EFFECT OF EXPOSURE TO NATURE ON SUBSEQUENT STRESS, AS MODERATED BY PERSONALITY AND CONNECTEDNESS TO NATURE

by

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Abstract

Experiences with nature can help us cope with the impact of stress. Research indicates that exposure to nature following a stressful event can reduce the stress evoked by that event (e.g., exposure to nature reduces autonomic arousal, stress, and stress-related health complaints). However, research has largely ignored the possibility that exposure to nature may prevent or reduce the effects of a subsequent stressor. Moderated multiple regression was used to assess whether personality and connectedness to nature moderate the inoculative effects of virtual nature and urban exposure on subsequent emotional stress. In a controlled laboratory environment, undergraduates completed self-report measures and took their own heart rate and blood pressure before and after watching one of three videos, and also before and after viewing emotionally negative pictures. Individuals high in neuroticism had a significant reduction in positive affect when exposed to virtual urban videos, and individuals high in openness had a significant reduction in diastolic blood pressure when exposed to a virtual nature video. No significant findings were found for agreeableness, conscientiousness, connectedness to nature, heart rate, or systolic blood pressure; although systolic blood pressure statistics approached significance and had congruent findings with diastolic blood pressure. Significant findings were found for the personality traits of openness and neuroticism. The findings suggest that exposure to virtual nature may have inoculative benefits to subsequent stress, but future research on duration of exposure, exposure to real nature, and exposure to various stressors is necessary to define under what circumstances inoculative effects take place. Implications of this research could impact education and health policy by promoting increased exposure to real and virtual nature.

Preface

A version of chapter one has been published as a book chapter [Crawford, M. R. & Holder, M. D. (2012). Enhancing spirituality and positive well-being through nature. In C. A. Stark & D. C. Bonner (Eds.), *Spirituality: Belief systems, societal impact and roles in coping* (pp. 171-189). Hauppauge, NY: Nova Publishing] as well as a journal article [Crawford, M. R. & Holder, M. D. (2012). Enhancing spirituality and positive well-being through nature. *International Journal of Psychology Research, 7,*(2). Retrieved from *https://www.novapublishers.com/catalog/product_info.php?products_id=30814*. The book chapter and journal article was a collaboration between Maxine Crawford and Mark Holder, with Maxine contributing 65% of the writing and Mark contributing 35%.

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Dedication

For Todd Thexton. You made this possible and I am eternally grateful.

Chapter One

Humans have an intrinsic and complex relationship with nature that has been difficult to understand and define. Historically, the relationship was understood from a pragmatic standpoint because the dependency of humans on their natural environment was far more tangible in the past than it is now. The intimacy between hunters and gatherers and the environment providing sustenance for them was imperative for survival. But to state that the human connection to nature is purely based on a relationship of sustenance is shortsighted. In addition to using the environment as a source of provision, using the environment as a source of inspiration and beauty has long been a preoccupation of humans. For centuries nature has served as a muse to inspire creative works, and has captivated the imagination of children and adults alike. Theories have been developed to explain why people find nature so enthralling and why they have such a strong connection to their natural surroundings (Kaplan & Kaplan, 1989; Orians & Heerwagen, 1992; Ulrich, 1983; Wilson, 1984). Explorations into the compelling aspects of nature have led to empirical investigations that attempt to explain our connection to nature, as well as how we benefit from the connection.

One area of research involves active interaction and the therapeutic impact that appears to exist when people physically interact with nature. Implementing gardening activities to facilitate healing has a long and rich history that demonstrates emotional, physical, social, and intellectual improvements for individuals (Hefley, 1973). Horticultural therapy is based on this premise and promotes active engagement with plant material for children, the elderly, and individuals diagnosed with mental illness.

Another area of research investigates passive interactions with nature and includes how just the *sight* of nature can impact a person's physical and psychological well-being. The fact that people enjoy nature influences how we design our backyards, design our park and urban settings, and implement policy concerning the preservation of natural areas (Parsons, Ulrich, & Tassinary, 1994). Much of the early passive interaction research focused on the aesthetic preferences of individuals, such as preferred tree shape and ground cover (Kaplan & Kaplan, 1989; Orians &0 Heerwagen, 1992). More recently, research has focused on how passive exposure to nature influences our physical and mental well-being. For instance, exposure to nature can increase recovery from illness (Raanaas, Patil, & Hartig, 2011; Ulrich, 1984), lead to therapeutic benefits for children with Attention Deficit Hyperactivity Disorder (Faber, Taylor, & Kuo, 2009), improve cognitive recovery (Kaplan, 1995), increase longevity (Takano, Nakamura, & Watanabe, 2002), and improve health (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenburg, 2006). As well, exposure to real or virtual nature reduces stress (Berto, 2005) and may act as a buffer to other stress-related health complaints (van den Berg, Maas, Verheij, & Groenewegen, 2010). The current study addresses these last benefits, and in particular examines whether nature can be used to inoculate against the impact of future stress. Before discussing the specific design of this study, an overview of the prevalent theories is presented.

Theories of the Human and Nature Connection

Biophilia.

One theory that purports to explain the connection people experience with nature is biophilia (Wilson, 1984). Biophilia supposes that we have a natural inclination toward

nature and other living things, which can be identified by our relationship to nature throughout history. In his book, Wilson uses the example of the relationship humans have with snakes because it exemplifies how we are drawn to other living organisms. From the time of the Pharaohs through Christianity, fear and fascination have guided human interest in the snake. Many cultures have transformed the humble snake into a serpent of power, viewed with trepidation and wonder. Humans have taken an organism with deadly potential and turned it into a mythical creature through our dreams, ceremonies, and folklore. Wilson's biophilia hypothesis is at the heart of this transformation because it speaks to our connection with other species, and this connection spans cultural and/or geographical boundaries.

Wilson's (1984) position is that we are not far removed from our ancestors who lived in more natural settings for several millennia. From an evolutionary perspective, it is unlikely that we have evolved so far in the last several hundred years that we are not drawn to, and influenced by, the natural world that surrounds us. It is quite probable that humans respond favourably to environmental features that increase their chance of survival. Two hypotheses address this affiliation we have to our natural surroundings: one purports an instinctual attraction to a similar biome as our ancestors, and the other suggests that we are drawn to environments that appear to have ample resources and offer safety and ease of movement.

Savanna hypothesis.

The savanna hypothesis suggests that humans have a natural predisposition toward an environment replicating our ancestral landscape. The lineage of *Homo sapiens* can be traced back to the savannas of Africa and our preference for this savanna-type

landscape has been empirically tested. Orians and Heerwagen (1992) found support for the savanna hypothesis by examining people's preferences for tree shapes. They reported that individuals prefer the shape of trees found in a savanna setting, which include moderately dense foliage and trunks that split into two close to the ground. Another empirical investigation of the savanna hypothesis is based on the concept that a predisposition for the savanna should be more prevalent in children rather than adults, as experience has not had the opportunity to alter or mask their genetic inclinations. Balling and Falk (1982) found support for this argument when their research demonstrated children favoured a savanna landscape, over other landscapes, as a potential place to live as well as visit.

General evolutionary hypothesis.

Another hypothesis is that humans have an innate connection with environments that appear to have the necessary resources to sustain them, as well as offer protection and ease of movement. Many communal and private spaces in urban landscapes (e.g., parks, golf courses, cemeteries and personal properties) all share common features. These landscapes are dominated by flowing lawns with smooth paths that meander through a landscape punctuated by small clusters of plants and trees, and ideally some form of water feature. Kaplan and Kaplan (1995) have completed various studies supporting the perspective that humans prefer natural environments that provide good visibility but also some form of protection. As well, we prefer landscapes that allow free movement through the environment rather than shallow, thick brush. The former landscapes are more open and allow one to move quickly which fosters a feeling of security. These environmental preferences remain relatively constant regardless of cultural background

(Ulrich, 1983) and the process by which we identify the preferred environment happens very quickly (Kaplan & Kaplan, 1995). Both characteristics support the theory that our reaction to nature is strongly guided by evolutionary principles.

Attention restoration theory.

Exploring the hypothesis that humans have an evolutionary preference for environments that protect and sustain us, Stephan and Rachel Kaplan have built upon the seminal work of William James on voluntary and involuntary attention (1892/1984). James identified involuntary attention as requiring no effort and as generally taking place when something exciting garners one's attention. Examples of this may be a car chase on television, a brightly coloured bird that flies by you, or a loud bang from a car backfiring. James characterized voluntary attention as a process that requires effort from the individual. This means that a person has to intentionally resist being distracted by other more appealing stimuli and continue to purposefully focus on the task or stimuli at hand. An example provided by James is of being at a dinner party and having to focus your attention on the boring conversation with your neighbour while the rest of the guests share in a rousing laugh.

Kaplan and Kaplan have expanded on James' inhibiting and purposeful concept of voluntary attention and refer to it as directed attention (Morecraft, Geula, & Mesulam, 1993). Due to the fact that an individual must resist and inhibit other stimuli to focus on the one at hand, Kaplan and Kaplan propose that an individual experiences mental fatigue as a result of sustained directed attention. This mental fatigue has been shown to have an impact on a person's well-being and their social interactions. For instance, it can make

people more aggressive (Donnerstein & Wilson, 1976) and less tolerant (Rotton, Olszewski, Charleton, & Soler, 1978).

Alleviating mental fatigue brought on by directed attention, and reducing the negative side effects, has been a focus of empirical studies and theory development. Attention restoration theory (ART; Kaplan & Kaplan, 1989; Kaplan, 1995) addresses the fact that prolonged focused attention can cause mental fatigue or exhaustion. From the ART perspective, restorative environments should include four properties: engage attention with ease (fascination), be different from the person's normal environment (being away), have a diverse and rich setting (extent), and be compatible with the individual's interests (compatibility). As well, an individual's recovery from attentional fatigue is more likely to occur in a setting where the demands for directed attention are relatively low. Settings with low demands for directed attention occur much more frequently in natural than urban environments (Berman, Jonides, & Kaplan, 2008; Cimprich, 1992; Hartig, Mang, & Evans, 1991). The suspected reason for this is that natural environments allow a chance for directed attention to rest because they are drawing on involuntary attention and soft fascination (Kaplan & Berman, 2010). Soft fascination is a bottom-up attentional process whereby involuntary attention takes place but does not monopolize attentional resources. In other words, the process by which a person is captivated by pleasing stimuli in a natural setting is effortless and does not drain attentional resources. To be clear, it is not impossible to restore directed attention in urban environments, but it is less likely because of the demands placed upon the individual in a busy urban environment.

Psychoevolutionary theory.

Conceptually different from ART, psychoevolutionary theory (PET; Ulrich, 1983; Ulrich et al., 1991) is another theory rooted in the evolutionary perspective that attempts to explain the human connection to nature. The PET perspective focuses primarily on emotion and views stress as a combination of physiological reactions to situations that threaten well-being. Ulrich (1983) proposes that our immediate affective response to an environment has an influence on the subsequent cognitive perception and actions. The affective response is based on a person's preferences in relation to the stimuli, and their reaction to it can occur without a cognitive process (Zajonc, 1997). Ulrich (1983) states that a person's immediate affective responses to stimuli are based on a combination of their history and preferences, and their emotional reactions to stimuli (approach-avoidance) require only minimal cognitive engagement. As well, the person's emotional state will dictate the environment they respond to best. For example, a highly stressed individual will be more satisfied with a calm natural scene, whereas an unstressed individual may be more satisfied with a more stimulating nature or urban scene. Research demonstrates that natural settings, compared to urban, are more efficient at reducing autonomic arousal and increasing positive mood (Hartig, Evans, Jamner, Davis, & Garling, 2003; Hartig et al., 1991; Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998; Ulrich et al., 1991), but research is lacking on individuals who are not stressed.

Similar to Kaplan's specifications of the components required in the environment for ART to occur, Ulrich has identified characteristics in the environment that influence people's affective and cognitive responses. One characteristic required for aesthetic

preference is moderate complexity (Ulrich, 1983). Ulrich (1983) states that visual complexity in the environment that is too high or too low is not preferred and can induce fear or boredom respectively. To be enjoyed, the environment must interest the onlooker and motivate them to explore the environment further.

Other characteristics in the environment that affect an individual's preference and interest are structural properties. Ulrich (1983) suggests that strong structural properties guide an individual and elicit positive affective reactions from individuals. He relates this to Gestalt theory where perceptual organizations influence the aesthetic preference people display. Landscape structural properties Ulrich believes influence affective reactions the most are focality (a focal point), depth (ability to see through), ground surface texture (uniformity and texture), threat or tension (visible threat), deflected vistas (line of visibility), and water (present or absent). These key properties have a large effect on the emotional response of the individual and influence future cognitive appraisal. For optimal positive affect, a natural scene would contain a focal point, trees with a high canopy, smooth and consistent ground texture, no visible threat, a curved sight line, and a water feature. All of these components arouse an individual's curiosity by providing multiple objects of interest as well as a safe environment to explore.

Inoculation Effects of Nature

The evolution-based theories by Stephen and Rachel Kaplan and Rodger Ulrich focus on how individuals recover in natural settings faster than in urban settings (van den Berg, Koole, & van der Wulp, 2003). What is not addressed by these theories is whether nature can be used to inoculate against stress. Empirical work has focused on initiating stress in participants and then placing them in natural or urban spaces to recover. The

present study reverses the order of exposure and examines whether individuals who are exposed to a nature stimulus respond differently when subjected to a subsequent stressor than those exposed to an urban stimulus. To the authors' knowledge, this specific methodology is novel and is viewed as exploratory work attempting to shed light on the human connection to nature.

The concept of investigating nature to inoculate stress is not new. Correlational studies often use the language of *buffering* to espouse the benefits of exposure to green space. For instance, the amount of green space within 1 km or 3 km radius around a person's home has a positive association to their overall health and it is most evident for people who spend more time at home (i.e., lower SES, children, and the elderly; Maas et al., 2006; Wells & Evans, 2003). The relationship between health and green space is not attributable to physical activity (Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008). There is conflicting research as to whether the advantages are more associated with mental benefits (Maas et al., 2009), or physical benefits (van den Berg et al., 2010) but the overall message that green space around your home improves both your physical and mental well-being is consistent. Other correlational studies examining the workplace report that a view of nature from an office window buffers stress and the intention to quit (Leather, Pyrgas, Beale, & Lawrence, 1998), as well as reduces physical illness and improves job satisfaction (Kaplan & Kaplan, 1989). An important detail to keep in mind is that these studies are correlational and the direction of influence cannot be confirmed as no experimental manipulations were implemented. It is plausible that the exposure to nature provided a restorative environment in which individuals recovered from stress, rather than creating a buffer from stress.

In a quasi-experimental study where participants were randomly assigned to one of three conditions (wilderness backpacking vacation, nonwilderness vacation, no vacation) those who participated in wilderness backpacking experienced significantly greater positive affect and overall happiness for a three-week period following the experiment (Hartig, Mang, & Evans, 1991). Their initial post-intervention mood was of slight depression, but three weeks later they were significantly happier. The authors of this study suggest that there may be an inoculation effect from the exposure to nature.

The uncertainty of which comes first, the inoculation or the restoration, is of no consequence to some researchers who embrace the circular nature of the relationship and state that due to the restoration process, nature can have an inoculative effect (Hartig et al., 2003). Hartig believes that inoculation is a subset of instoration, which occurs after restoration takes place (personal communication, September 6, 2011). The argument is that regular exposure to restorative natural environments can mitigate or disrupt the negative influence of stress on physical and mental well-being. From this standpoint, buffering would be more aptly categorized as resiliency because it refers to circumstances when the impact of stress is lessened because of an exposure to nature.

The current study took a novel approach and investigated whether inoculation occurs when an individual is not stressed. In other words, when people are at a normal level of stress, can exposure to nature prevent or reduce the effects of stress. The concept of inoculation is alluded to (de Vries, 2010; Hartig et al., 1991) but only one study has attempted to empirically test it. Parsons et al. (1998) used simulated driving roadsides to assess whether exposure to urban versus natural environments immunized participants to a subsequent stressor and found that natural environments did in fact ameliorate future

stress. Although Parsons et al. found an inoculative effect, the results were not conclusive as they still subjected participants to an initial stressor. The present investigation is the first study attempting to inoculate participants to stress when their baseline levels of stress are in a normal range.

Given the inoculative effect of nature for non-stressed individuals has not been empirically tested, it remains a possibility that exposure to nature may increase a person's response to a subsequent stressor rather than decrease their response. Although possible, there is no literature to support the argument. The response that humans consistently demonstrate when exposed to nature is one of satisfaction and improved well-being (Kaplan, 2001; Leather, et al., 1998; Nisbet et al., 2011). In fact, changing an environment from one devoid of nature to one with plant material can increase well-being and reduce stress levels for individuals exposed to both environments (Grinde & Patil, 2009). As well, recent research has revealed that it is not only the pleasant aspects of nature people are connected to, but the negative aspects as well (Bruni et al., 2012)

Assessing whether virtual nature has an inoculation effect on subsequent stress could initiate cost effective interventions aimed at improving the health of the general public and more specifically, marginalized populations. Socioeconomic factors often limit individuals who live in poverty or poor health from seeking healthy behaviours. If virtual nature offers inoculation to stress, the intervention could be implemented within an individual's home, public health offices, long-term care facilities, and mental health institutions, and could potentially utilize existing technology.

Study design

For the current study, a preliminary analysis of main effects was examined to assess whether inoculation was taking place. It was anticipated that main effects would not appear and so further analysis using moderators was implemented. Several moderators were tested to assess their impact on the relationship between predictor and criterion variables. The moderator variables were selected based on theoretical foundations for variables known to impact affect and anxiety when individuals are exposed to urban and natural stimuli. By incorporating the moderator variables, the study probes whether individual differences alter the inoculation effects of nature on stress.

Moderators defined.

Given the complexity of human interaction it is often not adequate to examine bivariate relationships between variables, and so researchers include third variables to more accurately represent the interaction. A common third variable interaction is that of a moderator. A moderator is a variable that has an impact on the direction and/or strength of a relationship between a predictor and criterion variable (Baron & Kenny, 1986; see Figure 1). A moderator can be qualitative, quantitative, continuous, or categorical and is used to assess the effect one variable has on another. For instance, the examination of what enhances a relationship, or under what circumstances does a relationship exist, or probing bivariate relationships which are not significant but theoretically should be, is addressed with moderators. Questions of interest often include “for whom” and “when” does the effect exist (Frazier, et al., 2004). Moderators can influence the relationship in one of three ways (Cohen, Cohen, West, & Aiken, 2003). First, they may augment the relationship whereby the predictor and moderator variables affect the criterion variable in

the same direction and strengthen the overall impact. Second, they may have an antagonistic effect because both the predictor and moderator variables influence the criterion variable in competing directions. Third, the moderator may buffer the interaction and thereby weaken the effect of the predictor variable on the criterion variable.

Predictor variables.

The predictor variable for the current study is categorical and consists of three levels (nature, urban, control). Of particular interest to this study are the reactions individuals have when exposed to virtual nature or virtual urban stimuli.

Research has demonstrated that exposure to nature can increase recovery from illness (Ulrich, 1984), has therapeutic benefits for children with ADHD (Faber, Taylor, & Kuo, 2009), improves cognitive recovery (Kaplan, 1995), increases longevity (Takano, Nakamura, & Watanabe, 2002), and improves health (Maas, et al., 2006). As well, exposure to real or virtual nature reduces stress (Berto, 2005; Parsons, 1998) and may act as a buffer to other stress-related health complaints (van den Berg et al., 2010).

Although strong evidence exists demonstrating that individuals recover faster from stressful events when they are subsequently exposed to natural elements, very little research has examined whether exposure to nature can be used to prevent or lessen the effects of future stress. Thus far, the examination of nature as a buffer of well-being has been limited to correlational studies (Leather et al., 1998; Wells & Evans, 2003) or studies that include a stressor before and after the nature intervention (Parsons et al., 1998).

Artificial environments.

Using artificial immersion (photos, slides, videos, art, television) of natural and urban settings rather than real immersion is common in this area of psychological research. Although it may appear odd to use artificial environments to study nature, minimizing potential confounds in the environment can help isolate the variable of interest. The isolation of the variables and high internal validity helps to distinguish which theories are most accurate, and preserving internal validity at the sacrifice of ecological validity is more appropriate for exploratory research such as this. Given that there are correlational claims of inoculative effects, it is important to include controlled lab experiments to confirm or contradict these claims.

The use of artificial stimuli has included extensive investigation on virtual environments and computer-based simulations. Slater and Wilbur (1997) use the terms *immersion* and *presence* to measure the extent to which a participant is engaged in the process. Immersion refers to the amount the computer system blocks outside sensory input from the individual, and presence refers to the experiential engagement the participant feels during the exposure. In a virtual setting, the more immersive the environment, the more presence the individual experiences and therefore the higher the impact of the intervention.

Watching videos of virtual nature has been shown to decrease blood pressure (Ulrich, Simons, & Miles, 2003) and heart rate (Ulrich, Simons, Losita, & Fiorito, 1991), as well as increase positive mood (Hartmann & Apaolaza-Ibanez, 2008; Mayer, McPherson Frantz, Bruehlman-Senecal, & Dolliver, 2008; van den Berg, Loole, & van der Wulp, 2003) and increase attentional capacity (Mayer et al., 2008). Additionally,

looking at photos of nature versus urban photos can improve sustained attention (Berto, 2005) and cognitive performance (Berman, Jonides, & Kaplan, 2008; Kaplan & Kaplan, 1995). Even office posters with nature content reduce anger and stress levels more than posters depicting abstract scenes (Kweon, Ulrich, Walker, & Tassinary, 2008).

Researchers are slowly compiling information on what forms of artificial nature are most effective, but the list is far from complete. Slater and Wilbur's (1997) conceptual guidelines of immersion and presence (mentioned above) align well with reported effects of various artificial stimuli. Not surprisingly, computer simulations with higher immersion levels have restorative effects similar to actual nature (Valtchanov, Barton, & Ellard, 2010) and factors such as screen size do make a difference (de Kort, Meijnders, Sponselee, & IJsselsteijn, 2006).

When implementing virtual exposure, stimuli must be shown for an adequate duration for participants to become immersed in the stimuli. The current study used a 10-minute video for the intervention, which is congruent with similar research (de Kort, 2006; Karmanov, D. & Hamel, R., 2008; Mayer et al., 2008; Parsons et al., 1998; Ulrich et al., 1991).

Criterion variables.

The current study employed nine criterion variables consisting of both biological and self-report measures. Heart rate and blood pressure were used as biological measures, while a state anxiety difference score, and positive and negative affect comprised the self-report measures. Biological and self-report measures were used in the current study to emulate psychophysiological methods used in seminal works (Hartig et al., 1991; Ulrich et al., 1991). Psychophysiology is considered to provide a more thorough evaluation of

the physiological systems pertaining to psychological processes. Early researchers believed psychophysiological methods were superior because of: 1) the ability to test various environments to assess whether physical responses are congruent with self-report data; 2) the possibility of a continuous collection of measurements; and 3) the gathering of affective and arousal information that is not available from self-report data (Parsons, Ulrich, & Tassinary, 1994). In addition, limiting the criterion variables to self-report measures assumes that participants have thought about their connection to nature and have an explicit belief about this relationship. Research has demonstrated that individuals do not think about their relationship to nature and that the relationship is not a conscious one (Dunlap, Van Liere, Mertig, & Jones, 2000; Schultz, Shriver, Tabanico, & Khazian, 2004). The utilization of biological measures more accurately assesses participants' implicit connection to nature.

Positive and negative affect.

To effectively address the investigation of stress and affect in the research design, measures of positive and negative affect were included as criterion variables. The current study implements an emotional stressor rather than a cognitive stressor, and so a criterion variable measuring affect was an important measure. As well, Ulrich's PET states that our first response to our environment is emotional, and this guides our future cognition and actions.

Positive and negative emotional response to nature and urban settings is a common gauge used to assess individual responses to stimuli. Research demonstrates that individuals exposed to nature often report higher positive affect and lower negative affect (Berman et al., 2012; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mang, &

Evans, 1991; Nisbet & Zelenski, 2011; van den Berg et al., 2003), but this is not always the case (Berman et al., 2008). Conflicting results could be related to how familiar an individual is with nature or urban areas and whether they feel more relaxed in one environment over another. Regan and Horn (2005) found that in general, people want to be around nature, but some want to be near nature when they are in a positive mood state, and others want to be near nature when they are in a negative mood state.

Including positive and negative affect as a criterion variable is based on research that found a significant positive relationship between how connected someone is to nature and their feelings of positive affect when exposed to nature (Nisbet and Zelenski, 2011; Nisbet, Zelenski, & Murphy, 2011). The current study, examined connectedness to nature as a moderating variable between exposure level and positive and negative affect.

State anxiety.

State anxiety is viewed as a temporary emotional state evoked by exposure to stimuli perceived as stressful or dangerous (Spielberger, Gorsuch, Vagg, & Jacobs, 1983). An individual will experience apprehension or worry due to the stimuli, thus increasing their state anxiety. When the stimuli are removed, the individual's state anxiety will dissipate. Exposing individuals to nature has been shown to significantly reduce state anxiety (Chang & Chen, 2005; Park & Mattson, 2009).

For the current study, state anxiety was measured twice using the State Anxiety Inventory (STAI S-Anxiety; Spielberger et al., 1983). Given that state anxiety is a transitory emotional state, measurements were taken before and after the intervention to assess the impact of the intervention on state anxiety. For each individual, the first measurement was used as a baseline to compare to the post-intervention measurement.

Biological measures.

The biological measures used in the current study monitored arousal, or activation of the sympathetic nervous system (SNS). The SNS is a division of the autonomic nervous system and is responsible for promoting a "fight or flight" response when necessary. Activation of the SNS results in the release of hormones that initiate physiological changes such as an increase in blood pressure (BP) and heart rate (HR) among others.

It is important to include more than just cognitive measurements of individuals' responses to natural and urban stimuli. Involuntary attention (Kaplan and Kaplan, 1995) suggests that people are held by their fascination with nature and this allows them time to recuperate and reduce their mental fatigue. In circumstances where the natural stimulus is alarming to the individual, for instance spiders and snakes, the individual still experiences fascination and autonomic responses, but it is not a restorative experience (Dimberg & Thell, 1988). When individuals are exposed to a negative natural stimulus and their HR decreases, it indicates strong involuntary attention as the individual is highly engrossed with the stressor. This evidence is contrary to the theoretical position that involuntary attention is fundamental for restorative processes and demonstrates that involuntary attention can occur in non-restorative settings (Ulrich et al., 1991).

Although HR is used extensively in research to assess stress (Dobkin & Pihl, 1992; Johnston & Anastasiades, 1990; Langewitz, Ruddel, & Von Eiff, 1987), it can be a misleading measure of arousal as it is innervated by the SNS and the parasympathetic nervous system (PNS; Parsons, Ulrich, & Tassinary, 1994). Given the potential for misinterpretation of HR, BP was viewed as the more accurate biological measure of the

two used in the current study. The use of systolic (SBP) and diastolic blood pressure (DBP) is often used to assess intervention effectiveness in psychophysiological stress research (Haynes, Gannon, Orimoto, O'Brien, & Brandt, 1991). Studies investigating exposure to natural and urban settings indicate that participants have lower BP when exposed to virtual or real nature as compared with urban settings (Hartig et al., 2003; Lee et al., 2011; Parsons et al., 1998; Ulrich et al., 1991). For the current study, separate biological measures were used in a manipulation check as well as to examine the hypothesized inoculation effect.

Moderator variables.

The moderators selected for the current study were the personality traits of agreeableness, openness, conscientiousness, and neuroticism, as well as measures of connectedness to nature, and trait anxiety. Each moderator variable was measured on a continuous scale using self-report inventories.

Personality traits.

Research does not indicate a consistent response between stress and an exposure to environment when bivariate relationships are investigated, and so personality was included as a moderator. As mentioned, moderated relationships are examined when the relationship between a predictor and criterion variable is not as consistent as one might expect. As well, to the authors' knowledge, there is no current research on personality and exposure to environment, but there has been research on personality and environmentalism or environmental concern (Hirsh, 2010; Hirsh & Dolderman, 2007; Markowitz, Goldberg, Ashton, & Lee, 2012).

The personality domains (agreeableness, openness, conscientiousness, neuroticism, extraversion) were measured using the NEO PI-R (Costa & McCrae, 1992). Personality traits such as agreeableness and openness have consistently demonstrated significant positive associations with environmentalism (Hirsh, 2010; Hirsh & Dolderman, 2007), and more recently, Hirsch (2010) used structural equation modeling to show that conscientiousness has a significant positive relationship and neuroticism has a significant negative relationship with environmentalism. For both studies, Hirsh defined environmentalism as a concern for the environment. The domain of extraversion was not used in the moderated multiple regression analysis as models are based on theory and currently there is no theory to suggest that extraversion alters the relationship between stress and environmentalism (Hirsh, 2010; Hirsh & Dolderman, 2007; Markowitz et al., 2012).

According to Costa and McCrae (1992), each of the personality domains is comprised of six facets. At this point, research has not itemized which of the facets have the most impact on individuals' environmental attitudes. Hirsh (2010) speculates that empathy is related to agreeableness, flexibility of thought is related to openness, social investment is related to conscientiousness, and anxiety about environmental degradation is related to neuroticism. Further research needs to explore the specific facets to itemize those significantly associated with environmental attitudes.

Connectedness to nature.

Research has consistently demonstrated that when an individual is exposed to actual or virtual nature, their sense of how connected they are to nature increases. This is true of

nature experiences that are pleasant (Mayer et al., 2008; Nisbet & Zelenski, 2011; Nisbet, Zelenski, & Murphy, 2011) and unpleasant (Bruni, Chance, Schultz, & Nolan, 2012).

There are various inventories to assess how connected an individual is to nature. The current study implemented the Connectedness to Nature Scale (CNS; Mayer & McPherson Frantz, 2004) because it is an affective inventory designed to assess an experiential connection to nature. The affective focus of the inventory is important given the current study is based on Ulrich's PET theory of an emotional response to stress, and that the study implemented an emotional rather than a cognitive stressor to participants.

Trait anxiety.

Trait anxiety refers to an individuals' predisposition to experience stressful situations as anxiety producing. Trait anxiety is seen as a relatively stable trait that varies from person to person and influences how a person reacts to a stressful event (Spielberger et al., 1983). Individuals with higher trait anxiety will experience higher levels of state anxiety when exposed to stressful stimuli, demonstrating the strong correlation between the two measures of anxiety.

The current study intended to examine whether trait anxiety influences the relationship between exposure to urban and nature stimuli and physiological and self-report measures, but did not include trait anxiety in the MMR model. As mentioned, state anxiety decreases when individuals are exposed to nature (Chang & Chen, 2005; Park & Mattson, 2009), but there is no theoretical justification for including trait anxiety in the model. As well, the correlation between trait anxiety and neuroticism in this study is high (r = .82, see Table 2), which is congruent with other research (Lee, Wadsworth, & Hotopf, 2006) and not recommended for moderators in MMR models. For the purposes

of this study, only neuroticism was used in the MMR model as it has a significant relationship to environmental behaviour (Hirsch, 2010). Bivariate analysis results are presented for trait anxiety to demonstrate the normality of the sample population.

Hypotheses.

Given the inconsistent pattern of bivariate relationships between exposure and stress, the current study focuses on moderated relationships. If a relationship is moderated, assessing for a main effect with a bivariate regression (i.e. ANOVA) results in an underspecified model, which makes hypothesis testing unreliable. In a moderated relationship, the effect of the predictor on the criterion is conditional on the values of the moderator. This means when conducting an ANOVA and you do not find significance, it may be due to an underspecified model because the ANOVA excludes the moderator. Or, in other words, all the variance is attributed to the predictor variable (Frazier et al., 2004).

1). Participants exposed to urban and control videos will not demonstrate an inoculation effect to the stressful photos. An inoculation effect will consist of higher positive affect, lower negative affect, lower state anxiety difference score, lower DBP, lower SBP, and lower HR.

2. Participants exposed to the nature video will demonstrate an inoculation effect to the stressful photos. An inoculation effect will consist of higher positive affect, lower negative affect, lower state anxiety difference score, lower DBP, lower SBP, and lower HR.

3). High levels of personality traits of agreeableness, openness, and conscientiousness will interact with exposure level (nature, urban, control), such that personality will moderate the relationship between exposure level and stress response. Stress response

will vary such that a high level of agreeableness, openness, and conscientiousness interacting with exposure to the nature level will result in a milder stress response. A mild stress response will consist of higher positive affect, lower negative affect, lower state anxiety difference score, lower DBP, lower SBP, and lower HR.

4). High levels of connectedness to nature will interact with exposure level (nature, urban, control), such that connectedness to nature will moderate the relationship between exposure level and stress response. Stress response will vary such that a high level of connectedness to nature interacting with exposure to the nature level will result in a milder stress response. A mild stress response will consist of higher positive affect, lower negative affect, lower state anxiety difference score, lower DBP, lower SBP, and lower HR.

5). High levels of the personality trait of neuroticism will interact with exposure level (nature, urban, control), such that personality will moderate the relationship between exposure level and stress response. Stress response will vary such that a high level of neuroticism interacting with exposure to the urban level will result in a strong stress response. A strong stress response will consist of lower positive affect, higher negative affect, higher state anxiety difference score, higher DBP, higher SBP, and higher HR.

Chapter 2

Methods

The entire study was conducted within a testing room and participants worked independently at a workstation. Informed consent and test inventories were completed online. Participants completed multiple inventories, watched a video, and viewed emotionally evocative photos.

Participants.

The participant sample for this study consisted of 206 undergraduate students. Participants were recruited through the University of British Columbia Okanagan psychology research participant pool website (Sona). Undergraduates self-selected a time slot from a list of available times and received 1.5% course credit for a psychology class. No other compensation was offered for participation in the study. The majority of participants were female (61%) and 98% of the participants were between the ages of 17-25 with 2% between the ages of 26-34.

Sample Size.

When the moderator variable is continuous, it is more important to focus on the total sample size for MMR, rather than focusing on both total sample size and subgroup size (Aguinis and Gottfredson, 2010). An important consideration is the ratio of cases to the predictor variables. Tabachnick and Fidell (1996) suggest a simple guide of $N \geq 50 + 8m$ in which m is the number of predictor variables. This formula has a drawback as it assumes a medium effect-size and does not have the flexibility to adjust as the number of predictors changes (Green, 1991). Green suggests a more appropriate formula taking lambda (L) into account $N \geq L/f^2$. Given an L of 9.5 and a medium effect size of f^2 of .15,

the sample size required in the present study is 63. If we use a small effect size of .02, the sample required is 475. The number of participants gathered for the current study was 206 for the self-report measures and 186 for the biological measures, which is adequate for medium effect but insufficient for small effect size.

Materials.

Inventories.

State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Jacobs, Lushene, & Vagg,1974; see Appendix A and B). The STAI was used as a pretest-posttest measure to assess participants' trait and transitory anxiety levels. This inventory is comprised of 40 questions; 20 items assess state anxiety and 20 items assess trait anxiety. State anxiety is a transitory emotional state that varies in intensity and fluctuates over time, while trait anxiety is a relatively stable emotional and behavioural disposition. The STAI State anxiety (S-Anxiety; Form Y-1) assesses how participants feel "right now, at this moment", while the STAI Trait anxiety (T-Anxiety; Form Y-2) measures how participants "generally feel". The S-Anxiety was selected for its high test-retest reliability (average r = .88; Grös, Anthony, Simms, & McCabe, 2007) as the present study includes a within-subjects pre-posttest design. Participants are asked to rate themselves on each question using a 4-point Likert-type scale, ranging from 1 = *not at all* to 4 = *very much so* for the S-Anxiety and from 1 = *almost never* to 4 = *almost always* for the T-Anxiety. Half of the items on each scale are reverse scored and the higher the calculated score, the higher the state or trait anxiety felt by the individual. The S-Anxiety mean scores for male and female college students are 36.47 and 38.76 respectively, and the T-Anxiety scores for male and female college students are 38.30 and 40.40. Factor analysis

demonstrates that the state and trait items consistently load on different factors (Spielberger, 1983). Correlations between the S-Anxiety and T-Anxiety inventories for university males and females are 0.75 and 0.70 respectively. Concurrent validity is also demonstrated with high T-Anxiety correlations to other anxiety inventories, as well as to instruments assessing emotional disturbance and psychopathology (Spielberger, 1983).

Connectedness to Nature Scale – Trait (CNS-T; Mayer & McPherson Frantz, 2004; see Appendix C). The CNS-T is a 14-item Likert-type instrument that measures individual's affective affiliation to nature as a stable trait. The Likert scale ranges from 1 = *strongly disagree* to 5 = *strongly agree.* Sample items include "I think of the natural world as a community to which I belong" and reverse scored items such as "I often feel disconnected from nature". Mayer and Frantz validated the instrument with university and community participants over the course of five studies. Factor analysis revealed a one-factor solution accounting for 35% of variance with all items loading positively (negative items reverse scored prior to analysis). The instrument has high internal consistency ($\alpha = 0.84$), test-retest reliability ($r = 0.79$), does not demonstrate a gender difference, and is correlated with other inventories that are conceptually related (Mayer et al., 2004). The CNS-T correlates with other inventories that measure environmental values ($r = .49$), environmental protectionism ($r = .35$), and significantly predicts eco-friendly behaviour. As well, in community and student samples, the CNS-T significantly predicts life satisfaction and happiness (Mayer et al., 2004).

Connectedness to Nature Scale – State (CNS-S; Mayer, McPherson Frantz, Bruehlman-Senecal, & Dolliver, 2009; see Appendix D). The CNS-S is a 13-item instrument that has been adapted from the CNS – T inventory. The questions from the

CNS-T were modified to assess how connected an individual presently feels to their natural world. It uses a 7-point Likert-type scale (1 = *strongly disagree* to 7 = *strongly agree*) to assess present feelings of connectedness to the natural world. The two inventories correlate well (*r*'s > 0.6) and the CNS-T is often utilized as a covariate in analyses. The inventory demonstrates good reliability ($\alpha = 0.91$; Mayer et al., 2009).

NEO Personality Inventory – Revised Self-Report Version (NEO PI-R; Costa & McCrae, 1992; see Appendix E). The NEO PI-R is a 240-item Likert inventory that measures a five-factor model of personality. Examples such as "I often get angry at the way people treat me" and reverse-scored items such as "I'm not known for my generosity" are measured on a scale of 0 = *strongly disagree* to 4 = *strongly agree*. Principal component analysis demonstrates the instrument measures the following five factors: Conscientiousness (0.89), Agreeableness (0.95), Neuroticism (0.91), Openness (0.95), and Extraversion (0.89; McCrae & Costa, 2010). Through meta-analysis, Markin, Krueger, and Watson (2005) confirmed the five-factor model is accurate in assessing personality traits. Each of the five factors is comprised of six sub-facets that reflect specific aspects of each of the five factors. Various studies reveal high construct, convergent, and discriminant validity for all sub-facets (McCrae & Costa, 2010).

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; see Appendix E). The PANAS is a 20-item instrument designed to measure both positive (PA) and negative affect (NA). Participants rate the items on a 5-point Likert-type scale from 1 = *very slightly or not at all* to 5 = *extremely*. Examples include "excited" as a positive item and "scared" as a negative item. The 20 items are split into two subscales (PA, NA), comprised of ten items each. For each subscale the ten items demonstrate

substantial loading on one factor (0.50 and above) and near zero loading on the second factor (- 0.16 or below), as well as low correlations between positive and negative affect (- 0.12 to - 0.23). Compared to four other positive and negative affect scales (Diener & Emmons, 1984; McAdams & Constantian, 1983; Stone, Hedges, Neale, & Satin, 1985; Bradburn, 1969; as cited in Watson et al., 1988), the PANAS demonstrates the strongest convergent/discriminant correlations. The four comparison inventories report convergent correlations range from 0.76 to 0.89 and discriminant correlations range from to – 0.11 to - 0.31. Whereas the PANAS convergent correlations are 0.92 and 0.91, and discriminant correlations are – 0.12 and – 0.16 respectively. The PANAS also correlates to the Hopkins Symptom Checklist (1974; 0.74), the Beck Depression Inventory (1961; 0.58), and the State Anxiety Scale (1970; 0.51) when used with a university sample (Watson et al., 1988).

Photos.

To elicit an emotional stress response, participants were exposed to photos from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008). The IAPS is a standardized database of colour photos used internationally by researchers (Bradley, Codispoti, Cuthbert, & Lang, 2001). The photos were vetted through multiple studies and assigned two primary ratings (affective valence and arousal) and one secondary rating (dominance) on a 9-point scale (1 = *negative valence* or *low arousal* and 9 = *positive valence* or *high arousal*).

The 26 photos selected from IAPS for this study were chosen to elicit moderate arousal and moderate negative valence (see Appendix G). As well, any photo that contained a nature component as the central focus was eliminated from the selection

process to minimize interference with the intervention. Each photo selected had a person, or persons, as the primary focus of the photo. The photos selected had arousal ratings ranging from 4.63 - 5.85 and valence ratings from 1.78 – 3.34. Each photo was shown for a five second duration in which the picture was slightly enlarged or slightly reduced using a program in iMovie. Altering the size of the displayed photos added movement and was done to elicit a higher level of focus from the participants.

Heart rate and systolic and diastolic blood pressure.

Using Omron BP791IT 10+ series blood pressure monitors, heart rates (HR) as well as systolic (SBP) and diastolic blood pressure (DBP) were measured in millimeters of mercury (mmHg) on 8 separate occasions, although only three of the measurements are of interest to the hypotheses. These include immediately before watching the video (Time 1), immediately after watching the video (Time 2), and immediately after viewing the photos (Time 3). The biological measures for pre and post video (Time 1 and Time 2) were used as a manipulation check, and the measures for pre and post photos (Time 2 and Time 3) were used to assess inoculation effects. The discarded measurements were to introduce participants to the blood pressure machine and allow them to acclimatize to the machine and the testing environment.

The monitor uses a calibration check system where dual sensors automatically double-check each reading to ensure accuracy. As well, there is a cuff wrap guide and sensor to indicate whether the cuff has been wrapped correctly on the individual's arm. The unit contains a pre-formed arm cuff that expands to fit both regular and large sized arms (from 9" to 17") so that the cuff does not need to be changed for each participant. The unit also records the date and time of the measurement and has 200-item memory

storage.

The initial HR, DBP, and SBP measurements were stored in the memory bank of the portable blood pressure monitors as well as hand copied onto a spreadsheet. Transferring the information to a spreadsheet was a precautionary measure in the event the memory on the blood pressure monitors failed and erased the data.

Videos.

Videos were recorded using a handheld Sony cx550 high definition camcorder. The camcorder records in 1920 x 1080 high definition using a 29.8 mm wide-angle lens. It has built-in image stabilization (SteadyShot), built-in 5.1 Zoom Microphone, as well as 10 times digital zoom. This particular camcorder was chosen due to the internal image stabilization capacity.

The media department at UBC provided training on the use of the camcorder as well as recording techniques for image stabilization. To maximize video stability, the camera person was seated in a wheelchair and pushed by another volunteer. The media department uses this technique in instances when a smooth image is required and laying down video tracks for the camera is not an option. Both videos were recorded to imitate a naturalistic walk through an urban or park setting with no interruption of movement.

Both the urban and nature video were recorded on August 25th, 2011 in downtown Vancouver, B.C. during the same four-hour period. The urban video was recorded in the vicinity of West Robson and Georgia Street. This area of downtown Vancouver was selected because it is a busy urban area with high vehicle and pedestrian traffic and it affords minimal green space or sightlines of the ocean. The audio on the urban video was the actual sound recorded during the video recording. No vocal recording of either the

camera person or the assistant were heard on the video.

The nature video was recorded in Stanley Park, Vancouver. The area was selected because it was removed from vehicular traffic and afforded a paved walkway, allowing for a very stable video picture. As well, Kaplan and Kaplan (1989) have demonstrated that people prefer relatively open sight-lines and that areas such as golf courses and parks are viewed as less threatening than authentic natural settings. As well, the nature video contains pictures of the general public to maximize a realistic experience an individual may have when walking through a park. The audio on the nature video was dubbed as the natural recording contained airplane and vehicular traffic noise. Audio clips from the media department containing native bird songs and wind replaced the original audio. The audio was synchronized to correspond to the editing cuts on the nature video.

Editing of the videos was performed under the guidance of the UBC Fine Arts department using iMovie ’09 version 8.0.6 on a MacBook Pro version 10.6.8. The urban video was edited to remove video segments of green space, as well as to remove instances where pedestrians or vehicular traffic impeded forward movement. The urban video was spliced five times using 1.5 second transitions; the splicing occurred at 58, 199, 312, 380, and 478 seconds. The nature video was spliced at exactly the same five time points as the urban video to ensure consistency between the two videos. Both videos were edited to run for exactly 10 minutes each.

The third video was used as a neutral or control level. The ten-minute video was produced in 2008 by HM Revenue and Customs and addresses the penalties regime brought in by the Finance Acts of 2007 and 2008. The video is of a solitary man speaking directly to the camera. He has an English accent, is dressed in a dark grey suit and

maroon tie, and the backdrop is entirely white. The video picture varies between the powerpoint presentation detailing the changes to the penalty regime, and the man speaking directly to the camera.

Procedure.

Participants read a recruitment introduction for the study on the psychology subject pool website for the University of British Columbia Okanagan and if interested, signed up for the study (see Appendix H). A participant flow chart for the study is shown in Figure 2.

Prior to the participants being brought into the testing room, a check-list was attended to by the experimenter (see AppendixI). This was to ensure a consistent testing atmosphere for each participant and to minimize potential problems during the testing procedure. Prior to the participants entering the room, the online questionnaire was opened and maximized on the screen, the photos were opened and minimized, and one of three videos was opened and minimized.

Participants were taken into a small private testing lab on the third floor of the Arts building. The maximum number of participants that could participate at one time slot was two; some participants were tested individually and some were tested with two people in the room. The testing room was approximately 9’ x 7’ and did not have any natural light or windows. Three desks, three chairs, and a filing cabinet were the only furniture in the room. Participants sat at identical work stations that each contained a 23 ½” ViewSonic monitor, a blood pressure monitor with cuff, a wireless computer mouse, a headset, and a hand placement guide (a left hand of brightly coloured paper taped to the work station desk top 5” from the front edge and 9” from the left edge). The hand

placement guide was to indicate to participants where their left hand should be placed for the entire experiment. The monitors and headset were connected to two laptops (MacBook Pro and MacBook Air both OS X version 10.6.8), which ran the testing program and videos. The laptops were placed away from the participant's workstation and the laptop screens were covered with identical construction paper to minimize distraction and increase privacy.

Upon arrival, participants were guided to their workstation and asked to make themselves comfortable. To help habituate participants to the testing room and facilitate accurate baseline BP and HR measures, the experimenter purposefully engaged the participants in a friendly discussion or what could be described as "small talk". The discussion generally included topics such as how the participant's day was going, their university classes, and the current weather outside. The goal was to allow time for the participant's HR and BP to normalize so that measurements taken during the study would be indicative of their normal range. Once the participants were settled, a script (see Appendix J) was read to the participants and any questions they had were addressed. The participants were then told to read the Informed Consent (see Appendix K) on their monitor and to click their response at the bottom of the page. The informed consent was the first page of the online questionnaire. All participants consented to participate in the study.

After the online consent had been agreed to, the experimenter attached the blood pressure cuff to their left arm, they were asked to put on their headset, and told that they could continue with the study when ready. Questionnaires were completed on surveymonkey.com which is a secure and encrypted website. Participants navigated

through the experiment at their own pace and worked independently. The online survey was programmed so that participants had to complete the current questionnaire prior to navigating to a new questionnaire. Each participant completed the inventories in the same order and viewed the identical sequence of photos. Participants were randomly assigned to one of three levels: nature, urban, or neutral. The experimenter sat in the room with the participant(s) for the duration of the study to answer any questions.

The second page of the survey instructed the participant to take their first BP and HR measurements (see Appendix L). Participants took their own BP and HR eight times during the course of the study. Participants were not informed of their BP or HR measurements during the study as it may have influenced their results.

The third page of the survey contained demographic and health questions as well as a code (see Appendix M). The code was assigned by the experimenter to match the participant with their BP and HR measures post-experiment. The survey's fourth page instructed the participant to take their second BP and HR measurements, which was followed by the S-Anxiety inventory and then the T-Anxiety inventory. When the inventories are used together, it is recommended that the S-Anxiety be administered first (Spielberger, 1983). The S-Anxiety was used twice in the experiment as a repeated measure. The T-Anxiety was given at the beginning of the experiment and was used as a baseline measurement of participants' inherent anxiety.

The seventh page of the survey displayed the CNS-T, which was followed by the third BP and HR measurements. The next questionnaire was the NEO PI-R, and the fourth BP and HR measures. The fourth BP and HR measures were considered baseline for the analysis as the participants were accustomed to testing environment, the BP

monitor and cuff, and they had been sitting for a minimum of 30 minutes.

Page twelve of the survey prompted the participants to pick up a piece of paper on their desk that had the words "Video Instruction" written on the back (see Appendix N). Participants followed the instructions on the paper and initiated a ten-minute video of a nature walk, an urban walk, or a neutral video played in QuickTime. The participants watched only one video and then measured their BP and HR for the fifth time.

The next page of the survey prompted the participants to pick up a piece of paper on their desk that had the words "Picture Instructions" written on the back (see Appendix O). Participants followed the instructions on the paper and viewed the 26 IAPS photos converted into a QuickTime movie. Each colour photo was shown for 5 seconds, equaling a total movie time of one minute and forty seconds. When the participants had finished watching the photos, they measured their BP and HR for the sixth time.

Page fourteen of the survey asked participants to complete the S-Anxiety inventory again. The participants were not notified that this was the identical inventory they completed earlier. Participants measured their BP and HR for the seventh time after the S-Anxiety inventory and then completed the PANAS and the CNS-S. The PANAS and CNS-S assessed the effectiveness of the intervention to alter affect and connection to nature.

The eighteenth page of the survey instructed participants to take their final BP and HR measurements. The nineteenth and final page of the survey thanked the participants for their time and provided contact information if they wished to contact the researcher. The participants were debriefed and any questions they had were addressed.

Safety protocols set in place for participants who had blood pressure readings over

135/85 mmHg- (Hypertension Canada guidelines 2011) and/or had readings that did not begin to return to baseline were not necessary as no blood pressure reading surpassed the cutoff of 135/85 mmHg.

Chapter 3

Results

Data analysis.

IBM SPSS Statistics version 20 was used to score the self-report inventories and perform all statistical analyses.

Gain scores.

A gain score is typically defined as a difference in score from Time 1 to Time 2 for an individual assessed twice with the same measure. Specifically, pretest scores are subtracted from posttest scores to assess the difference, or gain. Although gain scores have a controversial history, they are still often used to assess change. Cronbach and Furby (1970) suggest avoiding the procedure as the attained scores are systematically associated with the random error of measurement, but other researchers state that gain scores can be valuable when the research design and research question are appropriate (Rogosa & Willett, 1983; Thoman & Zumbo, 2012; Zimmerman & Williams, 1982). An appropriate research design and scenario for using gain scores is when the research question addresses how groups differ in gains without the assumption that participants start with the same pretest score, as is done when using ANCOVA (Cribbie & Jamieson, 2000). Gain scores are also the method of choice when analysis involves a moderator (Cribbie & Jamieson, 2000).

Gain scores were used in the current study for one of the self-report measure criterion variables (S-Anxiety Difference) and one of the biological criterion variables (HRa, DBPa, SBPa).

Screening.

For ease of interpretation, initial analysis of the self-report measures (STAI T-Anxiety, STAI S-Anxiety one, STAI S-Anxiety two, CNS-T, CNS-S, NEO conscientiousness, NEO agreeableness, NEO openness, NEO neuroticism, PANAS negative, PANAS positive) and the biological measures (HR, DBP, SBP) are discussed separately. Data cleaning procedures changed for each data set given differences in data collection and distribution patterns between the two collection methods. Self-report measures were gathered using an online data collection program (SurveyMonkey) and biological measures were collected using a portable blood pressure monitor.

Self-report measures.

Prior to analysis, the self-report measures were screened in SPSS for missing values and none were found. In part, this was because participants were required to answer each item presented on each questionnaire before they were permitted access to the next questionnaire. As well, the participants completed the online self-report measures in the presence of the researcher. Both of these conditions promoted high compliance from the participants, but may have caused some frustration to the participants. A visual search was conducted for patterned responses from the participants and none was found. A patterned response would indicate the participant was not reading the questions and was just clicking on the same answer for each question.

The self-report measures were initially screened as ungrouped data given the decision to use moderated multiple regression analysis (Tabachnick & Fidell, 1996). Descriptive statistics for the predictor and criterion measures are shown in Table 2.

The initial assessments of normality for the self-report measures used the Kolmogorov-Smirnov (K-S) test and the Shapiro-Wilk (S-W) test (DeCarlo, 1997). The K-S scores were as follows: STAI S- Anxiety one, $D(206) = .09$, $p < .001$, STAI S-Anxiety two, $D(206) = .07$, $p < .01$, STAI T-Anxiety $D(206) = .08$, $p < .01$, PANAS negative $D(206) = .09$, $p < .001$ and PANAS positive $D(206) = .09$, $p < .001$. The S-W scores were as follows: STAI S- Anxiety one, $W(206) = .95$, $p < .001$, STAI S-Anxiety two, $W(206) = .98$, $p < .01$, STAI T-Anxiety $W(206) = .97$, $p < .001$, PANAS negative $W(206) = .94$, $p < .001$ and PANAS positive $W(206) = .97$, $p < .001$. These significant scores indicate that the distributions for these self-report measures are different from a normal distribution (Field, 2009). The distributions for the CNS-T, CNS-S, NEO conscientiousness, NEO agreeableness, NEO openness, NEO neuroticism, were not significantly different from a normal distribution. Due to the large sample size of the current study, the Kolmogorov-Smirnov and Shapiro-Wilk tests should be interpreted with caution and so other assessments of normality were completed (Field, 2009).

To further assess the normality of the distribution for each self-report measure, skew and kurtosis values were converted to z-scores to highlight any values greater than 3.29 $p < .001$. All of the self-report inventories (- 2.22 to 3.17) demonstrated skew and kurtosis values within an acceptable range except for the PANAS negative. The PANAS negative value for skew was 5.26.

Histograms, probability plots, and detrended normal probability plots were used as visual aids to assess normality. All of the self-report measures demonstrated normal distribution patterns. The PANAS negative histogram displayed a slight positive skew but was considered acceptable. Given the large sample size, it is recommended to use visual

assessments rather than formal inference tests when assessing normality (Tabachnick & Fidell, 1996).

Screening for univariate outliers was performed prior to running the regression analyses to prevent overfitting (Tabachnick & Fidell, 1996). Univariate outliers were assessed for the self-report measures using simple box plots as well as z scores. The PANAS negative contained two outlier scores beyond 3.29 ($p < .001$, two-tailed test). The S-Anxiety contained three outlier scores beyond 3.29 ($p < .001$ two-tailed test). Given the large sample size, it is not unusual for several participants to have scores greater than 3.29 (Tabachnick & Fidell) and therefore these five scores from four participants were considered to be from the intended population and the scores were not substituted or deleted.

To assess multivariate outliers, Mahalanobis distances were calculated using STAI T-Anxiety, CNS-T, CNS-S, NEO openness, NEO agreeableness, NEO conscientiousness, and NEO neuroticism as independent variables, and STAI S-Anxiety difference score, PANAS positive, and PANAS negative as dependent variables. Using seven degrees of freedom and $p < .001$ the critical value (χ^2) 24.322 was exceeded by only one outlier, Participant 153 with a value of 25.750. Further examination of Participant 153 revealed a very high score on negative affect (PANAS negative) and a very high score on state anxiety (STAI S-Anxiety). Given hesitations about the reliability of using Mahalanobis distances as an evaluation procedure (Tabachnick & Fidell, 1996), Participant 153's data was considered part of the population and was not altered or removed from the data set.

No transformations were performed on any of the self-report measures (STAI T-Anxiety, STAI S-Anxiety one, STAI S-Anxiety two, CNS-T, CNS-S, NEO openness, NEO agreeableness, NEO conscientiousness, NEO neuroticism, PANAS positive, PANAS negative).

The CNS – S was not used to construct the models for moderator effects. The CNS – S inventory was included in the design as the initial model included a covariate. The decision was made to simplify the model and to remove covariates from the design.

Biological measures.

As mentioned, the three biological measures (HR, DBP, SBP) of interest consisted of immediately prior to watching the video (Time 1), immediately after watching the video (Time 2), and immediately after viewing the photos (Time 3). The biological measures for pre and post video (Time 1 and Time 2) were used as a manipulation check, and the measures for pre and post photos (Time 2 and Time 3) were used to assess inoculation effects.

To assess the inoculation effects using MMR, a gain score for pre and post photos was calculated to assess changes in HR, DBP, and SBP. Three biological measures (HR Time 3 minus Time 2 = HRa; DBP = Time 3 minus Time 2 DBPa; and SBP Time 3 minus Time 2 = SBPa) were assessed for normality.

Initial screening of the three biological difference scores identified participant difference scores greater than 3.29 $p < .001$. Seven participants were identified as having at least one difference score greater than three standard deviation points. Upon further investigation, due to human error one participant's data were entered incorrectly and were removed from the outlier list. The remaining six participant outliers included HRa

Participants 187 and 137; DBPa Participants 137, 17, and 22; SBPa Participants 33 and 22.

Histograms and probability plots with the six outliers in the data set and with the six outliers removed were compared. Removing the outliers improved the shape of the distribution and reduced the standard deviations for each of the three difference scores. As well, skewness and kurtosis z-scores were calculated twice; with the six outliers in the data set and with the outliers removed. With the outliers in the data set, all absolute values for kurtosis were greater than 3.29 $p < .001$ and two (HRa, DBPa) absolute values for skew were greater than 3.29 $p < .001$ (see Table 2). With the six outliers removed, all skew and kurtosis absolute values were less than 3.29 $p < .001$ for the three gain score.

The decision was made to remove the six outliers from the biological measures completely rather than transforming them or substituting their values. The six outliers were deemed outside of the population of interest given their measurements were so far removed from normal distribution. As well, one of the outliers had multiple biological measures outside the normal distribution, which suggests that the blood pressure cuff may not have been placed correctly, or shifted over time. Table 2 displays the descriptive statistics for the biological measures after the six outliers were removed from the data set. Once the six outliers were removed, the participant group numbers were nature = 62, urban = 61, and control = 63.

Manipulation check.

Photos.

A pilot study was conducted to ensure the 26 photos selected from the IAPS elicited a negative emotional response. Participants viewed the photos in the same lab and

at the same workstations as the sample population. All twelve pilot participants rated the photos at the two uppermost ratings on the 7-point Likert scale (*very unpleasant* or *unpleasant*).

Videos.

To ensure the videos had the desired effect on each group, paired-sample t-tests were calculated using the raw scores for HR, DBP, and SBP pre and post video (time 1 and time 2). There was no significant change in HR, DBP, or SBP for the participants in the urban group pre and post video. In the control group, there was a significant change in SBP post video ($M = 102.03$, $SE = 1.27$) compared to pre video ($M = 104.21$, $SE = 1.37$), $t\ (62) = 2.71$, $p < .01$, $r = .33$. As well, the nature group demonstrated a significant change in SBP post video ($M = 100.41$, $SE = 8.59$) compared to pre video ($M = 102.57$, $SE = 8.97$), $t\ (60) = 3.38$, $p < .001$, $r = .40$. These findings suggest the nature video reduced SBP more than the other levels.

In addition to the HR, DBP, and SBP, S-Anxiety paired-sample t-tests were calculated for the nature, urban, and control groups. The first S-Anxiety questionnaire occurred prior to the videos and the second S-Anxiety questionnaire took place after the photos. There was a significant change in S-Anxiety for all three levels of exposure. The nature group pre video ($M = 36.42$, $SE = 1.19$) compared to post photo ($M = 41.96$, $SE = 1.42$), $t\ (67) = -4.31$, $p < .000$, $r = .47$, while the urban group pre video was ($M = 37.83$, $SE = 1.27$) compared to post photo ($M = 42.01$, $SE = 1.34$), $t\ (70) = -3.48$, $p < .001$, $r = .38$, and the control group pre video ($M = 37.82$, $SE = 1.06$) compared to post photo ($M = 43.28$, $SE = 1.29$), $t\ (69) = -4.36$, $p < .000$, $r = .46$. All three exposure levels had an

increase in S-Anxiety which demonstrates that the photos elicited a excitatory response from the participants.

Main effects.

Prior to examining moderator effects, a main effects analysis for the criterion variables were assessed using linear regression. Dummy variables (D_1 and D_2) were used as the predictor variables, and PANASpos, PANASneg, HRa, DBPa, SBPa, and S-AnxietyDIFF were used as criterion variables. The linear regression results presented in Table 3 are only for the MMR models that achieved significance. The results show that none of the main effects from the regressions were significant. Although no significance was found for the main effect, MMR was conducted as it is often used in situations where a relationship is inconsistent or weak (Baron & Kenny, 1986; Frazier et al., 2004). The primary focus of the current study was to investigate the potential moderated effects of individual differences on nature exposure and stress, and it was anticipated that the linear regressions might not be significant.

Moderated multiple regression.

As mentioned in the introduction, MMR was selected as the analysis of choice as it addressed the research hypotheses most accurately. The current study examines whether personality or a connectedness to nature moderates a person's HR, DBP, SBP or state anxiety in response to virtual exposure of a natural, urban, or neutral environment. A moderator is a variable that has an impact on the direction or strength of the relationship between the predictor and criterion variables (Baron and Kenny, 1986). MMR is also particularly useful when an intervention is not consistent, or when an intervention may only benefit certain people (Frazier et al, 2004).

The current study implemented MMR to analyze interactions between continuous and categorical predictor variables, whereas historically, some researchers have used analysis of variance (ANOVA) to examine moderator effects. When using ANOVA the variable is dichotomized by breaking it into categories (i.e., median splits) and therefore does not maintain its continuous nature (Cohen, Cohen, West, & Aiken, 2003). This procedure discards valuable information and reduces the ability to detect a true significant effect (Aiken & West, 1991).

Outcome variables and information loss.

In regards to attenuation of power and MMR, Russell and Bobko (1992) demonstrated that moderator effects are best examined with criterion variables that provide participants with a continuous response scale. For some of the criterion variables in this study, the optimal number of responses was not available to participants. For the PANAS positive, PANAS negative, and S-Anxiety inventories, participants had to select from four and five response choices respectively. The remaining criterion variables (HR, DBP, and SBP) satisfy the requirements to reduce information loss recommended by Russell and Bobko.

Dummy variables.

As the current study contains a categorical predictor variable, dummy variables were created using G – 1 where G equals the number of groups. The current study contained three groups (nature, urban, control) and therefore two dummy variables were created. Dummy coding was chosen over effects coding and contrast coding because the interaction involved a categorical and continuous predictor variable and dummy coding allowed the mean of the control group to be compared to the mean of the nature and

urban groups (Aiken & West, 1991; Frazier et al., 2004). The control group was used as the reference group and therefore assigned a value of 0 for every code variable. The control group was selected because it was seen as a useful comparison, allowed for a clear interpretation of the results, and contained a similar sample size relative to the other groups (Cohen et al., 2003). Dummy variable one (D_1) contrasted the nature group to the control group, and dummy variable two (D_2) contrasted the urban group to the control group. As mentioned, the reference group (control) always had an assigned value of 0 and the contrast groups (nature and urban) were assigned a value of 1 when they were contrasted to the comparison and a value of 0 when not involved in the contrast.

Centering.

Prior to running the MMR, the continuous moderator variables were centered (NEO agreeableness, NEO conscientiousness, NEO neuroticism, NEO openness, CNS-Trait). Centering is required for variable interactions because predictor variables are highly correlated with the interaction terms created from the predictor variables. By centering, nonessential multicollinearity between first-order predictors is reduced (Aiken & West, 1991; Cohen et al., 2003; see Table 1). Centering involves converting variables into deviation scores so their mean equals 0 (Aiken & West, 1991). For the present study, once the centered variables were created in SPSS, descriptive statistics confirmed the means were equal to 0 for all five moderator variables. Centering was not performed on the categorical predictor variable or on the criterion variables. Centering the criterion variable has no effect and the predicted scores will be in the same unit as the original scale of the criterion variable (Aiken & West, 1991).

Product terms.

Moderated relationships are characterized by the interactions of variables (Cohen et al., 2003). For each case, product terms were created to represent the interaction of the predictor variable and the moderator variable. This entailed multiplying the coded categorical variables (D_1 and D_2) and the centered continuous variables (NEO agreeableness, NEO openness, NEO conscientiousness, NEO neuroticism, CNS-Trait). In total, ten non-centered product terms were created.

Creating the models.

To construct the MMR models, two individual predictor variables (D_1 and D_2) and five individual moderator variables (NEO agreeableness, NEO openness, NEO conscientiousness, NEO neuroticism, CNS-Trait) were entered separately as Model 1, followed by their product terms for Model 2. Each predictor, moderator, and their product terms were modeled for six separate criterion variables (PANAS positive, PANAS negative, S-AnxietyDIFF, HRa, DBPa, SBPa).

Multicollinearity.

Bivariate correlations for the self-report and biological measures were all within an acceptable range (Tabachnick & Fidell, 1996; see Table 1). Multicollinearity was assessed using the variance inflation factor (VIF) and tolerance statistic. For the self-report measures, VIF statistics ranged from 1.00 to 3.19 and the tolerance statistics ranged from 0.31 to 0.99. For the biological measures, VIF statistics ranged from 1.00 to 3.32 and the tolerance statistics ranged from 0.29 to 0.99. These values are all within acceptable range as the VIF should be below 10 and the tolerance statistic should be above 0.10 (Cohen et al., 2003).

Independence of errors.

To assess the independence of error, the Durbin-Watson value was calculated for each model using SPSS. The critical value of Durbin-Watson is difficult to calculate, therefore this study used the suggestion of Cohen et al (2003) that values close to $D = 2$ indicate an independence of errors. The range of self-report *D* values for each model were STAI S-Anxiety (1.8 - 1.9), PANAS positive (1.7 - 1.9), and PANAS negative (2.0 - 2.3). The biological *D* value ranges were HRa (2.1 – 2.2), DBPa (2.1 – 2.2), and SBPa (1.9 – 2.0).

Normality of residuals.

Using the casewise diagnostics provided through SPSS, the current study implemented a cutoff of less than -2 or greater than 2 for the standardized residuals. For both the self-report and biological measures, the number of cases outside of these parameters falls within expected guidelines given the sample size (Field, 2009).

A visual inspection of the SPSS residuals scatterplots, histograms, p-plots, and studentized and standardized regression plots revealed normal residual distribution for all self-report and biological measures except for the PANAS negative. There was a slight positive skew for NEO agreeableness, NEO openness, and NEO conscientiousness. These results are consistent with the initial screening completed prior to running the MMR. No transformations were undertaken.

Testing the significance of the moderated effect.

To determine the moderator effect for a categorical variable with three levels, the multiple degree of freedom omnibus *F* test is examined for the model containing the product terms (Aiken & West, 1991; Frazier et al., 2004). In the current study, Model 2

was inspected for statistically significant *R* square change (ΔR^2) interactions for each of the multiple regressions. The use of ΔR^2 instead of f^2 is recommended when the moderators are not categorical (Aguinis & Gottfredson, 2010). Overall, three significant interactions were revealed and one interaction that approached significance ($p = .053$). The significant MMR models have not been corrected for Type I error but there are Bonferonni adjustments listed as a footnote for each model. The reason for presenting the uncorrected results is due to the exploratory nature of the study and the high rate of Type II error with MMR. The models and their results for the MMR that did not achieve significance can be found in Appendix P. For each regression model the change in R^2 (ΔR^2) and the significant *F* change is presented for Step 2.

Moderator equation for neuroticism, grouping, and positive affect.

Table 4 shows the results of the model predicting positive affect. At Step 2, when the interaction terms for Neuroticism x Nature and Neuroticism x Urban were entered into the equation, $\Delta R^2 = .03$ ($p = .034$[1]). The moderated model including Neuroticism x Nature and Neuroticism x Urban explained an additional 3% of the variance in positive affect scores. As well, the unstandardized regression coefficient was -.12 ($p = .012$) indicating a negative relationship. Specifically, neuroticism was a negative predictor for positive affect for individuals in the urban group t (200) = -2.55, $p = .012$. Additionally, the Neuroticism x Urban interaction accounted for 2.68% of the variance ($sr = -.164$) for positive affect.

The significant overall interaction indicates a difference in the slopes of the regression lines, but to understand the form of the interaction, it is recommended to

[1] With a Bonferroni adjustment applied, alpha = .0008 and the results are non significant ($\alpha_{Bonferroni} = \alpha/p$, where $\alpha = .05$ and p = number of tests performed (60); Tabachnick & Fidell, 2007).

perform a simple slopes analysis (Aiken & West, 1991). To examine how neuroticism affected positive affect for each of the three levels, the Johnson-Neyman (Aiken & West) method examining regions of significance was implemented. This was achieved using a simple-3gps program (O'Connor, 1998) designed to work with SPSS. There were no regions of significance and so another simple slopes analysis was initiated.

The simple slopes program was designed for a dichotomous predictor variable and a continuous moderator variable (simple-2way; O'Connor, 1998). The current study has three levels of predictor variable that were transformed into D_1 (nature) and D_2 (urban) and therefore the control level was compared to D_1 and D_2 in two separate analyses.

The simple slopes procedure solves the regression equation for the selected values of the moderator. Values of the continuous moderator (neuroticism) were defined at the mean, one *SD* below (low), and one *SD* above (high) the mean. A plot of the predicted values of low, medium, and high neuroticism is shown for nature compared to control (see Figure 3), and urban compared to control (see Figure 4). No significant slopes were found for the nature or urban groups compared to the control group, and so a comparison between the nature and urban group was conducted (see Figure 5). Interpretation of the simple slopes for each significant MMR model are described from a face value perspective, with statistically significant slopes highlighted (Dawson & Richter, 2006).

Figure 3 indicates individuals with low, moderate, or high neuroticism all had higher positive affect in the nature group compared than individuals in the control group. Figure 4 indicates that only individuals in the urban group with low neuroticism

demonstrated higher positive affect than those in the control group with low neuroticism, while individuals in the urban group with moderate or high neuroticism demonstrated lower positive affect. Figure 5 indicates that only individuals in the urban group with low neuroticism had higher positive affect compared to the nature group, whereas individuals in the urban group with moderate or high neuroticism had lower positive affect than individuals in the nature group. In particular, those with high neuroticism in the urban group showed significantly lower positive affect t (202) = -2.04 p = .043 than individuals in the nature group.

Moderator equation for neuroticism, grouping, and negative affect.

Table 5 displays the results of the model predicting negative affect with neuroticism as the moderator. At Step 2, when the interaction terms for Neuroticism x Nature and Neuroticism x Urban were entered into the equation, ΔR^2 = .01 (p = .030[2]). The moderated model including Neuroticism x Urban and Neuroticism x Nature explained an additional 1 % of the variance in positive affect scores. As well, the unstandardized regression coefficient was -.05 (ns) indicating a negative relationship. Neither the Neuroticism x Urban or Neuroticism x Nature interaction t scores were significant, but the centered neuroticism variable was significant, t (200) = 7.63 p < .001. As well, neuroticism accounted for 15.05% of the variance, whereas Neuroticism x Urban accounted for 0.84% and Neuroticism x Nature accounted for 0.90%. Simple slopes procedures were not calculated for this model because including the product terms did not improve the model.

[2] With a Bonferroni Adjustment applied, the p-value is greater than .05. See Footnote 1.

Moderator equation for openness, grouping, and diastolic blood pressure difference pre and post photos (DBPa).

Results for the model predicting DBPa with openness as the moderator can be seen in Table 6. When the interaction terms for Openness x Nature and Openness x Urban were entered into the equation, $\Delta R^2 = .04$ ($p = .029$[3]). This means that the model including Openness x Nature and Openness x Urban explained an additional 4% of the variance in difference in DBP from before and after the photos were shown to participants. As well, the unstandardized regression coefficient was .12 ($p = .008$) indicating a positive relationship. In particular, openness was a positive predictor t (180) = 2.67 $p = .014$ of a change in DBP for individuals in the urban group. As well, the Openness x Urban interaction accounted for 3.76 % of the variance ($sr = .194$) for DBP.

The Johnson-Neyman method was implemented to examine how openness affects each of the three groups for DBP. No regions of significance were found using the simple-3gps program (O'Connor, 1998) and so the simple-2way program was used.

The simple slopes procedure solves the regression equation for the selected values of the moderator. For this model, openness was the continuous moderator and therefore values were defined at the mean, one *SD* below (low), and one *SD* above (high) the mean. A plot of the predicted values of low, medium, and high openness is shown for the nature and control groups (see Figure 6) and the urban and control groups (see Figure 7).

Figure 6 indicates individuals in the nature group with low, moderate, or high openness had higher DBP difference scores before and after viewing the photos

[3] With a Bonferroni Adjustment applied, the p-value is greater than .05. See Footnote 1.

compared to the control group. Figure 7 indicates that only individuals with low openness had lower DBP for the urban group compared to the control group. Individuals with moderate or high openness had higher DBP difference scores in the urban group compared to the control group before and after viewing the photos. The only significant slope was for high openness for the urban group t (182) = 3.24 p = .002.

Moderator equation for openness, grouping, and systolic blood pressure. difference pre and post photos (SBPa)

Results for the model predicting SBPa with openness as the moderator can be seen in Table 7. Although the model was not significant at the traditional .05 level (p = .053), the results are congruent with significant results found for DBP pre and post pictures. When the interaction terms for Openness x Nature and Openness x Urban were entered into the equation ΔR^2 = .03, which indicates that the model including Openness x Nature and Openness x Urban explained an additional 3% of the variance in difference in SBP before and after participants viewed the photos. As well, the unstandardized regression coefficient was -.09 indicating a negative relationship. In particular, openness was a negative predictor t (181) = - 1.91 p < .058 (*ns*) of a change in SBP for individuals in the nature group, accounting for 1.93 % of the variance (*sr* = - .139).

Simple slopes were performed on the model using openness as the continuous moderator. The values were defined at the mean, 1 *SD* below (low), and 1 *SD* above (high) the mean. A plot of the predicted values of low, medium, and high openness is shown for the nature and control groups (see Figure 8) and the urban and control groups (see Figure 9). Neither of the simple slopes plots revealed a significant slope and so the nature and urban groups were compared to each other (see Figure10).

Figure 8 suggests individuals low or moderate in openness who were exposed to the nature video had higher SBP difference scores after viewing the photos than those who were exposed to the control video. Individuals high in openness who were exposed to the nature video had lower SBP difference scores after viewing the photos than individuals exposed to the control video. Figure 9 suggests individuals with low, moderate, or high openness exposed to the urban video had lower SBP difference scores after viewing the photos compared to the control video. Figure 10 suggests individuals with low or moderate openness exposed to the nature video had higher SBP difference scores after viewing the photos compared to the urban video. In particular, the significant slope for Figure 10 is for individuals with low openness t (182) = 2.79 p = .006, although this should be interpreted with caution as the interaction model approached but did not achieve was significance. Individuals with high openness who were exposed to the nature video had lower SBP difference scores when compared to the urban video.

Chapter 4

Discussion

The present study investigated whether a virtual exposure to nature could influence the effects of a subsequent stressor, and whether this effect was more or less pronounced depending on a person's personality and their connection to nature. The results suggest that personality may moderate the relationship between exposure to virtual nature and one's biological and emotional responses to stress. The results also suggest that virtual nature may inoculate against an emotional stressor for individuals with particular personality traits.

Manipulation check.

The manipulation check to assess whether the three videos had the desired effect on participants was not conclusive, but provided some evidence that the manipulation worked. Comparing HR, DBP, and SBP pre and post video for each of the three levels demonstrated significant differences between groups, but not for all three measures. Ideally, the urban level participants would have higher HR, DBP, and SBP readings post exposure, the control level participants would have slightly lower HR, DBP, and SBP readings post exposure, and the nature level participants would have lower HR, DBP, and SBP readings post exposure. There were no significant differences for HR or DBP in any of the three levels, but there were significant changes in the desired direction for SBP for the control and nature levels. The degree of significance, large effect size, and consistency with other findings, suggests that the nature and control video manipulations were effective in reducing SBP.

The lack of results for HR could be attributed to the fact that HR is innervated by both the sympathetic and parasympathetic nervous system, which undermines the interpretation of arousal. HR can increase during inwardly focused activities and decrease during outwardly focused activities, which means that when difference scores are assessed, the subtlety of the measurement equates to zero, or no effect (Parsons et al., 1994).

The inconsistency of blood pressure results between DBP and SBP for the manipulation check is consistent with other research in that one measure may demonstrate a significant change, while the other demonstrates no change. In some cases, methodological issues such as sitting versus standing play a role, while in others, it may be nutritional factors. All the participants remained in the same physical position for the current study, but nicotine, food, and caffeine were not controlled prior to the study.

Main effects

The main effects analysis examining a basic inoculation effect revealed no inoculation for any of the three levels (nature, urban, control). This was contrary to the hypothesis stating that the nature level would demonstrate an inoculative effect. Although the results were not as anticipated, the moderated multiple regression analysis revealed that there was an inoculative effect for individuals with particular personality traits. As mentioned earlier, using moderated multiple regression addresses the third variable problem and is often used when a bivariate relationship does not perform as anticipated.

Connectedness to nature.

No moderated effects were found for how connected an individual is to nature and the relationship between exposure and stress. The lack of moderated effects for

connectedness to nature are not as anticipated, but do parallel empirical bivariate results. Mayer et al. (2009) found that CNS-Trait did not have a consistent relationship with positive or negative affect. In two out of three of Mayer's studies, there was no relationship between positive affect and CNS-Trait, and for all three studies, there was no relationship between CNS-Trait and negative affect. In the current study, the MMR model predicting negative affect, with CNS-Trait as a moderator had a $p = .06$ at step 2, while the model predicting positive affect had a $p = .25$. These results indicate that CNS-Trait may moderate the effects of nature on negative affect but not positive affect.

Personality traits.

A focus of the current study was to explore whether individual differences, particularly personality traits, moderate the relationship between natural and urban exposure and the response to an emotional stressor. The results offer insight into which personality traits are most influential in moderated relationships between natural and urban environments and emotional stress. Two out of the four personality traits investigated in this study supported the hypotheses of a moderated relationship. The two personality traits that did not demonstrate a moderated relationship were agreeableness and conscientiousness. Although Hirsh (2010) reported a bivariate relationship between agreeableness and conscientiousness and environmentalism, Markowitz et al., (2012) found that agreeableness and conscientiousness were inconsistently associated with pro-environmental behaviours. Although moderated relationships often appear when there is a weak bivariate relationship, it may be that agreeableness and conscientiousness have no relationship between exposure to nature and stress.

Neuroticism as a moderator for positive affect.

For participants with high levels of neuroticism, the effect of urban and nature videos on positive affect significantly differed. Congruent with hypothesis three, individuals with high neuroticism demonstrated a stronger stress response after the urban video than the nature video. The stronger stress response was measured as a significant decrease in positive affect when exposed to an urban environment. The stronger stress response is consistent with the characteristics of neuroticism as it is used to describe individuals who are anxious, fearful, sad, and insecure. As well, individuals with high neuroticism tend to experience negative feelings more and are less able to cope with stressful situations (McCrae & Costa, 2010). The finding is consistent with research demonstrating that exposure to urban stimuli reduces positive affect (Hartig et al., 2003; Hartig et al., 1991; Nisbet & Zelenski, 2011; van den Berg et al., 2003).

These results have important health policy implications as individuals with high levels of neuroticism have lower socioeconomic status (South & Krueger, 2011) and are two and a half times more likely to be homeless (Gill, Meltzer, & Hinds, 2003). For individuals living on the streets, a large portion of their day is spent exposed to the urban environment, which may be contributing to a reduction in their positive affect.

Although this finding is consistent with other research on positive affect, that fact that there were no significant moderated effects for neuroticism between the exposure levels and the other criterion variables (S-AnxietyDIFF, HRa, DBPa, or SBPa) is surprising. The inconsistent response indicates that research should explore the relationship further, and caution should be used when interpreting the current results.

Openness as a moderator for diastolic blood pressure.

The second significant relationship was between the urban level of exposure and DBP when participants were at a high level of openness. Hypothesis one was partially supported as individuals high in openness who were exposed to the urban video showed significantly higher DBP after the photos, whereas high openness individuals exposed to the nature video showed a nonsignificant increase in their DBP. The pattern shows that for the nature level, high openness leads to a smaller response to an emotional stressor, whereas high openness for the urban level leads to a larger response. The pattern of simple slopes for high openness and DBP are consistent with research showing increased DBP for individuals exposed to urban stimuli (Hartig et al., 2003; Lee et al., 2011; Parsons et al., 1998; Ulrich et al., 1991), but the present work is the first study to examine how openness influences the relationship. Individuals with high openness tend to be sensitive to aesthetics, enjoy variety, are imaginative, have high intellectual curiosity, and experience both positive and negative emotions more intensely than low openness individuals (McCrae & Costa, 2010). Perhaps the sensitivity to aesthetics and negative emotions played a role in the increase in DBP as most individuals rate urban landscapes as less aesthetically pleasing than natural landscapes (Kaplan & Kaplan, 1989) and the increased sensitivity to the emotional stressor caused an increase in DBP.

The DBP slopes reveal that five of the six slopes were higher for the nature and urban video than the control video. In other words, that DBP was higher for individuals shown the urban and nature video than those shown the control video. The only slope that was lower was for individuals low in openness that were shown the urban video. These general results indicate that the control video might not have been as stimulating as the

urban and nature videos and therefore participant's shown the control video had lower DBP.

Although the low openness simple slopes were not significant, the results of the current study suggest individuals with low openness had an opposite reaction in the nature and urban videos when exposed to an emotional stressor. Low openness individuals shown the nature video demonstrated higher DBP after the stressor, while low openness individuals shown the urban video had lower DBP post stressor. According to McCrae and Costa (2010), low openness refers to individuals who are conservative, conventional, prefer familiarity, and have muted emotional responses. The opposite pattern of the simple slopes for the nature and urban levels suggests that low openness impacts the relationship between and exposure to nature and a subsequent emotional stressor when measured with DBP. The pattern of slopes for individuals low in openness supports the concept of inoculation, as individuals with low openness appear less affected by exposure to the various videos. For instance, they did not demonstrate the positive benefits of an exposure to nature, or the negative effects of an exposure to an urban environment.

Openness as a moderator for systolic blood pressure.

There were no significant difference in PANAS positive, PANAS negative, S-anxietyDIFF, HR, or SBP between the various levels when openness was used as a moderator, but the SBP model did approach significance ($p = .053$). As this is exploratory research and MMR are known to be limited by low power (Aguinis, 1995; Frazier et al., 2004), it was decided to present the SBP model.

The simple slopes for SBP revealed that individuals with low and moderate openness who were shown the nature video had increased SBP following the photos compared to those shown the neutral video, whereas individuals with high openness exhibited a decrease in their SBP. Individuals with all levels of openness exposed to the urban video showed lower SBP after the photos than those shown the control video. When the nature and urban groups are compared, the pattern of slopes is similar to when the nature and control groups are compared, although the low openness slope is significant. The same pattern of slopes indicates that individuals with high openness have lower SBP post stressor in the nature group than either the control or urban groups. This suggests that individuals with high openness may benefit from an exposure to nature. The consistency of the pattern of responses for the nature and urban groups are congruent with research (Hartig et al., 2003; Lee et al., 2011; Parsons et al., 1998; Ulrich et al., 1991) and indicate the blood pressure cuff recordings were accurate. This pattern also supports the concept of inoculation, as individuals high in openness are demonstrating the benefits of an exposure to nature.

The finding that openness is a significant moderator between exposure to nature and subsequent stress is not surprising. A facet of openness is aesthetics; with high scorers having a deep appreciation for art and beauty, and low scorers relatively insensitive and uninterested in art and beauty (McCrae & Costa, 2010). As well, a significant relationship between environmentalism and openness exists, with speculation that the aesthetic components of openness enhance an individual's experience of nature (Hirsh, 2010; Hirsh & Dolderman, 2007).

As well, much of the general evolutionary hypothesis theory is based on people's aesthetic preferences. Both ART and PET itemize the important features in an environment that contribute to making people feel secure. Specific details of what differentiates a desirable natural space from a threatening natural space allude to the importance of attention to detail. Individuals who have high openness scores are more likely to attend to these details, while those with low openness scores may not pay as close attention to the specific details of their environment.

The current study differs from studies guided by ART in that participants were not stressed prior to the nature and urban video. ART proposes that the benefits of nature exposure are of a recuperative fashion as nature allows for bottom-up processing and does not drain attentional resources. The current study suggests that the benefits of nature extend beyond just restoration and actually offer inoculative effects. Additionally, the inoculative effects are not of a circular nature as suggested by Hartig et al. (1991) where the stress reducing capacity of nature (ART) immunizes individuals from future stress, or that inoculation occurs once a person has recovered from an initial stress. In the current study, the participants sat in a windowless room for 30 minutes with no stressful requirements other than filling in online self-report questionnaires and were considered to be at a low baseline level of stress.

Although PET also supports the concept of nature having restorative properties, it suggests that people benefit emotionally from a contact with nature and that people will respond differently given their current stress levels. Ulrich (1983) suggested that when individuals are not stressed, they might benefit more from a stimulating environment. The

current study demonstrates that tranquil nature scenes do still benefit individuals who are at a low level of stress.

Limitations.

A limitation of the present study involves the use of MMR as an analytical method. Although MMR is the preferred method for analyzing a continuous moderator variable, it suffers from low statistical power and the probability of finding population effects in the sample is low (Aguinis, 1995; Aguinis & Gottfredson, 2010; Frazier et al., 2004; McClelland & Judd, 1993). Issues such as measurement error for the predictor, moderator, and criterion variables have a large impact on statistical power (Aiken & West, 1991). Although the moderator variables were chosen with care, the measurement error present for the moderator variables dramatically reduces the reliability of the interaction terms and therefore diminishes the power of the test. As well, the criterion variables selected for the study do not have perfect reliability, which reduces their correlation with the predictor variables. This lowers the overall R^2 (proportion of data explained by the model; Field, 2009) and therefore the power of the test (Frazier et al., 2004). Other issues that may have reduced the power of the MMR for the current study include scale coarseness (Russell & Bobko, 1992) and low sample size (Aguinis & Gottfredson, 2010). The issues raised are common to MMR and are often cited as contributing to the high rate of Type II error when using this method of analysis.

Another limitation of the study is the high probability of Type I error. Due to the high number of criterion and moderator variables, a large number of statistical analyses were performed on the data. One of the advantages of using MMR is that multiple predictor and moderator variables can be entered into the model. However, with the

current study, there were no theoretical basis for combining the moderators into one model and so they were run as independent models. A Bonferroni adjustment was included in the statistical analysis and once corrected, no significant results remained for the MMR models. McClelland and Judd (1993) warn against including a high number of hypotheses to avoid inflated Type I error rates, but for the exploratory nature of this work, it was deemed necessary. As well, taking a conservative study-wise Type I error approach results in Type II error rates (West, Aiken, & Krull, 1996).

A third limitation of the current study was the use of HR as a criterion variable. Although HR is commonly used as a physiological measure of autonomic activity, it can be difficult to interpret correctly because it is innervated by both the parasympathetic and sympathetic nervous system (Parsons et al., 1994). There is consistent evidence to suggest that as a person's stress level rises, their heart rate increases (Dobkin & Pihl, 1992; Johnston & Anastasiades, 1990; Langewitz et al., 1987), but this can vary for mental versus emotional stress (Carter, Durocher, & Kern, 2008).

Another limitation related to the variability of HR, is the influence of external substances on HR and BP. For the current study, the participants were not asked to abstain from caffeine, food, or nicotine prior to the study. Although the effects of these substances are known to affect HR and BP, it was decided that the randomization of participants to the three exposure levels would help balance the effects of the extraneous substances.

A fifth limitation of the study was the use of virtual nature and urban videos rather than exposing participants to actual nature and urban stimulus. Although a large number of studies have demonstrated the effectiveness of virtual exposure to nature and

urban stimuli, the consensus is that real nature still provides the most effective intervention (de Kort et al., 2006; Kahn et al., 2009; Mayer et al., 2008). As this is exploratory research, the decision was made to increase the internal validity of the study and maintain experimental control, while compromising external and ecological validity. Included in this limitation are the stimulus used for the nature and urban groups. The videos were made specifically for this study and were not piloted on another population. As the videos were not piloted, there is no assessment of how the videos rated on the criteria for engagement for ART and PET. It is possible that the nature video did not have the complexity levels necessary to fully engage the participants and therefore the stimulus was not as effective as it could have been (Ulrich, 1983). As well, the video quality and subject material were not as immersive (de Kort, 2006) as that produced by a professional production, but both videos were recorded on the same camera, on the same afternoon, using the same technique. As well, exploring the use of virtual nature does allow more flexibility in research and applied settings. For instance, if virtual nature were proven to be consistently effective, easy implementation would allow researchers to compare and replicate studies. In applied settings, virtual nature offers flexibility with less mobile populations such as the elderly or hospitalized individuals.

Another limitation of the study addresses the sample population of university undergraduates. Although undergraduates are often used as sample populations in this area of research, it does limit the ability to generalize results to the general population. Considerations with this sample population include: 1) Undergraduates may generally have a higher stress level than the average person. 2) Students may be less sensitive to negative photos given a higher level of exposure to violent video games and/or movies.

3) Daily exposure to nature may be higher for undergraduates than the general population and this may have affected the results. Undergraduates often have to change buildings between classes, they often spend free time studying or socializing in outdoor spaces, and many first year students live on campus which is situated in a natural setting. It is possible that undergraduates have more exposure to nature than the average person who lives in a more urban environment.

An additional limitation related to sample employed is that cultural differences were not assessed or incorporated into the study. Demographic information regarding ethnicity was not collected, and no hypotheses were formulated related to how individuals from various ethnicities may respond differently to the videos and/or the stressful photos. No previous work specifically explores the combination of exposure to nature and stress and how this varies depending on ethnicity. Although research does suggest that cultures experience nature differently (Crowley, 2011), and react to stress differently (Radford, Nakane, Ohta, Mann, & Kalucy, 1991), assessing cultural differences regarding stress can be difficult as societies interpret stress in different ways (Pittu, 1996). Future research should address the knowledge gap regarding the influence of nature and cultural differences.

Given the limitations mentioned, further research in this area should implement specific changes when investigating the inoculative effects of nature on future stress. For instance, utilizing a real exposure to nature and urban environments would ensure a stronger manipulation and potentially more consistent results. Other changes to the methodology include using structural equation modeling instead of moderated multiple regression to reduce Type I and Type II error, as structural equation modeling is based on

latent traits and is considered more accurate (Frazier, et al., 2004). As well, using electromyography (EMG) rather than heart rate as a criterion variable may provide a finer grain analysis as it is considered a more reliable measure than heart rate (Parsons et al., 1994).

Implications and future research.

This research is a first attempt to assess the possibility that exposure to nature can be used to mitigate the effects of subsequent stress. The finding that individuals with high neuroticism have the strongest negative emotional response to urban environments extends previous empirical work demonstrating that urban exposure reduces positive affect. As well, this study provides new details on how levels of openness are related to an individual's experience when exposed to nature and subsequent stress. This information adds to a relatively small body of empirical work examining personality traits and environmentalism, but suggests a more detailed approach should include the facet level of personality traits. If researchers assessed the facets responsible for an individual's affinity with nature, rather than just the overall personality traits, perhaps this finer grain analyses could be used to enhance public environmentalism and sustainable behaviours. For example, if aesthetics is the openness facet that influences people the most, public awareness campaigns may have more success if they focus on aesthetics rather than the openness facet of fantasy.

The findings suggest that people with high openness may more readily absorb nature. Future research could explore this possibility by examining how an individual's openness levels relate to their affective state based on their exposure to natural and urban settings at work, at home, and during leisure. Correlational research has shown that

proximity to green space is related to decreased mortality rates (Maas et al., 2009) and fewer health problems (Maas et al., 2006; van den Berg et al., 2010), but research has not determined how openness might impact these relations.

In addition, it may be that personality traits are not as permanent as originally thought. From a biological perspective, it was thought that personality traits were stable from early adulthood on, but from a contextualist perspective they may change depending on environment (Helson, Jones, & Kwan, 2002). Research supports the idea that personality may be more malleable than predicted and that it may indicate increasing maturity (Srivastava, John, Gosling, & Potter, 2003). Of particular interest is a finding that openness can be increased through tasks as simple as Sudoku and crossword puzzles (Jackson, Hill, Payne, Roberts, & Stine-Morrow, 2012). These findings are encouraging because they are highly accessible interventions for low mobility and low SES status individuals. Future research could integrate these findings with work investigating the relationship between openness and the inoculative benefits of nature on stress.

To fully evaluate and develop Ulrich's PET, empirical work should investigate the affective responses to natural and urban stimuli for individuals in a non-stressed state. Most research focuses on the restorative benefits of nature and therefore cognitively or emotionally stress individuals prior to a natural or urban stimulus. Moving beyond ART to explore the potential capacity of nature to inoculate against the negative impact of stress with a focus on individual differences, could provide insight and change protocols for education and health policy.

Table 1.

Correlation Matrix for Predictor and Moderator Variable

Variables	1	2	3	4	5	6	7	8
1. Trait-Anxiety	--	-.13	.02	-.13	-.30	.82	-.08	.02
2. CNS-Trait	-.14	--	.45	.31	.09	-.09	.03	.00
3. NEO-Openness	.02	.45	--	.22	-.02	.00	.08	-.03
4. NEO-Agreeableness-	-.14	.31	.22	--	.09	-.22	.12	.04
5. NEO-Conscientiousness	-.31	.09	-.03	.10	--	-.29	.06	-.04
6. NEO-Neuroticism	.82	-.10	.01	-.23	-.30	--	-.09	-.03
7. D_1 (nature)	-.08	.04	.09	.12	.07	-.09	--	-.49
8. D_2 (urban)	.02	.01	-.03	.05	-.05	-.03	--	--

Note: Centered correlations are presented above the diagonal and un-centered correlations are presented below. D_1 and D_2 are not centered.

Table 2.

Descriptive Statistics for Predictor and Criterion Variables

Variable	*M*	*SD*	*S*	*Std. Error of S*	*K*	*Std. Error of K*
T-Anxiety	40.00	9.90	.55	.17	-.06	.34
CNS-T	47.44	6.92	-.02	.17	.27	.34
NEO openness	169.03	17.96	.03	.17	-.23	.34
NEO agreeableness	165.72	18.22	-.10	.17	.27	.34
NEO conscientiousness	161.66	19.31	.04	.17	-.25	.34
NEO neuroticism	139.05	21.60	.17	.17	-.20	.34
S-AnxietyDIFF	5.05	10.30	.56	.17	.36	.34
PANAS positive	34.03	6.55	-.38	.17	-.48	.34
PANAS negative	19.80	6.64	.89	.17	.76	.34
HRa	.19	4.90	.18	.18	.99	.35
DBPa	.33	4.45	.11	.18	.72	.36
SBPa	-.47	4.55	.16	.18	.16	.35

M = Mean, *SD* = Standard Deviation, *S* = Skew, *K* = Kurtosis. S-AnxietyDIFF = State Anxiety Difference score (S-Anxiety Two minus S-Anxiety one). Biological gain scores from time 3 minus time 2 (HRa,DBPa,SBPa) have outliers removed.

Table 3.

Main Effects Regression Models for PANAS positive, DBP, and SBP on D_1 (nature) and D_2 (urban)

Variables	*R*	R^2	*SE*	*F*	*Sig.*
PANAS Positive	.12	.01	6.54	1.39	.25
DBP	.13	.02	4.44	1.53	.22
SBP	.10	.01	4.55	.94	.40

Table 4.

Moderated Multiple Regression of Neuroticism and D_1 (nature) and D_2 (urban) on Positive Affect

Predictor	*B*	*SE B*	95% CI	β	*sr*	R^2	ΔR^2
Step 1						.14	.14
Constant	33.73	0.74	32.27, 35.19				
Nature	1.06	1.06	-1.03, 3.14	.08	.07		
Urban	-0.12	1.04	-2.18, 1.93	-.01	-.01		
Neuroticism Centered	-0.11	0.02	-0.15, -0.70	-.36	-.36		
Step 2						.17	.03*
Constant	33.52	0.74	32.07, 34.98				
Nature	1.32	1.05	-0.75, 3.34	.10	.08		
Urban	0.03	1.03	-2.01, 2.07	.00	.00		
Neuroticism Centered	-0.05	0.03	-0.12, 0.01	-.17	-.10		
Neuroticism x Nature	-0.03	0.05	-0.13, 0.06	-.07	-.05		
Neuroticism x Urban	-0.12	0.05	-0.21, -0.03	-.24	-.16		

*$p < .05$. *B* = unstandardized regression coefficient, *SE B* = standard error of *B*, 95% *CI* = 95% confidence interval (LL, UL), β = beta, *sr* = semipartial correlations, R^2 = multiple correlation squared, ΔR^2 = change in R^2.

Table 5.

Moderated Multiple Regression of Neuroticism and D_1 (nature) and D_2 (urban) on Negative Affect

Predictor	*B*	*SE B*	95% CI	β	*sr*	R^2	ΔR^2
Step 1						.47	.47
Constant	20.04	0.59	18.87, 21.21				
Nature	0.01	0.85	-1.66, 1.67	.00	.00		
Urban	-0.73	0.83	-2.37, 0.92	-.05	-.05		
Neuroticism Centered	0.21	0.02	0.18, 0.24	.68	.67		
Step 2						.48	.02*
Constant	20.04	0.59	18.87, 21.20				
Nature	0.17	0.84	-1.48, 1.83	.10	.01		
Urban	-0.77	0.82	-2.40, 0.86	-.06	-.05		
Neuroticism Centered	0.21	0.03	0.16, 0.27	.68	-.10		
Neuroticism x Nature	0.05	0.04	-0.03, 0.13	.10	.07		
Neuroticism x Urban	-0.05	0.04	-0.12, 0.03	-.10	-.07		

*$p < .05$. *B* = unstandardized regression coefficient, *SE B* = standard error of *B*, 95% *CI* = 95% confidence interval (LL, UL), β = beta, *sr* = semipartial correlations, R^2 = multiple correlation squared, ΔR^2 = change in R^2.

Table 6.

Moderated Multiple Regression of Openness and D_1 (nature) and D_2 (urban) on DBP Pre and Post Photos

Predictor	*B*	*SE B*	95% CI	β	*sr*	R^2	ΔR^2
Step 1						.02	.02
Constant	-0.40	0.56	-1.50, 0.71				
Nature	0.82	0.80	-0.77, 2.39	.09	.08		
Urban	1.38	0.80	-0.19, 2.95	.15	.76		
Openness Centered	0.00	0.02	-0.03, 0.04	.01	.01		
Step 2						.05	.04*
Constant	-0.40	0.55	-1.49, 0.69				
Nature	0.83	0.80	-0.73, 2.40	.09	.08		
Urban	1.42	0.79	-0.13, 2.97	.15	.13		
Openness Centered	-0.05	0.03	-0.10, 0.01	-.18	-.11		
Openness x Nature	0.04	0.04	-0.04, 0.13	.10	.07		
Openness x Urban	0.12	0.05	0.03, 0.21	.26	.19		

*$p < .05$. *B* = unstandardized regression coefficient, *SE B* = standard error of *B*, 95% *CI* = 95% confidence interval (LL, UL), β = beta, *sr* = semipartial correlations, R^2 = multiple correlation squared, ΔR^2 = change in R^2.

Table 7.

Moderated Multiple Regression of Openness and D_1 (nature) and D_2 (urban) on SBP Pre and Post Photos

Predictor	*B*	*SE B*	95% CI	β	*sr*	R^2	ΔR^2
Step 1						.01	.01
Constant	-0.47	0.58	-1.61, 0.68				
Nature	0.54	0.82	-1.08, 2.16	.06	.05		
Urban	-0.58	0.82	-2.19, 1.03	-.06	-.05		
Openness Centered	-0.00	0.02	-0.04, 0.03	-.01	-.01		
Step 2						.04	.03
Constant	-0.48	0.57	-1.61, 0.65				
Nature	0.73	0.82	-0.88, 2.34	.08	.07		
Urban	-0.54	0.81	-2.14, 1.05	-.06	-.05		
Openness Centered	0.02	0.03	-0.04, 0.08	.08	.05		
Openness x Nature	-0.09	0.04	-0.17, 0.00	-.20	-.14		
Openness x Urban	0.02	0.05	-0.07, 0.11	.04	.03		

B = unstandardized regression coefficient, *SE B* = standard error of *B*, 95% *CI* = 95% confidence interval (LL, UL), β = beta, *sr* = semipartial correlations, R^2 = multiple correlation squared, ΔR^2 = change in R^2.

Figure 1. Model of Moderator Effects

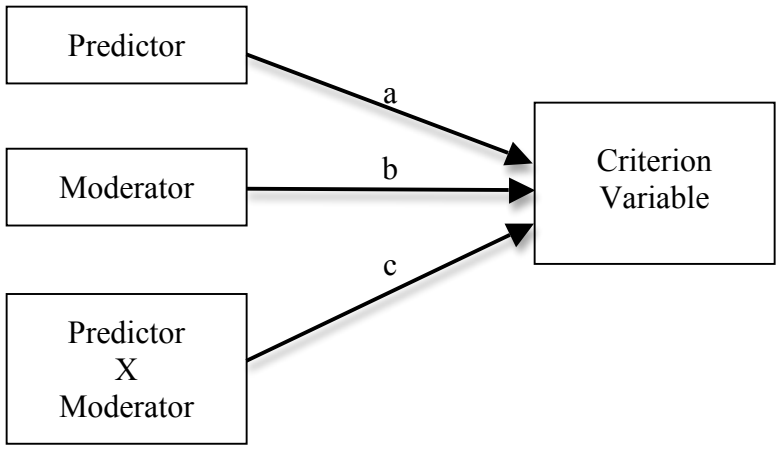
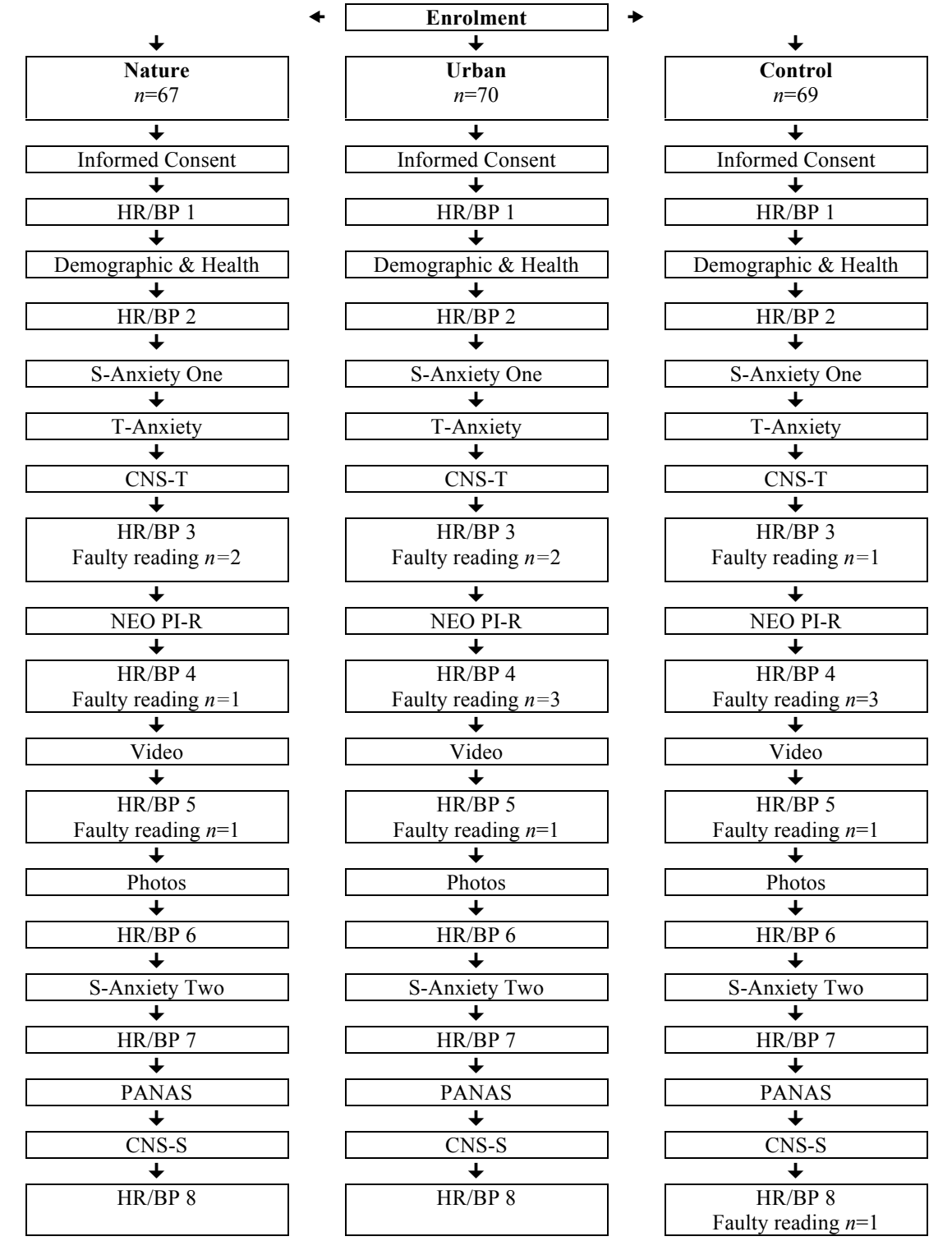


Figure 1. Generic moderation model demonstrating causal paths (Path *a*, Path *b* and Path *c*) on the criterion variable. When the interaction is significant (Path *c*), the moderation hypothesis is supported. Even if there are significant main effects (Path *a*, Path *b*), they are not considered relevant to the moderation hypothesis.

Figure 2. Flow of Participants Through a Randomized Experiment of Three Groups



If a faulty reading was obtained during a HR/BP check (time three through time eight), all of the participant's HR/BP data was removed from the analysis.

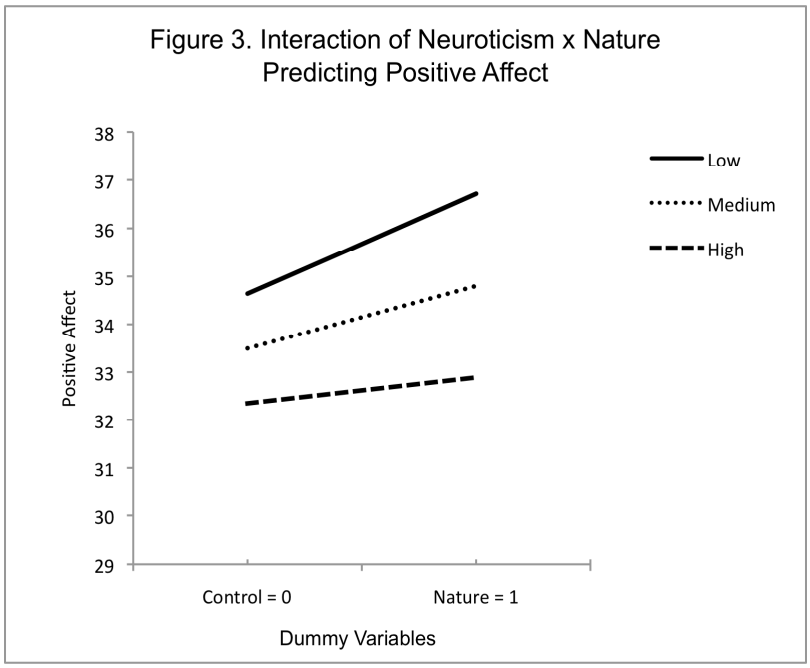


Figure 3. Interaction of Neuroticism x Nature Predicting Positive Affect
38
37
36
35
34
33
32
31
30
29
Positive Affect
Low
Medium
High
Control = 0
Nature = 1
Dummy Variables

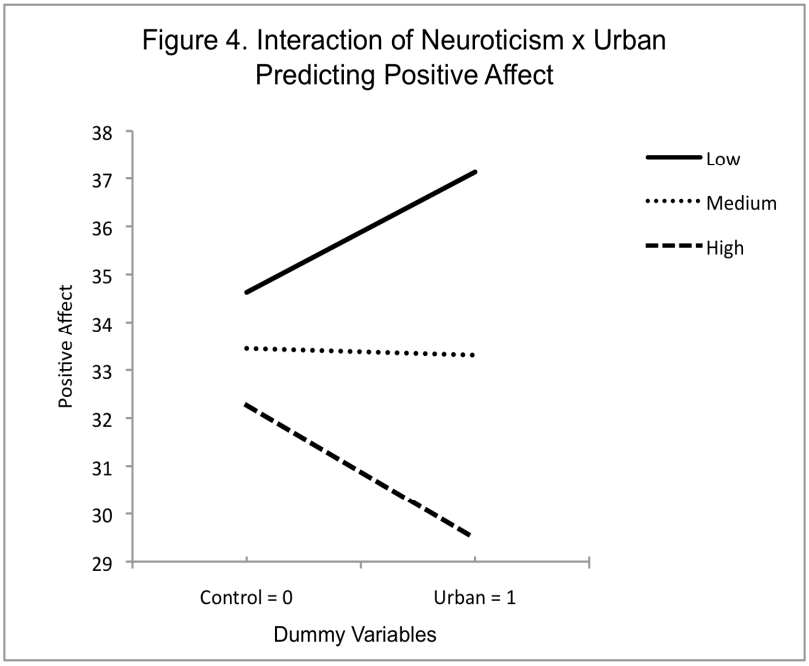


Figure 4. Interaction of Neuroticism x Urban Predicting Positive Affect
38
37
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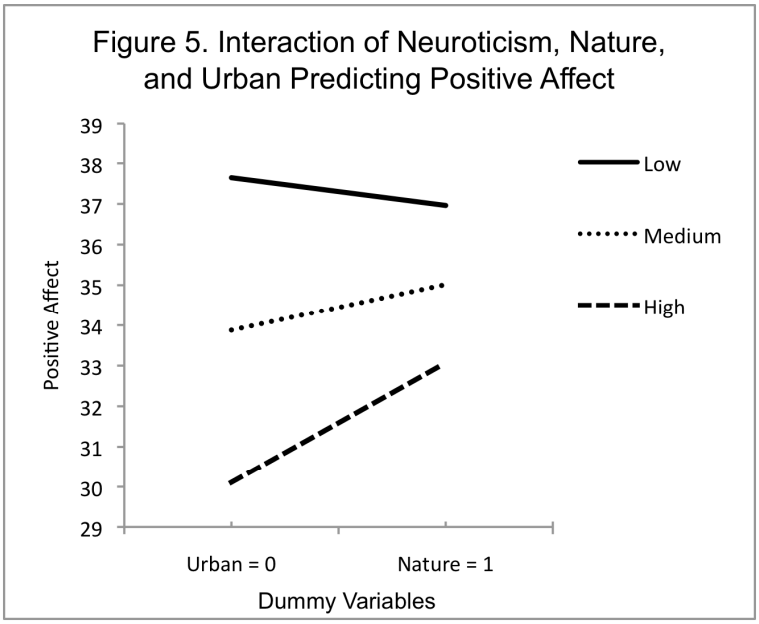
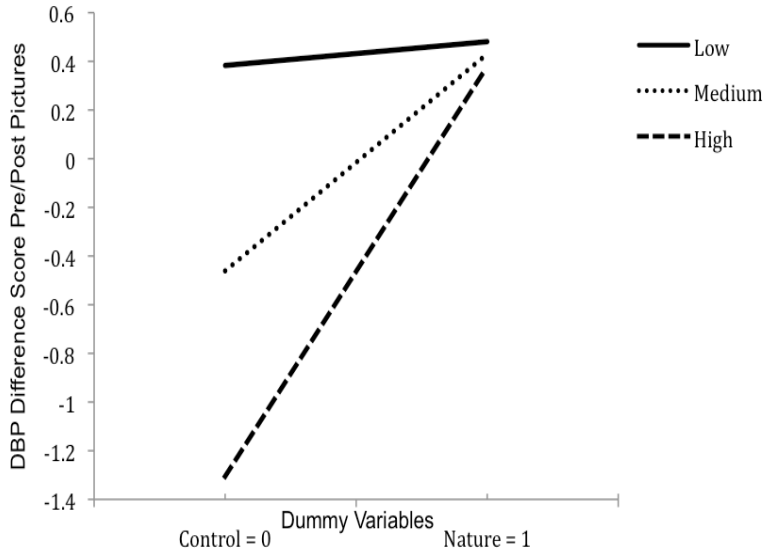
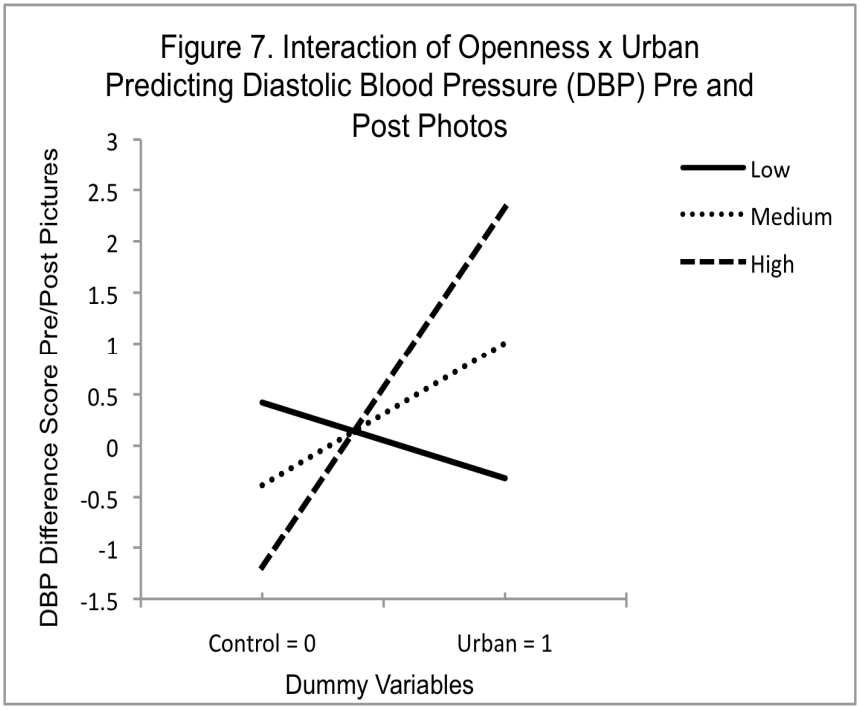
32
31
30
29
Positive Affect
Low
Medium
High
Control = 0
Urban = 1
Dummy Variables



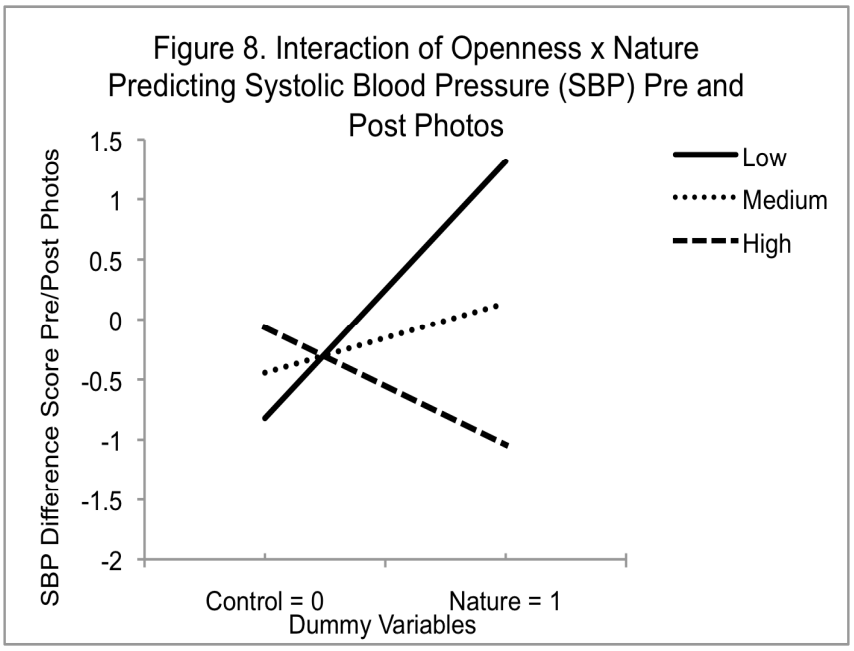
	Y	*B*	*SE*	*95% CI*
Neuroticism Low	37.65	-0.68	.11	-0.27, 0.16
Neuroticism Medium	33.88	1.14	.08	-0.07, 0.24
Neuroticism High	30.11	2.96	.11	0.01, 0.44

Figure 6. Interaction of Openness x Nature Predicting Diastolic Blood Pressure (DBP) Pre and Post Photos

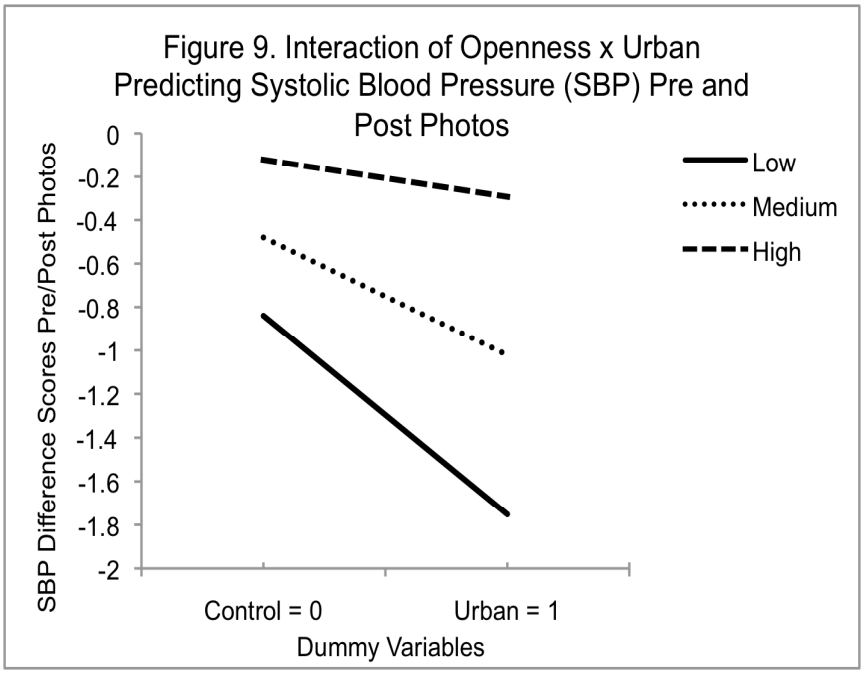




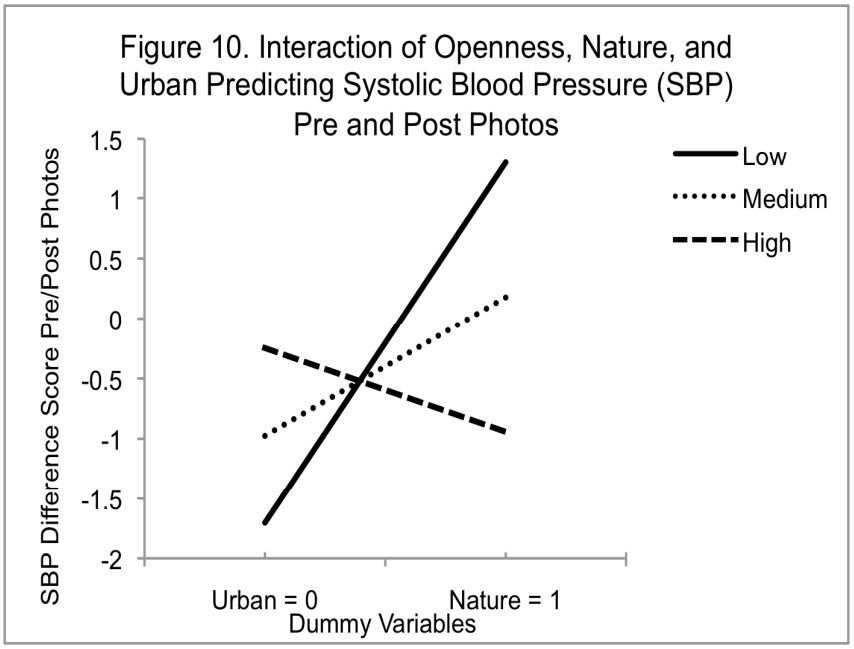
	Y	*B*	*SE*	*95% CI*
Openness Low	0.42	-0.74	.12	-0.33, 0.16
Openness Medium	-0.38	1.39	.09	-0.01, 0.33
Openness High	-1.19	3.52	.12	0.16, 0.65



*Overall model approached significance (p = .053). The low openness slope is significant t (183) = 2.57 p < .011.



*Overall model approached significance (p = .053).



	Y	*B*	*SE*	*95% CI*
Openness Low	-1.70	3.00	.13	0.10, 0.60
Openness Medium	-0.98	1.15	.09	-0.04, 0.31
Openness High	-0.25	-0.69	.13	-0.33, 0.17

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Appendix A

STAI-S Anxiety

A number of statements which people have used to describe themselves are given below. Read each statement and then select the answer to indicate how you feel RIGHT NOW, that is, AT THIS MOMENT. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.[4]

1. I feel calm:

1	2	3	4
not at all	somewhat	moderately so	very much so

2. I feel secure:

1	2	3	4
not at all	somewhat	moderately so	very much so

3. I am tense:

1	2	3	4
not at all	somewhat	moderately so	very much so

4. I feel strained:

1	2	3	4
not at all	somewhat	moderately so	very much so

5. I feel at ease:

1	2	3	4
not at all	somewhat	moderately so	very much so

[4] Copyright prohibits showing more than five questions from the State-Trait Anxiety Inventory

Appendix B

STAI-S Anxiety

A number of statements which people have used to describe themselves are given below. Read each statement and then select the most appropriate answer to indicate how you GENERALLY FEEL.[5]

1. I feel pleasant:

1	2	3	4
almost never	sometimes	often	Almost always

2. I feel nervous and restless:

1	2	3	4
almost never	sometimes	often	Almost always

3. I feel satisfied with myself:

1	2	3	4
almost never	sometimes	often	Almost always

4. I wish I could be as happy as others seem to be:

1	2	3	4
almost never	sometimes	often	Almost always

5. I feel like a failure:

1	2	3	4
almost never	sometimes	often	Almost always

[5] Copyright prohibits showing more than five questions from the State-Trait Anxiety Inventory

Appendix C

Connectedness to Nature Scale - Trait

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

1	2	3	4	5
strongly disagree		neutral		strongly agree

____1. I often feel a sense of oneness with the natural world around me.

____2. I think of the natural world as a community to which I belong.

____3. I recognize and appreciate the intelligence of other living organisms.

____4. I often feel disconnected from nature.

____5. When I think of my life, I imagine myself to be part of a larger cyclical process of living.

____6. I often feel a kinship with animals and plants.

____7. I feel as though I belong to the Earth as equally as it belongs to me.

____8. I have a deep understanding of how my actions affect the natural world.

____9. I often feel part of the web of life.

____10. I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'.

____11. Like a tree can be part of a forest, I feel embedded within the broader natural world.

____12. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.

____13. I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.

____14. My personal welfare is independent of the welfare of the natural world.

Appendix D

Connectedness to Nature Scale - State

Please answer each of these questions in terms of *the way you feel at the present moment.* There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

1	2	3	4	5
strongly disagree		neutral		strongly agree

____1. Right now I'm feeling a sense of oneness with the natural world around me.

____2. At the moment, I'm feeling that the natural world is a community to which I belong.

____3. I presently recognize and appreciate the intelligence of other living organisms.

____4. At the present moment, I don't feel connected from nature.

____5. At the moment, I can imagine myself as part of the larger cyclical process of living.

____6. At this moment, I'm feeling a kinship with animals and plants.

____7. Right now, I feel as though I belong to the earth just as much as it belongs to me.

____8. Right now, I am feeling deeply aware of how my actions affect the natural world.

____9. Presently, I feel like I am part of the web of life.

____10. Right now, I feel that all inhabitants of earth, human, and nonhuman, share a common life force.

____11. At the moment, I am feeling embedded within the broader natural world, like a tree in a forest.

____12. When I think of humans' place on earth right now, I consider them to be the most valuable species in nature.

____13. At this moment, I am feeling like I am only a part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.

Appendix E

NEO Personality Inventory – Revised Self-Report Version

Using the 1-5 scale below, please rate how accurately each statement describes you by placing the appropriate number on the dash beside each statement.

1	2	3	4	5
strongly disagree		neutral		strongly agree

____ (1) Certain kinds of music have an endless fascination for me.

____ (2) Even minor annoyances can be frustrating.

____ (3) Aesthetic and artistic concerns aren't important to me.

____ (4) I prefer to spend my time in familiar surroundings.

____ (5) I pride myself on my shrewdness in handling people.

____ (6) I pride myself on my sound judgment.

____ (7) As a child I rarely enjoyed games of make believe.

____ (8) At times I have been so ashamed I just want to hide.

____ (9) At times I have felt bitter and resentful.

____ (10) I believe laws and social policies should change to reflect the needs of a changing world.

____ (11) Being perfectly honest is a bad way to do business.

____ (12) Frightening thoughts sometimes come into my head.

____ (13) Sometimes I feel completely worthless.

____ (14) Sometimes I make changes around the house just to try something different.

____ (15) Sometimes I trick people into doing what I want.

____ (16) Sometimes I'm not as dependable or reliable as I should be.

____ (17) I have a lot of intellectual curiosity.

____ (18) I have a lot of self-discipline.

____ (19) I have a low opinion of myself.

____ (20) How I feel about things is important to me.

____ (21) Human needs should always take priority over economic considerations.

____ (22) I am not a cheerful optimist.

____ (23) I am not a very methodical person.

____ (24) I am not a worrier.

____ (25) I am not considered a touchy or temperamental person.

____ (26) I am sometimes completely absorbed in music I am listening to.

____ (27) I am seldom sad or depressed.

____ (28) I believe all human beings are worthy of respect.

____ (29) Sometimes things look pretty bleak and hopeless to me.

____ (30) I believe letting students hear controversial speakers can only confuse and mislead them.

____ (31) I believe that loyalty to one's ideals and principles is more important than "open-mindedness."

____ (32) I believe that most people are basically well-intentioned.

____ (33) I believe that most people will take advantage of you if you let them.

____ (34) I believe that the different ideas of right and wrong that people in other societies have may be valid for them.

____ (35) I believe that the "new morality" of permissiveness is no morality at all.

____ (36) I can be sarcastic and cutting when I need to be.

____ (37) I can handle myself pretty well in a crisis.

____ (38) I consider myself broad-minded and tolerant of people's lifestyles.

____ (39) I couldn't deceive anyone even if I wanted to.

____ (40) In dealing with other people, I always dread making a social blunder.

____ (41) I don't consider myself especially "light-hearted."

____ (42) I don't feel like I'm driven to get ahead.

____ (43) I don't find it easy to take charge of a situation.

____ (44) I don't get much pleasure from chatting with people.

____ (45) I don't like wasting my time daydreaming.

____ (46) I enjoy concentrating on a fantasy or daydream and exploring all its possibilities, letting it grow and develop.

____ (47) I enjoy parties with lots of people.

____ (48) I enjoy reading poetry that emphasizes feelings and images more than story lines.

____ (49) At times I bully or flatter people into doing what I want them to.

____ (50) I enjoy solving problems or puzzles.

____ (51) I enjoy working on "mind-twister" type puzzles.

____ (52) I experience a wide range of emotions or feelings.

____ (53) I feel comfortable in the presence of my bosses or other authorities.

____ (54) I find philosophical arguments boring.

____ (55) I feel I am capable of coping with most of my problems.

____ (56) I feel that I am no better than others, no matter what their condition.

____ (57) I find it easy to empathize--to feel what others are feeling.

____ (58) I find it easy to smile and be outgoing with strangers.

____ (59) I follow the same route when I go someplace.

____ (60) I generally try to be thoughtful and considerate.

____ (61) I go out of my way to help others if I can.

____ (62) I'm hard-headed and stubborn.

____ (63) I have a clear set of goals and work toward them in an orderly fashion.

____ (64) I have a good deal of faith in human nature.

____ (65) I have a leisurely style in work and play.

____ (66) I have a very active imagination.

____ (67) I have trouble resisting my cravings.

____ (68) I have a very high opinion of myself.

____ (69) I have an active fantasy life.

____ (70) I have fewer fears than most people.

____ (71) I have little difficulty resisting temptation.

____ (72) I have little interest in speculating on the nature of the universe or the human condition.

____ (73) I have never literally jumped for joy.

____ (74) I have often been a leader of groups I have belonged to.

____ (75) I have sometimes done things just for "kicks" or "thrills."

____ (76) I have trouble making myself do what I should.

____ (77) I have a wide range of intellectual interests.

____ (78) I hesitate to express my anger even when it's justified.

____ (79) I keep a cool head in emergencies.

____ (80) I keep my belongings neat and clean.

____ (81) I keep myself informed and usually make intelligent decisions.

____ (82) I laugh easily.

____ (83) I like being part of the crowd at sporting events.

____ (84) I like to be where the action is.

____ (85) I often get angry at the way people treat me.

____ (86) I often get disgusted with people I have to deal with.

____ (87) I like to have a lot of people around me.

____ (88) I like to keep everything in its place so I know just where it is.

____ (89) I love the excitement of roller coasters.

____ (90) I never seem to be able to get organized.

____ (91) I often come into situations without being fully prepared.

____ (92) I often crave excitement.

____ (93) I often do things on the spur of the moment.

____ (94) I often enjoy playing with theories or abstract ideas.

____ (95) I often feel as if I'm bursting with energy.

____ (96) I often feel as if I'm not as quick or lively as other people.

____ (97) I often get into arguments with my family and co-workers.

____ (98) I often try new and foreign foods.

____ (99) I often worry about things that might go wrong.

____ (100) I pay my debts promptly and in full.

____ (101) I plan ahead carefully when I go on a trip.

____ (102) I prefer jobs that let me work alone without being bothered by other people.

____ (103) I rarely experience strong emotions.

____ (104) I rarely make hasty decisions.

____ (105) I rarely overindulge in anything.

____ (106) I rarely use words like "fantastic!" or "sensational!" to describe my experiences.

____ (107) I really enjoy talking to people.

____ (108) I really like most people I meet.

____ (109) I really feel the need for other people if I am by myself for long.

____ (110) I seldom feel self-conscious when I'm around people.

____ (111) I seldom give in to my impulses.

____ (112) I seldom notice the moods or feelings that different environments produce.

____ (113) I seldom pay attention to my feelings of the moment.

____ (114) I shy away from crowds of people.

____ (115) I sometimes eat myself sick.

____ (116) I sometimes fail to assert myself as much as I should.

____ (117) I sometimes lose interest when people talk about very abstract, theoretical matters.

____ (118) I spend a lot of time looking for things I've misplaced.

____ (119) I strive to achieve all I can.

____ (120) I strive for excellence in everything I do.

____ (121) I rarely feel fearful or anxious.

____ (122) I rarely feel lonely or blue.

____ (123) I take personal interest in the people I work with.

____ (124) I tend to assume the best about people.

____ (125) I tend to avoid movies that are shocking or scary.

____ (126) I tend to be cynical and skeptical of others' intentions.

____ (127) I tend to be somewhat fastidious or exacting.

____ (128) I tend to blame myself when anything goes wrong.

____ (129) I think it's interesting to learn and develop new hobbies.

____ (130) I think most of the people I deal with are honest and trustworthy.

____ (131) I think of myself as a charitable person.

____ (132) I think that if people don't know what they believe by the time they are 25, there's something wrong with them.

____ (133) I am always able to keep my feelings under control.

____ (134) I am dominant, forceful, and assertive.

____ (135) I am easily frightened.

____ (136) I am easy-going and lackadaisical.

____ (137) I am efficient and effective at my work.

____ (138) I am intrigued by the patterns I find in art and nature.

____ (139) I am known as hot-blooded and quick tempered.

____ (140) I think things through before coming to a decision.

____ (141) I think twice before I answer a question.

____ (142) I try to be courteous to everyone I meet.

____ (143) I try to be humble.

____ (144) I try to do jobs carefully, so they won't have to be done again.

____ (145) I try to keep all my thoughts directed along realistic lines and avoid flights of fancy.

____ (146) I try to perform all the tasks assigned to me conscientiously.

____ (147) I usually prefer to do things alone.

____ (148) I usually seem to be in a hurry.

____ (149) I waste a lot of time before settling down to work.

____ (150) I work hard to accomplish my goals.

____ (151) I would hate to be thought of as a hypocrite.

____ (152) I would have difficulty just letting my mind wander without control or guidance.

____ (153) I would rather be known as "merciful" than as "just."

____ (154) I would rather cooperate with others than compete with them.

____ (155) I would rather go my own way than be a leader of others.

____ (156) I would rather keep my options open than plan everything in advance.

____ (157) I would rather praise others than be praised myself.

____ (158) I wouldn't enjoy vacationing in Las Vegas.

____ (159) I'd rather not talk about myself and my achievements.

____ (160) I'd rather vacation at a popular beach than an isolated cabin in the woods.

____ (161) I'd really have to be sick before I'd miss a day of work.

____ (162) I'm a superior person.

____ (163) I'm a very competent person.

____ (164) I'm an even-tempered person.

____ (165) I'm attracted to bright colors and flashy styles.

____ (166) I'm better than most people, and I know it.

____ (167) I'm hard-headed and tough-minded in my attitudes.

____ (168) I'm known as a warm and friendly person.

____ (169) I'm known for my prudence and common sense.

____ (170) I'm not compulsive about cleaning.

____ (171) I'm not crafty or sly.

____ (172) I'm not known for my generosity.

____ (173) I'm pretty emotionally stable.

____ (174) I'm pretty good about pacing myself so as to get things done on time.

____ (175) I'm pretty set in my ways.

____ (176) I'm seldom apprehensive about the future.

____ (177) I'm something of a "workaholic."

____ (178) I'm suspicious when someone does something nice for me.

____ (179) If I don't like people, I let them know it.

____ (180) If I feel my mind starting to drift into daydreams, I usually get busy and start concentrating on some work or activity instead.

____ (181) If I have said or done the wrong thing to someone, I can hardly bear to face them.

____ (182) If necessary, I am willing to manipulate people to get what I want.

____ (183) If someone starts a fight, I'm ready to fight back.

____ (184) In conversations, I tend to do most of the talking.

____ (185) In meetings, I usually let others do the talking.

____ (186) It doesn't embarrass me too much if people ridicule and tease me.

____ (187) It takes a lot to get me mad.

____ (188) It's often hard for me to make up my mind.

____ (189) Many people think of me as somewhat cold and distant.

____ (190) Most people I know like me.

____ (191) My first reaction is to trust people.

____ (192) My life is fast-paced.

____ (193) My work is likely to be slow but steady.

____ (194) Occasionally I act first and think later.

____ (195) Odd things--like certain scents or the names of distant places--can evoke strong moods in me.

____ (196) Often people look to me to make decisions.

____ (197) On a vacation, I prefer going back to a tried and true spot.

____ (198) Once I find the right way to do something, I stick to it.

____ (199) Once I start a project, I almost always finish it.

____ (200) Over the years I've done some pretty stupid things.

____ (201) Poetry has little or no effect on me.

____ (202) Political leaders need to be more aware of the human side of their policies.

____ (203) Social gatherings are usually boring to me.

____ (204) Some people think I'm selfish and egotistical.

____ (205) Some people think of me as cold and calculating.

____ (206) Sometimes I bubble with happiness.

____ (207) Sometimes I cheat when I play solitaire.

____ (208) Sometimes I do things on impulse that I later regret.

____ (209) Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement.

____ (210) There are so many little jobs that need to be done that I sometimes just ignore them all.

____ (211) Too often, when things go wrong, I get discouraged and feel like giving up.

____ (212) Watching ballet or modern dance bores me.

____ (213) We can never do too much for the poor and elderly.

____ (214) When a project gets too difficult, I'm inclined to start a new one.

____ (215) When everything seems to be going wrong, I can still make good decisions.

____ (216) When I am having my favorite foods, I tend to eat too much.

____ (217) When I do things, I do them vigorously.

____ (218) I don't mind bragging about my talents and accomplishments.

____ (219) I don't seem to be completely successful at anything.

____ (220) I don't take civic duties like voting very seriously.

____ (221) When I make a commitment, I can always be counted on to follow through.

____ (222) When I start a self-improvement program, I usually let it slide after a few days.

____ (223) When I'm under a great deal of stress, sometimes I feel like I'm going to pieces.

____ (224) When I've been insulted, I just try to forgive and forget.

____ (225) When people I know do foolish things, I get embarrassed for them.

____ (226) Without strong emotions, life would be uninteresting to me.

____ (227) I adhere strictly to my ethical principles.

____ (228) I always consider the consequences before I take action.

____ (229) I am a cheerful, high-spirited person.

____ (230) I am a productive person who always gets the job done.

____ (231) I am a very active person.

____ (232) I have sometimes experienced a deep sense of guilt or sinfulness.

____ (233) I have sometimes experienced intense joy or ecstasy.

____ (234) I have strong emotional attachments to my friends.

____ (235) I have sympathy for others less fortunate than me.

____ (236) I have sympathy for panhandlers.

____ (237) I believe we should look to our religious authorities for decisions on moral issues.

____ (238) I often feel helpless and want someone else to solve my problems.

____ (239) I often feel inferior to others.

____ (240) I often feel tense and jittery.

Appendix F

Positive and Negative Affect Schedule

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you generally feel this way, that is, how you feel on the average.

Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

_____ interested	_____ irritable
_____ distressed	_____ alert
_____ excited	_____ ashamed
_____ upset	_____ inspired
_____ strong	_____ nervous
_____ guilty	_____ determined
_____ scared	_____ attentive
_____ hostile	_____ jittery
_____ enthusiastic	_____ active
_____ proud	_____ afraid

Appendix G

Photos Selected from the International Affective Picture System

Picture Reference #	Arousal Rating	Valence Rating
2053	5.25	2.47
2055.1	4.95	3.15
2095	5.25	1.79
2120	5.18	3.34
2141	5.00	2.44
2155	4.98	3.83
2205	4.53	1.95
2276	4.63	2.67
2301	4.57	2.78
2345.1	5.50	2.26
2375.1	4.88	2.20
2455	4.46	2.96
2661	3.90	3.90
2682	4.48	3.69
2691	5.85	3.04
2703	5.78	1.91
2800	5.49	1.78
2900	5.09	2.45
2751	5.18	2.67
2710	5.46	2.52
3180	5.77	1.92
3181	5.06	2.30
3216	5.37	3.28
3301	5.21	1.80
3350	5.72	1.88
9421	5.04	2.21

Photos were not shown in the order presented in the table.

Appendix H

Recruitment Letter for Sona

Abstract	This face-to-face study looks at your personality, your stress, and your connection to nature.
Description	If you agree to participate, you will be given multiple questionnaires that measure personality, emotions, and stress. As well, you will watch a 10 minute video and a series of pictures for approximately 3 minutes. Your blood pressure will be measured throughout the study so please remember to wear a short-sleeved shirt. The entire study should take approximately 75 minutes and you will receive 1.5 credits for your participation. The study will take place in the Arts building in room # 352.
Prescreen Restrictions	No Restrictions -[**View/Modify Restrictions**]
Duration	75 minutes
Credits	1.5 Credits
Researchers	Maxine Crawford/Dr.M Holder Email: **maxcrawford@shaw.ca** Dr. Mark Holder Email: **mark.holder@ubc.ca**
Participant Sign-Up Deadline	12 hours before the study is to occur
Study Status	Visible to participants (approved) Inactive study (does not appear on list of available studies)
Behavioral REB Approval Code	H11-02056

Appendix I

Set-up Check-list for Lab

Pre-study Checklist

- turn on computers
- monitors turned on and are connected to the computers
- screen resolution set to 1280 X 720
- check wireless mice to ensure batteries are working
- hide the docks and get rid of extra icons
- "Video" open and minimized at the bottom of the page
- mark "N" or "U" on the spreadsheet depending on which video you opened
- check volume settings (nature video is quieter than urban video)
- "Pictures" open and minimized at the bottom of the page
- SurveyMonkey open and the survey maximized on the computer screen (go to my favourites and select Assessing Personality, Stress…..)
- BP grey cable securely fastened to the machine.
- headset cable (green) is plugged into the computer (don't use the pink cable)
- check to make sure the volume is on and turned up for both computers
- signs up in the hallway for "please be quiet"
- when you go to get the participant, make sure you have the right person as they may be waiting for another study (ask their name)
- once you have their name, fill in the BP code sheet so you know what code you are assigning to them (make sure you put **N** or **U** depending on which video they will watch)
- Attaching the BP cuff:
    - clothing out of the way
    - blue line on the cuff and cable running down the inside of the arm lining up with the palm of the hand
    - the bottom end of the cuff should be ½ inch up from the inside of the elbow joint
    - secure the flap on the cuff to the velcro (the end of the cuff does not have a velcro attachment)
    - make sure that the cable is still running down the inside of the arm.
    - double check that the blue cable connection has not come loose.

Post-study Checklist:

Once the participant has left the room:

- write down their blood pressure and heart rate information on the excel spreadsheet
- write down the date and times on the excel spreadsheet as well
- turn computers off
- put all the paper documents in the bottom drawer of the big desk and lock drawer
- take down the "study in progress" signs from the hallway and on the door
- turn off the lights
- close the door to the office and the door to the main hallway on your way out

Appendix J

Script Read to Participants

If you have a cell phone, please turn it off before we begin the study.

The study you're here for today has multiple online questionnaires, a 10-minute video, 3 minutes of pictures, and eight blood pressure measurements throughout the study. You'll only need my help two times; when I attach the blood pressure cuff to your left arm, and when the online questionnaire tells you to ask me for a code.

When you are doing the online questionnaires it is very important to read the instructions slowly and carefully as some of the questionnaires look the same but they are asking you different things.

When taking your blood pressure, you will rest your left arm on the desk and place your left hand on the blue hand on the desk. Once you press the start button, the blood pressure cuff will tighten quite snugly on your arm and this is normal. Please make sure that you do not rest your arm on the grey cable that goes from the machine to the blood pressure cuff. Its important for you to remain **very still** while the machine is reading your blood pressure

When taking your blood pressure, press the blue button **firmly** and look at the top of the blood pressure monitor to make sure that the machine is starting. You'll know that the machine is working because the "calibration check" light comes on and the date and time appear at the top. There is a delay of two seconds after you press the start button so please be patient. **There may be times when you need to press the blue start button more than once and it is very important that you take your blood pressure every time the questionnaire asks you to.**

You are not allowed to see your blood pressure while the study is happening, but you can wait around until after the study is done and I will let you know what it is.

The headset is for the video you'll watch; the microphone should go on the left side of your head. Please place it on your head now and leave it on for the rest of the study.

To answer the online questionnaires, you will use the mouse on the desk; you will not need a keyboard.

Please **do not talk** during the study.

Do you have any questions before we begin?

Appendix K

Informed Consent

Information Letter and Consent Form

Title of Study: Assessing the Role of Nature as a Moderator of Well-Being

Principal Investigator: Dr. Mark Holder, Psychology (250-807-8728)

Co-Investigators: Maxine Crawford (UBCO graduate student). The research project is to fulfill a Master's thesis requirement for Maxine Crawford. The results will be submitted for publication in an academic journal.
Study Procedure: If you agree to participate, you will be given multiple questionnaires that examine personality, emotions, and stress. As well, you will view a 10 minute video and a series of photos for approximately 3 minutes. Your blood pressure will be taken several times. You are free to withdraw from the study at any time while the study is happening and you are not required to provide a reason for your withdrawal. Once your participation has concluded, we cannot remove your information from the data file as your information will be associated with a code and you will no longer be identifiable.

Potential Risk: There are very few potential risks associated with participation in this study. You will evaluate your emotional states, both good and bad, as well as your personality and your stress levels. This, however, is no more serious than normal day-to-day evaluations.

Potential Benefits: Results from this study may help improve our understanding of the links between personality and emotion and stress.

Remuneration/Compensation: Each participant will be eligible for 1.5 credits for their participation assigned through the online Sona system. Participants can assign this credit to the participating class of their choice.

Confidentiality: Responses of all participants are strictly confidential (individual responses will only be seen by the principal and co-researchers). Each questionnaire will be coded in order to link the answers from each participant and only the researchers will know this code. After the data are collected, the codes will be destroyed so individuals cannot be identified. All of the questionnaires will be administered online and no identifying information will be attached to the questionnaires. The website (www.SurveyMonkey.com) is encrypted, and only the principal investigator and the co-investigators will have access to the original data. All data will be kept in electronic format on password protected computer drives. We plan to submit the findings for publication but no participant names will be used in any reports of the study. The results will only be reported for groups with no possibility of individual participants being identified.

Survey Monkey is an online survey company located in the USA and is thus subject to the US Patriot Act. This act allows authorities to access the records of Internet service providers. Servers used by Survey Monkey record IP addresses, including the address of the computer you use to complete the questionnaires. However, no connection can be made between your data and this IP address. If you participate in this study, your responses to the questionnaires will be stored and accessed in the USA. The complete security and privacy policy for Survey Monkey can be found at www.surveymonkey.com/Monkey_Privacy.aspx.
Contact for information about the study: If you have any questions about this study, contact Dr. Mark Holder (250-807-8728).

Contact for concern about the rights of research participants: If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 1-877-822-8598 or the UBC Okanagan Research Services Office at 250-807-8832.

Consent: Your participation in our study is completely voluntary and you may refuse to participate or withdraw from the study at any time without penalty while the study is happening.

Appendix L

Heart Rate and Blood Pressure Information

It is now time to take your blood pressure reading. There is a small delay from the time you press the start button to the time the machine begins. You will know it is working when the "Calibration Check" bar on the top left of the screen lights up blue and green.

Please ensure that:
1) your feet are placed flat on the floor.
2) your left arm is resting gently on the desk and your hand is covering the picture of the hand on the desk.
3) you do not move your arm.
4) you do not talk.

FIRMLY press the blue start button on the bottom right corner of the machine.

The blood pressure cuff will tighten around your arm and will maintain this pressure for approximately 40 seconds and then the pressure will be released. The entire measurement takes one minute.

Once you have taken your blood pressure, please move onto the next section.

Appendix M

Demographic Page on Survey Monkey

1. Please turn to the researcher and let them know you are ready to have your code number entered into survey monkey.

2. Sex:
Please select one of the following:

Male
Female
Transgender

3. Age:
Please select one of the following:

17-25
26-34
35-43
44-52
53-61
61 and above

4. Health:
Please select either "yes" or "no" to the following question.
Do you have high blood pressure (hypertension)?

Yes
No

5. Health:
Please select either "yes" or "no" to the following question.
Are you currently being treated for high blood pressure (hypertension)?

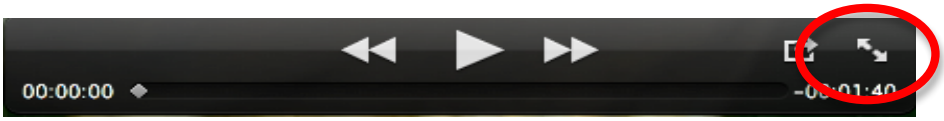
Yes
No

Appendix N

Video Instructions

STEP 1:
Drag your mouse cursur across the icons at the bottom of the monitor. Click on the icon called Video.mov (A large picture should now be on the screen in front of you)

STEP 2:
To make the video cover your entire screen, click on the 2 small arrows pointing away from each other on the play bar.



STEP 3:
To start the video, click on the large arrow in the centre of your play bar.

STEP 4:
Move the mouse cursor off of the play bar.

Once the video has stopped playing you will take your blood pressure again.

STEP 5: BLOOD PRESSURE:
Please ensure that:
1) your feet are placed flat on the floor.
2) your left arm is resting gently on the desk and your hand is covering the picture of the hand on the desk.
3) you do not move your arm.
4) you do not talk.
FIRMLY Press the blue start button on the bottom right corner of the machine.
(Remember there is a delay after you press the start button; look for the "Calibration Check" bar to light up blue and green)

STEP 6: TO CLOSE THE VIDEO:
1). To close down the video, click on the 2 arrows pointing away from each other on the play bar (like you did in Step 2).

2). Now click on the red dot on the top left side of your screen and the video will close.

Appendix O

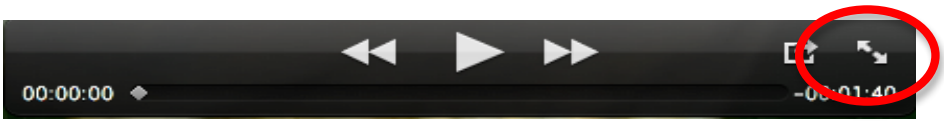
Picture Instructions

STEP 1:

Drag your mouse cursur across the icons at the bottom of the monitor. Click on the icon called Pictures.mov (A large picture should now be on the screen in front of you)

STEP 2:

To make the pictures cover your entire screen, click on the 2 small arrows pointing away from each other on the play bar.



STEP 3:

To start the pictures, click on the large arrow in the centre of your play bar.

STEP 4:

Move the mouse cursor off of the play bar.

Once the pictures have stopped playing you will take your blood pressure again.

STEP 5: BLOOD PRESSURE:

Please ensure that:
1) your feet are placed flat on the floor.
2) your left arm is resting gently on the desk and your hand is covering the picture of the hand on the desk.
3) you do not move your arm.
4) you do not talk.
FIRMLY press the blue start button on the bottom right corner of the machine.
(Remember there is a delay after you press the start button; look for the "Calibration Check" bar to light up blue and green)

STEP 6: TO CLOSE THE PICTURES:

1). To close down the pictures, click on the 2 arrows pointing away from each other on the play bar (like you did in Step 2).

2). Now click on the red dot on the top left side of your screen and the pictures will close.

Appendix P

Non Significant MMR Models

All statistics reported are from Step 2 of the MMR analysis. Step 1 results are left out to facilitate reading of the table.

Variables	Δ R^2	Sig F Change
State AnxietyDIFF		
Agreeableness X Nature, Agreeableness X Urban	.02	.10
Openness X Nature, Openness X Urban	.01	.45
Conscientiousness X Nature, Conscientiousness X Urban	.01	.58
Neuroticism X Nature, Neuroticism X Urban	.01	.49
CNS-Trait X Nature, CNS-Trait X Urban	.00	.66
PANAS positive		
Agreeableness X Nature, Agreeableness X Urban	.02	.22
Openness X Nature, Openness X Urban	.01	.45
Conscientiousness X Nature, Conscientiousness X Urban	.01	.34
CNS-Trait X Nature, CNS-Trait X Urban	.01	.25
PANAS negative		
Agreeableness X Nature, Agreeableness X Urban	.02	.11
Openness X Nature, Openness X Urban	.02	.17
Conscientiousness X Nature, Conscientiousness X Urban	.01	.55
CNS-Trait X Nature, CNS-Trait X Urban	.03	.06
Heart Rate Pre and Post Photos		
Agreeableness X Nature, Agreeableness X Urban	.00	.66
Openness X Nature, Openness X Urban	.03	.09
Conscientiousness X Nature, Conscientiousness X Urban	.01	.52
Neuroticism X Nature, Neuroticism X Urban	.01	.29
CNS-Trait X Nature, CNS-Trait X Urban	.01	.30
DBP Pre and Post Photos		
Agreeableness X Nature, Agreeableness X Urban	.01	.42
Conscientiousness X Nature, Conscientiousness X Urban	.01	.42
Neuroticism X Nature, Neuroticism X Urban	.02	.13
CNS-Trait X Nature, CNS-Trait X Urban	.01	.56
SBP Pre and Post Photos		
Agreeableness X Nature, Agreeableness X Urban	.02	.24
Conscientiousness X Nature, Conscientiousness X Urban	.01	.48
Neuroticism X Nature, Neuroticism X Urban	.00	.85
CNS-Trait X Nature, CNS-Trait X Urban	.00	.84