berto et al., 2010) making this a good measure for use in repeated surveys, such as daily diary designs. Objective cognitive tasks are challenging to do in the field and could paradoxically lead to reductions in cognitive resources if participants were asked to do these tasks repeatedly as with diary studies.

Lastly, there are still relatively few studies that track the naturalistic relationship between nature and well-being on a daily basis. Daily diary studies are ideally suited to capturing the fluctuating effects of environments and emotions at the within-person level (Conner, Barrett, Tugade, & Tennen, 2007; see also Mehl & Conner, 2012). By incorporating these designs into the nature and well-being literature, my thesis aims to better understand the dynamic within-person relationship between nature and well-being as it is experienced in daily life.

With these limitations in mind, the present thesis tried to fill several gaps in the literature by using a multi-method approach incorporating correlational, field experiments, and daily diary methods to investigate the causal link between nature and emotional well-being (PA and NA simultaneously) and to identify other mechanisms (i.e., mediators) that might account for this link. Given the consistency of findings in support of attention restoration theory (ART), and the known importance of fascination in evoking attention restoration, my first aim was to test the possibility that fascination acts as a potential
mediator between nature and PA/NA. Subsequent studies investigated other potential mediators that might play a similar role in the link between the nature and PA/NA.
3. CHAPTER 3: STUDY 1. FASCINATION IN NATURE (1)

Introduction

A majority of studies testing the nature and well-being relationship have been cross-sectional in their designs, showing that people who have greater exposure to natural environments also report greater well-being, as measured by a variety of markers (e.g., perceived general health and symptom - de Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; perceived mental health - Sugiyama, Leslie, Giles-Corti, & Owen, 2008; depression - Wells & Evans, 2003). Fewer studies have examined how exposure to nature in daily life is related to well-being on a day-to-day basis. The goal of Study 1 was to employ a micro-longitudinal daily diary design to understand the role of nature experiences and well-being on a daily basis. Although still correlational in design, this approach afforded the opportunity to track experiences of nature and well-being in ‘near to real-time’ to determine how well-being varies depending on whether a person experienced any nature that day.

Of the few studies that have tracked nature and well-being on a day-to-day basis, they generally show that being in nature corresponds with increased positive affect (PA). For example, a recent study of nearly 22,000 UK residents showed that people reported greater momentary happiness when they were near nature versus not (MacKerron & Mourato, 2013). Happiness was tracked over a period of time using the Mappiness

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1 It is noted that this chapter was a revised and updated version of the article: Sato, I. & Conner, T. S. (2013). The quality of time in nature: How fascination explains and enhances the relationship between nature experiences and daily affect. *Ecopsychology*, 5(3), 197-204.
iPhone application, which was analyzed with GPS location features to show co-variation between happiness and proximity to natural environments (parks, greenbelts, etc.).

Similarly, Ryan and colleagues investigated the effects of being in nature on ‘subjective vitality’ using a 14-day daily diary procedure (Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagne, 2010). Analysis of within-person patterns showed that time in nature predicted greater increases in daily vitality even after controlling for outdoor activities, social interactions, and weekday/weekend effects. Another study of 25 American adults also found that daily nature experiences in a national forest were associated with excitement and satisfaction (Hull & Stewart, 1995).

Relatively less is known about links between nature and daily negative affect (NA). One study examined daily stress levels in a sample of 100 older adults and found no associations with daily stress and the frequency of park visits measured retrospectively across the year (Orsega-Smith et al., 2004). However, that study did not measure the covariation between nature and negativity on a day-to-day basis. Therefore, a goal of the current study is to examine the relationship between nature and both PA and NA.

Although, contact with, or simply spending time in, nature (quantity of nature experiences) may benefit daily well-being, it might be helpful to understand what quality of nature experiences may actualize or potentially maximize the benefit of nature to well-being. According to the Attention Restoration Theory (ART; Kaplan & Kaplan, 1989; Kaplan, 1995), nature affords certain qualities that help restore attentional resources and relieve mental fatigue, leading to improvements in mood. One important quality that may
mediate the psychological benefits of nature is the degree of ‘fascination’ present in natural scenery that one experiences (Kaplan & Kaplan, 1989). Fascination is the quality of a stimulus being highly appealing and visually interesting. Because of this visual interest, the stimulus draws attention to itself effortlessly which, in turn, allows restoration of diminished psychological resources. According to the ART, fascinating qualities found in nature (vis-à-vis trees, rocks, landscapes, flowing rivers, etc.) allows people to rest their mental focus and process their surroundings in more involuntary ways (which uses fewer cognitive resources) (Kaplan & Kaplan, 1989) (which uses fewer cognitive resources). Although, built environments like museums can be fascinating and restorative (Packer, 2008), natural environments seem to evoke this quality particularly well (Purcell, Peron, & Berto, 2001; Ulrich et al., 1991). Therefore, Study 1 will investigate not only how contact with nature may be associated with daily well-being (i.e., higher PA and lower NA), but also whether perceived fascination in nature mediates the link between contact with nature and well-being, and possibly moderates (i.e., enhances) the beneficial effects of nature on well-being.

The study also examined gender differences in the effects of daily nature experiences on well-being. Evolutionary theories suggest that men and women may direct their attention differently within nature. Some theorists have proposed that in Paleolithic times, women (gatherers) tended to focus more on proximal features, whereas men (hunters) tended to focus more on distal objects and horizons (MacKerron & Mourato, 2013). Therefore it is possible that women, by focusing more on nearby features in nature
(e.g., trees, greenery) could extract more benefit from nature. However, a study about how men and women attend to natural features suggests that men and women may direct attention in nature fairly similarly (Hull & Stewart, 1995). Using a photoelicitation approach, in which people took pictures of what they were focusing on during a nature hike, there were more gender commonalities than differences. In fact, the main gender difference was that men paid more attention to the ground and other “topographical” features than women. Therefore Study 1 tested but made no predictions about the role of gender in the nature and well-being relationship. Previous research found no evidence for gender differences in the link between nature and positive affect (vitality) (e.g., Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagné, 2010), but research has not yet tested whether gender moderates the link between nature and NA.

**Overview**

The goal of the study was to examine whether time in nature and the quality of nature experiences (e.g., the degree of fascination in nature) were associated with within-person changes in PA and NA across a 13-day period. An Internet based daily diary procedure was used in which participants reported their daily experiences of PA and NA along with the amount of time spent in nature and fascination experienced within nature each day. I hypothesized that daily nature experiences would be associated with increased PA and, to a lesser extent, decreased NA. I also hypothesized that higher levels of fascination in nature would mediate and possibly moderate the link between contact with
nature and daily affective experiences. I examined gender differences in these pathways as well.

I also controlled for weekday/weekend effects in most statistical analyses (except for descriptive statistics and between-person correlations). Weekends are strongly related with higher PA and lower NA (e.g., Ryan, Bernstein, & Brown, 2010; Stone, Schneider, & Harter, 2012). Weekends also typically afford more opportunities to engage in nature compared to weekdays (Scopelliti & Giuliani, 2004). This difference can be a confounding factor – if people feel better on weekends and are in nature on weekends, the relationship between feelings and nature may simply be spurious (Liu & West, 2015).

Thus, following previous research by Ryan and colleagues (Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagne, 2010), I controlled for weekday/weekend effects.

Method

Participants

The sample consisted of 319 young adults (122 males and 197 females) with a mean age of 19 ($SD = 1.486$; range 17 – 25). Participants were part- or full-time students at the University of Otago, New Zealand. Their self-identified ethnicity was mostly European (n = 261; 81.8 %), followed by Asian (n = 27; 8.4 %), Indian (n = 10; 3.1 %), Māori or Pacific Islander (n = 8; 2.5 %), Middle Eastern (n = 4; 1.2 %), mixed ethnicity (n = 4; 1.2 %), or other ethnicity (n = 5; 1.5 %). An additional six participants started the study but were not included in the 319 analyses (2 = withdrawn due to technical difficulties; 4 did not complete the minimum 7 of 13 daily dairies). Participants were
recruited for a study of the “daily experiences of university students” as part of the larger Daily Life Study conducted in 2012.

**Setting**

Dunedin is the second-largest city in the South Island of New Zealand. Dunedin’s population is approximately 120,000 people. There are botanical gardens, beaches, and local hiking trails close to the University. The urban settings have several shopping malls and business areas which are concentrated in the downtown district as well as in the student quarter. The climate of Dunedin is cool and temperate. Data were collected during the fall season and early winter season (April – early June 2012) in which temperatures ranged from 0 – 21 degrees Celsius (32 – 69.8 degrees Fahrenheit).

**Measures**

The following measures were included in a larger 90-item daily diary survey that took approximately 10 minutes to complete. The other measures in the diary assessed a range of common daily experiences including physical activity and health.

*Daily time spent in nature.* Each day, participants were asked to report how long they spent in various green spaces (e.g., parks, gardens) that day. The wording of the item was “Have you visited or been in any green spaces today (e.g., parks, gardens)? This includes times intentionally or unintentionally spent in green spaces, such as going tramping, sitting on a sunny bench in the park, or walking through the gardens on the way to university. If you spent time in green spaces today, please indicate how long the visit was. Duration of the visit: ______ hour ______ minutes.” The hours were
multiplied by 60 and added to the minutes for a measure of daily time in nature (in minutes). To better understand the context of the visit, participants were asked, “What type(s) of green space(s) did you visit? Please describe.”

*Fascination.* To measure the fascination with nature, I used two items from the Perceived Restorativeness Scale (PRS) (Hartig, Korpela, Evans, & Gärling, 1997). The full PRS consists of 16 items designed to measure the four dimensions of nature restorativeness: being away, fascination, coherence, and compatibility. To reduce participant burden, we selected the two fascination items out of seven that loaded most highly on the fascination index (“That place had fascinating qualities.” and “My attention was drawn to many interesting things.”). Participants used a 7-point scale to indicate the extent to which the given statement described their experience in nature that day (0 = *not at all*, 6 = *completely*). Each participant’s responses to the fascination items were averaged for a measure of daily fascination. If they did not spend time in nature that day, responses to the fascination items were coded as 0.

*Daily positive and negative affect.* Participant’s daily emotional experiences were measured using an 18-item checklist that captured daily positive and negative affect (Barrett & Russell, 1998). The items for positive affect (PA) were: *excited, energetic, enthusiastic, happy, cheerful, pleased, calm, content, relaxed.* The items for negative affect (NA) were *irritable, hostile, angry, nervous, anxious, tense, dejected, sad, unhappy.* These items captured a range of high to low intensities of affect. Participants were asked to rate how they felt “that day” on each of the 18 items using a 5-point Likert
scale (1 = not at all, 5 = extremely). Responses to the nine positive affect and the nine negative affect items were averaged separately each day for a measure of daily positive affect (PA, $\alpha = 0.818$) and daily negative affect (NA, $\alpha = 0.783$); multilevel reliability procedures based on J. Nezlek (2012).

**Procedure**

Participants attended an initial briefing session in groups of two to five where they were briefed on the study aims and procedures, including the daily diary portion of the study. After the initial briefing, participants completed an initial survey on the computer which included demographic information as well as other questionnaires not relevant to the present study. The next day, participants began the daily diary procedure. For 13 days, participants completed a daily survey between 3 and 8 pm each evening by accessing a secure password protected website. Participants were sent nightly email reminders at 5 pm and nightly reminder texts at 7 pm. The survey took 5 to 10 minutes to complete. On average, participants completed 11 out of 13 diaries (91% completion rate). On the 14th day, participants attended a debriefing session and were reimbursed for their participation.
Results

Descriptive Statistics

Table 3.1 shows the average time spent in nature (in minutes), as well as scores on the fascination index, and daily positive and negative affect scales. On average, participants spent approximately 15 minutes per day in nature, with some participants spending no time in nature and others spending on average three hours in nature (due to weekend visits to parks and gardens). Regarding the types of nature visits, 29% of visits were to gardens (302 visits of total 1057), 22% were to parks (302 visits), 2% were to forests (16 visits), and 39% were classified as “other” (e.g., football field, 442 visits), and 3% did not say. Of all the places visited, the majorities of visits were green-space related nature (52%). Also shown in Table 3.1, when participants were in nature, they reported on average low to moderate levels of fascination, with some participants reporting no fascination and other participants reporting very high fascination. PA was greater than NA.

There were some gender differences. Men spent on average 18 minutes per day in nature, compared to 13 minutes per day for women, although this difference was only a trend, \( t(317) = 1.690, p = .093 \) (unequal variances). Men also reported greater daily PA \( (M = 2.88) \) than women \( (M = 2.72) \), \( t(317) = 2.565, p = .011 \) (unequal variances). Men and women reported similar levels of fascination \( (\text{men } M = 2.76; \text{women } M = 2.51) \), \( t(268) = 1.269, p = .206 \) unequal variances) and NA \( (\text{men } M = 1.65; \text{women } M = 1.71) \), \( t(317) = 1.065, p = .288 \) (unequal variances).
Table 3.1. Descriptive Statistics among Day-level (Aggregate) Variables

<table>
<thead>
<tr>
<th>Daily Measures</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent in nature</td>
<td>14.74</td>
<td>21.13</td>
<td>0.00</td>
<td>170.60</td>
</tr>
<tr>
<td>Fascination</td>
<td>2.61</td>
<td>1.67</td>
<td>0.00</td>
<td>6.00</td>
</tr>
<tr>
<td>Positive affect (PA)</td>
<td>2.98</td>
<td>0.50</td>
<td>1.53</td>
<td>4.74</td>
</tr>
<tr>
<td>Negative affect (NA)</td>
<td>1.69</td>
<td>0.47</td>
<td>1.03</td>
<td>3.71</td>
</tr>
</tbody>
</table>

Note. N = 319. Time spent in nature = Average minutes spent in green spaces each day. Fascination = Average fascination experienced in green spaces.

Table 3.2. Correlations among Day-level (Aggregate) Variables

<table>
<thead>
<tr>
<th></th>
<th>Fascination</th>
<th>Positive Affect</th>
<th>Negative Affect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily Time in Nature</td>
<td>.120 *</td>
<td>.149**</td>
<td>.126*</td>
</tr>
<tr>
<td>Average Fascination</td>
<td>-</td>
<td>.187**</td>
<td>-.051</td>
</tr>
<tr>
<td>Average Daily PA</td>
<td>-</td>
<td>-</td>
<td>-.344**</td>
</tr>
<tr>
<td>Average Daily NA</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: *p < .05; **p < .01

Table 3.2 shows the correlations among the aggregated daily measures across all participants for the two weeks (between-person correlations). Average daily time spent in nature was positively associated with all three other variables – fascination, PA, and NA. Participants who spent more time in nature across those 13 days reported experiencing more fascination in nature and they also reported higher average PA compared to
participants who spent less time in nature. Interestingly, participants who spent more time in nature also reported higher levels of NA. However, when testing men and women separately, only men showed these relationships between average time in nature and average PA and NA. For men, average time in nature was correlated significantly with higher average PA ($r = 0.181, p = 0.046$) and higher average NA ($r = 0.193, p = 0.033$). Thus it appears that men who spent more in nature had, on average, greater emotional intensity, both positive and negative. For women, time in nature did not correlate with either PA ($r = 0.086, p = .227$) or NA ($r = 0.060, p = .404$) at the between-person level. However, these analyses reflect aggregated variables across all 13-days, and do not reveal how nature and affect were related to each other on a day-to-day basis. For that, I turn to the within-person analyses.

**Within-Person Analyses**

The Hierarchical Linear Modelling (HLM) software program version 6.08 (Raudenbush, Bryk, & Congdon, 2009) was used to model within-person associations between daily time in nature and PA/NA. HLM is a software program for running multilevel random coefficient modeling (MRCM) which accommodates the specialised data structure with repeated daily observations nested within individuals.

First, HLM was used to determine the within-person relationship between daily time in nature as the level-1 predictor, and daily PA (or NA) as the level-1 outcome. This model enabled me to determine how daily time in nature and PA or NA covaried within a given individual over time. The equations were as follows:
Level 1 (Day-level):
\[ PA_{ij} = \beta_{0j} + \beta_{1j} \text{(Time in nature)} + \beta_{2j} \text{ (Weekend effect)} + r_{ij} \]

Level 2 (Person-level):
\[ \beta_{0j} = \gamma_{00} + u_{0j} \]
\[ \beta_{1j} = \gamma_{10} + u_{1j} \]
\[ \beta_{2j} = \gamma_{20} + u_{2j} \]

At level-1, time in nature was used to predict change in daily PA as the outcome variable. Time in nature was person centred (i.e., group mean centred) to model changes around each person’s own average time in nature (i.e., to test whether participants felt better when they spent more time in nature than they usually did). A weekend effect variable was entered as a control variable (0 for weekdays Mon-Fri; 1 for weekend Sat-Sun). No predictors were included at level-2 in these initial analyses. A significant \( \gamma_{10} \) would indicate that there was a significant relationship between time in nature and daily PA. A separate analysis was run with NA as the level-1 outcome variable.

Results from these analyses showed that daily time spent in nature significantly predicted higher daily PA, \( \gamma = 0.002, t(318) = 8.256, p < 0.01 \), but not less NA, \( \gamma = -0.0004, t(318) = -1.628, p = 0.104 \). On days in which participants spent more time in nature, they felt more positive than they normally did. However, time spent in nature was not related to how negative participants felt on a day-to-day basis.
Next, gender (0 = men, 1 = women) was added as a level-2 predictor to test whether men and women varied in their relationships between daily nature experiences and PA/NA. Gender did not moderate the relationship between nature and PA, $\gamma = -0.001$, $t(317) = -1.920$, $p = 0.055$. Thus, for both men and women, daily time spent in nature significantly predicted higher daily PA. However, gender moderated the relationship between nature and NA, $\gamma = 0.001$, $t(317) = 2.267$, $p = 0.024$. Women felt less negative on days when they spent more time in nature, $\gamma = -0.001$, $t(317) = -2.615$, $p = 0.01$, whereas men showed no relationship between NA and nature experiences, $\gamma = 0.0001$, $t(317) = 0.422$, $p = 0.673$. In summary, while time in nature significantly predicted higher PA for both men and women, it only predicted lower NA among women.

**Mediation analyses – Does fascination account for the relationship between nature experiences and daily affect?**

In this next set of analyses, I tested whether fascination mediated the within-person relationships between daily nature experiences and daily affect. I followed three steps using the procedure recommended by Card (2012) and Jose (2013): Step 1- use time in nature to predict affect; Step 2 - use time in nature to predict fascination; Step 3 – use fascination to predict affect while controlling for time in nature. Results showed that fascination partially mediated the relationship between daily nature experiences and PA for the sample as a whole (Sobel test = 6.289, $p < 0.01$). Step 1 path was significant ($\gamma = 0.002$). Step 2 path was significant ($\gamma = 0.055949$). And Step 3 path was significant ($\gamma = 0.017938$); however, significant variance still remained ($\gamma = 0.00115$). These patterns of
partial mediation were similar when testing women and men separately. Thus, for both men and women, their experiences of fascination in nature partially explained the associations between nature and PA (see Figure 3.1).

Figure 3.1. The mediational model showing how daily time spent in nature might lead to increased PA for all participants. Bolded coefficients were statistically significant ($p < .05$)

Next, I tested whether fascination mediated the within-person relationship between daily nature experiences and NA found for women only. Here, fascination fully mediated the relationship between time in nature and NA (see Figure 3.2). Results for women showed that fascination completely mediated the relationship between daily nature experiences and NA (Sobel test = -2.5099, $p < 0.01$). Step 1 path was significant ($\gamma = -0.000965$). Step 2 path was significant ($\gamma = 0.055949$). And Step 3 path was
significant ($\gamma = -0.025947$), with no significant remaining variance ($\gamma = -0.000319$).

This pattern for NA suggests that fascination in nature may play a key role in the process between exposures to nature and reduced NA among women.
Figure 3.2. The mediational model showing how daily time spent in nature might lead to decreased NA among women. Bolded coefficients were statistically significant (p < .05).

**Moderation analyses – Does fascination enhance the relationship between nature experiences and daily affect?**

Lastly, I tested whether fascination enhanced the relationship between nature and daily PA and NA. The level-1 equation included the following predictors: time in nature (group-centered), fascination (group-centered), their cross-product interaction term (computed on group-centered variables), and the weekend effect variable as a control variable. All four variables were used to predict daily PA (or NA). Results showed that fascination significantly enhanced the relationship between daily spent time in nature and PA, $\gamma = 0.0003, t(318) = 2.381, p < 0.05$, but not NA, $\gamma = -0.0001, t(318) = -1.124, p =$
0.263. This relationship is shown in Figure 3.4. As shown by the top line, when individuals reported more fascination in nature, they showed more enhanced PA compared to when they reported less fascination in nature. Unlike the findings for mediation, there were no gender differences in fascination as a moderator. Both men and women showed similar levels of enhancement in PA through fascinating nature experiences.

![Graph showing the relationship between time in nature and daily PA as a function of fascination.](image)

Figure 3.3. Relationship between time in nature and daily PA as a function of fascination. High and low fascination were defined as one standard deviation from the mean.
Discussion

Consistent with previous diary and experience sampling studies (Hull & Stewart, 1995; Orsega-Smith et al., 2004; Ryan et al., 2010), time in nature was associated with significant increases in daily PA among our young adult sample. Moreover, the restorative nature experiences (i.e., fascination) both partially accounted for this link between nature and PA and further enhanced the beneficial effects of nature on PA. These findings support the theory that fascination makes an important influence to PA. This link between nature and PA is important given that PA is perhaps the most significant ingredient in well-being – it can broaden attention capability and have beneficial effects on health, perhaps even more so than NA (Barton & Pretty, 2010).

I found that fascination not only acted as a partial mediator, but also as an enhancer (moderator) of PA. People felt better on days in which they reported experiencing more versus less fascination in nature. This finding is consistent with the interpretation that experiencing fascination within natural environments may lead to greater well-being, more than simply experiencing nature without fascination. What factors drive the experience of fascination? While fascination is certainly afforded by interesting visual stimuli in the natural environment, fascination also likely depends on the state of the person – whether they are in a frame of mind ‘to be fascinated.’ One possibility is that being in a positive mood may itself foster greater fascination within natural environments. Positive mood states are known to broaden rather than narrow attention (Fredrickson, 2001). While I favor the interpretation that PA follows from
experiencing greater fascination in nature, this correlational study design does not rule out the possibility that fascination follows from PA. It is entirely plausible that people in a happier mood who visit nature are in a better frame of mind to be fascinated. Another possibility is that people are better able to be fascinated when they have the leisure to do so. It may be that our fascination items are not tapping a cognitive state at all, but rather reflecting a wider meaning of their time in nature – whether they are ‘at play’ or not. I do not think this is the case. We measured two other items tapping a related construct called ‘Being Away’ from the Perceived Restorativeness Scale (“Being [in nature] was an escape experience” and “Spending time [in nature] gave me a break from my day-to-day routine”). Unlike fascination, these two measures did not enhance the relationship between nature and PA, although they did partially mediate the relationship between nature and PA and, unlike fascination, there was no meditational effect on NA for women. So while experiencing nature as an escape from the day-to-day routine accounted for some of the relationship between nature and PA, it did not enhance the beneficial effects of nature on PA, nor did it explain the relationship between nature and NA for women. This finding indicates that being away and fascination are different constructs, and that fascination may play a more important role in the nature-experience relationship.

Time in nature was also associated with improvements in daily NA for women only. I believe this study is the first to test for and show such gender differences in the links between nature and daily NA. I can only speculate on why this gender difference occurred. It is known that women are more likely to have mild forms of anxiety and
depression (Kendler, Gardner, Gatz, & Pedersen, 2007; Nolen-Hoeksema, Larson, & 
Grayson, 1999). In this sample, women reported lower PA than men. It may be that 
nature is particularly beneficial for women because of their poorer mood. However, there 
are many other factors that covary with gender that could be driving those differences. 
Regardless of the cause, our findings suggest that women’s negative mood may 
especially benefit from nature-style interventions. Replication and further study will be 
needed to clarify this. Moreover, this relationship between time in nature and reduced NA 
for women was completely mediated by the degree of fascination in nature. This finding 
further highlights the importance of experiencing certain qualities in nature – and 
provides support that fascination may be especially beneficial for reducing NA among 
women.

There were both strengths and limitations of this study. Strengths included the 
large sample size of over 300 participants, the micro-longitudinal study design across 13 
days that enabled within-person analyses, inclusion of both positive and negative affect to 
test their unique links to nature experiences, and testing for gender differences which 
showed that gender may play a role in the nature and well-being relationship. 
Limitations included the correlational design which limits establishment of causal 
relationships between nature, fascination, and daily affect.

In conclusion, these results provided support for the within-person link between 
nature and PA, and further showed that fascinating nature experiences can play an 
important role in mediating the nature well-being link. While simply spending time in
nature may be an important first step to greater well-being, my results suggest how one pays attention in those natural environments may be a key mechanism in that process and may further enhance (or impede) the beneficial effects of nature. This finding could suggest that people might cultivate a sense of fascination and wonder when they are in natural environments to gain the most benefit from nature. In the chapters that follow, I attempt to replicate these findings. Doing so could establish fascination as the default player which explains how nature influences emotion.
4. CHAPTER 4: STUDY 2. FASCINATION IN NATURE (2)

Introduction

Study 1 showed that nature was related to within-person increases in positive affect (PA) among both men and women and that fascination played a partial mediating role in the nature-PA link. Study 1 also showed that nature was related to decreases in NA, but only for women. Although Study 1 showed that there was dynamic co-variation between nature and well-being on a day-to-day basis, one of the limitations of Study 1 was the correlational research design, which limited drawing causal conclusions about the benefits of nature. Therefore, the primary aim of Study 2 was to investigate the causal relationship between nature and well-being (PA/NA) using an experimental field design. Accordingly, in Study 2, I manipulated the setting by randomly assigning people to walk for 30 minutes in a nature setting versus an urban setting and testing the effects on PA and NA and self-reported fascination. Additionally, I tried to replicate the results of Study 1; this time I tried to establish fascination as a potential mediator in an experimental fashion. A secondary aim of Study 2 was to explore the possibility of manipulating fascination in order to isolate the causal role of fascination on changes in well-being, and also to examine the possibility of enhancing the effects of the nature intervention on PA and NA. Not only did I measure fascination after the walk, but I also tried to manipulate fascination in a 2 x 2 design (with nature/urban, and fascination/ no fascination manipulation) to determine whether a fascination manipulation could further drive changes in well-being or enhance the benefits of visiting nature on the well-being outcomes. In this study, I tried to enhance fascinating experiences by instructing
participants to actively seek out and take pictures of fascinating visual stimuli in nature. In this way, I used picture taking as a way of focusing and enhancing participants’ attention to fascinating stimuli (following; Heyman, 2012). This process should work because fascinating stimuli are abundant in natural environments (Berto, 2005; Kaplan & Kaplan, 1989) – directing attention to those stimuli should be relatively easy. By continuously seeking out fascinating stimuli in nature and taking pictures each time fascinating stimuli are found, this study will attempt to enhance the effect of nature on well-being. As a control group, I compared the fascination induction to participants who simply were asked to take pictures at equal intervals.

To the author’s knowledge, no study has investigated the possibility of a “fascination intervention” whereby participants are instructed to intentionally seek fascinating experiences in their environments instead of just walking around without such intention. As the results of Study 1 showed, fascination might play an important role in the link between nature and PA. It will be interesting to see if fascination can be manipulated intentionally to test its direct causal effects on well-being. If fascination can be manipulated, this may provide a pathway for enhancing nature’s effect on PA.

Method

Participants

The sample consisted of 80 young adults (39 males and 41 females) with a mean age of 19 (SD = 2.916; range 18 – 34). Participants were students at Otago University, recruited for the “Dunedin Walking Study” conducted in 2013. Besides age/gender, other
information (e.g., ethnicity, etc.) was not asked in order to reduce the participants’ burden. Participants were remunerated with either 1 course credit or 10 dollars.

**Setting and Timing**

The data were collected during the late spring season and early summer season (mid-September – early November 2013) in Dunedin, NZ. Two locations were chosen. The nature location was the Dunedin Botanic Garden. Participants were asked to walk freely in the garden. The urban location was the central city shopping area. Participants were asked to walk along the main street in the business/shopping district.

**Procedure**

Each participant individually attended an initial briefing session at a chosen field site where they were briefed on the study procedures, and then given the specific instruction for their randomly-assigned condition. Participants in the nature condition met at the gate of the botanic garden and were instructed to take a 30 minute walk in the botanic garden. Participants in the urban condition met the researcher outside of a local city museum and were instructed to take a 30-min walk in an adjacent urban environment. Within these conditions, half of the participants were further assigned to a ‘fascination’ condition whereas the remaining participants were assigned to a ‘no-fascination control’ condition. Participants in the ‘fascination’ condition were instructed to look for fascinating stimuli and to take pictures each time they were fascinated (“During your walk, we want you to look for things in the natural/urban environment that fascinate you. This could be the natural/urban scenery, objects, or surroundings that particularly capture your interest and are visually appealing and interesting. Each time you are fascinated like

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this, take a picture of the thing or scene that you see using your mobile phone camera.”). Participants in the no-fascination control were asked to just take pictures every 5 minutes during the walk to document their route (“Take one picture no more than 5 minutes apart during the walk for the purpose of documenting your whereabouts.”). After the walk, participants returned to the original meeting place were asked to fill out a series of questionnaires that assessed their self-reported experiences of fascination, PA, and NA. Participants were then debriefed to the study aims and were reimbursed for their participation. All sessions lasted approximately 1 hour and were conducted between 10am and 12 pm on weekdays. The experiment was conducted on sunny or cloudy days (avoiding rainy days).

**Measures**

The following measures were included in the questionnaire that participants completed after their walk.

*Fascination.* Participant’s experiences of fascination were measured using the full 8-item fascination checklist from the larger Perceived Restorativeness Scale (PRS) (Hartig, Korpela, Evans, & Gärling, 1997). The larger PRS consists of 22 items designed to measure being away, fascination, coherence, and compatibility (see Appendix A). Examples of items measuring fascination are “That place had fascinating qualities.” and “My attention was drawn to many interesting things.” Participants used a 7-point scale to “rate the extent to which the given statement described your experience during the walk” (0 = not at all, 6 = completely). Each participant’s response to the fascination items were averaged for a measure of fascination (\( \alpha = .93 \)).
**Positive and negative affect.** Participant’s current emotional experiences were measured using an 18-item checklist that captured positive and negative affect (Barrett & Russell, 1998). The items for positive affect (PA) were: *excited, energetic, enthusiastic, happy, cheerful, pleased, calm, content, relaxed.* The items for negative affect (NA) were *irritable, hostile, angry, nervous, anxious, tense, dejected, sad, unhappy.* These items captured a range of high to low intensities of affect. Participants were asked to rate how they felt “right now” on each of the 18 items using a 5-point Likert scale (1 = *not at all*, 5 = *extremely*). Responses to the nine positive affect and the nine negative affect items were averaged for a measure of positive affect (PA) and negative affect (NA) (PA $\alpha$ = .92; NA $\alpha$ = .80).

**Results**

**Descriptive Statistics**

Table 4.1 shows the average scores on the fascination index, and positive and negative affect scales. As shown in Table 3.1, positive affect was greater than negative affect. The mean number of pictures taken in the fascination group was 12 compared to the control group, which was 9.
Table 4.1. Descriptive Statistics Among Variables

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fascination</td>
<td>4.14</td>
<td>1.30</td>
<td>1.13</td>
<td>6.00</td>
</tr>
<tr>
<td>Positive Affect</td>
<td>3.34</td>
<td>0.82</td>
<td>1.44</td>
<td>5.00</td>
</tr>
<tr>
<td>Negative Affect</td>
<td>1.39</td>
<td>0.52</td>
<td>1.00</td>
<td>3.44</td>
</tr>
</tbody>
</table>

*Note. N = 80.*

Table 4.2. Correlations Among Variables

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nature (vs Urban)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2. Measured Fascination</td>
<td>.654**</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3. Positive Affect</td>
<td>.450**</td>
<td>.616**</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4. Negative Affect</td>
<td>-.309**</td>
<td>-.219</td>
<td>-.443**</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note: *p < .05; **p < .001*
Table 4.2 shows zero order correlations among the key outcome variables and the Nature (vs. Urban) manipulation (coded 1 for Nature, 0 for Urban). As Table 4.2 shows, nature (vs. urban) experiences was positively associated with measured fascination ($r = 0.654, p < 0.01$), positive affect ($r = 0.450, p < 0.01$), and negatively associated with negative affect ($r = -0.309, p < 0.01$). Measured fascination was positively associated with positive affect ($r = 0.616, p < 0.01$), but was not associated with negative affect ($r = -0.219, p = 0.051$).

**Between-Person Analyses**

A series of ANOVA ($2 \times 2$) were conducted to determine how the between person factors of nature (vs. urban) environment and fascination (vs. control) influenced reports of PA, NA, and measured fascination as dependent measures. A significant main effect of nature was found on both PA, $F (1, 80) = 19.923, p < 0.01, \eta^2 = .208$, and NA, $F (1, 80) = 8.474, p < 0.01, \eta^2 = .1$. Figure 4.1 and 4.2 showed that the nature condition produced significantly greater PA and lesser NA than the urban condition regardless of the fascination manipulation. There was neither a main effect of the fascination manipulation nor any significant interaction with the nature intervention, although the interaction shown for NA in Figure 4.2 was approaching significance, $F (1, 80) = 3.230, p = 0.076$. As shown in Figure 4.2, negative mood was highest for those in the urban condition who were asked to take photos as a way to increase their fascination.
Figure 4.1. Mean Positive Affect as a Function of Environmental and Fascination Conditions
A significant main effect of the nature manipulation was also found for measured fascination as a dependent variable, $F (1, 80) = 61.411, p < 0.01, \eta^2 = .447$. As shown in Figure 4.3, higher self-reported (measured) fascination was found in nature versus urban environments. People who were randomly assigned to walk in the nature environment reported significantly higher experiences of fascination than participants randomly assigned to walk in the urban environment.
A significant main effect of the fascination manipulation was also found on measured fascination ($F(1, 80) = 5.123, p < 0.05, \eta^2 = .063$); however, this pattern was in the direction opposite of predictions (see Figure 4.3). As shown in Figure 4.3, people assigned to the fascination condition (solid line) actually reported significantly lower fascination than people assigned to the no-fascination condition (dotted line). However, this effect was relatively small ($\eta^2 = .063$) whereas the main effect of nature on fascination was much larger ($\eta^2 = .447$).

Figure 4.3. Mean Fascination as a Function of Environmental and Fascination Conditions
In summary, walking in a nature environment resulted in higher PA, lower NA, and greater fascination, compared to an urban environment. So, while measured fascination was highly influenced by the nature versus urban environment, the attempt to manipulate fascination was not successful. The attempt to evoke greater fascination in nature through picture taking of fascinating stimuli appeared to backfire, causing people to report experiencing less fascination compared to control participants.

**Mediation analyses – Does measured fascination account for the relationship between nature experiences and positive/negative affect?**

In this next set of analyses, I tested whether measured fascination mediated the relationships between nature experiences and PA and NA. The analytic procedure was identical to the previous study (Study 1) except that a categorical variable of nature vs. urban environment (1 vs. 0) was substituted for time in nature. I followed three steps using the procedure recommended by Card (2012) and Jose (2013): Step 1- use nature vs. urban condition to predict affect; Step 2 - use nature vs. urban to predict fascination; Step 3 – use fascination to predict affect while controlling for nature vs. urban condition. Results showed that fascination fully mediated the relationship between nature experiences and PA for the sample as a whole (Sobel test = 4.031, $p < 0.01$) (see Figure 4.4). Step 1 path was significant ($\gamma = 0.450, p < 0.01$). Step 2 path was significant ($\gamma = 0.654, p < 0.01$). Step 3 path was significant ($\gamma = 0.616, p < 0.01$); and now, there no longer remained significant variance ($\gamma = 0.082, p = 0.488$) between nature and PA. This pattern for PA suggests that fascination in nature may play a key role in the process between exposure to nature and increased PA (see Figure 4.4). However, there was no
significant mediation by fascination for the relationship between nature experiences and NA. Step 1 path was significant ($\gamma = 0.450, p < 0.01$). Step 2 path was significant ($\gamma = 0.654, p < 0.01$). However, Step 3 path was not significant ($\gamma = 0.030, p = 0.837$). These patterns of complete mediation were similar when testing women and men separately. Thus, for both men and women, experiences of fascination in nature partially explained the association between nature and positive affect. Fascination did not mediate the relationship between nature experiences and NA for women. Step 1 path was significant ($\gamma = -0.313, p < 0.01$), and Step 2 path was significant ($\gamma = 0.637, p < 0.01$). However, Step 3 path was not significant ($\gamma = -0.123, p = 0.541$). Therefore, fascination was not a significant mediator between nature and NA for either men or women in Study 2.

![Diagram](image)

Figure 4.4. The mediational model showing the nature vs. urban condition led to increased PA via heightened attentional fascination. Bolded coefficients were statistically significant ($p < .05$).
Moderation analyses – Does fascination enhance the relationship between nature experiences and positive/negative affect?

Lastly, I tested whether measured fascination enhanced the relationship between nature and PA/NA. Unlike Study 1, there was no significant moderation effect of measured fascination on the relationship between nature experiences and PA/NA.

Discussion

This experimental study showed that nature experiences elicited more PA and less NA compared to urban environments in a relatively short time (30 minutes); the effect size for PA ($\eta^2 = .208$) was larger than for NA ($\eta^2 = .100$). People who were randomly assigned to walk for 30 minutes in a natural environment reported feeling more positive and somewhat less negative than people randomly assigned to walk in an urban environment. People who walked in a natural environment also reported more fascinating experiences, suggesting that natural environments are more fascinating environments.

Further, that level of fascination completely accounted for the improvements in PA, suggesting that PA may be induced by nature through fascination, whereas the link between nature and NA may not depend on fascination.

It is very interesting to note that the manipulation to increase fascination actually backfired, resulting in somewhat less fascination for those who were asked to take pictures when they were fascinated. However, the effect size of the fascination manipulation was small ($\eta^2 = .063$). It is possible that the action of taking pictures itself might have something to do with the ironic result; the mean number of pictures taken in
the fascination group was 12 compared to the control group, which was 9. The deed of taking more pictures in the fascination group (than in non-fascination group) might have been bothersome, and interfered with the actual experiences of being fascinated. However, post hoc ANCOVA analyses controlling for the number of pictures taken showed the number of pictures taken had no significant effect on measured fascination, $F(1, 79) = 1.724, p = 0.193$.

This backfiring might result from the attentional conflict induced by trying to perform multiple things in a short period of time. Literature on dual-task performance (e.g., Pashler, 1994) and task-switching (e.g., Monsell, 2003) have suggested that when attention is divided or switched over two or more tasks, dual-task interference/switching costs may occur especially if these tasks involve visual searching (Borst, Taatgen, & van Rijn, 2010; Salvucci & Taatgen, 2008). In this Study 2 experiment, participants were asked to complete the visual searching task (searching for/attending to the stimuli of fascination), and a decision making task (making a decision—whether or not to take a picture). In this way, attention was divided or switched over between visual searching and decision making tasks, which might result in the exhaustion of attentional resources. This attentional exhaustion could offset the gain from attentional restoration by fascination.

A third possibility is that the act of seeking out fascinating stimuli could have impaired processing of those stimuli by inducing ‘meta-aware’ state. There is some evidence that taking pictures of stimuli (like art, in a museum) can actually impair enjoyment of those stimuli and impair memory (e.g., Henkel, 2014). This is similar to the
verbal overshadowing effect where verbally describing how beautiful a sunset is can interfere with one’s actual enjoyment of that sunset by evoking a meta-cognitive state of ‘being aware that one is aware’ versus just experiencing the event and ‘being in the moment’ (Schooler, 2002; Schooler & Schreiber, 2004). It is possible that trying to identify and take pictures of fascinating objects disrupted how participants’ naturally respond to those stimuli, taking a person out of the moment and providing a barrier to full immersive interaction, thereby leading to reduced fascination.

With these limitations in mind, I focused the next study on trying to manipulate fascination in a way that would not hamper the quality of a person’s attention in their environment. Specifically, for Study 3, I drew upon the construct of mindfulness, which might be used as a suitable substitute for a fascination intervention.
5. CHAPTER 5: STUDY 3. MINDFULNESS IN NATURE

Introduction

Study 3 was a brief study designed to try to manipulate fascination in a more subtle way that does not evoke a meta-conscious state. To do this, I tried to enhance fascination by evoking a state of mindfulness in participants while they walked in nature. Mindfulness is defined as enhanced awareness of on-going experience or present reality, and can indicate the regulatory ability of open awareness and sustained attention (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Brown & Ryan, 2003). Past research has shown a beneficial effect of mindfulness on PA (Brown, Ryan, & Creswell, 2007; Keng et al., 2011). Experience sampling research has also shown that state and momentary mindfulness is associated with more intense and frequent positive emotions. For example, in a large study using iPhones to track people’s happiness, Killingsworth and Gilbert (2010) found that the degree to which people oriented their attention toward the present moment (i.e., mindfulness) was a strong predictor of their current happiness (Killingsworth & Gilbert, 2010).

It is interesting to note that mindfulness shares some similarities with fascination. For example, both can play an important role in regulating attention; fascination can restore attentional resources (Berto, 2014; Kaplan, 1995), and mindfulness can enhance attentional capabilities (Brown et al., 2007; Brown & Ryan, 2003). Plus, mindfulness can also play an important role in emotion regulation, and be used as an effective intervention tool which can promote the cultivation of emotional well-being (e.g., Dunn, 2012; Hill &
Updegraff, 2012). However, it is unknown whether manipulating mindfulness in nature might induce the enhancement of fascination or not. If so, it is possible that a mindfulness intervention could be used as the substitute for a fascination intervention. This might also open the possibility of mindfulness playing a similar role as fascination in terms of nature’s effect on PA.

Thus, the aim of Study 3 was to enhance people’s mindfulness in nature and test how this manipulation may translate to increases in fascination and PA/NA. In this short and focused “mini-study,” I used only a nature condition (with enhanced mindfulness, reduced mindfulness, and no-instruction control group) without an urban condition.

**Method**

**Participants**

The sample consisted of 45 young adults (13 males and 32 females) with a mean age of 22 ($SD = 4.64$; range 18 – 46). Participants were recruited for the “Dunedin Walking Study II” conducted in 2014. Similar to Study 2, participants were students at Otago University, remunerated with either 1 course credit or 10 dollars.

**Setting**

The setting was identical to Study 2 except that only a nature setting was tested in the botanic garden. Participants were asked to walk freely in the garden. Data were collected during the late summer season and early fall season (mid-February – late March 2014).
**Procedure**

Each participant attended an initial briefing session individually where they were briefed on the study aims, procedures, and then given the specific instruction for the study. In this study, participants were not instructed to take pictures. Instead, the randomly assigned participants were instructed to focus their attention to the current walking experiences (mindful condition: “We want you to focus your attention on your current walking experience—what you are experiencing in the “here and now.” Notice the sights and the sounds in your environment. If you find your attention wandering, please gently bring it back to the present moment.”), the past experiences (non-mindful condition: “We want you to focus your attention on your past experience—what you have experienced in the past few days. Recall the sights and the sounds of those experiences. If you find your attention wandering, please bring it back to the past.”), or whatever they like (control condition: “Please go inside the garden and walk around freely.”) during the walk. All participants were asked to walk in the botanic garden only. After the walk, participants returned to the original meeting place and were asked to fill out a questionnaire with the measures listed below. Then, participants were debriefed and reimbursed for their participation. All sessions were conducted between 10am and 12 pm on weekdays (excluding rainy days).
Measures

The same measures of fascination (α = .79), PA (α = .85) and NA (α = .67) were used in this study. For each item, participants were asked to rate their current levels of fascination, PA, and NA.

Mindful Attention Awareness Scale (MAAS). Mindfulness was measured using a MAAS; 5-item state version) (Brown & Ryan, 2003). The items were “I was finding it difficult to stay focused on what was happening.” “I was doing something without paying attention.” “I was preoccupied with the future or the past.” “I was doing something automatically, without being aware of what I was doing.” and “I was rushing through something without being really attentive to it.” (All reverse scored). Participants were asked to report their mindful experiences “during the walk” for each of the five items, which were then averaged (α = .81).
Results

Descriptive Statistics

Table 5.1 shows the average scores on the fascination index, PA, NA, and mindfulness scales. The levels of fascination showed a ceiling effect ($M = 5.02$ of $6.00$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>$M$</th>
<th>$SD$</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fascination</td>
<td>5.02</td>
<td>0.61</td>
<td>3.63</td>
<td>6.00</td>
</tr>
<tr>
<td>Positive Affect</td>
<td>3.70</td>
<td>0.54</td>
<td>2.00</td>
<td>4.78</td>
</tr>
<tr>
<td>Negative Affect</td>
<td>1.11</td>
<td>0.17</td>
<td>1.00</td>
<td>1.67</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>3.68</td>
<td>1.25</td>
<td>0.80</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Manipulation check

A one-way ANOVA indicated that measured mindfulness differed significantly between the three mindfulness conditions, $F (2, 44) = 5.146, p < 0.05$. As shown in Figure 5.1, a comprehensive post hoc analysis showed that participants in the non-mindful condition reported significantly lower mindfulness after the walk than participants in the mindful condition (Mean Difference, 1.173; $p < 0.05$) or the control condition (Mean Difference, 1.160; $p < 0.05$). There was no significant difference between participants in the mindful and control conditions (Mean Difference, 0.013; $p = 0.99$). The fact that the no-Instruction control group was identical to the mindfulness instruction suggested that by default people were mindful in nature.
Figure 5.1. Mean Mindfulness across the three Conditions (error bars: 95% CI)
Although the manipulation created less mindfulness, this did not translate to differences in fascination (see Figure 5.2). This suggests that mindfulness is not the same as fascination though fascination was positively associated with mindfulness ($r = 0.300, p < 0.01$).

![Figure 5.2. Mean Fascination across the three Conditions](image)

**Effects on PA/NA**

Moreover, there were no differences in positive affect or negative affect between the three conditions. As shown in Figure 5.3 and 5.4, regardless of the condition, people tended to report higher PA and lower NA. This finding suggests that even when asking people to be less mindful, they still experienced relatively high PA and low NA in natural
environments. Thus, differences in mindfulness between the conditions did not translate into differences PA or NA.

Figure 5.3. Mean PA across the three Conditions
Discussion

This brief experimental study showed that nature experiences yielded the same amount of affect and fascination regardless of whether participants were instructed to be mindful or not. The fact that the mindfulness manipulation influenced mindfulness, but did not translate to any differences in fascination, PA or NA, suggests that mindfulness does not play a similar role as fascination in terms of nature’s effect on affective outcomes.
There were several interesting findings from this brief experiment. First, it is interesting that even when participants were instructed to be *mindless* (to think about the past, rather than the present), they still showed a similar benefit of nature to the other conditions. This finding suggests that nature might have therapeutic benefits that could overcome mindlessness; the benefits of nature were the same for the no-instruction control group compared to the other groups. This finding suggests that it is not necessary or more effective to provide instructions for how people should engage in nature. When considered with the findings from Study 2 (where instructions to seek out fascinating stimuli backfired), it would seem that just letting participants “be” in nature seems to be more appropriate than having them try to do or be something.

There were some limitations of this study. There was a ceiling effect for the fascination scores, which were very high. It would have been more sensitive to include a pre-test measure of fascination, PA, and NA to show that there were changes in these outcomes following the walk. Use of pre- and post-test scores to track changes within the same person over time would allow more sensitivity to show changes in mood before and after the intervention. Another limitation is that there was no urban condition. It was because this mini-study only focused on examining the possibility of mindfulness as an alternative fascination manipulation.

Taken together, I learned three things from Study 2 and 3. First, it might not be easily possible or even necessary to manipulate fascination in order to extract the most benefit from nature. Second, fascination is not the same thing as mindfulness, and
mindfulness is probably not a mediator of the relationship between nature and well-being association, but this null result needs confirmation before ruling it out entirely. Third, fascination is shaping up to be consistent factor in explaining why nature influences affect. But again, this link still requires confirmation in subsequent studies.
6. CHAPTER 6: STUDY 4. HEART RATE VARIABILITY IN NATURE

Introduction

In the studies run thus far, the strongest finding has been that exposure to nature is consistently related to increases in PA, less consistently related to NA, and that the nature-PA link is either partially or fully mediated by experiences of fascination. I also showed that fascination is not the same thing as mindfulness. However, my attempt to manipulate fascination (or alternatively, mindfulness) in order to magnify the direct effect of nature on PA was unsuccessful. Fascination was difficult to manipulate, and different from mindfulness. Therefore, for the rest of the studies in this PhD thesis, I decided to continue to measure fascination rather than to manipulate fascination, and to instead focus on replicating this mechanism and testing it against other potential mechanisms.

Replication is an important part of science (Aarts et al., 2015). Therefore, in Study 4, I conducted another field experiment similar in design to Study 2 to replicate the effects of a nature vs. urban walk intervention on changes in PA (and NA) measured pre- and post-walk, and to test fascination as a mediator of these changes. If I can show that the changes in PA (and NA) can still occur and these changes indeed occur via fascination again, then I can consolidate the effect of nature on PA/NA. With the successful replication of the results across all previous studies, I can identify fascination as the default player which explains the nature–PA mechanism.

Study 4 also sought to broaden the investigation of this mechanism—including an additional measure that might account for the benefits of nature on PA. The literature on nature and well-being has indicated that natural environments can be associated with
positive physiological effects that indicate better coping (e.g., Beute & de Kort, 2014; Park et al., 2011; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010). One recent experimental laboratory study showed that participants exposed to nature (vs. urban) stimuli through viewing pictures of natural environments on the computer screen had greater improvements in their physiological state as measured by heart rate variability (HRV) (Beute & de Kort, 2014). Heart rate variability (HRV) is defined as variation of the time interval change between each heartbeat, which is a typical of cardiac physiological activity (Appelhans & Luecken, 2006). HRV is an index of vagal tone activity, which is associated with the parasympathetic nervous system. Higher levels of HRV are better: high levels indicate successful adaptation, which is flexibility in the face of changing physiological and environmental demands (Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012; Thayer, Hansen, Saus-Rose, & Johnsen, 2009; Thayer & Lane, 2000). Past research has shown that high HRV is related to natural scenes (Beute & de Kort, 2014), greater positive emotion and better emotion regulation (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995) whereas lower HRV predicts anxiety, poor attentional control/emotion regulation, and behavioral inflexibility (Friedman & Thayer, 1998). It is possible that HRV could act the primary or complementary mechanism linking nature to changes in PA/NA. However, research has not yet investigated HRV as a mechanism linking nature to changes in affect, nor has research tested this link outside of the lab.

Study 4 aimed to replicate the results of the previous studies and investigate the possibility of HRV as another potential mediator that might account for the effect of nature on PA. This study applied a field experimental design similar to Study 2. This time, I tried to improve measurement sensitivity by including baseline and follow up measurements to track changes before and after the nature versus urban walk
manipulation. I also tried to establish HRV as an objective mediator in addition to testing the subjective experiences of fascination as a mediator of the nature-well-being link.
Method

Participants

The final sample consisted of 24 young adults (13 males and 11 females) with a mean age of 26.04 (SD = 4.97; range 18 – 39). Seven additional participants dropped out because they were unable to be measured for HRV due to the technical difficulties. Participants were recruited for the “Dunedin Walking Study III” conducted in 2014. Besides age and gender, other information (e.g., ethnicity, etc.) was not asked, and participants were remunerated with either 1 course credit or 10 dollars as in Study 2-3.

Setting and Timing

The data were collected in two different field sites – one urban and one nature. The urban field site was in the central area of Dunedin city. Participants were asked to walk along the main street in the business/shopping district. The nature field site was in the botanic garden. Participants were asked to walk freely in the garden. The experiment was conducted in winter and early spring (mid-July – September 2014).

Procedure

Each participant individually attended an initial briefing session at a designated field site (time 1). Participants in both conditions (urban/nature) were asked to meet at the front of a local university building (Clocktower building), where they were briefed on the study procedures. Following this, an initial baseline heart rate variability (HRV) reading was taken (for equipment, see Measures section below), and participants filled out a short baseline questionnaire. Then they were given specific instructions for their randomly-assigned condition. Participants in the nature condition walked to the starting point in the botanic garden with the researcher (6 minute walk; 400 metres away). They were instructed to take a 20-30 minute walk in the botanic garden and to meet the
researcher back at this starting point. Participants in the urban condition walked to a different starting point of the busy street of shopping/business district with the researcher (with a similar distance as in the nature condition). They were instructed to take a 20-30 minute walk in an adjacent urban environment and to meet the researcher back at this starting point. After the urban or nature walk, participants returned to the starting point and were measured for a final HRV reading, and asked to fill out a series of questionnaires that assessed their current and recent experiences during the walk (e.g., fascination, PA, and NA). This second questionnaire included the questions assessed at baseline as well as additional questions to more fully assess their experiences. Participants were then debriefed to the study aims and were reimbursed for their participation. All sessions lasted approximately 1 hour and were conducted between 10am and 12 pm/2pm and 4pm on non-rainy weekdays.

**Measures**

The following measures were included in the questionnaire that participants completed at the start and after their walk.

*Fascination.* Participants’ experiences of fascination were measured using the 8-item fascination subscale from the Perceived Restorativeness Scale (PRS) (Hartig, Korpela, Evans, & Gärling, 1997). Example items included were “That place was fascinating.” and “I wanted to get to know that place better.” Participants used a 5-point scale to indicate the extent to which the given statement described their experience (for pre-walk instruction: “Please rate the extent to which the given statement described your experience now.”; for post-walk: “Please rate the extent to which the given statement described your experience during the walk.”) (1 = slightly, 5 = extremely). The wording was changed from the previous studies in order to be used at baseline and follow up and
to be comparable with the affect scale. To reduce participant burden, a short 3-item measure of fascination was used at baseline to leave enough time to assess HRV. The three chosen items were “That place was fascinating,” “There was much to explore and discover there,” and “I wanted to get to know that place better.” These items were selected because they loaded highest on fascination in a factor analysis (conducted from previous studies). Each participant’s responses to the fascination items were averaged for a measure of fascination (baseline $\alpha = .92$; follow up $\alpha = .94$).

**Positive and negative affect.** Participant’s current emotional experiences were measured using an 18-item checklist that captured positive and negative affect (Barrett & Russell, 1998). The items for positive affect (PA) were: *excited, energetic, enthusiastic, happy, cheerful, pleased, calm, content, relaxed*. The items for negative affect (NA) were *irritable, hostile, angry, nervous, anxious, tense, dejected, sad, unhappy*. These items captured a range of high to low intensities of affect. Participants were asked to rate how they felt “that moment” on each of the 18 items using a 5-point Likert scale ($1 = slightly, 5 = extremely$). Again, a short measure (three items for PA and three items for NA) was used for the baseline assessment to reduce participant burden (PA: happy, relaxed, enthusiastic; NA: sad, anxious, angry). Responses to the positive affect and the negative affect items were averaged for a measure of positive affect (PA) and negative affect (NA) (baseline PA $\alpha = .80$; follow up PA $\alpha = .92$; baseline NA $\alpha = .75$; follow up NA $\alpha = .81$).

**Heart rate variability.** Participants’ baseline and follow up physiological heart rate variability (HRV) was measured using a smartphone device with a pulse-wave finger sensor. An infra-red light is sent through the tip of the finger with a sensor (iThlete Finger Sensor: HRV Fit Pty Ltd, Hampshire, UK) on the other side which
measures changes in the amount of light received. There is no electricity involved. The input of pulse-to-pulse data series by the finger sensor were used to calculate HRV by an iOS-compliant smartphone software on site. HRV value was computed by the iThelete software using a standardized measurement of parasympathetic heart-rate variability (see Figure 6.1).

Figure 6.1. The iThlete Finger Sensor

Results

Descriptive Statistics and Baseline Differences

Table 6.1 shows the descriptive statistics for the measured variables. HRV values were within the normal range of 50 to 100, which indicates healthy functioning (Heathers, 2013).
Table 6.1. Descriptive Statistics Among Variables

<table>
<thead>
<tr>
<th></th>
<th>$M$</th>
<th>$SD$</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Affect (time 1)</td>
<td>3.29</td>
<td>0.74</td>
<td>2.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Positive Affect (time 2)</td>
<td>3.10</td>
<td>0.71</td>
<td>1.33</td>
<td>4.78</td>
</tr>
<tr>
<td>Negative Affect (time 1)</td>
<td>1.81</td>
<td>0.88</td>
<td>1.00</td>
<td>4.67</td>
</tr>
<tr>
<td>Negative Affect (time 2)</td>
<td>1.44</td>
<td>0.44</td>
<td>1.00</td>
<td>2.78</td>
</tr>
<tr>
<td>Fascination (time 1)</td>
<td>3.09</td>
<td>1.04</td>
<td>1.33</td>
<td>5.00</td>
</tr>
<tr>
<td>Fascination (time 2)</td>
<td>3.44</td>
<td>0.92</td>
<td>1.25</td>
<td>4.88</td>
</tr>
<tr>
<td>HRV (time 1)</td>
<td>77.4</td>
<td>9.8</td>
<td>57.2</td>
<td>94.5</td>
</tr>
<tr>
<td>HRV (time 2)</td>
<td>76.4</td>
<td>11.3</td>
<td>47.9</td>
<td>96.9</td>
</tr>
</tbody>
</table>

Note. HRV = heart rate variability

Preliminary analyses revealed no baseline group differences in the measured variables before the walking intervention. T-tests showed that there were no significant group differences between participants randomly assigned to the nature and urban conditions for baseline NA (nature: $M$ = 1.78, $SD$ = 0.66; urban: $M$ = 1.83, $SD$ = 1.10), $t(22) = -0.93$, $p = .88$, $d = -0.39$), baseline fascination (nature: $M$ = 3.08, $SD$ = 1.06; urban: $M$ = 3.11, $SD$ = 1.08, $t(22) = -0.06$, $p = .95$, $d = -0.03$), or baseline HRV (nature: $M$ = 75.24, $SD$ = 10.89; urban: $M$ = 79.55, $SD$ = 8.57), $t(22) = -1.08$, $p = .29$, $d = -0.46$). However, there was a trend for higher baseline PA in the urban condition (nature: $M$ = 3.00, $SD$ = 0.74; urban: $M$ = 3.58, $SD$ = 0.91), $t(22) = 2.05$, $p = .053$, $d = -0.69$)

**Main Analyses**

Table 6.2 shows the zero order correlations for the measured variables. The nature (vs. urban) condition was positively associated with both PA and fascination at time 2, but nothing else, including HRV. Fascination at time 2 was positively associated
with PA at time 2, but not NA or HRV. However, HRV at both time points were highly correlated, suggesting consistency in measurement.
Table 6.2. Correlations Among the Variables

<table>
<thead>
<tr>
<th></th>
<th>Nature</th>
<th>PA (t1)</th>
<th>PA (t2)</th>
<th>NA (t1)</th>
<th>NA (t2)</th>
<th>Fascination (t1)</th>
<th>Fascination (t2)</th>
<th>HRV (t1)</th>
<th>HRV (t2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA (time 1)</td>
<td>–</td>
<td>-.400</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA (time 2)</td>
<td>.501*</td>
<td>-.038</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA (time 1)</td>
<td>-.032</td>
<td>-.211</td>
<td>.014</td>
<td>-.321</td>
<td>.324</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA (time 2)</td>
<td>-.075</td>
<td>.191</td>
<td>-.231</td>
<td>.324</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fascination (time1)</td>
<td>-.014</td>
<td>.416*</td>
<td>.190</td>
<td>.236</td>
<td>.478*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fascination (time2)</td>
<td>.756**</td>
<td>.093</td>
<td>.737**</td>
<td>.088</td>
<td>.037</td>
<td>.379</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HRV (time 1)</td>
<td>-.224</td>
<td>.055</td>
<td>-.320</td>
<td>.055</td>
<td>-.321</td>
<td>-.348</td>
<td>-.308</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>HRV (time 2)</td>
<td>-.169</td>
<td>.109</td>
<td>-.229</td>
<td>.109</td>
<td>-.140</td>
<td>-.389</td>
<td>-.195</td>
<td>.638**</td>
<td>–</td>
</tr>
</tbody>
</table>

*Note: *p < .05; **p < .001. Nature was coded 1 for the nature condition and 0 for the urban condition.
Two-way mixed ANOVAs with environmental condition (nature/urban) as the between-person factor and time (before/after walk) as the within-person factor were conducted on the primary outcome measures (PA, NA, fascination, and HRV).

Analyses of PA revealed a significant condition by time interaction ($F(1, 22) = 14.02; p < 0.01, \eta^2 = .39$), with no main effects of either condition ($F(1, 22) = 0.07; p = 0.79, \eta^2 = .003$) nor time ($F(1, 22) = 1.30; p = 0.27, \eta^2 = .06$). As shown in Figure 6.2, the nature walk increased PA from baseline, whereas the urban walk decreased PA from baseline. Post hoc t-tests showed (post-intervention) that participants in the nature condition reported significantly higher PA than participants in the urban condition (nature: $M = 3.44, SD = 0.73$; urban: $M = 2.75, SD = 0.82$), $t(22) = 2.72, p < 0.05, d = 0.59$) (see Figure 6.2).
Analyses of NA revealed no significant condition by time interaction ($F(1, 22) = 0.001; p = 0.98, \eta^2 = .000$), no main effect of condition ($F(1, 22) = 0.07; p = 0.78, \eta^2 = .003$) but there was a main effect trend for time ($F(1, 22) = 4.25; p = 0.051, \eta^2 = .16$). Post hoc tests for repeated-measures ANOVA showed that post-intervention NA was significantly lower than that of pre-intervention NA regardless of condition, $F(1, 23) = 4.44, p < 0.05, \eta^2 = .16$ (see Figure 6.3).
Figure 6.3. Mean Negative Affect as a Function of Time and Environmental Conditions

The two-way mixed ANOVA for fascination revealed a significant condition by time interaction ($F(1, 22) = 15.87; p < 0.01, \eta^2 = .42$) as well as a significant main effect of condition ($F(1, 22) = 4.67; p < 0.05, \eta^2 = .18$). There was no significant main effect of time ($F(1, 22) = 3.91; p = 0.06, \eta^2 = .15$). As shown in Figure 6.4, the nature walk increased fascination from baseline, whereas the urban walk decreased fascination. Post hoc t-tests of fascination following the intervention showed that the nature condition
contributed to significantly higher fascination than the urban condition (nature: $M = 4.13$, $SD = 0.40$; urban: $M = 2.76$, $SD = 0.77$), $t(22) = 5.42$, $p < 0.01$, $d = 2.31$).

Figure 6.4. Mean Fascination as a Function of Time and Environmental Conditions

Analyses of HRV revealed no significant condition by time interaction ($F (1, 22) = 0.02$, $p = 0.89$, $\eta^2 = .001$), no main effect of condition ($F (1, 22) = 0.56$, $p = 0.46$, $\eta^2 = .003$), and no main effect of time ($F (1, 22) = 0.27$, $p = 0.61$, $\eta^2 = .001$).
Mediation analyses – Does fascination account for the relationship between nature experiences and positive affect?

In this next set of analyses, I tested whether fascination mediated the relationship between nature (vs. urban) experiences and PA. NA was not tested because there was no condition x time effect on NA. The analytic procedure was identical to Study 2 where a categorical variable of nature vs. urban environment (1 vs. 0) was used for time in nature. I followed three steps using the procedure recommended by Card (2012) and Jose (2013): Step 1- use nature vs. urban condition to predict PA; Step 2 - use nature vs. urban to predict fascination; Step 3 – use fascination to predict PA while controlling for nature vs. urban condition. Results showed that fascination fully mediated the relationship between nature experiences and positive affect for the sample as a whole (Sobel test = 3.1215, p < 0.01) (see Figure 6.5). Step 1 path was significant (γ = 0.501, p < 0.05). Step 2 path was significant (γ = 0.756, p < 0.01). Step 3 path was significant (γ= 0.836, p < 0.01), meaning there was no longer any significant variance remaining between nature and positive affect (γ = -0.131, p = 0.56). This pattern for positive affect replicated the previous studies suggesting that fascination in nature mediates the relationship between exposure to nature and increased positive affect (see Figure 6.5).
Figure 6.5. The mediational model showing the nature vs. urban condition led to increased positive affect via heightened attentional fascination (complete mediation). Bolded coefficients were statistically significant ($p < .05$).

**Moderation analyses – Does fascination enhance the relationship between nature experiences and positive/negative affect?**

Lastly, I tested whether fascination enhanced the relationship between nature and positive and negative affect. The possibility of moderating effect between nature and PA/NA was estimated using the equation below. For the moderation to be established, parameter $\beta$ for the interaction ($\beta_3$) needed to be significant.

$$ PA/NA = \beta_0 + \beta_1 \text{(Nature)} + \beta_2 \text{(Fascination)} + \beta_3 \text{(Nature \times Fascination)} + r_i. $$

Where nature is dummy coded (0 = Urban, 1 = Nature), fascination is centered on the mean, and nature x fascination is the cross-product interaction term computed using the
centered fascination variable. There was no significant moderation effect of fascination on the relationship between nature experiences and either PA or NA ($\beta = -0.19$, $p = 0.28$ for PA; $\beta = -0.16$, $p = 0.56$ for NA).
Discussion

The first aim of this intervention study was to replicate the results of previous studies by testing PA and NA changes before and after a nature (vs. urban) walking intervention. I replicated the beneficial effects of nature on increases in PA and again showed that effects were mainly for PA and not NA. I also replicated the effects of nature on fascination, and showed again that fascination completely mediated the relationship between nature and PA. The result has further reinforced the finding that fascination plays a critical role in the improvement of positive affect in natural environments.

The second aim of the study was to test the effect of nature (vs. urban) environments on physiological well-being by measuring changes in HRV. However, the results showed no significant differences in HRV between the nature vs. urban conditions. This could be due to the technical difficulties reading HRV, particularly in an outdoor setting. Direct sun light and windy conditions made it challenging to get HRV readings in the field. Often, multiple tries were required, and this took more than ten minutes. However, despite these challenges, the HRV measure showed good test-retest reliability ($r = .638$ between time 1 and time 2) suggesting that the measurement may not have been compromised. Alternatively, it may be that the sample size was small and did not have enough statistical power to detect changes in HRV. However, even though the sample size was small, we saw significant changes in PA as a function of the nature (vs. urban) condition. If HRV was a strong mechanism, there should have been some evidence even in this small sample. The fact that there was not even a hint of differences by condition
suggests that HRV may not be a physiological mechanism. It may also be the case that HRV is sensitive to physical activity, and that the fact that everyone took a walk could have obscured differences in HRV between conditions; however, HRV showed no changes between time 1 (77.4) versus time 2 (76.4) suggest that walking did not influence pre- and post-test effects on HRV level. Alternatively, it is possible that the timing of HRV (immediately after the walk, but not during the walk) might have obscured differences. Due to the continuously dynamic nature of HRV activity, it is possible that a post-walk measurement of HRV might not have captured changes in HRV during the walk. Thus, continuous monitoring of HRV activity throughout the walk might be needed to capture the change precisely. Further development of more reliable ambulatory equipment to assess physiological measures (such as HRV) will be desired.

One of the main limitations of this study was the small sample size (n = 24) which limited the study’s statistical power. However, smaller sample sizes are more typical in studies with physiological recording due to time and resource demands. Nevertheless, it is interesting to note that I still managed to show an effect of condition on both PA and fascination, and re-established the mediating role of fascination on the relationship between nature and PA. The short version of fascination, PA, and NA scales were used as baseline measures in this study. It was necessary to save time and reduce participants' burden. The exclusion of the items could have been problematic. However, considering the fact that the difference of reliability was actually minimal, and the items for the shorter version were chosen from the highest factor loadings, this was not the case.
In summary, Study 4 firmly established two findings – firstly, that walking in nature uniquely increases PA, and second, that fascination is a key mediator in this nature – PA link. Study 4 also cast doubt on fascination as a moderator of the nature well-being link (found previously in the correlational Study 2) and HRV as a possible physiological mechanism linking nature to PA. In the next and final study of this thesis, my goal was to replicate and extend the findings of the thesis so far, by introducing several other potential mediators (in addition to fascination) that might also account for the nature–PA mechanism. Moreover, in the final study, I applied a more complex design incorporating the best design elements from the previous studies – conducting an extended field experiment across a one week period, combined with daily diary tracking of experiences. In order to handle more complex data properly, I introduced more sophisticated statistical techniques (e.g., multi-level structural equation modeling).
7. CHAPTER 7: STUDY 5. FASCINATION/FLUENCY/SAVORING IN NATURE

Introduction

Studies 1 to 4 all suggest that experiencing nature increases PA, and that fascination plays an important role in mediating this nature-PA link. However, questions still remain whether fascination is the most important mechanism linking nature and PA or whether other aspects of cognition or emotion might better account for this link. Study 5 aimed to shed new light on the underlying process by investigating two other mechanisms—processing fluency, which is grounded in an information-processing perspective, and savoring, which is grounded in emotion regulation theory. Mindfulness was also investigated to rule it out once again as a potential mechanism. Importantly, Study 5 built upon the research designs used in previous studies by combining a field experiment with intensive daily tracking of experiences over a one week period. In this way, Study 5 served as a final ‘capstone study’ for this thesis to test a range of mechanisms - including fascination - that might account for the nature – PA link over a one week period in daily life. Study 5 also incorporated more sophisticated statistical modeling techniques, including multilevel mediation and path analysis in order to derive a final model linking nature to PA.

Information-processing Perspective: Fluency

Processing fluency is the ease with which information from the environment is processed (Halberstadt & Winkielman, 2014; Reber, Winkielman, & Schwarz, 1998; Winkielman et al., 2003). There are several types of fluency. For example, individuals
experience perceptual fluency when they perceive incoming visual stimuli easily and clearly. Similarly, they experience memory-based fluency when they retrieve information from memory easily (Alter & Oppenheimer, 2009). There is growing experimental evidence that fluency increases positive emotions (e.g., Winkielman & Cacioppo, 2001; Winkielman et al., 2003). For example, in an experimental study by Winkielman and Cacioppo (2001), participants were asked to rate how much they liked pictures of everyday objects on a scale ranging from 1 to 4. Based on the fact that fluency can be influenced by the degree of exposure to stimuli (Reber et al., 1998), the fluency of the pictures was manipulated by varying the duration of pictures being presented. Participants’ reactions were also measured with facial electromyography (EMG) to capture their physiological emotional responses. The results showed that high fluency was associated with increases in PA (but not NA) and was accompanied by EMG responses also indicative of PA (Winkielman & Cacioppo, 2001). According to the “fluency as hedonically marked” hypothesis, Winkielman et al. (2003) suggested that high fluency might serve as an metacognitive cue to efficient cognitive progress and signal a positive cognitive state which may lead to positive affective responses.

Natural environments possess their own unique set of stimuli that might favor more fluent processing, in turn, leading to increases in PA. According to the aesthetic experiences model (Leder, Belke, Oeberst, & Augustin, 2004), objects with aesthetic interest (e.g., a scenery in nature/ paintings in museums) can be processed through the perceptual stage of fluency (the ease of perceiving incoming visual stimuli) and memory-based fluency (the ease of retrieving these visual stimuli), which, in turn, lead to aesthetic pleasure (Leder & Nadal, 2014). The link between aesthetic experiences and higher liking / positive emotion appears to be mediated by higher processing fluency
Coupled with the fact that aesthetic nature (the state of perceiving nature as beautiful) is related to PA (Zhang, Piff, Iyer, Koleva, & Keltner, 2014), it is possible that natural environments might lead to higher fluency than urban environments, and this difference in fluency could account for the relative increases in PA in natural environments. To the author's knowledge, no study has investigated how fluency might account for the link between nature and PA. Although the Leder et al. (2004) study included some photos of natural scenes in their stimuli, they used many photos of non-nature ones. Study 5 also aimed to address this issue.

**Positive Emotion Regulation Perspective: Savoring**

Savoring is the process by which individuals actively use cognitive and behavioral strategies to enhance and prolong positive experiences (Bryant & Veroff, 2007; Quoidbach et al., 2010). Savoring involves various strategies such as being in the present moment (experiential absorption), intensifying their experiences by focusing on them (sensory-perceptual sharpening), gratitude making (counting blessings), and sharing these experiences with others (sharing with others) (Bryant, Chadwick, & Kluwe, 2011; Bryant & Veroff, 2007; Jose, Lim, & Bryant, 2012). Through these savoring strategies, people can derive greater positive emotion from everyday events and experiences (Jose et al., 2012). For example, Jose and colleagues tracked the daily experiences of young adults for 30 days and found that daily positive events were associated with daily happiness, and daily savoring accounted for the link between positive events and happiness (Jose et al., 2012).

Savoring strategies can be used in the process model of positive emotion regulation: situation selection, situation modification, attentional deployment, cognitive
change, and response modulation (Gross & Thompson, 2007; Quoidbach et al., 2015). Situation selection involves a decision to choose a particular situation to boost positive emotion (e.g., deciding to go to the park). Situation modification involves a decision making to make the most of the situation (e.g., decide to walk around the best spots in the park). Attentional deployment involves an attentional effort to savor the moment (e.g., immerse yourself in the walking experience). Cognitive change involves a cognitive reappraisal to appreciate positive experiences (e.g., find the positive aspects of the walking experience). Response modulation involves a behavioral effort to express positive emotion (e.g., share with others/express the joy) (Quoidbach et al., 2015). As Table 7.1 shows, savoring strategies such as experiential absorption, sensory-perceptual sharpening, counting blessings, and sharing with others (Bryant & Veroff, 2007; Jose et al., 2012) can be fitted well in the process model of positive emotion regulation (Quoidbach et al., 2015).

Table 7.1. How Savoring fits into the Process Model of Positive Emotion Regulation (adapted from Bryant & Veroff, 2007; Quoidbach et al., 2015)

<table>
<thead>
<tr>
<th>The Five Stages of Positive Emotion Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situation selection</td>
</tr>
<tr>
<td>Example</td>
</tr>
<tr>
<td>Savoring</td>
</tr>
</tbody>
</table>
Natural environments might stimulate savoring more than urban environments, which could account for the nature – PA link. Natural environments are more favorable places than urban ones (Korpela, Hartig, Kaiser, & Fuhrer, 2001) and so people might be more likely to savor their experiences during or following a walk in nature. Already, there is evidence that nature can be used as emotion regulatory tool (Johnsen & Rydstedt, 2013). In their correlational study, Johnsen and Rydstedt (2013) found that participants tended to seek nature experiences when they felt happy, which could be considered a situation selection strategy to savor and prolong their positive state. However, it is not known whether or not nature promotes other forms of savoring like experiential absorption, sensory-perceptual sharpening, counting blessings, and sharing with others. This study aimed to address the gap.

Other Mechanisms - Mindfulness and Physical Activity

In Study 3, I examined how mindfulness in nature could impact PA, and possibly account for the nature-PA link. Although the mindfulness manipulation itself was successful in increasing self-reported mindfulness, these differences did not translate into differences in PA. Those results suggested that mindfulness is not accounting for the nature-PA link. However, that field study was limited because it did not include an urban condition. Therefore, mindfulness was measured again in Study 5 to more thoroughly rule it out as a potential mediator.

Lastly, physical activity is known to increase PA (Korpela, Ylén, Tyrväinen, & Silvennoinen, 2008; Pretty, Peacock, Sellens, & Griffin, 2005; Ryan, Weinstein, Bernstein, Brown, Mistretta, & Gagné, 2010). Although the previous studies in this
thesis controlled for activity by assigning the same length of walk in nature and urban environments, it is possible that being in a natural environment might promote additional physical activity over and above the time spent walking in nature. People might feel better and more motivated from their time in nature, which could stimulate them to do more exercise. The added physical activities (besides the walk in nature/urban settings) could account for the nature-PA link, so the effect of additional physical activities needs to be considered. Daily physical activity was measured in Study 5 to ensure that other mediators of the link between nature and PA still remain after controlling for daily physical activity.

**Present Study**

Study 5 aimed to better understand the cognitive and emotional mechanisms driving the nature-PA link. Specifically, I examined how fascination, fluency, savoring, and mindfulness mediated the relationship between nature (vs. urban) environments and PA (controlling for physical activity). I expected that the two information processing variables (fascination, fluency), and the emotion regulation variable of savoring, would each as act as potential mediators of the nature–PA link. I did not expect that mindfulness or physical activity would be significant mediators. If it turned out that multiple mediators were significant, I then conducted follow up analyses to determine which one was the most powerful among them. The main focus was the mechanism involving PA as using fascination as the standard mediator and considering fascination’s exclusive association with PA; NA was used for reference only in this study.

Study 5 also aimed to address the methodological limitations of the previous studies. In Study 5, I employed both a week-long daily diary method, which addressed
the relatively short time period of Studies 2 to 4, and I employed an experimental design (a daily nature vs. urban walk manipulation as a between-subjects variable), which addressed the limitation of the cross-sectional design in Study 1. Hence, this study design was characterized as an experimental daily diary study. It is important to note that Study 1 tracked change over time but did not incorporate a manipulation (nature vs. urban). Studies 2 to 4 were experimental, but did not track change over a longer time period in daily life. Study 5 filled these gaps by tracking change over time in an experimental design.

The unique feature of this daily experimental design also required some special consideration when dealing with mediation in multilevel modeling. As Figure 7.1 shows, the independent variable (condition X – nature vs. urban) was manipulated at the between-person level (level 2) whereas the mediators (M) and outcome variables (Y) were assessed at the within-person daily level (level 1). This type of structure is called a “2-1-1 design” (Preacher, Zyphur, & Zhang, 2010). In the “2-1-1 design”, condition X varied only between people (individuals assigned to group X) whereas both M and Y varied at both the between and within person level. This means that people will differ between each other in their average levels of M and Y, and individuals differ will differ across time at the within-daily level in M and Y. These sources of variance needed to be taken into account appropriately. To address this issue, multi-level structural equation modeling was conducted for estimating indirect effects (Preacher, Zhang, & Zyphu, 2011; Preacher et al., 2010) instead of using Baron and Kenny’s stepwise method (Baron & Kenny, 1986; Card, 2012; Jose, 2013) with a Sobel test (Sobel, 1982).
Figure 7.1. Multi-level mediation model framework (2-1-1 model with a random level-1 effect); adapted from Preacher et al. (2011). (Note. X; independent variable, M; mediator variable, Y; outcome variable).
Method

Design Overview

This study was an experimental daily diary study consisting of a mixed between- and within-subjects experimental design. The between-subjects component was the experimental manipulation: Participants were randomly assigned to take either a daily 20 minute walk in nature or a daily 20 minute walk in an urban environment for seven consecutive days. The within-subjects component was the daily-repeated measures assessment each evening across the seven days. I coined the term “experimental daily diary study” to describe the unique feature of the study.

Participants

The final sample consisted of 60 young adults (18 males and 42 females) with a mean age of 21.72 (SD = 3.76; range 18 – 34). A chi-square test revealed that gender was equally distributed across the two conditions (\(\chi^2 (1, 60) = 0.32; p = 0.57\)). An additional two participants were excluded from analysis (one participant dropped out because of sickness during the experiment; one participant completed fewer than 4 diary records). Participants identified as Caucasian (73.3%), Asian (20.0%), or another ethnicity (6.7%). A chi-square test revealed that three ethnic groups were equally distributed across the two conditions (\(\chi^2 (2, 60) = 0.42; p = 0.81\)). Participants were recruited for the “Daily Walk Study” conducted in Dunedin New Zealand between February and April 2015, which corresponded to the end of summer and spring seasons. Participants were required to have access to nightly Internet via smartphone or pc/laptop. Participants were reimbursed through research credits based on completing a worksheet exercise (up to 3 credits) if recruited through the University of Otago Psychology Department’s experimental participation programme (\(N = 34, 57\%) or
reimbursed with $20 in cash for their time if recruited through flyers/word of mouth ($N = 26, 43\%)$.

**Procedure**

Each participant individually attended an initial briefing session by meeting the experimenter at the front of a local university building (Clocktower building), where they were briefed on the study procedures and completed informed consent by signing a paper form. Following this, participants were asked to fill out an online initial questionnaire through SurveyMonkey (http://www.surveymonkey.com) using either their smartphone immediately or later than night through an Internet-accessible computer. The initial questionnaire contained demographic questions (i.e., age, gender, ethnic background) followed by written instructions for their randomly-assigned condition. Participants received instructions verbally and in writing through a take-home handout. Participants in the nature condition were instructed to take a 20 minute walk alone in the botanic gardens daily beginning the next day. Participants in the urban condition were instructed to take a 20 minute walk alone in an adjacent urban environment (on the busy street of shopping/business district) beginning the next day. They took the walk whenever they saw fit during the daytime period. At the end of each day (between 7 pm and 12 midnight), participants were prompted via e-mail to fill out an online daily questionnaire using either their smartphone or Internet-accessible computer. They were sent an email at 7 pm with a hyperlink to the survey, which was available to complete until midnight. In the daily survey, participants were asked to fill out a series of questionnaires that assessed whether they completed their walk that day (yes / no), and their cognitive and emotional experiences (e.g., fascination, fluency, savoring, mindfulness, PA, and NA) that day. After repeating the daily procedure for 7
consecutive days, participants were asked to return to the front of the local university building (the same location the initial session was held). Participants were then debriefed to the study aims and were reimbursed for their participation.

**Measures**

The following measures were included in the daily questionnaire that participants completed between 7 pm and 12 midnight each day for one week.

*Daily fascination.* Participants’ recalled experiences of fascination during the walk were measured using 3-items from the larger 8-item fascination subscale from the Perceived Restorativeness Scale (PRS) (Hartig, Korpela, Evans, & Gärling, 1997). A short 3-item measure of fascination was used for this daily study to reduce participant burden. The 3-items were the same as those used in Study 4 and were chosen because they loaded the highest on fascination in a factor analysis conducted from previous studies. The three items were: “That place was fascinating.”, “I wanted to get to know that place better.”, and “There was much to explore and discover there.” Participants used a 5-point scale to indicate the extent to which the given statement described their walk experience today (1 = not at all, 5 = extremely). Each participant’s responses to the fascination items were averaged for a measure of fascination (see Results Section for scale reliability information).

*Daily fluency.* Participants’ recalled experiences of fluency during the walk were measured using three items—two measuring perceptual fluency and one measuring memory-based fluency. The two items assessing perceptual fluency were: “Fluency is the ease with which stimuli in the world one perceived and cognitively processed. How fluent was the environment on your walk?” (Perceptual Fluency 1) and “How vivid were the surroundings?” (Perceptual Fluency 2). Participants were asked to rate how
they felt “during the walk”. The one item assessing memory-based fluency was: “I can easily remember the walk” (Memory Fluency). Participants were asked to rate how well they retrieved the memory of the walk experience. Each of the 3 items used a 5-point Likert scale (1 = not at all, 5 = extremely). The new daily items were based on previous research (e.g., Alter & Oppenheimer, 2009; Forster, Leder, & Ansorge, 2013; Reber, 2012; Reber, Wurtz, & Zimmermann, 2004), created with the help of Prof. Jamin Halberstadt. These three items were combined into a single measure for preliminary analyses. For the main analyses, these were treated as a latent variable.

Daily savoring. Participants’ experiences of savoring were measured using the 4-item “momentary savoring” scale (Jose et al., 2012) which was taken from a subset of items from Bryant and Veroff’s Ways of Savoring Checklist (Bryant & Veroff, 2007). The four items were: “I thought only about the present – got absorbed in the moment.” (experiential absorption), “I tried to intensify the moment by focusing on it.” (sensory-perceptual sharpening), “I felt grateful for the pleasant event(s).” (counting blessings), and “I tried to share the positive aspects with another person.” (sharing with others). Participants were asked to rate how they felt during the walk for two of the items (experiential absorption and sensory-perceptual sharpening) because these items were about experiences during the walk. For the other two items (sharing with others and counting blessings), participants were asked to rate their experiences after the walk. Each of the 4 items was rated using a 5-point Likert scale (1 = not at all, 5 = extremely).

Daily mindfulness. Participants’ recalled experiences of mindfulness during the walk were measured using 1-item from 5 items scale of Mindful Attention Awareness Scale (MAAS) state version (Brown & Ryan, 2003). To reduce the participants’ burden, one item was chosen for this study, which was “I was doing something without paying
attention” (reverse scored). The chosen item was the one that loaded highest in a factor analysis conducted from previous studies. Participants were asked to rate how they felt 

during the walk on this item using a 5-point Likert scale (1 = not at all, 5 = extremely).

**Daily positive and negative affect.** Participant’s daily emotional experiences were measured using 6 items selected from the larger 18-item checklist used in Studies 1-3 of the present thesis. (Barrett & Russell, 1998). The items for positive affect (PA) were: happy, relaxed, enthusiastic. The items for negative affect (NA): sad, anxious, angry. These items captured a range of high to low intensities of affect and were selected to reduce participant burden. Participants were asked to rate how they felt “that day” on each of the 6 items using a 5-point Likert scale (1 = not at all, 5 = extremely). Responses to the three positive affect and the three negative affect items were averaged for a measure of positive affect (PA) and negative affect (NA).

**Daily physical activity.** As an additional control measure, a measure of daily physical activity (aside from the assigned walk) was included in the daily diary. Participants were asked to freely report “How many minutes did you spend doing vigorous and moderate physical activities besides the walk today?”.
Results

Psychometrics and Descriptive Statistics

Participants completed all of 7 diaries on average (99% response rate; $M = 6.92$; $SD = 0.38$; range 5 – 7). They reported taking their walk on most days (walking 413 out of 420 requested days; 98% compliance).

Prior to analyses, a multilevel confirmatory factor analyses (MCFA) was conducted for the newly introduced daily fluency scale. MCFA was based on the method developed by Muthén (1994), which can estimate the factor loadings at both between and within levels properly. Table 7.2 shows the factor loadings for both levels. The factor loading indicated that the three items loaded strongly at the between-person level, ranging from 0.815 to 0.957 and were lower, although still in acceptable levels at the within-person level, ranging from 0.526 to 0.752 comparatively. Thus, it was appropriate to combine these three items into a scale and use in both the between and within-person analyses.

Table 7.2. Standardized Factor Loadings for the Daily Fluency Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor Loading (Between)</th>
<th>Factor Loading (Within)</th>
</tr>
</thead>
<tbody>
<tr>
<td>How fluent was the environment on your walk?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Perceptual Fluency1)</td>
<td>.815</td>
<td>.566</td>
</tr>
<tr>
<td>How vivid were your surroundings?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Perceptual Fluency2)</td>
<td>.957</td>
<td>.752</td>
</tr>
<tr>
<td>I can easily remember the walk.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Memory Fluency)</td>
<td>.860</td>
<td>.526</td>
</tr>
</tbody>
</table>

*Note. All factor loadings were significant ($p < 0.01$). CFI: .992, RMSEA (Root Mean Square Error of Approximation): .054.*
The reliabilities of each daily measure were estimated at both levels (between-person and within-daily) using the method recommended by Geldhof, Preacher, and Zyphur (2014). They have suggested that an MCFA approach can be used to estimate between- and within-level alpha (\(\alpha\)) separately by using MCFA model parameters directly. Multilevel \(\alpha\) was computed in Mplus software version 7.31 (Muthén & Muthén, 2012). Table 7.3 shows the multilevel reliability estimates at both levels. The reliability estimates indicated that the item reliabilities were more consistent at the between-person level, ranging from 0.823 to 0.974 and were lower but still acceptable at the within-person level, ranging from 0.555 to 0.807 comparatively. The observed reliability at both levels indicated that it was appropriate to use these measures in both the between- and within-person analyses.

Table 7.3. Multilevel Reliability Estimates for the Daily Measures

<table>
<thead>
<tr>
<th>Daily Variable</th>
<th>Reliability Estimate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Between)</td>
<td>(Within)</td>
</tr>
<tr>
<td>Fascination</td>
<td>.974</td>
<td>.807</td>
</tr>
<tr>
<td>Fluency</td>
<td>.906</td>
<td>.638</td>
</tr>
<tr>
<td>Savoring</td>
<td>.944</td>
<td>.716</td>
</tr>
<tr>
<td>Positive Affect</td>
<td>.883</td>
<td>.691</td>
</tr>
<tr>
<td>Negative Affect</td>
<td>.823</td>
<td>.555</td>
</tr>
</tbody>
</table>

Table 7.4 shows the descriptive statistics for the aggregated daily variables.

Daily fascination and savoring showed similar descriptive statistics. Fluency was higher on average than fascination and savoring because of higher minimum fluency values.

Daily PA was greater than NA, which is typical and consistent with Studies 1 to 4. All variables showed sufficient range.
Table 7.4. Descriptive Statistics Among the Aggregated Daily Variables

<table>
<thead>
<tr>
<th>Daily Variable</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fascination</td>
<td>2.95</td>
<td>0.93</td>
<td>1.11</td>
<td>5.00</td>
</tr>
<tr>
<td>Fluency</td>
<td>3.48</td>
<td>0.67</td>
<td>2.10</td>
<td>4.95</td>
</tr>
<tr>
<td>Savoring</td>
<td>2.72</td>
<td>0.86</td>
<td>1.04</td>
<td>4.89</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>3.13</td>
<td>0.77</td>
<td>1.29</td>
<td>4.43</td>
</tr>
<tr>
<td>Positive Affect</td>
<td>3.16</td>
<td>0.56</td>
<td>1.57</td>
<td>4.43</td>
</tr>
<tr>
<td>Negative Affect</td>
<td>1.77</td>
<td>0.49</td>
<td>1.00</td>
<td>3.24</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>28.78</td>
<td>22.93</td>
<td>0.00</td>
<td>111.43</td>
</tr>
</tbody>
</table>

Note. M = Mean, SD = Standard Deviation, Min = Minimum, Max = Maximum.

Preliminary Analysis with Aggregated Data

Table 7.5 shows the zero order correlations for the aggregated daily measured variables. The nature (vs. urban) condition was associated with all cognitive regulation measures except mindfulness. The nature (vs. urban) condition was also associated with greater savoring. As expected, participants in the nature walk condition reported higher average levels of fascination, fluency, and savoring compared to participants in the urban condition. Surprisingly, there was no association between the nature condition and PA ($r = 0.083, p = 0.528$). Moreover, fascination, fluency, and savoring were very highly correlated with each other (all correlations were above 0.75). The high overlap between these measures highlights the necessity to investigate which measure could better account for the nature-PA link. I addressed this issue later in the section Multi-level Multiple Mediation Path Analysis.
Table 7.5. Correlations Among the Aggregated Daily Variables

<table>
<thead>
<tr>
<th></th>
<th>Nature</th>
<th>Fascination</th>
<th>Fluency</th>
<th>Savoring</th>
<th>Mindfulness</th>
<th>PA</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fascination</td>
<td>.569**</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluency</td>
<td>.405**</td>
<td>.783**</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savoring</td>
<td>.360**</td>
<td>.867**</td>
<td>.757**</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>.085</td>
<td>-.078</td>
<td>.051</td>
<td>-.201</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Affect</td>
<td>.083</td>
<td>.502**</td>
<td>.356*</td>
<td>.587**</td>
<td>-.203</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Negative Affect</td>
<td>-.078</td>
<td>.060</td>
<td>-.238†</td>
<td>-.021</td>
<td>-.059</td>
<td>-.265*</td>
<td>–</td>
</tr>
</tbody>
</table>

Note. N = 60. † p < 0.1; * p < 0.05; ** p < 0.01. 0 = Urban condition, 1 = Nature condition. Mindfulness was reverse-scored so that higher number indicated greater mindfulness.
### Table 7.6. Partial Correlations Among the Aggregated Variables after Controlling for Physical Activity

<table>
<thead>
<tr>
<th></th>
<th>Nature</th>
<th>Fascination</th>
<th>Fluency</th>
<th>Savoring</th>
<th>Mindfulness</th>
<th>PA</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fascination</td>
<td>.457**</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluency</td>
<td>.406**</td>
<td>.786**</td>
<td>–</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savoring</td>
<td>.172</td>
<td>.795**</td>
<td>.762**</td>
<td>–</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>.086</td>
<td>-.075</td>
<td>.044</td>
<td>-.197</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Affect</td>
<td>.083</td>
<td>.350*</td>
<td>.370**</td>
<td>.488**</td>
<td>-.188</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Affect</td>
<td>-.078</td>
<td>-.111</td>
<td>-.248†</td>
<td>-.175</td>
<td>-.075</td>
<td>-.355*</td>
<td>–</td>
</tr>
</tbody>
</table>

*Note. N = 60. † p < 0.1; * p < 0.05; ** p < 0.01.*
I also tested whether the associations found between nature and the outcome variables remained significant when controlling for physical activity. Table 7.6 shows the partial correlations between nature and fascination partialling out physical activity. The majority of associations were still highly significant, including fascination ($r = 0.569$, $\rightarrow r = 0.457$) and particularly fluency, which remained the same ($r = 0.405$, $\rightarrow r = 0.406$). The one exception was the correlation between nature and savoring was no longer significant ($r = 0.172$, $p = 0.236$) after controlling for physical activity. Therefore, the daily nature walk was uniquely associated with fascination and fluency, but not with savoring after holding physical activity constant at the between-person level. The preliminary results warranted further analysis in multilevel modeling to explore how exactly those variables could play in the link between nature and PA.

Prior to the main analyses (i.e., multi-level mediation analysis and multiple mediation path analysis), I examined how the main variables changed over time between the two groups. Figures 7.2-7.6 show the graph of daily PA, NA, fascination, fluency, and savoring over time for the nature and urban groups. PA showed the same trajectory in both groups except for a small increase in PA for the nature condition in the last few days of the study (and a small dip for the urban condition on the final day) (see Figure 7.2). NA showed the similar pattern (note a slight improvement for the nature condition on the final day) (see Figure 7.3). Fascination and savoring were consistently higher in the nature condition than the urban condition across the entire week (see Figures 7.4 and 7.6). And, it is interesting to note that daily fluency for the nature condition was stable whereas fluency for the urban condition was continuously decreasing over time (see Figure 7.5).
Figure 7.2. Daily changes in positive affect (PA) by condition (with 95% confidence interval error bars)
*Note.* The solid line = nature; the dot = urban.

Figure 7.3. Daily changes in positive affect (NA) by condition (with 95% confidence interval error bars)
*Note.* The solid line = nature; the dot = urban.
Figure 7.4. Daily changes in fascination by condition (with 95% confidence interval error bars)
*Note.* The solid line = nature; the dot = urban.

Figure 7.5. Daily changes in fluency by condition (with 95% confidence interval error bars)
*Note.* The solid line = nature; the dot = urban.
Figure 7.6. Daily changes in savoring by condition (with 95% confidence interval error bars)

*Note.* The solid line = nature; the dot = urban.
Multi-level Mediation Analysis

In the next set of analyses, I used the disaggregated data and investigated the relationships among variables at the within-person or daily level. To analyse the multilevel data (between/within level) and latent variables properly, multilevel structural equation modeling (SEM) was conducted using Mplus software version 7.31 (Muthén & Muthén, 2012). Multilevel mediation analyses were conducted to test whether potential mediators (fascination/ fluency/ savoring/ mindfulness) mediated the relationship between nature and PA for participants in the nature (versus urban) condition, controlling for physical activity. Although there was no direct effect of nature on PA overall, the recent literature on mediation analyses has indicated that the direct effect of an independent variable on a dependent variable is no longer required when computing all steps simultaneously (not computing in a step-by-step fashion), and each path (independent variable to mediation variable path/ mediation variable to dependent variable path) is significant (MacKinnon & Fairchild, 2009; Preacher, 2015). Multilevel SEM using Mplus can compute the paths simultaneously. As illustrated in Figure 6, the multilevel mediational model was defined as a 2-1-1 model. In the 2-1-1 model, a predictor (i.e., nature coded as 1 vs. urban coded as 0) was assessed at Level 2 (between-person level) whereas the potential mediator (e.g., fluency) and outcome (e.g., PA) were assessed at Level 1 (within-daily level). To use fluency as an example, the equation for this particular multilevel mediation model is shown below (adapted from Preacher et al., 2011; Preacher et al., 2010).
Level 1:
\[ \text{Fluency}_{ij} = \beta_{\text{Fluency}j} + \varepsilon_{ij} \]
\[ P_{Aij} = \beta_{PAj} + b_{wj}\text{Fluency}_{ij} + \varepsilon_{ij} \]

Level 2:
\[ \beta_{\text{Fluency}j} = \gamma_{\text{Fluency}} + a_{\text{Nature}j} + \mu_{\beta_{\text{Fluency}j}} \]
\[ \beta_{PAj} = \gamma_{PA} + c'_{\text{Nature}j} + b_{b}\beta_{\text{Fluency}j} + \mu_{\beta_{PAj}} \]
\[ b_{wj} = b_{w} + \mu_{b_{wj}} \]

For these equations, the level-1 model is just an intercept for “Fluency” and “PA”, and a within-daily effect of “Fluency” on “PA”. The level-2 model estimates a random “Fluency” intercept from “Nature” (a mean difference, path a), a random “PA” intercept from level-2 “Nature” (an adjusted mean difference and the direct effect of “Nature”, path c’), and the “Fluency” intercept for level-2 unit j (a between-person effect of “Fluency” on “PA”, path b), and allows the within-daily effect of “Fluency” on “PA” to vary between person (path b_w).

Following the method recommended by Preacher et al. (2010), a Monte Carlo procedure was used to estimate multilevel indirect effects. This procedure is suitable for multi-level designs in which other procedures might be difficult to apply technically (Preacher & Selig, 2012). Table 7.7 shows the unstandardized path estimates with 95% confidence intervals for the indirect effects. As expected, for participants in the nature condition, daily fascination, fluency, and savoring each significantly mediated the link between nature and PA. This is demonstrated by the finding that both their individual
paths (a/b) and overall indirect effects were significant even after controlling for daily physical activity (see Table 7.7). This was not the case for mindfulness (path a = -0.005, $p = 0.978$; path b = -0.015, $p = 0.836$; indirect effect = 0.000, $p = 0.980$). Although fluency appeared to be a mediator of the nature – NA link, the test of the indirect effect was not significant.
Table 7.7. Unstandardized path coefficients and 95% confidence intervals for indirect effects of the multilevel mediation model

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Mediator</th>
<th>Outcome</th>
<th>Path a</th>
<th>Path b</th>
<th>Indirect effect</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Lower)</td>
<td>(Upper)</td>
</tr>
<tr>
<td>Nature (vs. urban)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fascination</td>
<td>Positive Affect</td>
<td>.917**</td>
<td>.937**</td>
<td>.860**</td>
<td>.425</td>
<td>1.294</td>
</tr>
<tr>
<td>Fluency</td>
<td>Positive Affect</td>
<td>.719**</td>
<td>.864**</td>
<td>.621*</td>
<td>.042</td>
<td>1.201</td>
</tr>
<tr>
<td>Fluency</td>
<td>Negative Affect</td>
<td>.650**</td>
<td>-.416*</td>
<td>-.270†</td>
<td>-.564</td>
<td>.023</td>
</tr>
<tr>
<td>Savoring</td>
<td>Positive Affect</td>
<td>.677**</td>
<td>1.008**</td>
<td>.682**</td>
<td>.456</td>
<td>.908</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>Positive Affect</td>
<td>-.005</td>
<td>-.015</td>
<td>.000</td>
<td>-.006</td>
<td>.006</td>
</tr>
</tbody>
</table>

*Note. Path a coefficient represents the path between the predictor and mediator, and Path b represents the path between the mediator and the outcome. Path/Indirect effect estimates represent the unstandardized coefficient. The 95% confidence interval (CI) represents the lower and upper boundaries of the estimated indirect effect of the predictor on the outcome via the mediator.; † p < 0.1; * p < 0.05; ** p < 0.01. (significant all in bold)
Multi-level Multiple Mediation Path Analysis using Fascination as the Benchmark

Lastly, analyses were conducted with all three mediators (fascination, fluency, and savoring) entered simultaneously to examine the relative importance of these three mediators for the link between nature and PA. As Figure 7.7 shows, only daily savoring survived as the most proximal mediator of the nature/PA link ($\beta = 0.422, p = 0.038$). Daily fascination and fluency were no longer significantly associated with PA when entered together with savoring ($\beta = -0.077, p = 0.620; \beta = 0.038, p = 0.834$, respectively).

Figure 7.7. Multiple mediation path analysis. (Note. unstandardized path/correlation coefficient; † $p < 0.1$; * $p < 0.05$; ** $p < 0.01$).
An ad hoc analyses was conducted separating the savoring construct into savoring during the walk (experiential absorption, sensory-perceptual sharpening as savoring 1), and savoring after the walk (sharing with others, counting blessings as savoring 2) to determine whether savoring during or after the walk was the stronger predictor of PA. As Figure 7.8 shows, only daily savoring 2 survived as a mediator of the nature/PA link ($\beta = 0.429$, $p = 0.035$). Daily fascination, fluency, and savoring 1 were no longer significantly associated with PA ($\beta = -0.057$, $p = 0.701$; $\beta = -0.053$, $p = 0.798$; $\beta = 0.040$, $p = 0.795$, respectively).

![Figure 7.8](image)

Figure 7.8. Multiple mediation path analysis separating out savoring during the walk (savoring 1) and savoring after the walk (savoring 2).
Additional analyses were conducted with the three remaining mediators (fascination, fluency, and savoring 1) entered simultaneously excluding savoring 2 to examine the relative importance of the remaining three variables. As Figure 7.9 shows, all three mediators were no longer associated with PA (β = 0.020, p = 0.891; β = 0.147, p = 0.378; β = 0.233, p = 0.173, respectively). This could be due to their multi-collinearity or possible bidirectional relationship.

Figure 7.9. Multiple mediation path analysis modeling only savouring during the walk (Note. unstandardized path/correlation coefficient; † p < 0.1; * p < 0.05; ** p < 0.01).
Final Path Model

Taken together, the results implied a rather complex mediational relationship between nature and PA. So I conducted a final path analysis to better understand this relationship based on the results of the multiple mediation path analyses. Figure 7.10 presents the proposed process model of how nature is related to PA at the between-person level. In this model, the bi-directional relationship between fascination and fluency was emphasized, and the temporal relationship between savoring 1 and 2 was included. This process model shows that walking in nature increased feelings of fascination overall, which had bidirectional effects on fluency. Higher fascination, in turn, was associated with higher average savoring during the nature walk. In turn, higher savoring after the walk increased PA. This process model showed good to excellent fit with the data: a comparative fit index (CFI) = 0.913, Tucker–Lewis index (TLI) = 0.882, root-mean-square error of approximation (RMSEA) = 0.059, standardized root mean square residual (SRMR) for between = 0.079, (SRMR) for within = 0.045 (Kline, 2011).

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2 A final within-person path model was not computed because the nature (vs. urban condition) varied only at the between-person level; therefore, the within-person model cannot be modeled.
Figure 7.10. Multi-level Process Model of How Nature is related to PA (Between-person). Note. Unstandardized path/correlation coefficient; † p < 0.1; * p < 0.05; ** p < 0.01.
Discussion

Study 5 aimed to test other potential mediators in addition to fascination that might account for the beneficial relationship between nature and PA. This study expanded the scope of research by showing that fluency and savoring also mediated the relationship between nature and PA in addition to fascination. However, when all mediators were compared with each other, savoring proved to be the single most proximal mediator, which itself was influenced by feelings of fascination. Mindfulness did not play any role in this relationship. It is interesting to note that there was no direct effect of the nature manipulation (the daily walk in nature) on PA. This contrasted sharply with the results of the previous studies. It may be because the way PA was measured. In this study, PA was measured at the end of the day, not immediately after the walk like the other studies. This was a limitation, but one that was overcome by applying more sophisticated tools for testing mediation that did not require significant direct effects.

Fascination

This study replicated the results of the previous studies in which fascination mediated the nature – PA link. Across a week-long intervention, walking each day in nature increased feelings of fascination, which in turn, increased end-of-day PA. This finding is encouraging given there is such consistency in results particularly when using a week-long diary experiment, not just a short-term experiment or correlational study. When considered with the other mediators in a path model, fascination continued to play
a central role in this link, however, fascination only influenced PA indirectly through its effects on savoring.

Fluency

Fluency proved to be a promising potential mediator in the relationship between nature and PA when tested individually, but it appears to be strongly related to fascination, and more likely to augment experiences of fascination in a bidirectional way in the end. According to the final process model (Figure 7.10) fluency seems to play a supporting role in the nature–PA link by indirectly affecting PA via increased fascination and savoring.

Interestingly, higher daily fluency was associated with significantly lower NA regardless of whether people were assigned to walk in nature or urban environments (path b; from Table 7.7). This finding suggests that the more fluency experienced during the walk, the less anxious, angry, and sad they felt later in the day. Yet, according to the hedonic marked theory of fluency, fluency should “selectively” work on only PA, not NA (Halberstadt & Winkielman, 2014; Winkielman et al., 2003). It may be due to differences in that previous studies assessed fluency in the lab under strict controlled environment, whereas I assessed fluency outside of the lab in a daily context. Unlike more controlled laboratory stimuli, the stimuli that participants are exposed outside the lab cannot be controlled, and are therefore more varied and complicated. For example, ambient noise outside the lab might contribute to the differences. One recent study suggested that high fluency can amplify the effect of stimuli (either positive or negative) compared to low fluency (Albrecht & Carbon, 2014). It is possible that the less intensified negative stimuli
(e.g., less ambient noise outside) participants were exposed to, the less NA they felt later in the day if they experienced high fluency during the walk. Further investigation needs to clarify this issue.

The newly introduced three item daily fluency measure was a welcome addition in this study. The scale had excellent multilevel reliability and face validity. It is interesting to note that reliability was higher at the between-person level than at the within-person daily level. This is common in measurement reliability analyses because the within-person reliability is more influenced by the number of items (i.e., one more item can increase reliability to some extent). Considering the fact that fluency had a small number of items (i.e., three items), the new scale’s reliability value of .64 at the within-person level is reasonable (see Shrout & Lane, 2012 more detail). This indicates the scale’s suitability for a range of daily diary studies focused on between and within-person differences. For example, this kind of a measure can be used to examine whether people vary in their average daily experiences of fluency (between-person) or whether daily fluency varies as a function of other daily behaviors like walking in nature, sleeping, and engaging in social interactions (within-person). More studies need to be done to validate this new scale.

**Savoring**

Initially, daily savoring turned out to be the most potent player in the mechanism linking nature to PA (see Figure 7.7). However, after separating into savoring *during the walk* (savoring 1) and *after the walk* (savoring 2), it was savoring *after the walk* that was the most proximal and significant predictor of PA (see Figure 7.8). This finding suggests
that positive emotion regulation plays an important role in the beneficial effects of nature; however, it is too early to conclude that savoring plays a more crucial role compared to the other information processing variables like fascination or fluency. One issue is that positive affect was only measured at the end of the day, and not immediately after the walk. It is possible that if positive affect was measured immediately after the walk, the information processing variables may have had equal effects on immediate increases in PA. For example, Figure 7.11 below presents what results might have occurred if PA was measured immediately after the walk in addition to the end of the day. I predict that nature would be associated with fascination (which has a bi-directional relationship with fluency), and then fascination would be associated with savoring during the walk (savoring 1). This is similar to the original model (Figure 7.10). However, whether fascination would be associated uniquely with PA immediately after the walk is unknown. I can only speculate that fascination would be associated uniquely with PA considering its strong ties with PA as the previous studies demonstrated. It would be important for future research to shed more light on these temporal issues.
Figure 7.11. Extended Multi-level Process Model of How Nature is related to PA (Between-person)

**Mindfulness**

Mindfulness did not mediate the link between nature and PA. This is consistent with Study 2 but still surprising considering the fact that similar constructs such as fascination and savoring were shown to meditate the nature-PA association in this study. However, it does not mean that mindfulness never increases PA in general. It merely indicates that mindfulness is not the pathway through which a daily nature (vs. urban) walk increases PA.
Limitations

The main limitation of this study, as mentioned above, is that the PA measure was taken only at the end of the day, and with a relatively wide timeframe, asking people about how they felt “that day”. Their PA reports were a summary judgment of their entire day. This timeframe may have introduced more error and less sensitivity, making it harder to detect the exact temporal sequence existing between predictors (fascination/fluency/savoring) and the outcome (PA). Similarly, people were asked to retrospect on their experiences of fascination, fluency, and savoring during the walk which decreases memory accuracy when asked at the end of the day. However, according to Parkinson and his colleagues (Parkinson, Briner, Reynolds, & Totterdell, 1995), end of day retrospective reports are reasonably accurate, suggesting that memory bias in this study was reasonable. Further studies need to address these temporal measurement issues, possibly using experience sampling methods to track the dynamics of real-time experiences throughout the day. Another limitation was the relatively small sample size (n = 60). Although the repeated measures aspect of the designed increased the sample size to 420 observations, a larger sample would have potentially improved sensitivity to detect patterns in the data. For example, with more subjects, the nature (vs. urban) condition might have had more detectable main effects on PA. Moreover, the indirect effect of nature on NA through daily fluency might have been statistically significant with a larger sample size (particularly given that the magnitude of the indirect effect was relatively large enough to be meaningful). The last limitation is that the mindfulness measure was quite limited; only one item was used given severe space restrictions in the
daily diary. Nevertheless, this one item was the top scoring item of the mindfulness index, and so if there were mindfulness effects, I would expect at least some signal with this one item, but there was not even a trend for mindfulness in this study. Further investigation needs to address these issues.

**Conclusion**

This capstone study demonstrated that processes related to both information processing and emotion regulation can play important roles in mediating the beneficial effect of nature experiences. Study 5 replicated the role of fascination found in Studies 1–4, and it extended this to show a role for fluency, including introduction of a new daily fluency measure. Perhaps the most interesting finding of Study 5 was the discovery of savoring as an emotion regulation strategy that mediated the nature PA–link. This finding suggests that nature can enrich human’s everyday emotional life via its effect on emotional savoring. Lastly, this study demonstrated the usefulness of emerging statistical techniques such as multi-level SEM that enabled me to directly test the structural pathways linking nature to PA. These techniques provided a useful analytic tool for building a latent variable modeling framework and for testing indirect effects at the between and within-person level.
8. CHAPTER 8: GENERAL DISCUSSION

The aim of the thesis was to examine the effects of nature on emotional well-being and to identify potential mechanisms that might account for this relationship. In Studies 1 to 4, I mainly focused on each potential mechanism in isolation. However, Study 5 showed that several variables played important roles in mediating the nature well-being link – including fascination, fluency, and savoring. These findings suggest that variables related to information processing (fascination and fluency) and emotion regulation (savoring) are both important for understanding the beneficial effects of nature on people’s feelings.

The strength of this thesis was its multi-method approach. I investigated the links between nature and well-being using a range of research strategies including a large scale correlational study, field experiments, and daily diary designs. My capstone study – Study 5 – combined the best elements of these designs by combining a repeated field experiment with a daily diary method to track the effects of nature (vs. urban) environments over a longer period of time in daily life. Regardless of how nature was tested (either measured or manipulated), experiencing nature consistently resulted in increased benefits to the individuals tested. People who engaged in nature reported higher PA, fascination, fluency, and savoring, and sometimes lower NA. Moreover, recent statistical advancements enabled me to handle the complex data properly. In addition to
applying statistical tests of moderation and mediation (Jose, 2013; Sobel, 1982), I was able to estimate indirect effects in a sophisticated multilevel dataset by using multi-level structural equation modeling (MSEM) in Study 5 (Preacher et al., 2011; Preacher et al., 2010). Using this approach, I was able to estimate indirect effects at the daily and person level and construct more complicated path models taking into account the nested data. The application of MSEM revealed the dynamic processes of the nature and PA relationship by testing daily and person processes separately using the special software package (Muthén & Muthén, 2012).

Overall, the most consistent finding of this thesis was that nature was related to increases in PA, whereas urban environments were related to decreases in PA. The one exception was in Study 5, which found no direct effect of nature on PA, but for what are likely methodological reasons. The generally consistent findings for PA are consistent with a range of past research that has shown, for example, viewing nature images results in increased PA in lab settings (van den Berg, Koole & van der Wulp, 2003), that proximity to nature results in higher PA (Stigsdotter et al., 2010), and that walking in natural environments results in more enhanced PA than walking in urban environments (Hartig et al., 2003).

A less consistent finding in this thesis was the link between nature and NA. Some past research has also failed to detect the effect of nature on NA (e.g., Herzog & Strevey, 2008) whereas other studies were able to detect the effect (e.g., Bratman et al., 2015). These inconsistent findings imply that the relationship between nature and NA might not
be straightforward. One possibility is that nature’s effect on NA could be via indirect pathways. For example, the daily fluency yielded the marginal indirect effect of time in the Study 5 results (indirect effect = -.270, p = 0.071). I would like to point out that there are some moderating effects on NA too (e.g., Wells & Evans, 2003). Inconsistent effects of NA might also reflect the influence of “biophobia” - the specific human inner tendency opposite to biophilia. Biophobia is the tendency to experience fear in nature as a way to avoid the risk of direct encounter with predators (Ulrich, 1993). This biophobia tendency could operate against the biophillic tendency in terms of its effects on NA, possibly counteracting any benefits. In short, biophobia could cancel out the effects of biophilia on changes in NA. However, what kind of nature exactly can trigger this cancel-out operation is unknown and further investigation is needed. The other possibility is due to the lack of important intermediate agents. The existence of the intermediate agents (fascination/fluency/savoring) seems to be vital in harvesting nature experiences. Considering the fact that PA is associated with all of these agents (NA is associated with only fluency), the overall nature’s link to NA might be weak (if not nonexistent).

The most important contribution of the thesis is to deepen our understanding of the psychological mechanisms that mediate the nature–PA link. It is very impressive that fascination has continued to be a significant mediator throughout all five studies (Study 1- 5). The consistency of these findings suggests that fascination is a key element to enhancing well-being in natural environments. This finding is consistent with attention restoration theory (Berto, 2014; Kaplan & Kaplan, 1989; Kaplan, 1995). According to
this theory, nature provides the opportunity for participants to be exposed to fascinating stimuli. These stimuli require very little conscious effort to attend to (Kaplan & Kaplan, 1989), which allows participants’ attentional resources to rest and be preserved for further additional use. These positive experiences of attention restoration accompanied with relief from mental fatigue can result in enhanced PA (Berman et al., 2008).

Nature provides the opportunity for participants to be exposed to fascinating stimuli easily. Attending to these fascinating stimuli does not require any conscious effort, so participants can put their attentional resources at rest and be preserved for further use. This process of attention restoration may provide additional attentional capability to regulate and appreciate PA as a result. However, urban environments foster less fascination, which had ill effects on PA. Urban environments may be stimulating, but they also have many distractions (traffic lights, pedestrian traffic, noisy environments, etc.). These distractions demand greater attentional resources compared to nature, which may prevent efficient attentional restoration (i.e., less fascination). This attentional cost might give less room for PA to be attended and appreciated. Fascination is the key which might supply additional attentional resources for regulating/appreciating PA, and natural environments provide more fuel for fascinating experiences than urban environments.

Fluency also explained some of the relationship between nature and PA. I hypothesized that fluency might play a role given that visual stimuli from beautiful objects (including visual stimuli in nature) are associated with higher fluency (Leder et al., 2004), and that fluency is consistently associated with higher PA in laboratory
experiments (Winkielman et al., 2003). My predictions were confirmed with the results of Study 5 showing that when tested as a separate mediator, daily fluency significantly mediated the link between nature and PA. This is a completely novel finding that suggests that other factors associated with information processing play a role in the nature–PA link. Specifically, this finding suggests that as people experience nature, they are processing natural stimuli more fluently. Nevertheless, when tested with the other mediators in the final model, fluency’s effect on PA was indirect, and mediated through fascination as the multi-level process model from Study 5 suggests (see Figure 7.9 in Study 5). This finding suggests that fluency plays a key supporting role by increasing feelings of fascination, which influenced subsequent affective processing. Fluency is thus an important player through its indirect effects on subsequent affective processes via fascination.

**Fascination – Fluency Circuit**

Overall, these findings suggest that fascination and fluency reinforce each other in order to process incoming information effectively overall, which is consistent with previous research showing that both fascination and fluency can play a similar important role in enhancing information processing (Alter & Oppenheimer, 2009; Berto, 2014). The evidence supporting a fascination–fluency circuit might be backed up by the literature on fractal geometry. Fractal geometry is found in many natural objects and is defined by the presence of repeating and nested geometric features (Mandelbrot, 1983). A recent study suggested that fractal geometric objects may have some characteristics of fascination, which can be translated into fluency (Joye, Steg, Ünal, & Pals, 2016). Together, these
results suggest that a fascination–fluency circuit system could be crucial in the relationship between nature and PA link.

The fact that fluency might play a role in the nature-PA process is plausible from an evolutionary sense. Human beings have been exposed to nature for a few million years. Unlike natural environments, urban environments have been introduced to human civilization only recently. Considering that repeated exposure is one of the major determining factors in fluency (other factors are symmetrical or aesthetic stimuli) (Reber et al., 1998; Winkielman et al., 2003), people’s repeated exposure to nature over their evolutionary history could make the stimuli from nature environments more fluent than the stimuli from urban environments. This fluency, in turn, can produce pleasurable feelings, consistent with a large body of laboratory research (e.g., Reber, 2012; Reber, Schwarz, et al., 2004; Winkielman et al., 2006; Winkielman et al., 2003).

Another novel finding of this thesis was the discovery of savoring as an important mediator of the nature-PA link. I propose that nature may promote an “inner savoring tendency” which has a perpetuating effect on positive emotion. Natural environments not only provide an opportunity for experiencing happiness per se, but they also possess the capacity of prolonging this experience. According to biophilia (Wilson, 1984), interaction with nature has an adaptive value for human survival. Thus, I speculate that nature promotes processes in the human mind that not only enhance pleasure while in nature but also encourages interaction with nature as much as possible. This tendency may include behavioral strategies for prolonging and maximizing the pleasurable experiences from
nature, which is savoring (Bryant & Veroff, 2007; Jose et al., 2012). Taken together, the “fascination–fluency” circuit (information processing) could serve as a core element that triggers savoring (emotion regulation) which translates into enhanced emotional states. It is interesting for future research to investigate how nature, via the fascination–fluency circuit, can trigger and enhance similar behavioral strategies (e.g., acceptance/reappraisal).

My research also suggests that nature might automatically “switch on” a fascination–fluency circuit, which stimulates savoring, which then results in improved emotional states. The repeated cycles of fascination–fluency circuit (which resulted in the rewarding experiences of savoring each time humans were exposed to nature) (see Figure 8.1) might have been automated over a few million years. Now, with the effects of “conditioning” on the fascination–fluency circuit, it may become possible to switch on without any conscious effort whenever humans have contact with nature. This fascination–fluency circuit could be ancient.
Implications

The present thesis confirmed several positive benefits of nature, which suggests that people should incorporate more nature into their daily lives. First, my research suggests that nature could have certain cognitive benefits by reason of enhanced information processing via greater fascination. According to the information processing view of decision-making, enhanced information processing (via fascination) may help improve a range of cognitive outputs – from enhancing motor abilities associated with
complicated actions (Gibson, 2002) such as driving, (Satariano et al., 2012), to making better decisions in uncertain situations (Daft & Lengel, 1986; Galbraith, 1977), and better top-down cognitive control to help cope with challenging situations, like stress or pain (e.g., Johnson, 1984; Johnson, Lauver, & Nail, 1989). As shown in the restorative literature, nature walks can help people improve their cognitive processes (e.g., Lee et al., 2015), which could even translate into health benefits. Better information-processing is known to enhance understanding and acceptance of negative experiences, such as coping with surgery (Johnson, 1984) or radiation therapy (Johnson et al., 1989). Nature walks might help to ease the pain in this regard.

On top of the possible cognitive benefits, my research suggests clear emotional benefits from interacting with nature (and clear deficits when interacting in strictly urban environments). This finding has wide reaching implications for how cities and spaces should be organized to maximize well-being. Foremost, city planners should consider trying to incorporate more natural elements into urban design. Past research suggested that people who lived in greater urban proximity to green space had better health (Stigsdotter et al., 2010). The same goes with indoor plants (Bringslimark, Hartig, & Patil, 2009), green roofs (Loder, 2014), and green (trees/plants) views from windows (Ulrich, 1984). It may begin with small-steps, such as encouraging people to put more plants in their work places/houses. Larger steps can be taken such as motivating people to build more green roofs with tax incentives. Implementing green roofs in cities can help to ease the problems which are typical of modern cities (i.e., limited surface spaces). A few cities
have already promoted green roofs (e.g., Toronto and Chicago; Loder, 2014). City planners should try to preserve and develop inner city-gardens and greenbelts so that people can have rooms with green views, and places to interact with nature. Introducing more green features into the urban environment can potentially mitigate “nature deficit disorder.” (Louv, 2005). The potential well-being benefits would be welcome to any city planner/policy maker concerned with the well-being of their citizens.

Findings from this thesis also have implications for improving individuals’ well-being. People should actively seek out and maximize opportunities to engage in nature in their daily lives. Importantly, deriving benefit from nature does not require a multiple-day nature expedition; it may only require a 20-minute walk in a park/garden. However, people in urban cities may have some difficulties in taking a “green-walk” because of the limited access to natural environments.

Although the current thesis focused on natural environments as a primary driver of well-being, other research has found that some urban stimuli such as visiting museums can provide similar experiences (e.g., Kaplan et al., 1993). By distilling the complex nature experience into more simple mechanisms (e.g., fascination, fluency), it is safe to say that an important environmental prerequisite can be anything which can trigger the fascination–fluency circuit. In this regard, public art (e.g., sculptures/art objects in public spaces) in urban environments might be good candidates for environmental intervention since the presence of urban public art in a city can induce pleasant feelings (Motoyama & Hanyu, 2014). Fractal geometric objects can be another candidate as the fractal objects
may have restorative effects (Joye et al., 2016). This may open the possibility for city dwellers who have limited access to nature and for city planners who need more options besides making their cities greener. It is worth exploring how public art objects/ fractal objects can influence PA in urban public places. Whether urban environments with specially designed objects are rated equally as fascinating and fluent as natural objects/green spaces is an open question. Further studies need to address these issues.

**Limitations**

This thesis identified several pathways by which nature influences well-being, but this is by no means a complete list. There may be a range of other possible pathways linking nature and PA. For example, Mayer and colleagues demonstrated that subjective feelings of “connectedness” to nature (i.e., the present feeling of closeness toward natural environments) mediated the relationship between nature and PA (Mayer et al., 2009). Moreover, a recent review article by Kuo (2015) offered a list of 21 potential candidates of pathways linking nature to health outcomes. These pathways included relaxation, vitality, sleep, and social ties. Of these, Kuo suggested that immune functioning might be the central pathway linking nature to health (Kuo, 2015). In Kuo’s model, nature stimulates various optimal physiological and psychological conditions (e.g., blood glucose and relaxation), which, enhance immune functioning, which ultimately contributes to good health outcomes. Kuo (2015) included attention restoration (i.e., fascination) on the list, but as a separate cognitive mechanism not mediated by immune function. It is interesting to note that fluency and savoring were not on the list of the 21
candidates linking nature to health outcomes (Kuo, 2015). My research suggests that they should be on the list. It is an open question whether fluency and savoring would predict immune system changes – there is no evidence to suggest that either way. Although immune system function is related to well-being in a broader sense (via enhanced inflammation, which can improve healing from surgery, reduce physical symptoms, or reduced inflammation, which is linked to lower depression), this thesis was focused mainly on the link between nature and PA. The pathways to emotional well-being could be quite different from the pathways to physical health (via inflammation).

Furthermore, fascination, savoring, and fluency themselves may not always lead to PA, and the effects are likely moderated by other factors. For example, many stimuli in nature are beautiful, and beauty in itself influences PA. A recent lab study (Zhang, Howell, & Iyer, 2014) showed that participants with exposure to more beautiful natural images had significantly increased positive emotions than participants with exposure to less beautiful ones. But not all images in nature are aesthetically pleasing, and it may be the combination of fascination and aesthetic beauty/ugliness could function as a supplement/suppressive variable to the relationship between nature and PA. Being fascinated by the sight of natural beauty (e.g., a seaside town) can lead to increased PA; being fascinated by the sight of natural ugliness (a seaside town following a tsunami) might lead to the opposite effect. It is possible that only a combination of beauty and fascination is sufficient to evoke PA, which would be an important topic for future research.
Conclusion

This thesis showed that nature can offer powerful “feel good” experiences. These experiences are directly tied to cognitive experiences of fascination and fluency, and emotional processes such as savoring, which are evoked from natural environments. These findings linking nature to PA, and the ease of cognition and emotion in natural environments support a biophillic principle, suggesting that humans have an inherent affiliation to natural environments (Kellert, 1993; Wilson, 1984). Although such biophillic tendencies provided a competitive evolutionary advantage during ancestral environments (Berto, 2014; Kaplan & Kaplan, 1989), the present thesis suggests that the advantages of nature are still present among modern humans. Although it might be increasingly difficult to find nature in a modern environment, once in nature, we humans do not have to motivate ourselves too much to gain maximum benefit from nature. The inner drive to seek nature has been there with us since the early human evolutionary stage. All we need is to quietly listen to this inner voice and just follow its advice; that is the power of nature.
REFERENCES


### APPENDIX: PERCEIVED RESTORATIVENESS SCALE (PRS)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all</th>
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<th>Completely</th>
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<td>1. Being there was an escape experience.</td>
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<td>2. I wanted to spend more time looking at the surroundings.</td>
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<td>3. It was a confusing place.</td>
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<td>4. It was chaotic there.</td>
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<td>5. I had a sense that I belong there.</td>
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<td>6. Being there suited my personality.</td>
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<td>7. My attention was drawn to many interesting things there.</td>
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<td>8. I wanted to get to know that place better.</td>
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<td>9. There was much to explore and discover there.</td>
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<td>10. Spending time there gave me a break from my day-to-day routine.</td>
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<td>11. I could find ways to enjoy myself there.</td>
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<td>12. That place was fascinating.</td>
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<td>13. There was nothing worth looking at there.</td>
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<td>14. There was too much going on.</td>
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<td>15. It was a place to get away from it all.</td>
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<td>16. There was a great deal of distraction.</td>
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17. Being there helped me to relax my focus on getting things done.

18. **That place had fascinating qualities.**

19. I could do things I like there.

20. Going there helped me to get relief from unwanted demands on my attention.

21. **That place was boring.**

22. I had a sense of oneness with that setting.

*Note. Fascination items are bolded.*