

DISSERTATION

INVESTIGATING THE IMPACT OF EXPOSURE TO DEGRADED NATURAL
ENVIRONMENTS ON WORKING MEMORY THROUGH PHOTOGRAPHIC STIMULI

Submitted by

Truc Anh Dao

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2025

Doctoral Committee:

Advisor: Michael Steger

Patricia A. Aloise-Young

Bryan J. Dik

Sara LoTempio

Copyright by Truc Anh Dao 2025
All Rights Reserved

ABSTRACT

INVESTIGATING THE IMPACT OF EXPOSURE TO DEGRADED NATURAL ENVIRONMENTS ON WORKING MEMORY THROUGH PHOTOGRAPHIC STIMULI

The benefits of nature on human well-being have been well-documented under the umbrellas of several theoretical frameworks. Such research is often used to encourage people to go on walks in nature or in other ways become immersed in natural surroundings. However, beyond the fact that a good number of studies often use only photographic stimuli to simulate nature exposure, they have employed nature stimuli that are high in valence and low in arousal, as well as used urban stimuli that are average or low in both valence and arousal as a comparison. Such practices make it difficult to isolate the effects of nature and emotions on outcome measures in those studies. The use of mostly intact beautiful nature in these studies also suggests a gap in understanding how humans interact with damaged nature, especially the impact of damaged nature on humans. As the likelihood of people experiencing changes in their living environments increases with the rate of climate change, there is a need to better understand the influence of degraded nature on well-being in an experimental setting. Thus, the current project addressed two concerns: the lack of a set of image stimuli that can be used for environmental studies with various ratings of valence and arousal, and the limited investigation about the impact of damaged nature on working memory. Study 1 was conducted to obtain ratings of valence, arousal, sense of restoration, and preference on 780 images depicting scenes of built, intact natural, and degraded natural environments. Results affirmed intact natural environments

are generally preferred, perceived as restorative, and associated with positive affect and low arousal. In contrast, degraded natural environment scenes are not preferred, associated with reduced restoration, low affect, and heightened arousal. Using images that were counterbalanced for valence, arousal, sense of restoration, and preference, Study 2 implemented an experimental design to examine the impact of types of environments on participants' working memory capacity. Findings revealed participants who viewed images of degraded environments performed worse on a working memory task at Time 2 compared to those who viewed images of intact environments. Notably, this effect emerged even when participants did not fully comprehend the content of the degraded nature images.

TABLE OF CONTENTS

ABSTRACT.....	ii
Chapter 1 – Introduction.....	1
Nature and well-being.....	1
Nature and stress.....	2
Nature and cognitive processes.....	5
Processing natural environments.....	9
The role of emotion.....	11
Degraded nature and well-being.....	16
The current study.....	18
Chapter 2 – Methods and Results.....	21
Study 1.....	21
Methods.....	21
Results.....	24
Study 2.....	26
Methods.....	26
Results.....	32
Exploratory analyses.....	34
Chapter 3 – Discussion.....	39
The nature of nature.....	41
Nature’s restorative effect.....	45
Degraded nature’s impact.....	48
Clinical implications.....	54
Strengths.....	55
Limitations and future research.....	57
Chapter 4 – Conclusion.....	60
Tables.....	61
Figures.....	86
References.....	100
Appendix.....	121

CHAPTER 1 – INTRODUCTION

Ever since the rise of the human species about 315,000 years ago (Hublin et al., 2017), humans have mostly lived in low-density rural settings close to nature. As such, the human-nature relationship is characterized by not only the natural resources we rely on but also the benefits to health and well-being nature provides (Capaldi et al., 2015; Russell et al., 2016). With the start of the Industrial Revolution in the 18th century, changes to human settlement, labor, society, and the natural environment occurred rapidly. These changes have decreased humans' contact with nature (e.g., Cox et al., 2017; Cox et al., 2018) and impacted nature in various ways (e.g., Bai et al., 2017; Bren d'Amour et al., 2016).

Indeed, the emission of greenhouse gases, which is a byproduct of industrialization and urbanization, has been identified by the scientific community as the main cause of global warming (Dong et al., 2019). Consequentially, humans are the primary driver of climate change (IPCC, 2022). As climate change continues to disrupt human and natural systems rapidly, there is an urgent need to develop strategies of adaptation and mitigation to ensure a future for humans and nature (IPCC, 2022). Thus, better understanding of how degraded nature impact humans physically and mentally on both individual and societal levels is pertinent.

The aim of the current project is to explore the impact of degraded nature on human cognition. Such an attempt will start with a review of nature's benefits on well-being, potential factors influencing said mechanism, and a review of degraded nature impacts on well-being.

Nature and well-being

Since the birth of environmental psychology in the early 1960s (Spencer & Gee, 2009), studies have demonstrated that contact with natural environments, whether through simulation or

direct exposure (e.g., viewing a slideshow of nature scenes, taking a walk in the forest), is linked with multiple benefits (e.g., Bratman et al., 2019; Engemann et al., 2020). The benefits include, but are not limited to, stress reduction (e.g., Brown et al., 2013; Gladwell et al., 2012) and cognitive restoration (e.g., Berman et al., 2008; Berto, 2005). There are currently three frameworks explaining these benefits.

Nature and stress

Stress Reduction Theory (SRT) was developed to explain the affective responses to the natural environments (Ulrich, 1983). SRT proposes that the healing and calming effects of nature result from an unconscious and autonomic affective response to natural elements. This positive shift in emotion then leads to changes in psychological and physiological states, as well as changes in behavior (Ulrich, 1983). Thus, being in nature automatically reduces stress through regulation of both psychological and physiological responses.

In support of this theory, Ulrich (1984) compared recovery rates of patients residing in hospital rooms with a window view of a natural setting vs. patients in rooms with a window view of a brick wall. Results showed that patients who had nature views had shorter postoperative hospital stays, received less negative nurse evaluations, and took less analgesics than patients who had non-nature views. Using an experimental design, Ulrich et al. (1991) had 120 participants watch a stressful movie, and then subsequently watch videotapes of different environments that varied on the degree of exposure to natural and urban settings. During the entire viewing, participants' physiological levels were measured through heart rate, skin conductance, muscle tension, and systolic blood pressure. Participants also indicated self-reported affective states. Results from physiological measures showed that participants recovered from stress faster after viewing videos of natural environments compared to those who viewed

urban environments. Self-reported data also suggested that participants perceived natural scenes to be more restorative than urban scenes.

One of the more studied topics under the framework of SRT is “shinrin yoku” – a term coined by the Japanese Ministry of Agriculture, Forestry, and Fisheries in 1982 (Park et al., 2007). Translated as “forest bathing” in English, “shinrin yoku” refers to the process of encountering and taking in the atmosphere of a forest (Park et al., 2007). Park et al. (2010) conducted a series of field experiments at different locations in Japan to test the physiological effects of forest bathing. Participants were randomly assigned to walk in either a forest or a city area on the first day and then walked into the other area on the second day. Salivary cortisol, blood pressure, pulse rate, and heart rate were measured before and after each walk. Results show that participants in forest environments had lower cortisol levels, pulse rate, blood pressure, sympathetic arousal, as well as greater parasympathetic arousal compared to those in city environments (Park et al., 2010). Although most empirical evidence for the benefits of forest bathing come from samples in Japan (e.g., Lee et al., 2009; Li, 2009; Park et al., 2007), parallel findings have been reported in multiple experimental studies across research laboratories (see Wen et al., 2019 for a review). For example, forest bathing has been found to have therapeutic effects on hypertension within a sample of Chinese older adults (Mao et al., 2012) and enhance moods during wintertime within a sample of Polish young adults (Bielinis et al., 2018).

With such support, forest bathing, or elements of this activity, has developed into various forms of nature therapy (see Hansen, 2017 and Kotera, 2020 for reviews). In a study conducted in the United Kingdom, the effectiveness of forest bathing was compared with an established well-being intervention called Compassionate Mind Training (CMT) which has been found to increase heart rate variability (McEwan et al., 2021). Sixty-one participants were allocated to

three conditions including forest bathing, CMT, or forest bathing combined with CMT. Well-being indicators such as positive emotions, mood disturbance, rumination, nature connection, compassion, and heart rate variability were measured at baseline, post-intervention, and three-months follow-up. Results showed overall improvements in several of the well-being measures, along with an increase in heart rate variability for 57% of the sample. There were no significant differences between conditions, indicating that forest bathing had equivalence with an established well-being intervention such as CMT (McEwan et al., 2021).

Evidence from imaging studies has also offered some clues about the biological pathway between nature and its impact on stress and stress-related behaviors. One study examined rumination tendency between participants who took a 90-minute walk in a forest vs. participants who took a 90-minute walk on a busy city street using functional magnetic resonance imaging (fMRI) (Bratman, Hamilton et al., 2015). Results demonstrated that walking in nature as opposed to the city decreased both self-reported rumination and neural activity in the subgenual prefrontal cortex – an area in the brain that has been associated with rumination. Such effects were not observed in participants who took a walk in a city setting. With a similar study design, a recent fMRI study explored the impact of one's environment on stress-related brain regions among participants who took a one-hour walk in a forest vs. participants who took a one-hour walk on a busy street (Sudimac et al., 2022). Before and after the walk, participants underwent an fMRI scanning procedure which employed a fearful faces task and a stress task. During the fearful faces task, participants viewed images depicting fearful or neutral facial expressions of men and women. This task has been used in multiple studies to measure amygdala activity during fearful and neutral facial expressions. During the stress task, participants solved arithmetic problems within a time limit. Results showed that activation of the amygdala – a part of the limbic system

associated with fear processing, decreased after the walk in nature, whereas it remained stable after the walk in an urban environment. These results suggest that going for a walk in nature can decrease activation of stress-related brain regions compared to going for a walk in urban environments. Thus, under SRT framework, natural environments facilitate alleviation of stress and enhancement of well-being via biological mechanisms.

Nature and cognitive processes

Attention Restoration Theory (ART) was developed based on William James' work on attention (Kaplan & Kaplan, 1989; Kaplan, 1995). James (1890) defined attention as taking possession of the mind to choose "one out of what seem several simultaneously possible objects or trains of thought" through which there is a process of "withdrawal from some things in order to deal effectively with others." Similar to James, Kaplan and Kaplan (1989) distinguished between *involuntary attention*, where attention is effortlessly captured by "exciting" or "interesting" stimuli, and *voluntary or directed attention*, where attention is directed by cognitive control to focus on a specific stimulus while blocking out distracting stimulation. As directed attention is a limited resource, prolonged exposure to stimuli that requires directed attention leads to mental fatigue and decreases in cognitive processes that require effortful control. In contrast, contact with restorative environments, such as nature, tends to employ involuntary attention, allowing directed attention to rest and replenish. Thus, exposure to restorative environments should help improve performance on cognitive tasks requiring effortful control. According to ART, environments must have four distinct qualities to be qualified as restorative. First, the environment must create a sense of *soft fascination* by having "effortless attention-holding stimuli" (Kaplan & Berman, 2010, p. 49). In doing this, the environment engages involuntary attention while limiting the need for directing attention, allowing this limited

resource to rest and relax. As *soft fascination* environments capture attention effortlessly, they permit other mental processes, such as reflection, to emerge (Basu et al., 2018). Examples of soft fascinations include “clouds, sunsets, scenery, the motion of the leaves in a breeze” (Kaplan & Kaplan, 1989, p. 192) or looking at “a scenic view or an interesting painting” (Kaplan & Berman, 2010, p. 49). On the other hand, *hard fascination* involves stimuli that are intense and difficult to resist, which tend to fill up one’s mind, and thus preventing reflection or wandering (Herzog et al., 1997). Examples of *hard fascination* include watching violence, sex, and intense competition (Kaplan & Berman, 2010). Second, the environment has to bring a sense of *being away* – the process of distancing oneself from the mental demands that are causing attentional fatigue. This can be achieved physically, such as leaving the office to take a walk in the park, however, the most important aspect is a mental shift that allows people to feel separated from the usual environments and thought patterns. According to Kaplan (1995), “A change in the direction of one’s gaze, or even an old environment viewed in a new way can provide the necessary conceptual shift.” (p. 173). Third, the environment must have *extent*, meaning that it has to be large and rich enough for one to explore or imagine exploring it. Finally, the environment should be *compatible* with one’s purposes, inclinations, and preferences. In other words, the setting must fit what one is trying to do and what one would like to do.

While natural environments are not the only restorative environments, they were shown by early ART studies to be associated with lower resource depletion in natural experimental studies compared to other kinds of environments. In one such study, students residing in three university dormitories with window views ranging from “all natural” to “all built” were recruited (Tennessen & Cimprich, 1995). Participants were administered a series of directed attention measures. Results showed that students who had predominantly natural views from their

dormitory windows performed significantly better than those with predominantly built views on the Symbol Digit Modalities Test and the Necker Cube Pattern Control task. Moreover, students who lived in rooms with an “all nature” view rated their attentional functioning as more effective than those in all the other view groups combined. In another study, residents living in an urban public housing facility were randomly assigned to buildings with varying levels of nearby nature (e.g., trees, grass) were recruited (Kuo & Sullivan, 2001). Participants were interviewed about incidences of interpersonal aggression and then administered a measure of directed attention. Results indicated that residents living in buildings with little access to nature reported more incidences of aggression and violence than did residents living in buildings with more access to nature. Similarly, attentional functioning, measured by performance on the Digit Span Backwards task, was lower in individuals living in buildings with little access to nature. Results also indicated that the relationship between nearby nature and aggression was fully mediated through attentional functioning. While these studies could not establish a causal relationship between exposure to nature and improved cognitive processes due to their designs, they showed a link between natural environments and attention, indicating potential restorative benefits of nature.

With further research in laboratory settings, the restorative effects of nature on cognitive processes have been observed in both *in vitro* (i.e., images) and *in vivo* (i.e., taking a walk) exposures. In one study, participants were presented with images of natural environments, built environments, or geometrical figures (presumed to be a neutral control) and asked to complete a sustained attention task both before and after viewing the images (Berto, 2005). Results revealed that only participants exposed to natural environments improved in the final sustained attention task, suggesting that contact with natural environments, even when experienced indirectly

through images, does help replenish and enhance attention. Similarly, participants' performance on Digit Span Backwards significantly improved after taking a 50-minute walk in nature compared to after taking a walk in urban area (Berman et al., 2008). Researchers also compared the cognitive functioning between participants who took a 50-minute walk in a park and participants who took a 50-minute walk on a busy street (Bratman, Daily et al., 2015). Results demonstrated that walking in a park as opposed to the city street improved mood and working memory measured by the operation span task (OSPAN). The OSPAN (Turner and Engle, 1989, Unsworth et al., 2005) is a test of working memory that requires participants to memorize items and recall them in the correct serial order while solving simple math problems.

More recently, there has been preliminary evidence from electroencephalography (EEG) studies showing neurophysiological correlates of nature's effect on cognition. As ART dictates that nature provides a unique environment for directed attention to rest and replenish, it is expected that neural resources related to such mechanism would reflect a similar pattern. In a series of studies intended to measure EEG patterns during prolonged exposure to nature, participants were tested while resting or completing attention tasks before, during, and after a four-day camping trip in Bluff, Utah. One study found that resting state posterior alpha power was significantly lower during the trip compared to measures taken pre- and post-trip (Hopman et al., 2020). As EEG shows how attention changes by measuring shifts in brain activity at different frequencies, such results indicate posterior alpha power as a potential biomarker for changes between exposure to nature and urban environments. Another study found that the amplitude of error-related negativity (ERN) was significantly higher during the trip compared to pre- and post-trip (LoTempio et al., 2020). ERN is a component of an event-related brain potential (ERP) and appears when participants commit errors during task (Holroyd & Coles,

2002). ERN amplitude is positively associated with motivation to perform well (Gehring et al., 1993), error correction, learning tendency to avoid negative events (Frank et al., 2005), and cognitive function (Yeung & Cohen, 2006). Such evidence supports ART's notion that natural environments can improve cognitive processes via ways of restoring and replenishing cognitive preserves.

Processing natural environments

To integrate key elements from SRT and ART under a unifying framework, perceptual fluency account (PFA) was developed based on processing fluency literature (Joye & Van den Berg, 2011). According to Joye and Van den Berg (2011), processing fluency is defined as “the subjective experience of the ease with which a certain stimulus organization is processed” (p. 266). Thus, PFA argues that the calming and restorative benefits of nature are evoked through the ease by which people process natural environments compared to other environments. Similar to SRT, PFA suggests that the restoration effect of nature on human physiology is initiated by positive affect. The difference between SRT and PFA is that SRT attributes the positive affect derived from nature to evolutionary factors, while PFA posits that the positive affect is caused by ease in processing (Joye & Van den Berg, 2011). PFA also agrees with ART's argument that natural environments demand less attentional resources than urban environments as PFA establishes an advantage in processing natural scenes over urban settings and thus expects less cognitive effort in processing the former than the latter. In other words, “PFA views attention restoration and stress reduction as by-products of fluent processing” (Joye & Van den Berg, 2011, p. 266).

In support of PFA, studies from visual perception research have shown that images of natural environments differ in several properties compared to images of urban environments.

Some of those differences include spectral slope (Braun et al., 2013; Wang & Ogawa, 2015) which measures the “naturalness” of a given image, along with edge (natural images tend to have fewer straight edges and more non-straight edges) and color properties (Berman et al., 2014; Ibarra et al., 2017). Studies have also found that such “lower-level” properties in natural images are easier to process and less energy-demanding than urban images. For example, eye tracking and blink rate data indicated less effort for viewing nature compared to urban images (Berto et al., 2008; Valtchanov & Ellard, 2015). Similarly, neuroimaging studies indicated that nature compared to urban images placed less demand on visual and attentional processes (Grassini et al., 2019; Tang et al., 2017).

Besides lower-level properties (i.e., contrast, complexity), “higher-level” processing (i.e., being able to recognize the scene and objects) also plays a role in explaining the different reactions to nature and urban images. Indeed, the difference in preference between nature and urban scenes diminished when participants could not identify scenes in manipulated images (Tinio & Leder, 2009; Valtchanov & Ellard, 2015). In a study by Menzel & Reese (2022), participants were randomly assigned to view pictures of natural or urban environments and completed measures of mood, perceived restoration, and preference. Those images were unaltered (original images), manipulated to either lack spatial information or retain certain image properties (phase-scrambled images), or contained some spatial information while lacking some lower-level properties (line drawing images). Results showed that although nature and urban scenes differed in several image properties, there was no significant difference in perceived restoration between nature and urban images when participants looked at phase-scrambled images. In contrast, participants were more likely to rate nature images as more restorative compared to urban images when they could recognize the environments (original and line

drawing images). Interestingly, preference and perceived restoration remained significantly higher for nature when participants were exposed to words describing nature vs. urban scenes despite the lack of the preferred lower-level properties associated with nature images (Menzel & Reese, 2022). These findings suggested that lower-level properties of natural images do not fully explain nature's restorative effects as suggested by PFA and that higher-level processing of environments might play a more central role in delivering nature benefits.

The benefits of nature on human well-being are currently explained by three main frameworks. Based on the notion of biophilia, human tendency to interact or be closely associated with other forms of life in nature, SRT suggests that nature calms us through biological and physiological processes during which positive affect is enhanced and stress is reduced. On the other hand, ART champions the restorative effect of nature on cognitive performance. ART posits that nature possesses unique qualities that allow involuntary attention to rest and replenish which results in better performance on cognitive tasks after exposure to nature. Finally, PFA proposes that nature benefits come from the ease by which human process natural environments. As such, by processing certain lower-level properties that nature scenes typically contain, people feel less stressed and more relaxed.

The role of emotion

A common thread across SRT, ART, and PFA is that they all provide support that exposure to natural environments results in positive affect. According to SRT, exposure to natural environments instantly brings about positive reactions which include improvement in mood and regulation of stress system. Similarly, data from PFA establishes a preference for natural environments over built environments and suggests the benefit of mood and cognition come from the ease with which humans process natural scenes. In most ART studies, results

often show an increase in positive affect after exposure to nature compared to urbanity; however, changes in affect do not correlate with changes in cognitive performance (Berman et al., 2008; Berman et al., 2012). Such phenomenon is thought to indicate that improvements in memory are not influenced by mood, and that “separate mechanisms may underlie the cognitive and affective effects of interacting with nature” (Berman et al., 2012, p.303). It is worth noting that the natural and built scenery (either experienced in vivo or in vitro) used in most, if not all, of the nature and human well-being literature have been selected based on the contents they include (e.g., green spaces for nature vs high rises for urbanity) without controlling for the emotional aspects of such scenes. Without more close attention to whether and how the different stimuli used in such studies vary in terms of the emotional states they elicit among participants, it is difficult to isolate effects of such studies to nature per se.

Among the various models used to access emotions, there are two distinct perspectives: dimensional and discrete. Theories under the dimensional framework argue that emotions are organized by underlying factors such as valence, arousal, and motivational state (Russell & Barrett, 1999; Watson et al., 1999). In contrast, theories from discrete emotion framework assert that each emotion has unique properties with distinct experiential, physiological, and behavioral qualities. Within dimensional perspectives, the dimensions mostly studied are valence, arousal, and to a lesser extent approach–avoidance (e.g., Davidson, 2000; Lang et al., 1997). Most evidence points towards the idea that contemporary measures of emotional response capture its dimensions rather than discrete states (see Mauss & Robinson, 2009, for a review). As such, studies comparing natural and urban environment, through their practice of picking/creating stimuli, create two conditions that are not only different in content but also in emotional dimensions. Specifically, scenes of natural environments tend to have high valence/low arousal

ratings while scenes of built environments tend to have average valence/average arousal ratings (Roe et al., 2013; White et al., 2015).

ART's implication that affect has little or no impact on cognitive functioning seems to be at odds with the massive evidence of the impact of positive emotions on cognition. Since the 1980s, research by Isen has shown that positive affect can influence cognitive flexibility and organization, motivation, and decision-making (see Isen, 2008 for a review). Specifically, experimental studies have shown that people experiencing positive affect can group categories that are typically not seen as belonging to the same group (e.g., "feet" in the category "vehicle;" Isen & Daubman, 1984; Kahn & Isen, 1993), perform better in creative problem-solving tasks (Isen et al., 1987), as well as deliver a correct diagnosis more quickly, exhibit more efficiency in clinical thinking, and express more clinical interest within a hypothetical medical decision-making scenario (Isen et al., 1991). Those findings serve as the foundation for a theory regarding the impact of positive emotions on human functioning and flourishing – the broaden and build theory (Fredrickson, 2001). The broaden and build theory proposes that positive emotions "share the ability to broaden people's momentary thought-action repertoires and build their enduring personal resources, ranging from physical and intellectual resources to social and psychological resources." (Fredrickson, 2001, p. 3). Compared to neutral and negative emotions (e.g., anger/disgust and anxiety/fear), positive emotions (e.g., amusement and contentment) prompted participants to perceive stimuli more holistically in a global-local visual processing task and express more action urges (Fredrickson & Branigan, 2005). Positive emotions can also reduce the own-race bias in facial recognition (Johnson & Fredrickson, 2005). In a facial recognition task, White participants watched videos eliciting joy, fear, or neutrality before the learning or testing stages of the task. Compared to neutral and fear, joy experienced before either stage

improved recognition of Black faces, as well as significantly reduced the own-race bias (Fredrickson & Branigan, 2005).

Similarly, findings from neurocognitive psychology also suggest an overlap between emotion and cognition functionally and anatomically (see Pessoa, 2008 for a review). A prime example of this interaction is the case of the human amygdala. The amygdala is involved in emotional learning, processing and understanding of emotion, changing emotional responses, and the influence of emotion on memory, attention, and perception (see Phelps, 2006 for a review). Studies on neural circuits have allowed mapping of the amygdala's anatomical connections onto behavioral function (see Janak & Tye, 2015, for a review). Findings suggest the basolateral amygdala (BLA) receives sensory and cortical inputs, integrating perceptual information with emotional value then sending signals to other brain regions, such as the hippocampus and prefrontal cortex which are heavily involved in memory function. The BLA also sends signals to the central nucleus of the amygdala (CeA), which helps coordinate emotional responses and influences how emotional experiences are remembered. Furthermore, evidence shows different circuits within the amygdala that are responsible for shaping specific emotional behaviors such as fear or reward-seeking. These circuits also help assign emotional meaning to experiences, making them more likely to be stored as lasting memories. Additionally, findings suggest emotion activates brain chemicals like glutamate, norepinephrine, and dopamine within the BLA, enhancing the brain's ability to strengthen and store emotionally important memories.

Emotion has also been shown to influence working memory in various ways depending on which task is tested (e.g., information updating, span) (see Ribeiro et al., 2019 for a review). While both positive and negative emotional stimuli impair verbal modalities compared to neutral

stimuli in updating tasks, negative emotional stimuli decrease both verbal and visuospatial modalities in storage, span, and complex working memory tasks. In a study by Storbeck & Maswood (2015), high valence stimuli were shown to improve performance in both verbal and spatial complex span tasks compared to low or neutral valence stimuli. Participants were randomly assigned to watch videos to induce either happiness, sadness, or neutral mood. Participants then learned a set of words (experiment 1) or spatial information of a red box within a 3x4 matrix (experiment 2) and were asked to solve simple math problems. Finally, participants were asked to recall the learned targets in the correct order they were shown. Results showed that positive mood predicted better performance in verbal and spatial working memory and executive control, while no difference was found in performance between neutral and negative condition (Storbeck & Maswood, 2015). Findings from another study show that high valence stimuli enhance working memory capacity while high arousal stimuli reduce working memory capacity (Gokce et al., 2021). In this study, participants were shown four grey squares out of eight possible locations in the learning phase and asked to indicate whether the grey square shown in the testing phase matched one of the previously occupied square positions. Between learning and testing, participants saw negative (low valence), positive (high valence), or neutral (medium valence) emotional pictures. Results showed that while low valence pictures reduced working memory capacity, high valence pictures increased working memory capacity compared to the neutral valence pictures (Gokce et al., 2021). Correlational analyses also showed a positive relationship between valence and working memory capacity and a negative relationship between arousal and working memory capacity (Gokce et al., 2021).

Based on findings about the relationship between emotion and cognitive functioning, ART's claim that there is no influence of mood on working memory during contact with nature

seems to be amiss. Specifically, the lack of control over valence and arousal of stimuli used in those studies could have created confounding variables that interfere with the effect of environment on performance. In a meta-analysis on 46 ART studies published from July 2013 to November 2017, results showed that working memory, cognitive flexibility, and to a lesser degree, attentional control were improved after exposure to natural environments compared to other environments. However, pooled estimated mean effect sizes (Hedges' g) for the three cognitive domains were in the low (-.156 and .162) to moderate range (-.317) (Stevenson et al., 2018). It is possible that one of the reasons for such outcomes and the varying effect sizes between individual studies included in the meta-analysis (Stevenson et al., 2018) is due to the lack of control for emotional aspects in stimuli used.

Degraded nature and well-being

Most studies on the benefits of nature have exposed participants to natural settings that would be considered by most to be pleasant, beautiful, and non-threatening. However, given the evidence showing that valence of emotional stimuli and perhaps arousal level of those stimuli can affect cognitive performance, it is an open question whether nature itself, or simply high valence stimuli that happen to include nature are responsible for the observed findings. Furthermore, the effects of exposure to environmentally degraded nature, either directly or indirectly, on individuals' mental health and well-being have been well-documented through numerous studies. Field studies conducted with individuals located in rural Australia have shown that contact with stressful environmental conditions (e.g., drought, dry land salinity) is associated with a sense of displacement or loss (Albrecht et al., 2007), decreased satisfaction with life and future (Drought Policy Review Expert Social Panel, 2008), increased levels of anxiety, depression, and psychological distress (Edwards et al., 2008; Ellis &

Albrecht, 2017; Speldewinde et al., 2009; Stain et al., 2011), as well as increased rates of suicide (Hanigan et al., 2012). Similar concerns have also been reported within Inuit communities in Canada. Specifically, participants shared that shifts in land, snow, ice, weather, wildlife, and vegetations due to climate change led to negative emotions, such as anxiety and depression, and negatively impacted their health, identity, and sense of self-worth (Cunsolo Willox, Harper, Edge et al., 2013). Community members also reported such changes leading to family stress, high likelihood of increased substance use, and exacerbation of previous trauma and mental health stressors (Cunsolo Willox, Harper, Ford et al., 2013).

In addition to the documented psychological impacts of direct exposure to degraded environments, emerging research highlights that even indirect experiences, such as perceptions and awareness of environmental decline, can also evoke significant emotional distress. Such reactions have been identified as eco-anxiety or climate anxiety, defined as “heightened emotional, mental or somatic distress in response to dangerous changes in the climate system” (Climate Psychology Alliance, 2020, p. 22, as cited in Dodds, 2021). In 2018, the American Psychological Association (APA) conducted its annual Stress in America survey with 3,458 respondents aged 18 and above living in the United States. Findings show that 51% of respondents listed climate change and global warming as a significant source of stress (American Psychological Association, 2018). In the same year, data from Climate Change in the American Mind – an initiative aimed to track and investigate public understanding of climate change and support for climate policies – showed that about seven in ten Americans (69%) say they are at least “somewhat worried” about global warming, with three in ten (29%) are “very worried” about it (Leiserowitz et al., 2018). Nearly half of Americans say they have personally experienced the effects of global warming (46%) or think people in the United States are being

harmful by global warming (48%) (Leiserowitz et al., 2018). About half or more Americans think they (49%), their family (56%), and/or people in their community (57%) will be harmed by global warming (Leiserowitz et al., 2018). Not only is climate anxiety becoming more prevalent, but perceptions of climate change are also causing distress similar to that of direct experience of climate change. A systemic review of 12 studies on the impact of climate anxiety with samples coming from multiple countries (e.g., United States, Australia, Philippines) shows that climate anxiety is associated with symptoms of depression, anxiety, stress, insomnia, higher psychological distress, lower self-rated mental health, and PTSD (see Boluda-Verdú et al., 2022 for a review).

While there has been no experimental study on the impact of climate change or environmental degradation on well-being (due to obvious ethical and logistical reasons), there has been ample evidence showing the drastic effects that environmental changes have on mental health. In combination with the data showing that exposure to intact nature (either in vivo or in vitro) produces robust positive impacts on human well-being under the SRT and ART experimental literatures, such effects of environmental degradation on mental health make it reasonable to expect that exposure to degraded nature, either directly or indirectly, will produce the opposite effect on emotional and cognitive functioning. In other words, it is expected that compared to contact with intact nature, contact with degraded nature should elevate stress and physiological rating, decrease cognitive functioning via ways of attention loading, and be unfavorable due to difficulty in processing.

The current study

The benefits of nature on human well-being have been well-documented over the last few decades under the umbrellas of SRT, ART, and, more recently, PFA, through several

experiments. Most, if not all, studies have employed nature stimuli that are high in valence and low in arousal, as well as used urban stimuli that are average in both valence and arousal as a comparison. As such, without controlling for valence and arousal, nature's benefits on human well-being might have been impacted in part by our preference for beautiful natural environments. At the same time, despite the data coming from field and cross-sectional studies that link the impacts of climate change (through holistic changes in environment, weather, vegetation) to poor outcomes, there have been no experiments exploring the impact of damaged nature on cognitive performance. Findings from such experiments are important as the likelihood of people experiencing changes in their living environments increases with the rate of climate change.

The current project intends to address two concerns: the lack of a set of image stimuli that can be used for environmental studies with various ratings of valence and arousal, and the limited investigation about the impact of damaged nature on working memory.

First, there is a need for a standardized photo set of different environmental settings to utilize in environmental psychology research. Although studies using in vitro methods (e.g., walking in the park vs. walking in a city street) produce the largest effect of nature benefits on human well-being (see Ohly et al., 2016 and Stevenson et al., 2018 for reviews), it is difficult to replicate those studies widely as climate and vegetation conditions vary greatly across locations. Studies about the benefits of natural environments also come mostly from Western countries (e.g., Germany, USA, the Netherlands) and some East Asian countries (e.g., China, Japan). As access to natural environments is not equally distributed worldwide, there is a need to develop a standardized set of stimuli that can be easily shared and used across labs. While there have been image sets depicting climate change and environmental hazards with ratings of valence and

arousal (Lehman et al., 2019; Prete et al., 2022), they often contain scenes of destroyed man-made structure and living subjects (e.g., humans, animals). Although such stimuli could be helpful for studies focusing on belief, reaction to, or communication of climate change, using them to explore the impact of degraded nature as opposite to the benefits of intact nature is inappropriate. Thus, the first goal of this project is to determine the preference, valence, and arousal of sceneries depicting intact natural, degraded natural, and built environments.

Second, there is a need to explore the impact of damaged nature (either by human or natural disasters) on human functioning in an experimental setting. Although the impact of climate change on well-being is well-documented, it is important to understand how exposure to damaged nature influences behavior and performance. Such knowledge would then allow for more exploration into the relationship of humans and nature, for example, comparing the effect of built environments and degraded nature on well-being, or determining whether there is a threshold of acceptable degradation that we can process without getting impacted. Perhaps, in understanding how damaged nature corrupts us, we will better comprehend how intact nature has fixed us. Thus, the second goal of this project is to examine the impact of exposure to images of degraded natural environment, on cognitive performance, specifically working memory.

From the second goal, the current study proposes two hypotheses:

- Hypothesis 1: There is an increase in working memory performance after exposure to intact nature compared to built environment and degraded nature.
- Hypothesis 2: There is a decrease in working memory performance after exposure to degraded nature compared to built environment and degraded nature.

CHAPTER 2 – METHOD AND RESULTS

Study 1

The goal of Study 1 was to develop an image pool that can be used for future studies based on the norming procedure of the International Affective Picture System (IAPS) (Lang et al., 1997) which includes more than 1,000 examples of human experience and emotion with rating of valence and arousal obtained from women and men. Images of intact nature, damaged nature, and built environments were rated in terms of valence, arousal, and preference.

Methods

Stimuli. Images of intact nature and built environments were utilized from a previous study on “naturalness” and “disorder” of environments (Kotabe et al., 2017). From that study, images were selected from the Scene UNderstanding (SUN) image database (Xiao et al., 2010) which is a collection of annotated images covering a large variety of environmental scenes, places, and the objects within. As the original pool contained 1,105 images which included nature and built scenes that varied on “disorder” level or the extent to which components appear disorganized and out of place, several images were eliminated from the pool to fit with the goals of the current project. Specifically, images that cannot be easily distinguished as either nature or built environments such as tree-lined roads, vast farmland, or fields with scattered residences in the background were eliminated. Images depicting floating icebergs were also deleted from this set. Finally, images depicting built environments with high “disorder” such as abandoned residences or hurricane aftermath were discarded. This process yielded a final set of 360 nature scenes and 290 built scenes from the 1,105 images used in a study by Kotabe et al. (2017). Pictures of degraded nature were collected through Google Images, Flickr, and Unsplash by

searching for terms such as “deforestation” and “melting glacier.” Only images with Creative Commons licenses that permit use for non-commercial purposes and modifications of the original images were selected. This process yielded 130 images. All images were then resized to 1200x900 pixels to ensure consistency in viewing. Thus, the total pool of images included 780 pictures. This pool was then divided into five random subsets, each including 156 images. Each subset contained 72 images of intact nature, 58 images of built environments, and 26 images of degraded nature.

Participants. Since the goal of Study 1 was to collect ratings on images across conditions in order to select appropriate stimuli for other studies, no a priori power analysis was run. However, the goal was to have about 50 ratings per image. Based on potential attrition and incomplete responding, the goal was to recruit approximately 300 people for Study 1.

Participants were 345 college students from Introductory Psychology classes at a large public university in the Rocky Mountain region completing the study for course credits. The sample consisted of 218 cis women, three trans women, 99 cis men, two trans men, and 11 non-binary individuals. Three individuals listed their gender as “Other,” seven participants did not wish to share their gender, and two participants did not indicate a response. Participants’ age ranged from 18 to 69 years old ($M = 19.23$, $SD = 3.29$). The sample comprised 84.1% White, 3.5 Black, 2% Asian, and 10.4% other ethnicities. 16.23% of the sample identified as Hispanic.

Procedures. Once they access the study via Qualtrics, participants completed the consent form and were randomly assigned to a subset of images with each subset containing 156 images (72 for the intact natural environment condition, 58 for the built environment condition, and 26 for the degraded natural environment). Images in each subset were presented in a random order. Participants were shown each image along with three measures, asking them to rate the picture

on two dimensions of emotion, sense of restoration, and preference. Each slide of image and scales was presented for at least ten seconds before participants could advance to the next slide. After seeing and rating all 156 images, participants filled out a demographic questionnaire and were debriefed.

Measures. The *Self-Assessment Manikin* (SAM) (Bradley & Lang, 1994) was used to assess for two dimensions of emotions including valence and arousal. Participants saw a figure depicting varying expressions on a continuous scale for each dimension. For the valence dimension, the scale ranges from a frowning, unhappy figure to a smiling, happy figure. For the arousal dimension, it ranges from a relaxed, sleepy figure to an excited, wide-eyed figure. Participants were instructed to select any of the five figures comprising each scale, or between any two figures, resulting in a 9-point rating scale for each dimension. Ratings were scored such that 9 represents a high rating on each dimension (i.e., high pleasure, high arousal), and 1 represents a low rating on each dimension (i.e., low pleasure, low arousal).

Sense of restoration was assessed by the item “This environment offers relaxation, calming and an escape from everyday stress.” Participants were asked to rate on a Likert scale from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*) to indicate the extent they think the picture creates a sense of restoration. This approach has been used in a recent image rating study (Franek, 2023).

Likewise, a single item question “How much do you like this image?” assessed the visual preference of an image, following approaches used in other studies of environmental preference (Herzog & Gale, 1996). Participants rated on a Likert scale from 1 (*Dislike a great deal*) to 7 (*Like a great deal*) on the extent to which they liked the image they had just seen.

Descriptive information about participants was gathered at the end of the study. This demographic form includes items related to age, gender, assigned sex at birth, race, ethnicity, and household income.

Results

Mean ratings on valence, arousal, feeling of restoration, and preference of each image were calculated (See Table 1 for descriptive statistics). One-way ANOVAs were conducted to test the differences in the four variables across three conditions (See Table 2 for descriptive statistics and F values for all analyses and Figures 1 to 12 for visualization of all data points).

There was a significant difference in valence among the three environments, $F(2, 777) = 122.40, p < .001, \eta^2 = .239$. Tukey's HSD post hoc tests showed that participants rated images of intact environments ($M = 6.47, SD = 1.04$) significantly higher in valence than images both degraded environments ($M = 4.84, SD = 1.65$) and built environments ($M = 5.33, SD = 1.10$). Additionally, participants graded images of degraded environments lower in valence than images of built environments.

There was a significant difference in arousal among the three environments, $F(2, 777) = 29.76, p < .001, \eta^2 = .071$. Tukey's HSD post hoc comparisons showed that participants rated images of degraded environments ($M = 4.98, SD = 0.54$) significantly more arousing than images of built environments ($M = 4.73, SD = 0.39$). In contrast, participants rated images of intact environments ($M = 4.60, SD = 0.54$) significantly less arousing than images of both degraded and built environments.

There was a significant difference in sense of restoration among the three environments, $F(2, 777) = 139.30, p < .001, \eta^2 = .26$. Tukey's HSD post hoc comparisons showed that participants rated images of intact environments ($M = 4.98, SD = 0.04$) significantly higher in

feeling of restoration than images of both degraded environments ($M = 3.78$, $SD = 0.10$) and built environments ($M = 4.05$, $SD = 0.05$). Participants also graded images of built environments significantly higher than images of degraded environments.

There was a significant difference in preference among the three environments, $F(2, 777) = 119.70$, $p < .001$, $\eta^2 = .24$. Tukey's HSD post hoc comparisons showed that participants liked images of intact environments ($M = 516$, $SD = 0.04$) significantly more than images of both degraded environments ($M = 4.09$, $SD = 0.10$) and built environments ($M = 4.34$, $SD = 0.05$). Participants also liked images of built environments significantly more than images of degraded environments.

Pearson correlation analyses were conducted to examine the relationships among valence, arousal, sense of restoration, and preference within each environmental condition (intact, built, degraded) (See Table 3, 4, and 5 for all correlation coefficients for all three environments).

Among the images of intact environments, valence was positively correlated with sense of restoration ($r = .95$, $p < .001$) and preference ($r = .98$, $p < .001$), and negatively correlated with arousal ($r = -.13$, $p < .05$). Sense of restoration and preference were also strongly positively correlated ($r = .91$, $p < .001$). Arousal was negatively associated with feeling of restoration ($r = -.33$, $p < .001$), but not significantly with preference ($r = -.05$, $p = .31$).

Among the images of built environments, valence was positively associated with sense of restoration ($r = .97$, $p < .001$) and preference ($r = .99$, $p < .001$), and negatively with arousal ($r = -.20$, $p < .001$). Feelings of restoration and preference were highly correlated ($r = .96$, $p < .001$). Arousal was negatively associated with both sense of restoration ($r = -.34$, $p < .001$) and preference ($r = -.18$, $p < .01$).

Among the images of degraded environments, valence was strongly positively correlated with a sense of restoration ($r = .98, p < .001$) and preference ($r = .98, p < .001$), and negatively with arousal ($r = -.47, p < .001$). Sense of restoration and preference were also strongly correlated ($r = .96, p < .001$). Arousal showed negative associations with both feelings of restoration ($r = -.57, p < .001$) and preference ($r = -.38, p < .001$).

Results from Study 1 suggested that different types of environments elicit distinct emotional and psychological responses. Specifically, images of intact natural environments were rated as significantly higher in valence, preference, and restoration, and lower in arousal, compared to built and degraded natural environments. Additionally, valence was strongly correlated with both perceived restoration and preference across all environmental categories, indicating that positive affect is tied to how restorative or likeable an image is perceived to be. These relationships highlight an important methodological consideration: previous studies using photographic stimuli to examine the benefits of nature exposure may have unintentionally confounded nature content with high valence. The current study contributes a valuable dataset of 780 images with ratings of valence, arousal, restoration, and preference, which can be used by future researchers to more carefully disentangle the unique psychological effects of nature itself from the emotional factors often embedded within such stimuli.

Study 2

The purpose of Study 2 was to assess whether looking at images of degraded natural environment worsens working memory capacity.

Methods

Stimuli. Thirty-nine images with 13 representing each type of environment, intact nature, degraded nature, and built environments, were selected for use in Study 2 (See Table 6 for

descriptive statistics of the images used in Study 2). Due to distinct rating patterns across the three environment types, it was not possible to create a fully matched stimulus set across all categories. As the primary focus of the present study was the comparison between intact and degraded natural environments, images in those two categories were closely matched based on valence and arousal ratings. For example, the image coded *degraded_80* (Valence: 6.87, Arousal: 3.93) was matched with *intact_81* (Valence: 6.84, Arousal: 3.86). Images of built environments were selected based on their average ratings of valence and arousal (around 4.5 on a 9-point scale) in order to serve as a neutral comparison condition.

In order to ensure similarity between images of intact and degraded environments, one-way ANOVAs were conducted to test the differences in the four variables across three types of environments (See Table 7 for descriptive statistics and F values for all analyses). It was expected that ratings of valence, arousal, sense of restoration, and preference would be equivalent between images of intact and degraded environments.

There was a significant difference in valence among the three environments, $F(2, 36) = 288.9, p < .001, \eta^2 = .94$. Tukey's HSD post hoc tests showed that participants rated images of built environments ($M = 4.51, SD = 0.04$) significantly lower in valence than images of degraded environments ($M = 6.84, SD = 0.09$) and intact environments ($M = 6.85, SD = 0.10$). There is no significant difference in valence between images of intact and degraded environments.

There was no significant difference in arousal among the three environments, $F(2, 36) = 0.30, p = .74$.

There was a significant difference in sense of restoration among the three environments, $F(2, 36) = 224.3, p < .001, \eta^2 = .93$. Tukey's HSD post hoc tests showed that participants rated images of built environments ($M = 3.49, SD = 0.05$) significantly lower in feeling of restoration

than images of degraded environments ($M = 5.16$, $SD = 0.07$) and intact environments ($M = 5.19$, $SD = 0.07$). There is no significant difference in sense of restoration between images of intact and degraded environments.

There was a significant difference in preference among the three environments, $F(2, 36) = 278.4$, $p < .001$, $\eta^2 = .94$. Tukey's HSD post hoc tests showed that participants rated images of built environments ($M = 3.71$, $SD = 0.04$) significantly lower in preference than images of degraded environments ($M = 5.38$, $SD = 0.07$) and intact environments ($M = 5.35$, $SD = 0.06$). There is no significant difference in preference between images of intact and degraded environments.

Thus, stimuli for intact and degraded environments are completely matched across all four variables. Stimuli used for built environments are matched with the other two environments based on arousal ratings. Ratings for valence, sense of restoration, and preference of images of built environments are significantly lower compared to those ratings of intact and degraded environments.

Participants. A power analysis was conducted to estimate the sample size for this study. Based on the effect size (Cohen's d) of 0.5 found in a result of the impact of natural environments on working memory performance (Berman et al., 2008), our power analysis utilized the design of a one-way ANOVA model, a medium effect size, and 80% power which resulted in an estimated sample size of 159. Based on potential attrition and incomplete responding, the goal was to recruit approximately 180 participants for Study 2.

Participants were 318 college students from Introductory Psychology classes at a large public university in the Rocky Mountain region completing the study for course credits. The sample consisted of 202 cis women, one trans woman, 90 cis men, one trans man, and five non-

binary individuals. Two individuals listed their gender as “Other,” 14 participants did not wish to share their gender, and three participants did not indicate a response. Participants’ age ranged from 18 to 50 years old ($M = 20.31$, $SD = 3.29$). The sample comprised 80.5% White, 5.97% Black, 3.46% Asian, and 10.07% other ethnicities. 13.84% of the sample identified as Hispanic.

Procedures. Upon accessing the study via Qualtrics, participants completed the consent form and the Digit Span Backwards task, a measure of working memory frequently used in ART studies. They then completed a visual task search and the Visual Analogue Scale for fatigue. Next, participants were randomly assigned to either intact nature, degraded nature, or built environment. They were assigned to look at 13 images according to their condition in random order. Each image was shown for at least 20 seconds. During viewing, participants were given the following instruction, “Please describe the picture above in as much detail as possible. Also, describe how this picture makes you feel.” After looking at all 13 images, participants completed the Digit Span Backwards task for the second time. Lastly, participants completed a demographics questionnaire and were debriefed.

Measures. The *Digit Span Backwards* task (DSB) was used to assess working memory capacity. It has been implemented in prior studies of attention restoration as a measure of working memory (see Ohly et al., 2016 and Stevenson et al., 2018). Participants had two teaching trials before completing the actual task. Participants were instructed to listen closely to the audio as it could only be played once and asked to type in the numbers spoken in reverse order. Once the audio was finished, participants entered the sequence in reverse order to the computer. Each sequence length was repeated twice (with different numbers). Sequences of numbers started with two digits and extended by one digit at a time with a maximum of eight in total. Correct sequences were scored the same independently of sequence length, with a

maximum score of 14 (seven digit lengths times two repetitions of each length). However, scoring was discontinued when participants failed the same sequence length twice.

A *Visual Search Task* was used to induce mental fatigue. ART posits that exposure to restorative environments, specifically natural environments, helps decrease mental fatigue as it allows directed attention to rest and replenish. Thus, the present study aimed to maximize the potential effect of natural environments on working memory capacity by implementing a stress task. In the Visual Search Task, participants were asked to identify the letter to the immediate right of a target letter announced at each trial among a group of other letters. Participants had a practice trial before starting the real task. On the instruction screen, participants saw this direction: “For each trial, you will first be told which letter to search for (the “target” letter). Then a large block of letters will be shown. Your job is to search through the block of letters as quickly as possible and find the target letter. Once you have found the target letter, write down the letter to its immediate right. You will have eight seconds to do this.” Once participants press start, the screen shows the target letter. On the next screen, participants saw the letter block with a blank box at the end for answer. There were 15 trials.

The *Visual Analogue Scale* (VAS) was used to measure mental fatigue. The VAS measures the intensity of certain sensations and feelings, such as pain, and has been shown to be an appropriate tool for assessment of psychological conditions in clinical settings (Lesage et al., 2012). As a pain measure, the VAS is usually presented as a horizontal line with the left end indicating no pain, and the right end indicating the most severe pain possible. Individuals then mark a point on the line that matches the intensity of their pain. For this study, a straight line with marking of 10-point increments (ranging from 0 to 100) was presented. Participants were asked to click on the mark of the line to indicate how fatigued they are feeling at the moment.

The *Brief Nature Relatedness Scale* (NR-6) was used to assess participants' connection with nature. Nature relatedness refers to individual levels of connectedness with the natural world (Nisbet et al., 2008) and is positively related with pro-environmental behaviors, environmental identity, and environmental self-identity (e.g., Balundè et al., 2019; Mackay & Schmitt, 2019; Whitburn et al., 2019). As nature relatedness has been shown to mediate the effect of exposure to nature on well-being, the current study wanted to explore whether or not nature relatedness moderates the impact of environments on participants' working memory capacity. The NR-6 has high reliability and has been found to be predictive of happiness, environmental concern, and nature contact ($\alpha > 0.84$; Nisbet & Zelenski, 2013). The scale comprises six items and asks participants to rate the extent to which they agree with each statement on a 5-point Likert Scale.

Finally, participants' prediction of their performance on the DSB was assessed by the item "How do you think you perform on the second memory task compared to the first memory task?" Participants were asked to rate on a Likert scale from 1 (*Much Worse*) to 5 (*Much Better*) to indicate how they did on the second DSB compared to the first DSB. Memory research suggests that judgement of past performance is positively correlated with actual performance accuracy (e.g., Fleming et al., 2016). The present study wanted to explore whether or not participants' prediction of their performance moderates the effect of different environments on their actual memory performance.

Descriptive information about participants was gathered at the end of the study. This demographic form includes items related to age, gender, assigned sex at birth, race, ethnicity, and household income.

Results

First, a series of one-way ANOVA was conducted to test potential differences in performance on the DSB among three conditions at Time 1 and Time 2. There was no significant difference in participants' performance on the DSB between the three environments before viewing the images, $F(2, 315) = 0.81, p = .445$. Similarly, there was no significant difference in participants' performance on the DSB between the three environments after viewing the images, $F(2, 315) = 2.86, p = .059$.

Next, a series of paired t-tests were conducted to test for changes in performance on the DSB over time for each condition. There was no significant difference in working memory capacity over time for any of the three conditions. Change scores between Time 1 and Time 2 were also calculated for the three conditions. One-ANOVA was conducted to test whether there is any difference between the change scores among the three conditions. There was no significant difference in participants' change score from Time 1 to Time 2 between the three environments, $F(2, 315) = 1.901, p = .151$. While Tukey's HSD post hoc tests showed that participants who viewed images of intact environments gained the highest change score on the DSB ($M = 0.27, SD = 2.28$) and participants who viewed images of degraded environments lost the highest change score on the DSB ($M = -0.39, SD = 2.32$), there was no significant difference between the change scores across the three conditions. Thus, the hypotheses as written were not supported.

As the current project aims to explore the impact of types of environments and time on participants' working memory capacity, not just whether the difference in performance over time varied among the three conditions, a 2 (time: Time 1, Time 2) \times 3 (environment types: intact, built, degraded) mixed factorial ANOVA was conducted (See Table 8 for descriptive statistics

and F values for all analyses and Figure 13 for data visualization). There was no significant main effect of time or types of environments on participants' performance on the DSB. There was also no significant interaction effect detected. Data was then split into subsets in order to better examine the effect of time and types of environments on participants' performance on the DSB.

A 2 (time: Time 1, Time 2) \times 2 (environment types: intact, degraded) mixed factorial ANOVA was conducted to test the effect of time and types of environments on participant's working memory capacity (See Figure 14 for data visualization). There was no significant main effect of time or types of environments on participants' performance on the DSB. However, there was a statistically significant interaction between types of environments and time, $F(1, 211) = 4.35, p < .05, \eta^2 = .003$, such that performance on the DSB improved at Time 2 for participants who viewed images of intact nature while performance on the DSB decreased at Time 2 for participants who viewed images of degraded nature. Similar analyses were conducted on the subsets of intact and built environments and the subset of degraded and built environments. In both subsets, there was no significant main effect of time or types of environments on participants' performance on the DSB. There was also no significant interaction effect of time and types of environments on participants' DSB score.

A series of linear mixed-effects models were carried out to test for potential moderation effects of stress, nature relatedness, and participants' prediction of their performance within the data subset of intact and degraded environments. (See Table 9 for all analyses). There was no significant main effect of stress, nature relatedness, performance prediction, or interaction effect that includes those three variables. All three models revealed a significant interaction effect between time and types of environments on participants' working memory capacity.

Similar analyses were conducted on the subset of intact and built environments and the subset of degraded and built environments (See Table 10 and 11 respectively for all analyses within the intact vs. built subset and the degraded vs. built subset). In both subsets, there was no significant main effect of stress, nature relatedness, or interaction effect that includes those two variables. There was also no significant interaction effect of time and types of environments on participants' DSB score. While there was no significant main effect of performance prediction, there was a significant interaction effect between time and performance prediction found in both data subsets. Specifically, participants who predicted that they performed "Much Worse" at Time 2 indeed performed worse on the DSB at Time 2 compared to participants who predicted that they performed "About the Same" at Time 2.

Exploratory analyses

Curiously, qualitative responses to the images of degraded environments indicated that many participants did not recognize the scenes as representing environmental damage. For instance, in response to image *degraded_40*, while most participants correctly identified the scene as featuring a coral reef, only a small number recognized that the coral was "dead." A similar pattern emerged with images *degraded_11* and *degraded_41*, which also depicted bleached or damaged coral. To explore whether recognition of environmental degradation influenced participants' ratings, a subset of participants was removed from the dataset for further analyses. it should be noted that these analyses are exploratory and are not intended to test for the hypotheses.

Among the 13 images used in the degraded environment condition, some conveyed less obvious signs of environmental damage (e.g., mining fields, low water levels), while four images

clearly reflected commonly recognized signs of climate change (i.e., dead coral reefs and oil spills). The participant exclusion process focused on these four clearer images.

With image *degraded_126* that depicted an oil spill, many participants expressed confusion or uncertainty in their responses, often stating they did not know what they were looking at. Responses were flagged for exclusion if they showed no recognition of the environmental damage or lacked any questioning or uncertainty about the scene. Additionally, responses that described the image as "beautiful," "pretty," or eliciting feelings such as "good" or "happy" were flagged. However, mentions of feeling "calm," "peaceful," or "relaxed" were not grounds for exclusion. If a participant expressed both a positive and a negative emotion (i.e., "scared," "anxious"), the response was retained. The same criteria were applied to images *degraded_11*, *40*, and *41*, all of which depicted dead coral.

A participant was excluded if they had two or more flagged responses out of the four target images. Using these criteria, nine participants were removed from the original dataset. While the criteria were exploratory and somewhat arbitrary, care was taken not to exclude too many participants, as very few recognized the environmental damage depicted in the images. This refined dataset was then used to repeat the same analyses conducted on the original data set to examine whether recognition of degradation influenced the results.

First, a series of one-way ANOVA was conducted to test potential differences in performance on the DSB among three conditions at Time 1 and Time 2. There was no significant difference in participants' performance on the DSB between the three environments before viewing the images, $F(2, 306) = 1.092, p = .337$. There was a significant difference in participants' performance on the DSB between the three environments after viewing the images,

$F(2, 306) = 3.183, p < .05, \eta^2 = .020$. However, Tukey's HSD post hoc tests did not show any significance difference between each pair of environment types.

Consistent with the original dataset, a 2 (time: Time 1, Time 2) \times 3 (environment types: intact, built, degraded) mixed factorial ANOVA revealed no significant main effect of time or environment type on participants' DSB performance (see Table 12 for descriptive statistics and F values for all analyses). No significant interaction effect was detected. To further examine potential differences over time by environment type, the data was split into subsets. Because modifications were made only to the degraded environment condition, additional analyses were conducted using two subsets: degraded vs. built and degraded vs. intact environments.

A 2 (time: Time 1, Time 2) \times 2 (environment type: built, degraded) mixed factorial ANOVA was conducted to test the effect of time and types of environments on participant's working memory capacity. There was a significant main effect of types of environments on participants' performance on the DSB, $F(1, 200) = 4.44, p < .05, \eta^2 = .017$, indicating that participants who viewed images of built environments performed better on the DSB than those who viewed images of degraded environments. However, there was no significant main effect of time and no significant interaction between time and environment type.

A series of linear mixed-effects models were then carried out to test for potential moderation effects of stress, nature relatedness, and participants' prediction of their performance for participants who viewed images of built and degraded environments (See Table 13 for all analyses). No significant main effects or interaction effects were found for stress or nature relatedness. Consistent with findings from the original dataset, performance prediction did not show a significant main effect. However, there was a significant interaction between time and performance prediction such that participants who predicted they performed "Much Worse" at

Time 2 indeed showed decreased DSB scores at Time 2 compared to those who predicted they performed “About the Same.”

Another 2 (time: Time 1, Time 2) × 2 (environment type: intact, degraded) mixed factorial ANOVA was conducted to examine the effect of environment type on working memory capacity. There was no significant main effect of time or types of environments on participants’ performance on the DSB. Unlike the original data set, the interaction between time and environment type approached significance, $F(1, 202) = 3.76, p = .054, \eta^2 = .003$.

To understand why the interaction effect previously observed disappeared after data exclusions, the means and standard deviations of change scores on the DSB over time were examined (See Table 15 for descriptive statistics). Among participants who viewed images of degraded nature, the mean change score on the DSB became slightly less negative (i.e., closer to zero), while the standard deviation increased marginally. Additionally, the sample size for the group of participants that viewed images of degraded nature decreased by nine participants, representing approximately 8.5% of that group. This reduction in sample size, along with the weakened negative change score, reduced the difference in DSB performance between participants who viewed images of degraded nature and those who viewed images of intact nature. The small increase in variability within the group of participants who viewed images of degraded environments further masked any existing pattern, making it harder to detect differences. Because there was no change in the group of participants who viewed images of intact environments, the contrast that had driven the original interaction effect became less pronounced, and thus disappeared.

Finally, a second set of linear mixed-effects models was conducted to examine potential moderation effects of stress, nature relatedness, and performance prediction for participants who

viewed images of intact and degraded environments (See Table 14 for full results). No significant main effects or interaction effects were found for any of the three moderators. However, all three models showed that the interaction between time and environment type approached significance, suggesting a potential trend in the relationship between environment exposure and working memory over time.

CHAPTER 3 – DISCUSSION

A recent systematic review of 16 relevant meta-analyses covering 832 independent studies from diverse regions found consistent evidence that physical contact with nature improved human cognition, social skills, physical and mental health, and individuals' sense of connectedness with the natural world (Barragan-Jason et al., 2023). However, there is some evidence suggesting a decline in people's direct contact with nature (e.g., visits to national parks) as well as indirect contact with nature (e.g., the presence of nature in cultural products, such as movies or books) across regions in North America, Western Europe, and Japan (Cazalis et al., 2022). At the same time, climate change, which is driven largely by human activity, is transforming natural landscapes in ways that are harmful to both ecosystems and public health (Bloomfield et al., 2020; Gibb et al., 2020). The present project's goal is to examine the impact of exposure to degraded natural environments on human functioning, specifically cognitive skills, using stimuli that can be implemented across geographically diverse laboratories. In order to accomplish such goals, the present project first sets out to develop a standardized photo set of three types of environments—intact natural, degraded natural, and built environments—by assessing participants' responses in terms of valence, arousal, perceived restoration, and preference. Then, the project aims to investigate how visual exposure to different environments influences cognitive performance, specifically working memory capacity using the standardized photo set as stimuli. Two hypotheses guide this work: (Hypothesis 1) working memory performance would increase following exposure to intact nature compared to both built and degraded environments, and (Hypothesis 2) performance would decrease following exposure to degraded nature compared to the other conditions.

Findings from Study 1 indicated that participants responded most positively to images of intact environments, rating them higher in valence, sense of restoration, and preference, and lower in arousal compared to built and degraded environments. Degraded environments consistently received the lowest ratings across these dimensions. The strong positive correlations among valence, sense of restoration, and preference across all three environment types suggest these constructs are closely linked in how individuals evaluate environments. In contrast, arousal was negatively associated with the other variables, particularly in degraded environments, indicating that more arousing images were perceived as less restorative and less preferred.

Results from Study 2 provided partial support for hypothesis 1 and 2. Participants who viewed images of intact environments performed slightly better on the DSB at Time 2, whereas those who viewed images of degraded environments performed worse on the DSB at Time 2, as evidenced by a significant interaction effect between time and types of environments. This effect remained significant even after accounting for individual differences in stress, nature relatedness, and performance expectations, none of which significantly moderated the relationship.

Qualitative responses from Study 2 indicated that most of the participants who viewed images of degraded nature did not recognize the environmental degradation they were shown (especially scenes that are often seen as typical demonstrations of climate change, such as dead coral and oil spills). Several participants who showed marked difficulties in perceiving the image content were dropped to allow for further analysis. Results on this updated data set revealed a significant main effect of types of environments on working memory capacity between participants who viewed images of built environments and participants who viewed images of degraded environments. Unlike results from the original data set, the interaction effect between time and types of environments on DSB performance among participants who viewed images of

intact and degraded nature was not significant. Further analyses revealed that, in the degraded environment condition, the mean change in DSB performance decreased while the variability of change increased, contributing to the observed pattern of results. Tests of moderation also showed that participants who believed they performed “Much Worse” in Time 2 indeed scored lower on the DSB in Time 2 compared to participants who thought they performed “About the Same.” This effect was observed regardless of types of environments.

The following section will provide possible explanations for the pattern of results and explore the implication of such results for research on human nature interaction.

The nature of nature

Findings from Study 1 contribute to a well-established phenomenon within environmental psychology research: natural environments are generally preferred, perceived as restorative, and associated with positive affect and reduced stress (e.g., Ulrich, 1983; Kaplan & Kaplan, 1989; Hartig et al., 1991). The strong positive relationships between valence, sense of restoration, and preference found across all three types of environments are also consistent with SRT and PFA’s notion of positive affect influence perceived restoration of an environment. Likewise, the ratings of intact and built environments in this project replicate previous findings: scenes of natural environments tend to have high valence/low arousal ratings while scenes of built environments tend to have average valence/average arousal ratings (Roe et al., 2013; White et al., 2015).

In a series of studies intended to test whether nature offers unique emotional benefits beyond just being something people prefer, Meidenbauer et al. (2020) found that nature’s positive effect on mood was mainly due to participants liking those scenes and finding them aesthetically pleasing. When images of natural scenes were not especially beautiful, or when

they were compared to images of urban environments or animals that people liked just as much, nature did not have any extra mood-lifting power. Even when participants were asked to rate the naturalness of the images, in order to prime a different thinking process rather than preference, preference still predicted mood changes. This suggests that nature's positive effect on mood is closely tied to how much people like or value what they see (Meidenbauer et al., 2020). However, the study did not address why people prefer natural environments over other environments. It also showed that participants' naturalness ratings were inconsistent, with over a quarter of participants judging urban scenes as more natural than man-made, raising concerns about the validity of those ratings and thus were not used in analyses (Meidenbauer et al., 2020). Finally, the focus of these studies was on mood after exposure rather than the immediate emotional response to the environment itself.

These findings point to a challenge in human-nature research: studies often compare natural environments to urban environments that are less beautiful and less preferred, potentially confounding results. For example, urban images in many studies are rated lower in preference than natural images (Berman et al., 2008), or preference ratings are not collected at all (Berto, 2005; Jiang et al., 2020). In in-person studies, urban environments often consist of busy streets with traffic, commercial buildings, and noise, compared to quieter, greener natural spaces (e.g., Bratman, Daily et al., 2015; Bratman, Hamilton et al., 2015; Sudimac et al., 2022). These differences in aesthetics and preference could blur whether the observed effects on well-being reflect true restorative or stress-reducing properties of nature (as proposed by ART and SRT), or simply differences in how much people liked the environment. Potential support for this idea comes from a study that used EEG to examine how different parts of a city affect the brain activity of older adults (Neale et al., 2019). The study found that brain signals associated with

relaxation increased when participants moved from busy streets to green spaces. However, there was no difference in brain activity between green spaces and quiet urban streets. In this study, green spaces were areas with mostly vegetation and few built elements. Busy streets featured mixed-use buildings, paved areas, and heavy pedestrian and vehicle traffic. Quiet urban streets mostly had residential buildings, small front gardens, paved areas, and little to no traffic. The absence of a difference between green spaces and quiet streets suggests that the aesthetics and lower demands of quiet urban streets may resemble those of green spaces. This points to the possibility that aesthetics and preference, rather than environmental type alone, may confound findings attributed to ART and SRT.

Similar to the challenges in the Meidenbauer et al. (2020) studies, the present project found it was not feasible to create a stimulus set where preference was evenly distributed across environment types. While there was some overlap, intact natural environments were significantly more preferred than built environments, and especially more than degraded environments. There was no degraded image as preferred as the most preferred intact nature images, and no intact image as disliked as the least preferred degraded images. Likewise, the images clustered unevenly in the valence-arousal space. Specifically, images of intact environments tended toward high valence, images of degraded environments toward low valence, and images of built environments mostly fell in the middle. This pattern, along with the lack of clear evidence that naturalness influenced responses independently of preference, suggests that while preference plays a central role, those preferences may reflect inherent characteristics unique to different environments—especially those that go beyond what can be detected from simple semantic cues.

Supporting this idea, research has identified certain properties that set natural environments apart from more urban environments. Those properties include “lower level” (i.e.,

spectral slope, density of non-straight edges) and “higher level” features (i.e., water, vegetation) (Rim et al., 2025). These features not only influence perception but also thought content. When shown images of different environments and asked to write down all associations that came to mind, people primarily produced positive associations in response to natural environments, while associations for urban environments were more mixed (Beute & De Kort, 2018). Similarly, when asked to select words that best matched different types of images, people chose words related to nature when viewing images of natural environments, and words related to spirituality and their life journey when viewing images with more non-straight edges (Schertz et al., 2020).

Expanding on those ideas, the present project reveals a unique profile for degraded natural environments. Compared to intact and built environments, degraded scenes were associated with significantly lower affect, reduced perceived restoration, heightened arousal, and the lowest preference ratings among the three types of environments. These findings are consistent with characteristics of images depicting climate change: images rated highly relevant to climate change are higher in negative emotional valence and emotional arousal (Lehman et al., 2019). Such patterns indicate certain qualities of degraded natural environments that are distinct from traditional “natural” and “urban” environments. As the degraded environments presented in this project still contain natural elements (i.e., vegetation, water), the difference in their ratings cannot be fully explained by a lack of natural features alone. Processing Fluency Theory, which serves as the basis of PFA, can be used to further examine degraded environments’ characteristics. The theory posits that the more easily individuals mentally process an object, the more positive they respond to the object (Reber et al., 2004). In degraded nature, the juxtaposition of natural elements (i.e., greenery, open landscapes) and signs of ecological damage (i.e., pollution, deforestation) may disrupt the mental processing of the environment,

which could give rise to perceptual or cognitive dissonance. This conflict could then lead to increased vigilance, tension, or confusion, which in turn elevates arousal and reduces both aesthetic appeal and perceived restoration. Rather than just lacking positive effects, degraded nature seems to actively create a qualitatively different, disruptive experience, reinforcing the need to treat it as a distinct environmental category.

Nature's restorative effect

While findings suggest a trend of participants performing better at Time 2 after viewing intact natural images, the improvement was not as robust as the performance decline observed in participants who viewed degraded environments. As such, although the results align conceptually with ART, the marginal improvement offers limited support for the restorative effect of intact nature on working memory capacity. Furthermore, the lack of a significant difference in DSB performance between intact nature and built environments challenges ART's prediction that natural environments should be more restorative than urban environments, especially when sense of restoration was rated higher in the images of intact environments than images of built environments in this study. These findings, at best, offer limited support for ART and, at worst, raise questions about the strength of its predictions in controlled laboratory conditions using static imagery.

This pattern mirrors findings from a growing body of research reporting null or inconsistent effects of nature exposure on cognitive functioning. Several studies have failed to replicate earlier strong effects of nature on attention restoration, particularly when exposure was brief or occurred through photographs rather than direct experiences (see Stevenson et al., 2018). One potential reason for these mixed outcomes is the method of nature exposure. Unlike in-person experiences or even immersive simulated experiences, which engage multiple sensory

systems and may evoke stronger emotional and physiological responses (e.g., Berman et al., 2008; Bratman, Daily et al., 2015; Crossan & Salmoni, 2019), viewing images of nature may lack the richness required to activate the full restorative effect.

Another explanation lies in the nature of the stimuli themselves. The images used in this study intentionally included a variety of intact environments, including natural scenes not commonly seen in ART research such as clouds and canyons, in order to diversify the types of natural environments and match degraded scenes across emotional ratings. However, not all natural environments are equally restorative. In a large survey asking people to recall a recent visit to nature, respondents recalled greater connectedness to nature and restoration following visits to rural and coastal locations compared to urban green space, and to sites that are protected or have designated area status (i.e., Nature Reserves) (Wyles et al., 2017). Although the images of intact environments used in Study 2 have a higher self-reported sense of restoration than those of images of built environments, the ratings might not capture the four distinct qualities that make for a restorative environment (Kaplan & Berman, 2010). In the same vein, in order to match emotional ratings across the three environmental conditions, the intact nature images used in this study may have excluded the most restorative types of imagery, those evoking the highest valence, restoration, preference, and lowest arousal. This may have inadvertently constrained the potential for intact environments to demonstrate a significant impact on cognition.

The characteristics of the built environment stimuli used in this study could also explain the lack of evidence for ART. Specifically, the built images used in Study 2 encompassed a diverse range of manmade structures, including commercial and residential buildings, interior space, and streets, rather than depicting purely urban settings. This differs from other ART studies, where the environments used to contrast nature is strictly “urban.” In image-based

studies, urban environments often include pictures of high-rise buildings, highways, and busy streets with cars and people (e.g., Berman et al., 2008; Berto, 2005). Similarly, in in-person and virtual reality studies, participants usually walked through the downtown area of a city (Berman et al., 2008), navigated a busy street with multiple car lanes (Bratman, Daily et al., 2015), or engaged in a simulated driving task on a barren highway (Jiang et al., 2020). In contrast, asking participants to walk down a quiet residential street would present a very different kind of built environment, one that may not significantly tax attention or elicit negative emotional responses. Furthermore, the images of built environments used in Study 2 were selected to be emotionally neutral, averaging near the midpoints of valence and arousal. Unlike prior studies where urban images may have been perceived more negatively, potentially heightening the restorative effect of nature by comparison, the neutrality of the built scenes here may have rendered them less aversive and more cognitively benign. This may have reduced the contrast between built and natural conditions, weakening the predicted interaction effects under ART. It is possible that the effects of ART are most reliably observed when comparing serene, low-demand natural environments with loud, crowded urban settings that impose a higher attentional load. These results ultimately raise broader questions about ART's predictions in lab settings using static images. If nature's restorative effect only emerges when there is a stark contrast between nature and urban scenes, the effect may not be due to nature itself, but rather to differences in preference, aesthetics, or valence between the environments. As discussed earlier, images of nature are often rated higher than images of urban scenes in preference. This suggests that in experiments comparing nature and urban settings, it is difficult to separate restorative qualities from how much people simply like what they see. Although ART acknowledges that restorative environments do not have to be nature, most studies test the theory using green spaces with

features like trees and water. As Joye and Dewitte (2018) point out, participants are rarely exposed to other potentially restorative settings, such as caves, fires, clouds, or sunsets, despite these being cited as examples of soft fascination (Kaplan & Kaplan, 1989; Kaplan, 1995). This narrow focus on vegetation-rich environments means we know little about what specific features of green spaces actually make them restorative beside aesthetic appeal and preference (e.g., Van den Bogerd et al., 2018; Wang et al., 2019).

This gap brings us back to the role of aesthetics and preference: are green spaces restorative because of their inherent qualities, or because they are simply more beautiful and preferred? Supporting this concern, recent research suggests that nature's benefits for cognitive tasks may stem from its beauty, which boosts motivation, rather than from attentional restoration. In one study, participants viewed either beautiful or pixelated (less aesthetically pleasing) nature photos before completing a simple clicking task (Joye et al., 2022). Those who saw the beautiful images clicked more and reported feeling more motivated, while those who saw pixelated images showed less engagement. These findings suggest that nature's positive effects on cognitive performance may be driven by its aesthetic appeal and the motivation it inspires, rather than by the mental resource replenishment proposed by ART.

Degraded nature's impact

The present project is the first to directly test the effect of exposure to degraded natural environments on working memory capacity. Compared to participants who viewed images of intact environments, participants who viewed images of degraded environments performed worse on the DSB at Time 2. This result, along with the fact that all stimuli used were controlled for valence, arousal, and preference, suggests degraded natural environments possess distinct characteristics that may impair cognitive functioning.

Notably, participants' qualitative responses to the images suggest the effect emerged even when participants were not aware of the degradation they viewed. For example, in response to image *degraded_40*, while most participants correctly identified the scene includes a coral reef, only nine out of 106 participants recognized the coral was "dead." The same pattern was observed for image *degraded_11* and *degraded_41*, which also depicted scenes of damaged or bleached coral. Likewise, in response to image *degraded_126*, which documented the BP oil spill in the Gulf of Mexico in 2010, only seven participants identified the content as "oil spill," "chemical spill," or "something spilled," and two participants thought it was "polluted water," or "some sort of pollution." The rest of participants expressed curiosity and confusion over the content of the image, often stating they were "not sure" or "don't know" what they were looking at.

This pattern suggests that most participants in Study 1 probably failed to recognize the environmental degradation depicted in images of degraded nature, which led to high ratings of valence for those images. In other words, participants may have perceived the images as more neutral or positive because they did not fully comprehend the scenes they viewed. Had they correctly identified the images as showing harmed nature (i.e., dead coral, oil spill), participants' rating on those images would have shifted toward lower valence and higher arousal. This misinterpretation poses a significant challenge to the goal of creating a balanced image data set, as it results in some images of degraded environments being misclassified as emotionally neutral or positive. This then undermines the ability to form well-matched groups of intact and degraded environmental images across the dimensions of valence and arousal.

When participants who struggled to recognize environmental damage were excluded from the data, the pattern of results changed. Specifically, those who viewed images of built

environments performed better on the DSB than those who viewed images of degraded environments, no matter the time point. There was also no significant interaction between time and types of environments on working memory capacity between participants who viewed images of intact nature and those who viewed images of degraded nature. Further analyses showed that the mean difference in DSB performance between Time 1 and Time 2 among those who viewed degraded nature became less negative, resulting in reduced separation between group means on the change scores. There was also a slight increase in variability within the degraded group and reduced statistical power due to the smaller sample size. Together, these factors contributed to the disappearance of the interaction effect between time and condition. These findings suggest that participants who failed to recognize the environmental damage experienced greater disruption in their working memory performance, which contributed to the pattern originally observed between the intact and degraded nature groups.

To explore how degraded nature may directly harm working memory, three key frameworks explaining nature's effects on well-being, SRT, ART, and PFA, are used to offer insights. SRT emphasizes affective responses to natural environments as the basis for stress reduction. Although the stimuli in this study were controlled for valence and arousal, we did not collect participants' affective responses after exposure. Since SRT draws on evolutionary roots, it could be speculated that exposure to degraded environments might trigger perceptions of threat or danger, leading to stress and reduced cognitive performance. This aligns with recent research showing that exposure to nature reduces activity in the amygdala, a region central to emotion regulation and memory (Sudimac et al., 2022). However, because the focus of the current project was cognitive function rather than emotional response, there is no direct data to support an SRT-based explanation beyond speculation based on prior research.

ART proposes that restorative qualities of an environment, most often found in nature scenes, help replenish depleted attention and improve cognitive performance. In this study, valence, arousal, preference, and perceived restoration ratings did not significantly differ between intact and degraded environments. This suggests that degraded nature's impact on performance was not due to a lack of perceived restorative features. One might argue that our reliance on a single-item restoration rating limited the ability to fully capture restorative potential. However, since most participants did not recognize the images of degraded nature as depicting environmental degradation, it would have been difficult for them to assess restorative qualities that require comprehension (i.e., soft fascination, compatibility). Furthermore, the lack of a significant interaction effect between time and types of environments for intact and built scenes raises additional questions about ART's predictive power in this context. Thus, degraded nature's negative impact on working memory cannot be attributed solely to reduced perceived restoration.

PFA suggests that nature's benefits arise from the ease with which people visually process natural environments. While higher-level recognition (e.g., identifying a scene as natural or built) contributes to restoration, restoration may not be the key driver of nature's positive effects (discussed in the previous section). Menzel and Reese (2022) found that participants rated mood, restoration, and preference similarly when images were scrambled to obscure their meaning, regardless of whether the original image depicted nature or urban scenes. Our findings reveal a somewhat similar pattern. The images of intact and degraded nature used in Study 2 did not differ in restoration and preference, possibly because many participants in Study 1 could not recognize what they were looking at in these degraded environment images. Despite the similarity in ratings, participants who viewed degraded nature still showed worse performance at

Time 2. Interestingly, once participants who showed marked difficulty recognizing the degradation were excluded from the data set, the performance effect disappeared. Further analyses suggested that those who failed to recognize the environmental damage experienced greater disruption in their working memory performance, which contributed to the interaction effect observed in the original data set. Because this study did not control for lower-level visual properties (e.g., edge density, spectral slope), it is possible that such differences drove the observed effect. Alternatively, ensuring participants recognize what they are viewing (which would likely result in overall low ratings for degraded nature and prevent matching between degraded and intact images) could help clarify whether preference and aesthetics are what drive degraded nature's impact on working memory capacity.

Although these frameworks highlight that affective responses, perceived restoration, and ease of processing could offer some insights, none fully explains the negative impact of degraded nature on working memory observed in this study. This limitation reflects both the scope of the study and the need for future research to incorporate additional measures (i.e. low-level visual features) to better understand the unique and harmful effects of degraded nature. It also raises the question of which factors shape our response to degraded nature. Specifically, how do individuals come to perceive, interpret, and ultimately normalize degraded environments?

This difficulty in recognizing environmental harm may be partly explained by the concept of environmental generational amnesia (Kahn Jr., 2002), which emerged from research on children's relationships with nature. In interviews with children from diverse locations such as Houston, Texas, and Lisbon, Portugal, Kahn Jr. (2002) found that individuals' perceptions of what is considered "normal" in nature are shaped by the nature they experienced in childhood. As environmental degradation worsens over time, each generation comes to accept increasingly

degraded conditions as the baseline or "normal" state of nature. As a result, people may lose positive associations with nature and come to view negative experiences as the norm leading to a situation in which “we suffer physically and psychologically and hardly know it” (Kahn Jr., 2002, p. 113). A similar phenomenon, known as shifting baseline syndrome, has been observed in the field of fisheries (Pauly, 1995). Pauly, a marine biologist known for his work on human impacts on global fisheries, explains that each generation of fisheries scientists tends to regard the stock sizes and species compositions they encounter at the start of their careers as the standard baseline. As fish populations continue to decline over time, each subsequent generation recalibrates its expectations based on a more diminished state. This leads to a gradual erosion of standards, obscuring the true extent of overfishing and undermining efforts to set conservation goals. In urban settings, where accessible natural spaces are increasingly scarce, children have fewer opportunities to interact meaningfully with nature. This limited exposure can reduce their ability to value and connect with the natural world, contributing to a broader sense of disconnection (Kahn Jr., 2002). In turn, reduced interaction with nature not only diminishes a wide range of health and wellbeing benefits, but also weakens the development of positive emotions, attitudes, and behaviors toward the environment (Soga & Gaston, 2016). Given research showing a positive association between childhood experiences in nature and adult pro-environmental attitudes (Wells & Lekies, 2006), it is reasonable to conclude that a lack of meaningful nature experiences in childhood may be linked to reduced environmental concern in later life.

Findings from the current project raise a critical ecological and psychological concern: individuals may be exposed to degraded natural environments, fail to recognize the degradation, and still suffer consequences from it. The results further revealed that those who had the most

difficulty recognizing degraded nature scenes appeared to be most affected by exposure to these environments. While many studies have documented the impact of climate change and environmental degradation on psychological well-being (see Cianconi et al., 2020; Martin et al., 2021), the present study provides direct experimental evidence that simply viewing degraded nature can impair cognitive functioning. There are two potential implications. First, if individuals cannot distinguish between intact and degraded environments, they may unknowingly expose themselves to harmful settings and may be especially vulnerable when they do not realize what they are seeing. Second, the inability to perceive degradation could weaken public support for conservation efforts, as individuals may underestimate the urgency of ecological problems or assume that existing conditions are acceptable. In the context of rapidly changing landscapes due to climate change, results from the present project highlight the urgent need for environmental education and restoration efforts.

Clinical implications

These findings not only point to ecological and societal challenges but also carry important counseling and clinical implications. Because exposure to degraded natural environments impaired working memory, even when people were unaware of the degradation, clinicians should consider clients' environmental contexts as part of comprehensive assessment and intervention. This is especially critical for individuals living in urban or degraded settings, where cognitive burdens linked to environmental conditions may go unrecognized. Results also highlight the need to address environmental generational amnesia in psychoeducation as needed, helping clients build awareness of degradation and its psychological impacts. In addition, fostering environmental stewardship within counseling, through values exploration, advocacy, or

nature-based therapy, may promote both ecological well-being and clients' sense of purpose and agency.

The potential mental health consequences of degraded environments are particularly concerning for individuals living with serious mental illness (SMI), such as schizophrenia or bipolar disorder. For instance, Boers and colleagues (2018) found that individuals hospitalized for psychotic disorders at an academic hospital in the Netherlands had significantly less access to green spaces, even after controlling for age, gender, urbanicity, and socioeconomic status. Likewise, Beyer and colleagues (2024) reported that natural environment exposure was negatively associated with psychotic experiences in a sample of 22,952 participants in the United Kingdom. A large-scale Danish study involving more than 900,000 individuals also showed that lower green space exposure during childhood was linked to significantly higher risks for a wide range of psychiatric disorders, including schizophrenia, with the lowest green space availability associated with up to a 55% increased risk (Engemann et al., 2019). Given these associations, it is plausible that not only the absence of natural environments, but also the presence of degraded ones, could exacerbate mental health issues, especially those involving cognitive and thought disturbances. Findings from the present project that degraded environments impair working memory underscore the need for mental health professionals to consider the environments people live in when treating individuals with SMI. These findings point to the importance of incorporating environmental considerations into both therapeutic practice and mental health policy to support cognitive functioning and overall psychological well-being.

Strengths

The current project is the first to establish a set of images across intact natural, degraded natural, and built environments with ratings of valence, arousal, restoration, and preference. This

study is also the first to employ a standardized set of images that are controlled for valence, arousal, sense of restoration, and preference to examine the impact of different environments on cognitive functioning. Moreover, this study is the first experiment to explore the effect of intact and degraded environments on working memory in a controlled setting.

As such, the project offers several strengths that advance our understanding of human interaction with different environments and its effect on cognitive functioning. First, results from Study 1 not only reaffirmed previous findings on qualities of intact natural environments but also established degraded natural environments as a unique environmental category with distinct characteristics. Such findings will allow for further inquiries into degraded environments and their impacts on the human psyche. Second, the control of affective properties (i.e., valence and arousal) across stimuli strengthens the internal validity of the experiment. By ensuring that valence and arousal were matched across intact and degraded environments, and that average ratings of restoration and preference did not differ between the two, the study helps isolate the influence of affective responses and preference, allowing for a clearer interpretation of how the environment itself impacts cognitive functioning. The images from this project and their various ratings can also be used to explore queries regarding the impact of diverse nature scenes on well-being (e.g., controlled for arousal, would intact nature and built environments with high valence have similar effect on working memory?). Most importantly, these images can be easily shared across labs and adapted for use in diverse settings, including studies conducted in areas with limited access to natural environments.

Third, results from Study 2 displayed evidence of the harmful impact of degraded natural environments on cognitive functioning. Qualitative responses revealed that this effect occurred even when participants did not fully comprehend the content of the images. Additional analyses

suggested that the negative impact of degraded nature on working memory may be especially pronounced when the degradation is not consciously recognized. The present project therefore addresses an important gap in research on degraded environments and expands our understanding of how people are affected by increasingly altered natural settings.

Finally, the current project raises important questions about the core claim of ART that the benefits of nature on well-being primarily stem from its capacity to restore depleted attention. The results add to existing evidence suggesting that valence is closely tied to preference, highlighting the importance of accounting for aesthetic and preference in nature research. By including intact nature, degraded nature, and built environments, the study offered a valuable opportunity to integrate multiple theoretical frameworks to better understand the mechanisms that differentiate these environments. Findings from this study suggest that restoration alone may not fully account for nature's cognitive benefits and that factors like preference, aesthetics, and perceptual processing likely play a critical role.

Limitations and future research

The fact that this project was conducted online rather than in a controlled laboratory setting introduces some important limitations. Although display quality was partly addressed by restricting participation to desktops or laptops and recording screen resolution data, there was no controlling the environment where participants completed the task. Participants may have been distracted by their surroundings or exposed to noise, despite being instructed to complete the study in a quiet place. This is particularly relevant because the DSB relied on processing audio stimuli, which could have been difficult to do in crowded or noisy settings. Without direct oversight, participants may also have been less focused, less motivated, or more likely to multitask, which could have weakened the impact of the stimuli and added variability to the

results. Additional factors, such as differences in lighting, time of day, or participant fatigue, were not controlled and may have influenced performance. For these reasons, future research should replicate the study in a controlled laboratory setting to more reliably test these findings.

Due to the limited scope of the current project, lower-level properties (i.e., spectral slope, density of non-straight edges) of images were not assessed. Thus, it remains unknown which perceptual properties are characteristic of degraded natural environments. Additionally, results suggest a disconnect between recognition and cognitive consequences of environmental degradation, but lack of information on lower-level properties prevents potential identification of specific features of degraded environments that drive this effect. As such, investigation of which specific visual or content features contribute to the unique qualities of degraded environments is warranted. Future research should aim to identify low- and high-level properties of degraded environments that could predict certain emotional reaction and cognitive performance. These insights will help refine the design of experimental stimuli and clarify the mechanisms through which degraded nature impact human well-being.

The current project assumed the representativeness of each image within its own category without obtaining ratings on dimensions such as intact vs degraded or natural vs man-made. Thus, ratings on valence, arousal, restoration, and preference for some images of degraded natures might not be valid as most participants in Study 1 could not comprehend the image content. This not only impacts the validity of the image data set from Study 1 but also leads to further confusion for participants in Study 2. Similarly, instead of having participants rate the images on its naturalness and level of intact, Study 2 instructed participants to identify the environments themselves through qualitative responses. While this design highlights the subtle impact of degraded scenes on cognitive performance even when participants did not fully

comprehend the environment, it limits internal validity. Thus, having participants rate the images on dimensions such as intact vs. degraded and natural vs. man-made could strengthen internal validity by ensuring that participants are indeed perceiving the environments as intended. This approach would also clarify how truly degraded nature affects cognitive functioning. Therefore, future studies should include participant ratings of images along the intact–degraded dimension and use these ratings to select stimuli that clearly represent each condition. Additionally, future research should examine whether recognizing an environment as degraded amplifies or reduces its negative impact on working memory capacity.

CHAPTER 4 – CONCLUSION

The current project is the first to provide experimental evidence that simply viewing degraded natural environments can impair working memory. Importantly, these cognitive effects emerged even when participants did not consciously recognize the environmental degradation. This finding underscores a troubling implication: people may be cognitively and emotionally affected by environmental harm without being fully aware of it.

The results contribute to growing concerns about phenomena such as environmental generational amnesia and the shifting baseline syndrome, which describe how gradual environmental decline can go unnoticed across generations. If individuals struggle to detect subtle but meaningful environmental changes, the capacity for collective action and advocacy may be diminished over time.

As such, these findings point to an urgent need for more robust environmental education and restoration initiatives, as well as deeper investigation into the perceptual and cognitive mechanisms through which environmental degradation exerts its effects. Clinicians, educators, and policymakers should recognize that degraded environments may influence cognitive functioning and well-being — even in the absence of conscious awareness — and take these hidden costs into account in their work.

TABLES

Table 1

Descriptive Statistic for All Images

Image	Valence	Arousal	Restoration	Preference
intact_1	6.3 (2.2)	4.3 (2.4)	4.9 (1.5)	5.1 (1.5)
intact_10	7.8 (1.3)	4.3 (2.8)	5.9 (1.1)	6.2 (0.9)
intact_100	6.6 (1.8)	4.7 (2.2)	4.8 (1.3)	5.3 (1.2)
intact_101	7.1 (1.8)	4.6 (2.6)	5.4 (1.2)	5.4 (1.3)
intact_102	6.8 (1.6)	5.1 (2.2)	5.1 (1.3)	5.3 (1.2)
intact_103	6.7 (1.7)	4.8 (2.3)	5.2 (1.3)	5.3 (1.2)
intact_104	7.3 (1.5)	4.1 (2.6)	5.8 (1.1)	5.7 (1.1)
intact_105	6.6 (1.8)	4.9 (2.1)	5.1 (1.1)	5.3 (1.3)
intact_106	5.9 (2.1)	4.7 (2)	4.8 (1.2)	4.7 (1.5)
intact_107	8.3 (1)	4.6 (3)	6.3 (0.8)	6.4 (0.7)
intact_108	6.9 (2)	5.1 (2.1)	5.2 (1.3)	5.4 (1.3)
intact_109	7.3 (2.3)	5.7 (2.6)	5.5 (1.4)	5.7 (1.5)
intact_11	7 (2)	5.4 (2.4)	5.1 (1.5)	5.4 (1.3)
intact_110	6.9 (1.9)	5.2 (2.4)	5.2 (1.3)	5.4 (1.3)
intact_111	5.2 (2)	3.9 (1.9)	4.5 (1.6)	4.7 (1.5)
intact_112	3.8 (2)	5.4 (1.8)	3 (1.4)	3.4 (1.5)
intact_113	7 (1.7)	4.3 (2.3)	5.4 (1.1)	5.5 (1.2)
intact_114	8 (1.4)	4.4 (3)	6.2 (1)	6.5 (0.8)
intact_115	6.7 (1.6)	4.1 (2.1)	5.2 (1.1)	5.3 (1.2)
intact_116	5.7 (1.9)	4.6 (1.9)	4.4 (1.3)	4.6 (1.3)
intact_117	5.5 (1.7)	4.7 (1.4)	4.1 (1.5)	4.4 (1.4)
intact_118	4.9 (2.2)	4.2 (1.7)	3.7 (1.5)	4 (1.5)
intact_119	8.2 (1.4)	4.9 (3)	6.4 (1)	6.4 (0.9)
intact_12	7.3 (1.7)	4.1 (2.6)	5.7 (1.1)	5.5 (1.2)
intact_120	7.8 (1.4)	4.4 (2.8)	6 (1.1)	6 (1)
intact_121	8.3 (1.1)	4.1 (3.1)	6.4 (0.9)	6.5 (0.9)
intact_122	6.3 (1.8)	4.5 (2)	5 (1.2)	5 (1.3)
intact_123	7.5 (1.9)	4.1 (2.7)	5.7 (1.4)	5.8 (1.5)
intact_124	5 (1.9)	4.6 (1.8)	4 (1.3)	4.1 (1.5)
intact_125	5.7 (1.8)	4.8 (1.8)	4.5 (1.3)	4.7 (1.3)
intact_126	5.9 (2.2)	5.1 (2.2)	4.2 (1.6)	5 (1.6)
intact_127	6.8 (2)	4.4 (2.3)	5.3 (1.3)	5.4 (1.2)
intact_128	5.6 (1.9)	4.5 (2)	4.3 (1.4)	4.4 (1.3)
intact_129	6.6 (1.6)	4.6 (2)	5 (1.1)	5.1 (1.2)
intact_13	5.1 (2.1)	4.1 (1.7)	4 (1.4)	4 (1.5)
intact_130	6.7 (1.9)	4.4 (2.3)	5.2 (1.5)	5.2 (1.4)
intact_131	8.2 (1.1)	4.4 (3)	6.2 (1.1)	6.3 (0.8)

intact_132	7.8 (1.3)	4 (2.7)	6 (1)	6 (0.9)
intact_133	5.6 (1.9)	3.9 (1.9)	4.6 (1.5)	4.6 (1.6)
intact_134	7.3 (1.7)	4.7 (2.7)	5.6 (1.3)	5.7 (1.2)
intact_135	6.1 (2.1)	4.5 (2.1)	4.9 (1.4)	5 (1.4)
intact_136	7.7 (1.4)	3.5 (2.5)	5.7 (1.2)	5.8 (0.9)
intact_137	7.1 (1.7)	4.1 (2.2)	5.6 (1.1)	5.6 (1.1)
intact_138	8.3 (1.1)	4.1 (3.1)	6.4 (0.8)	6.5 (0.7)
intact_139	7.6 (1.6)	5 (2.7)	5.5 (1.4)	6.0 (1.1)
intact_14	7.2 (1.6)	4.6 (2.3)	5.6 (1.1)	5.6 (1.2)
intact_140	6.7 (1.7)	4.3 (2.1)	5.1 (1.3)	5.2 (1.3)
intact_141	4.5 (1.9)	4.1 (1.6)	3.7 (1.2)	3.7 (1.4)
intact_142	7.1 (1.6)	4 (2.4)	5.6 (1.3)	5.6 (1.2)
intact_143	7.4 (1.7)	3.9 (2.4)	5.7 (1.2)	5.8 (1.2)
intact_144	6 (1.8)	5.1 (2)	4.8 (1.3)	4.6 (1.4)
intact_145	7.8 (1.5)	4.3 (2.8)	6 (0.9)	6.1 (1)
intact_146	6.4 (2.1)	4.4 (2.5)	5 (1.4)	5.2 (1.3)
intact_147	7.4 (2)	5.1 (2.9)	5.7 (1.3)	6.1 (1.2)
intact_148	5.5 (2)	4.9 (2.1)	4.3 (1.4)	4.3 (1.5)
intact_149	5.1 (1.8)	4.4 (1.4)	4.1 (1.2)	4.1 (1.2)
intact_15	6 (1.7)	4.5 (2)	4.9 (1.2)	4.9 (1.3)
intact_150	5.1 (2.4)	6.2 (2)	3.2 (1.7)	4.9 (1.6)
intact_151	7.4 (1.6)	4.3 (2.7)	5.8 (1.1)	5.9 (1.1)
intact_152	5.8 (1.7)	4.6 (1.8)	4.7 (1.1)	4.8 (1.2)
intact_153	7.6 (1.2)	3.9 (2.7)	5.8 (0.9)	5.8 (1)
intact_154	6.2 (2.2)	4.5 (2.1)	4.8 (1.4)	4.9 (1.4)
intact_155	5.1 (2)	4.6 (1.6)	4 (1.3)	4.2 (1.4)
intact_156	8 (1.3)	4.1 (2.9)	6.1 (1.1)	6.3 (1)
intact_157	5.8 (1.8)	4.7 (1.8)	4.6 (1.3)	4.5 (1.4)
intact_158	5.3 (2)	4.7 (1.8)	4 (1.3)	4.3 (1.5)
intact_159	7.8 (1.7)	5.1 (2.7)	6 (1.1)	6.3 (0.9)
intact_16	7.2 (1.8)	4.5 (2.4)	5.5 (1.3)	5.6 (1.3)
intact_160	5.5 (1.8)	4.5 (1.7)	4.4 (1.1)	4.3 (1.3)
intact_161	7.5 (1.7)	5.1 (2.6)	5.6 (1.3)	5.8 (1.2)
intact_162	4.7 (2)	4.4 (1.7)	3.9 (1.4)	4 (1.6)
intact_163	5.1 (2)	4.8 (1.6)	4.2 (1.6)	4.2 (1.6)
intact_164	8.6 (0.9)	4.2 (3.2)	6.5 (0.7)	6.7 (0.7)
intact_165	5.9 (2.4)	4.6 (2.1)	4.7 (1.5)	4.9 (1.6)
intact_166	6.4 (1.8)	4.4 (1.9)	5.1 (1.2)	5.2 (1.3)
intact_167	6.1 (2)	4.1 (2)	5 (1.3)	5.1 (1.3)
intact_168	6.4 (2)	5.2 (2)	4.7 (1.5)	5.2 (1.2)
intact_169	3.9 (1.9)	4.4 (1.6)	3.3 (1.4)	3.4 (1.5)
intact_17	5.9 (1.8)	4.4 (1.8)	4.8 (1.1)	4.5 (1.4)
intact_170	6.8 (1.8)	4.2 (2.1)	5.4 (1.3)	5.2 (1.2)
intact_171	5.1 (1.9)	4.4 (1.7)	4.1 (1.3)	4.2 (1.6)
intact_172	5.1 (2)	4.6 (2)	4.3 (1.5)	4.4 (1.4)

intact_173	4.3 (1.9)	4.7 (1.3)	3.2 (1.3)	3.3 (1.3)
intact_174	5.4 (2)	5.1 (1.8)	4.2 (1.6)	4.3 (1.5)
intact_175	6 (1.8)	4.4 (1.7)	4.9 (1.2)	4.8 (1.5)
intact_176	7.1 (1.7)	4.8 (2.4)	5.4 (1.3)	5.6 (1.2)
intact_177	7.8 (1.5)	4.5 (2.8)	6 (1.1)	6.1 (1.1)
intact_178	7.7 (1.6)	4.7 (2.7)	5.9 (1.2)	6 (1.2)
intact_179	6.4 (1.8)	4.9 (1.9)	5.1 (1.3)	5.3 (1.3)
intact_18	4.4 (2.8)	5.6 (2.2)	2.9 (1.5)	3.9 (1.9)
intact_180	6.2 (2.1)	4.3 (2.1)	4.9 (1.3)	4.8 (1.5)
intact_181	6 (2)	4.7 (2.1)	5 (1.3)	5 (1.4)
intact_182	7.8 (1.6)	4.3 (2.9)	6 (1.1)	6.3 (1.1)
intact_183	5.7 (2.1)	4.6 (2)	4.7 (1.4)	4.7 (1.5)
intact_184	5.6 (1.9)	4.8 (1.8)	4.5 (1.4)	4.5 (1.4)
intact_185	6.3 (1.6)	4.3 (2.1)	5.1 (1.2)	5.1 (1.2)
intact_186	5.1 (2)	4.5 (2)	4 (1.5)	4 (1.6)
intact_187	7.7 (1.8)	4.3 (2.9)	6 (1.1)	6 (1.2)
intact_188	4.4 (2)	4.6 (1.7)	3.5 (1.3)	3.6 (1.3)
intact_189	6 (1.9)	4.5 (1.8)	4.7 (1.2)	4.8 (1.3)
intact_19	7.1 (1.6)	5 (2.4)	5.1 (1.3)	5.6 (1.3)
intact_190	6.5 (1.8)	3.2 (2.2)	5.3 (1.2)	5.2 (1.3)
intact_191	5.1 (2.6)	6 (1.9)	3.5 (1.8)	4.9 (1.8)
intact_192	5.3 (1.8)	4.5 (1.8)	4.3 (1.3)	4.2 (1.3)
intact_193	5.3 (1.7)	4.1 (1.6)	4.4 (1.4)	4.2 (1.4)
intact_194	6.9 (1.6)	4.8 (2)	5.2 (1.2)	5.5 (1.2)
intact_195	5.4 (2.2)	5.1 (2)	4.3 (1.6)	4.4 (1.7)
intact_196	6.4 (2.1)	3.8 (2.1)	5.1 (1.3)	5.4 (1.3)
intact_197	4.9 (2.1)	4.1 (2.1)	4.2 (1.6)	4.1 (1.7)
intact_198	5.7 (1.8)	4.3 (1.8)	4.5 (1.3)	4.4 (1.2)
intact_199	6.9 (1.6)	4.7 (2.2)	5.3 (1.1)	5.3 (1.3)
intact_2	6.6 (2.1)	5.5 (2.4)	4.1 (1.8)	5.6 (1.4)
intact_20	4.9 (2.6)	5.7 (2.1)	3.5 (1.9)	4.2 (1.8)
intact_200	7 (1.7)	5 (2.3)	5.3 (1.3)	5.4 (1.3)
intact_201	7.1 (1.8)	4.3 (2.4)	5.5 (1.1)	5.6 (1.2)
intact_202	6 (2)	4.4 (1.8)	4.7 (1.2)	4.7 (1.4)
intact_203	7 (1.9)	5.4 (2.4)	4.9 (1.4)	5.5 (1.3)
intact_204	7.9 (1.4)	4.4 (2.7)	5.9 (1)	6.1 (1.1)
intact_205	6.9 (1.8)	4.6 (2.3)	5.3 (1.3)	5.5 (1.2)
intact_206	6.7 (1.9)	4.2 (2.4)	5.2 (1.5)	5.5 (1.3)
intact_207	7.9 (1.5)	4.8 (3)	5.8 (1.2)	6.2 (1)
intact_208	7.8 (1.6)	4 (2.6)	5.8 (1.2)	6.1 (1.1)
intact_209	7 (1.5)	3.9 (2.2)	5.4 (1)	5.5 (1)
intact_21	4.9 (1.8)	4.4 (1.6)	3.8 (1.4)	3.9 (1.3)
intact_210	7.8 (1.4)	4.7 (2.8)	6.1 (0.9)	6.2 (0.9)
intact_211	6.8 (1.5)	5 (2.2)	5.1 (1.2)	5.3 (1.3)
intact_212	5.8 (1.9)	4.1 (1.9)	4.7 (1.4)	4.7 (1.5)

intact_213	6.3 (1.8)	4.6 (1.6)	4.8 (1.1)	4.8 (1.2)
intact_214	6.6 (2.1)	4.9 (2.3)	4.9 (1.6)	5.2 (1.6)
intact_215	5.5 (2.5)	5.9 (2.3)	3.9 (1.8)	4.6 (1.8)
intact_216	6.2 (1.7)	4 (2.1)	5.1 (1.2)	4.9 (1.3)
intact_217	5.3 (2.2)	4.7 (2)	4.5 (1.4)	4.3 (1.4)
intact_218	6.9 (2.1)	4.1 (2.5)	5.4 (1.4)	5.7 (1.4)
intact_219	6.1 (2)	4.2 (2)	4.7 (1.3)	5 (1.3)
intact_22	7.4 (1.5)	4.1 (2.6)	5.8 (0.9)	5.9 (1)
intact_220	5.9 (1.9)	4.9 (1.9)	4.7 (1.4)	4.8 (1.4)
intact_221	6.1 (2.1)	4.8 (2.2)	4.6 (1.6)	5 (1.5)
intact_222	7 (2.1)	4.9 (2.7)	5.4 (1.4)	5.7 (1.1)
intact_223	6.8 (1.7)	4.2 (2.2)	5.1 (1.2)	5.3 (1.4)
intact_224	4.5 (2.1)	4.3 (1.9)	3.8 (1.5)	3.7 (1.6)
intact_225	5.7 (1.6)	4.4 (1.8)	4.8 (1.1)	4.6 (1)
intact_226	6.2 (1.9)	4.6 (2.1)	4.7 (1.4)	4.9 (1.4)
intact_227	5.6 (1.9)	4.5 (2)	4.5 (1.5)	4.5 (1.5)
intact_228	5.6 (2.4)	3.9 (2)	4.6 (1.6)	4.6 (1.6)
intact_229	6.2 (1.8)	5 (2)	4.9 (1.4)	5 (1.5)
intact_23	7 (1.8)	4 (2.4)	5.4 (1.3)	5.6 (1.2)
intact_230	6.1 (2)	4.7 (2.1)	4.4 (1.5)	5.2 (1.5)
intact_231	7.7 (1.4)	5 (2.7)	5.9 (1.1)	6.1 (1)
intact_232	6.3 (1.8)	4.4 (2)	4.9 (1.4)	4.9 (1.4)
intact_233	5 (1.9)	4.6 (1.8)	4 (1.4)	3.9 (1.4)
intact_234	4.6 (2.2)	5 (1.8)	3.8 (1.5)	4 (1.5)
intact_235	6.1 (2.1)	4.5 (2)	5 (1.2)	5.1 (1.2)
intact_236	6.3 (1.7)	4.6 (2.3)	4.9 (1.3)	5.1 (1.3)
intact_237	6.9 (1.5)	4.3 (2)	5.3 (1.1)	5.3 (1.1)
intact_238	7 (1.4)	4.5 (2.3)	5.3 (1)	5.5 (1.1)
intact_239	5.9 (2.1)	4.9 (1.9)	4.7 (1.4)	4.9 (1.3)
intact_24	5.4 (2.6)	5.7 (2.1)	3.6 (1.7)	4.6 (1.8)
intact_240	7.4 (1.8)	6.7 (2.2)	4.8 (1.6)	5.8 (1.2)
intact_241	7.9 (1.3)	3.8 (2.5)	6.1 (1)	6.1 (1)
intact_242	4.7 (2)	4.4 (1.7)	4 (1.5)	3.9 (1.5)
intact_243	7.4 (1.7)	3.2 (2.3)	5.7 (1.2)	5.5 (1.3)
intact_244	7.6 (1.5)	6.7 (2.3)	5.2 (1.5)	6.2 (1.1)
intact_245	6.1 (1.7)	4.3 (2)	4.7 (1.1)	4.7 (1.2)
intact_246	8.1 (1.4)	3.7 (2.9)	6.2 (1)	6.4 (0.9)
intact_247	7 (1.8)	4.6 (2.4)	5.4 (1.3)	5.5 (1.3)
intact_248	6.2 (2.1)	4.9 (2.2)	4.7 (1.5)	4.9 (1.5)
intact_249	4.2 (2.2)	4.8 (1.9)	3.6 (1.5)	3.8 (1.7)
intact_25	7 (1.8)	4.4 (2.2)	5.3 (1.3)	5.6 (1.1)
intact_250	7.5 (1.7)	4.1 (2.5)	5.8 (1.1)	5.9 (1.1)
intact_251	6.3 (2.1)	4.6 (2.3)	4.8 (1.5)	5.1 (1.5)
intact_252	7.4 (1.7)	3.8 (2.5)	5.7 (1.2)	5.6 (1.3)
intact_253	6.5 (1.7)	4.6 (1.8)	5 (1.1)	5.1 (1)

intact_254	5.6 (2.1)	4.5 (2.1)	4.2 (1.4)	4.5 (1.5)
intact_255	5.1 (1.8)	4.5 (1.6)	4.2 (1.4)	4.2 (1.5)
intact_256	6.4 (2.2)	4.7 (2.2)	4.8 (1.3)	5.1 (1.5)
intact_257	5.5 (2.1)	4.8 (1.9)	4.5 (1.5)	4.5 (1.5)
intact_258	6.2 (1.8)	4.3 (2)	5.2 (0.9)	5.2 (1)
intact_259	5.7 (2)	4.3 (1.9)	4.4 (1.3)	4.5 (1.3)
intact_26	7.8 (1.5)	4.4 (2.9)	5.9 (1.3)	6.3 (1.1)
intact_260	7.5 (1.4)	4.2 (2.2)	5.6 (1.1)	5.8 (1)
intact_261	8.3 (1.3)	5.1 (3.1)	6.2 (1)	6.4 (0.9)
intact_262	4.9 (2.1)	4.2 (1.9)	4.1 (1.5)	4.1 (1.4)
intact_263	6.5 (2.3)	4.7 (2.5)	4.8 (1.6)	5.4 (1.5)
intact_264	6.7 (2.1)	5.3 (2.3)	4.7 (1.6)	5.2 (1.5)
intact_265	5.2 (2.1)	4.3 (1.8)	3.9 (1.4)	4 (1.5)
intact_266	7.5 (1.6)	4.1 (2.5)	5.8 (1.1)	5.8 (1.1)
intact_267	7 (1.8)	4.3 (2.2)	5.4 (1.1)	5.5 (1.1)
intact_268	7.7 (1.6)	4.4 (2.8)	5.8 (1.2)	6 (1.4)
intact_269	5.1 (2.3)	5.9 (1.8)	3.1 (1.6)	5 (1.5)
intact_27	4.4 (2)	4.4 (1.7)	3.9 (1.3)	3.8 (1.3)
intact_270	5.4 (1.9)	4.4 (1.9)	4.3 (1.5)	4.3 (1.4)
intact_271	5.7 (1.6)	4.4 (1.7)	4.7 (1.2)	4.6 (1.2)
intact_272	6.8 (1.9)	4.3 (2.4)	5.4 (1.4)	5.5 (1.4)
intact_273	6.4 (2.2)	4.2 (2.2)	5.1 (1.5)	5 (1.6)
intact_274	5.1 (2)	4.7 (1.9)	3.9 (1.6)	4.3 (1.6)
intact_275	6.1 (1.6)	4.1 (2)	5.1 (1.1)	5 (1.2)
intact_276	6.6 (2)	5 (2)	5 (1.3)	5.4 (1.3)
intact_277	6.5 (1.8)	3.8 (2.3)	5.3 (1.3)	5.3 (1.3)
intact_278	6.4 (2.2)	5.6 (2.6)	4.9 (1.7)	5.4 (1.7)
intact_279	7 (1.7)	3.9 (2.2)	5.3 (1.3)	5.3 (1.3)
intact_28	7.9 (1.4)	5.8 (2.6)	5.8 (1.2)	6.2 (1.1)
intact_280	5.2 (2.1)	4.6 (1.9)	4.2 (1.4)	4.1 (1.5)
intact_281	8.2 (1.1)	4 (2.9)	6.3 (1)	6.2 (0.9)
intact_282	6.6 (1.9)	4.7 (2.3)	5.1 (1.2)	5.4 (1.3)
intact_283	5.2 (2)	4.8 (1.9)	4.2 (1.6)	4.2 (1.5)
intact_284	6.2 (1.9)	4 (2.1)	4.8 (1.3)	4.8 (1.4)
intact_285	7.3 (1.5)	4.8 (2.4)	5.4 (1.2)	5.5 (1.3)
intact_286	6.7 (1.8)	4.2 (2.2)	5.3 (1.2)	5.2 (1.3)
intact_287	5.3 (2)	4.8 (1.9)	4.2 (1.4)	4.5 (1.4)
intact_288	7.1 (1.6)	4.5 (2.3)	5.4 (1.2)	5.5 (1.1)
intact_289	6.4 (1.8)	4.2 (2)	5.3 (1.1)	5.1 (1.2)
intact_29	6.1 (1.9)	4.6 (1.9)	4.7 (1.2)	5 (1.4)
intact_290	6.7 (2)	4.9 (2.1)	5.2 (1.3)	5.3 (1.4)
intact_291	6.3 (2.1)	4.9 (2.1)	4.8 (1.3)	5.2 (1.3)
intact_292	7.9 (1.3)	4.9 (2.9)	6 (0.9)	6.2 (0.8)
intact_293	7 (1.5)	4.4 (2.3)	5.4 (1.1)	5.5 (1.1)
intact_294	6 (2.3)	4 (2.4)	4.7 (1.7)	5.1 (1.4)

intact_295	6.3 (2.1)	4.5 (2.3)	5 (1.4)	5.1 (1.3)
intact_296	5.8 (2.2)	4.9 (1.9)	4.5 (1.4)	4.7 (1.5)
intact_297	7 (2)	5.6 (2.4)	5.2 (1.3)	5.7 (1.3)
intact_298	7.7 (1.6)	4.5 (2.7)	5.7 (1.2)	6.1 (1)
intact_299	4.4 (1.9)	4.3 (1.7)	3.7 (1.4)	3.8 (1.4)
intact_3	6.1 (2.1)	4.8 (2)	4.7 (1.5)	4.9 (1.6)
intact_30	5.7 (1.8)	4.7 (1.7)	4.7 (1.2)	4.5 (1.3)
intact_300	7.5 (1.6)	4.3 (2.4)	5.6 (1.1)	5.8 (1)
intact_301	5.9 (2.1)	5 (2)	4.6 (1.4)	5.2 (1.3)
intact_302	6.7 (2.2)	5 (2.1)	5.1 (1.5)	5.2 (1.5)
intact_303	7.3 (1.8)	4.7 (2.6)	5.3 (1.4)	6 (1)
intact_304	6.1 (2.1)	4.4 (2.1)	4.7 (1.4)	4.9 (1.4)
intact_305	6.6 (1.7)	3.8 (2)	5.1 (1.2)	5.1 (1.2)
intact_306	4.6 (2)	4.2 (1.8)	4.1 (1.3)	3.8 (1.3)
intact_307	7.7 (1.5)	4.9 (2.8)	5.7 (1.2)	6 (1.1)
intact_308	7.1 (1.4)	3.9 (2.1)	5.5 (0.9)	5.5 (1.1)
intact_309	5.5 (2.1)	4.6 (1.9)	4.5 (1.4)	4.6 (1.5)
intact_31	8.4 (1.3)	4 (2.9)	6.4 (0.9)	6.4 (0.9)
intact_310	7.6 (1.4)	3.7 (2.4)	5.7 (1)	5.9 (0.9)
intact_311	6.7 (2)	4.9 (2.4)	5 (1.5)	5.5 (1.5)
intact_312	6.3 (2.1)	5.7 (2.1)	4.3 (1.6)	5.3 (1.5)
intact_313	7 (1.6)	3.3 (2.5)	5.5 (1.2)	5.4 (1.3)
intact_314	6.6 (1.7)	4.8 (2.2)	5 (1.2)	5.1 (1.3)
intact_315	5.8 (2.2)	4.6 (1.9)	4.8 (1.4)	4.8 (1.3)
intact_316	8.2 (1.1)	5.2 (2.8)	6.1 (1.1)	6.4 (0.7)
intact_317	7.8 (1.7)	4.9 (2.6)	5.8 (1.2)	6.2 (1)
intact_318	6.8 (1.3)	4 (1.9)	5.3 (0.9)	5.4 (1)
intact_319	5.8 (1.9)	4.5 (2)	4.6 (1.3)	4.8 (1.3)
intact_32	6.8 (1.8)	5.1 (2.2)	5.3 (1.1)	5.3 (1.3)
intact_320	7.2 (2)	4.3 (2.5)	5.4 (1.3)	5.8 (1.3)
intact_321	7.6 (1.6)	6.2 (2.5)	4.9 (1.7)	5.9 (1.2)
intact_322	5.6 (1.9)	4.4 (1.9)	4.5 (1.5)	4.5 (1.4)
intact_323	5.7 (2.4)	4.3 (2.3)	4.3 (1.7)	4.8 (1.7)
intact_324	6.8 (1.8)	4.2 (2.2)	5.4 (1.1)	5.3 (1.2)
intact_325	5 (2.7)	6.5 (2.1)	2.6 (1.5)	4.7 (1.9)
intact_326	7.3 (2)	4.2 (2.6)	5.6 (1.4)	5.8 (1.4)
intact_327	7.1 (1.7)	4.3 (2.3)	5.3 (1.2)	5.4 (1.3)
intact_328	8 (1.4)	4.1 (2.7)	6.2 (1)	6.3 (0.9)
intact_329	7.2 (1.7)	4.5 (2.5)	5.7 (1.1)	5.7 (1.1)
intact_33	7.5 (1.5)	4.4 (2.5)	5.7 (1.1)	5.8 (1)
intact_330	6.8 (1.9)	4.8 (2.2)	5 (1.3)	5.3 (1.4)
intact_331	8 (1.4)	5.1 (2.7)	6.2 (1)	6.2 (1.1)
intact_332	6.4 (2.2)	4.4 (2.3)	4.9 (1.5)	5 (1.7)
intact_333	7.3 (1.4)	4.2 (2.2)	5.6 (1)	5.6 (1.1)
intact_334	4.7 (1.9)	4.1 (1.7)	4 (1.2)	3.9 (1.3)

intact_335	4.7 (2)	4.3 (1.7)	3.9 (1.5)	3.9 (1.4)
intact_336	6.8 (1.5)	3.8 (2.3)	5.5 (1)	5.4 (1)
intact_337	6.7 (1.9)	4.7 (2.2)	5 (1.2)	5.3 (1.4)
intact_338	5.2 (2.1)	5.2 (1.8)	4.2 (1.4)	4.2 (1.4)
intact_339	7.7 (1.6)	3.7 (2.6)	6 (1.2)	5.9 (1.3)
intact_34	6.9 (1.9)	4.6 (2.5)	5.3 (1.4)	5.5 (1.3)
intact_340	4 (1.8)	4.3 (1.7)	3.5 (1.5)	3.5 (1.4)
intact_341	5.9 (2)	4.5 (2)	4.7 (1.3)	5 (1.5)
intact_342	6.5 (1.9)	4.6 (2.3)	4.9 (1.5)	5.3 (1.2)
intact_343	7.2 (2)	5.2 (2.5)	5.2 (1.6)	5.7 (1.4)
intact_344	6.6 (1.9)	4.7 (2)	5 (1.4)	5.3 (1.5)
intact_345	6.2 (2.3)	4.5 (2.4)	4.7 (1.6)	5 (1.6)
intact_346	8.1 (1.2)	4.5 (2.8)	6.3 (0.7)	6.4 (0.8)
intact_347	4.7 (2.2)	6.4 (2.1)	2.9 (1.5)	4.6 (1.6)
intact_348	8 (1.4)	3.4 (2.8)	6.1 (1)	6.1 (0.9)
intact_349	5.9 (2.1)	5.9 (2)	4.3 (1.5)	4.9 (1.6)
intact_35	7.3 (1.7)	4.6 (2.4)	5.5 (1.2)	5.6 (1.2)
intact_350	3.3 (1.7)	4.7 (1.8)	3 (1.4)	2.9 (1.4)
intact_351	5.7 (1.9)	4.6 (1.7)	4.7 (1.3)	4.6 (1.3)
intact_352	5.6 (2.2)	4.7 (2.2)	4.6 (1.5)	4.6 (1.4)
intact_353	6.1 (1.6)	4.3 (1.9)	4.8 (1.2)	4.7 (1.3)
intact_354	5.5 (1.9)	4 (1.8)	4.6 (1.3)	4.4 (1.3)
intact_355	8 (1.2)	4.5 (2.9)	6 (0.9)	6.2 (1)
intact_356	7 (1.7)	4.1 (2.4)	5.4 (1.2)	5.4 (1.3)
intact_357	4.4 (1.9)	3.8 (1.8)	4 (1.4)	3.7 (1.4)
intact_358	6.3 (2.2)	5 (2.2)	4.4 (1.6)	5.2 (1.4)
intact_359	6 (1.7)	4.7 (2.1)	4.8 (1.1)	5 (1.2)
intact_36	7.2 (1.6)	5.4 (2.3)	5.4 (1.1)	5.6 (1.3)
intact_360	6.2 (2.3)	5.6 (1.8)	4.4 (1.7)	5 (1.6)
intact_37	7.3 (1.6)	4.8 (2.4)	5.4 (1.2)	5.7 (1)
intact_38	4.8 (2.6)	4.9 (2.1)	3.7 (1.7)	4 (2)
intact_39	7.2 (1.8)	4.8 (2.5)	5.4 (1.4)	5.6 (1.4)
intact_4	7.3 (1.8)	4.4 (2.4)	5.6 (1.2)	5.6 (1.2)
intact_40	6.1 (2.5)	4 (2.3)	5.1 (1.7)	5.4 (1.6)
intact_41	5.4 (2.3)	5.7 (1.9)	4.1 (1.5)	4.7 (1.7)
intact_42	7.8 (1.3)	4.1 (2.8)	5.9 (0.9)	6 (0.9)
intact_43	6.2 (1.8)	4.8 (2.1)	4.8 (1.2)	4.8 (1.4)
intact_44	6.7 (2)	4.4 (2.3)	5.3 (1.2)	5.3 (1.3)
intact_45	6.6 (2)	5.1 (2)	4.9 (1.3)	5.1 (1.4)
intact_46	6.8 (2.1)	4.3 (2.4)	5 (1.4)	5.2 (1.6)
intact_47	7.8 (1.7)	5.4 (2.5)	5.6 (1.2)	6 (1.2)
intact_48	7.5 (1.7)	4.4 (2.4)	5.5 (1.3)	5.6 (1.2)
intact_49	6.5 (2.2)	5.5 (2.2)	4.8 (1.6)	5.1 (1.5)
intact_5	5.8 (2.3)	5.1 (2)	4.5 (1.6)	4.8 (1.5)
intact_50	3.6 (2.2)	4.7 (1.9)	3 (1.4)	3.1 (1.6)

intact_51	7.8 (1.4)	4.4 (2.8)	6.1 (1)	6.1 (1)
intact_52	6.4 (2.1)	4.6 (2.3)	4.9 (1.6)	5.2 (1.5)
intact_53	5.3 (2.2)	4.7 (1.7)	4.1 (1.3)	4.2 (1.4)
intact_54	5.5 (2.5)	4.2 (2.1)	4.2 (1.7)	4.3 (1.8)
intact_55	7.8 (1.6)	3.8 (2.7)	6 (1)	6 (1.2)
intact_56	7.8 (1.5)	4.3 (2.7)	5.8 (1.1)	6 (1.1)
intact_57	7.1 (1.9)	4.8 (2.2)	5 (1.5)	5.4 (1.5)
intact_58	6.9 (1.9)	5 (2.2)	5.1 (1.2)	5.3 (1.3)
intact_59	7.4 (1.6)	5 (2.6)	5.8 (1.1)	5.9 (1.1)
intact_6	5.3 (1.9)	4.3 (1.8)	4.3 (1.3)	4.2 (1.4)
intact_60	5.5 (2.1)	5.8 (2)	4.1 (1.5)	4.7 (1.6)
intact_61	5.9 (2.1)	4.2 (2)	4.8 (1.4)	4.9 (1.4)
intact_62	4.5 (2.7)	5.9 (1.9)	3.5 (1.8)	4 (2.1)
intact_63	6.1 (1.7)	4.8 (1.8)	4.8 (1.2)	4.8 (1.3)
intact_64	7 (1.8)	4.1 (2.5)	5.5 (1.2)	5.4 (1.3)
intact_65	6.1 (1.8)	4.8 (2)	4.5 (1.4)	4.7 (1.3)
intact_66	8.3 (1.2)	4.3 (3)	6.2 (0.8)	6.3 (0.9)
intact_67	5.5 (1.9)	4.5 (1.9)	4.4 (1.3)	4.3 (1.4)
intact_68	8.1 (1.2)	4.7 (3.1)	6.1 (1)	6.1 (1.2)
intact_69	5.5 (1.7)	4.5 (1.6)	4.3 (1.2)	4.3 (1.3)
intact_7	5.7 (1.8)	4.7 (1.8)	4.4 (1.2)	4.7 (1.3)
intact_70	7.5 (1.4)	4.6 (2.5)	5.7 (1.1)	5.8 (1.1)
intact_71	8 (1.3)	5.2 (2.7)	6 (0.9)	6.2 (0.9)
intact_72	8.3 (1.2)	4.5 (3.2)	6.3 (1)	6.6 (0.8)
intact_73	8.1 (1.4)	4 (2.9)	6.2 (0.9)	6.3 (0.9)
intact_74	6.8 (2)	5 (2.2)	5.1 (1.3)	5.4 (1.4)
intact_75	5.8 (1.8)	4.5 (1.9)	4.4 (1.4)	4.7 (1.3)
intact_76	7.1 (1.7)	4.9 (2.3)	5.3 (1.2)	5.5 (1.2)
intact_77	6.8 (1.7)	4.8 (2.1)	5.1 (1.2)	5.2 (1.4)
intact_78	7 (1.6)	4.1 (2.3)	5.4 (1.1)	5.5 (1.1)
intact_79	7.9 (1.7)	5 (2.8)	6 (1.2)	6.2 (1.1)
intact_8	5.6 (2.5)	6.2 (2.1)	4.1 (1.8)	5 (1.8)
intact_80	6.8 (1.6)	4.7 (1.8)	5.4 (1)	5.3 (1.2)
intact_81	6.8 (1.8)	3.8 (2.5)	5.4 (1.2)	5.3 (1.3)
intact_82	5.5 (2.1)	4.3 (1.9)	4.4 (1.5)	4.5 (1.4)
intact_83	7.5 (1.5)	5.5 (2.2)	5.4 (1.3)	5.6 (1.2)
intact_84	7.9 (1.3)	4.8 (2.8)	5.9 (1.1)	6.1 (1)
intact_85	7.9 (1.3)	3.9 (2.8)	6.1 (1.1)	6.2 (1)
intact_86	5.2 (2.1)	4.5 (1.9)	4.3 (1.5)	4.4 (1.5)
intact_87	6.6 (2)	4.3 (2)	5.2 (1.3)	5.3 (1.3)
intact_88	6.5 (1.8)	4.8 (1.9)	5 (1.2)	5.1 (1.4)
intact_89	5.3 (2.3)	4.6 (2)	4.3 (1.6)	4.4 (1.5)
intact_9	7.4 (1.8)	5.2 (2.5)	5.1 (1.4)	6.1 (1)
intact_90	6.7 (1.8)	3.2 (2.3)	5.5 (1.3)	5.2 (1.2)
intact_91	6.3 (2.5)	4.1 (2.5)	4.9 (1.7)	5.1 (1.7)

intact_92	6 (2.1)	4.6 (2.1)	4.8 (1.4)	4.8 (1.5)
intact_93	5.8 (2.1)	4.4 (2)	4.5 (1.4)	4.7 (1.5)
intact_94	6.2 (1.8)	5.2 (1.8)	5 (1.2)	5 (1.3)
intact_95	7.2 (1.7)	4.7 (2.5)	5.5 (1.2)	5.6 (1.2)
intact_96	8 (1.5)	3.4 (2.7)	6.3 (1)	6.3 (1.1)
intact_97	7.3 (1.6)	5.5 (2.3)	5.2 (1.3)	5.6 (1.4)
intact_98	5.9 (1.9)	4.1 (1.9)	4.8 (1.2)	4.8 (1.2)
intact_99	7.1 (1.9)	4.1 (2.4)	5.4 (1.2)	5.5 (1.3)
built_1	6.8 (1.7)	3.9 (2.1)	5.3 (1.1)	5.4 (1.4)
built_10	5.5 (1.6)	4.5 (1.6)	4 (1.3)	4.5 (1.3)
built_100	5.8 (1.8)	5.1 (1.8)	4.5 (1.2)	4.6 (1.3)
built_101	6.3 (1.7)	4.2 (1.8)	4.8 (1.1)	4.8 (1.3)
built_102	6.8 (1.8)	4.6 (2.4)	5.4 (1.3)	5.5 (1.4)
built_103	5.8 (1.9)	4.8 (1.7)	4.5 (1.2)	4.8 (1.3)
built_104	7.1 (1.8)	5 (2.5)	5.6 (1.3)	5.5 (1.2)
built_105	4.4 (1.8)	4.6 (1.9)	3.4 (1.3)	3.9 (1.3)
built_106	5.2 (1.8)	4.6 (1.6)	4.2 (1.2)	4.2 (1.3)
built_107	5.7 (1.6)	4.7 (1.6)	4.3 (1.2)	4.5 (1.3)
built_108	6.3 (2)	4.1 (2)	4.9 (1.3)	5 (1.3)
built_109	6.6 (1.7)	4.3 (2.1)	5.4 (1)	5.3 (1.2)
built_11	5.9 (1.8)	4.6 (1.7)	4.4 (1.3)	4.7 (1.4)
built_110	5.4 (1.9)	4.2 (1.9)	4.1 (1.4)	4.4 (1.5)
built_111	6.8 (1.5)	4.4 (2.1)	5.1 (1.4)	5.3 (1.2)
built_112	3.9 (1.6)	4.7 (1.4)	3.1 (1.2)	3.3 (1.3)
built_113	5.6 (1.9)	4.5 (1.8)	4.4 (1.3)	4.5 (1.4)
built_114	5.1 (2)	4.6 (1.6)	3.9 (1.5)	4.5 (1.6)
built_115	4.8 (1.9)	5.3 (1.8)	3.4 (1.2)	4 (1.4)
built_116	4 (1.6)	5 (1.6)	3.2 (1.2)	3.6 (1.2)
built_117	4.6 (2.1)	4.4 (2)	3.9 (1.5)	3.8 (1.6)
built_118	6.9 (2)	4.7 (2.7)	5.4 (1.5)	5.3 (1.6)
built_119	4.3 (2)	4.9 (1.9)	3.2 (1.4)	3.6 (1.5)
built_12	3.7 (1.7)	4.6 (1.6)	3 (1.2)	3.3 (1.3)
built_120	6.1 (1.5)	4.8 (1.7)	4.8 (1.1)	4.8 (1.3)
built_121	5.6 (1.7)	4.7 (1.8)	4.3 (1.3)	4.4 (1.3)
built_122	4.8 (1.8)	5 (1.7)	3.5 (1.2)	3.9 (1.3)
built_123	5.2 (2.1)	4.8 (1.8)	4.2 (1.4)	4.5 (1.5)
built_124	4.6 (1.4)	4.8 (1.2)	3.6 (1.1)	3.9 (1.2)
built_125	6.1 (1.8)	4.1 (1.8)	4.8 (1.3)	5 (1.3)
built_126	6.7 (1.8)	5.1 (2.1)	5.4 (1.2)	5.2 (1.2)
built_127	4.9 (1.7)	4.8 (1.7)	3.7 (1.2)	4 (1.2)
built_128	4.4 (2.2)	4.7 (2)	3.7 (1.5)	3.8 (1.5)
built_129	5.2 (1.9)	4.6 (1.9)	4.1 (1.5)	4.1 (1.5)
built_13	3.7 (1.7)	4.9 (1.3)	2.9 (1.3)	3.1 (1.4)
built_130	6.4 (1.9)	5.3 (2.2)	4.9 (1.3)	4.9 (1.5)
built_131	5.2 (2.1)	4.3 (2)	4.3 (1.3)	4.1 (1.5)

built_132	6.1 (2)	5 (2)	4.9 (1.3)	4.8 (1.4)
built_133	5.2 (1.7)	4.4 (1.5)	3.9 (1.3)	4 (1.3)
built_134	6.4 (2)	4.7 (2.1)	4.7 (1.4)	5.3 (1.3)
built_135	6.6 (1.5)	5.1 (1.9)	4.7 (1.1)	5.2 (1.1)
built_136	5.3 (2.1)	4.6 (1.9)	4.4 (1.4)	4.3 (1.3)
built_137	5.3 (2.1)	4.4 (1.9)	4.3 (1.4)	4.3 (1.6)
built_138	4.7 (1.6)	5 (1.4)	3.4 (1.2)	3.9 (1.3)
built_139	4.7 (1.8)	4.9 (1.6)	3.3 (1.3)	3.7 (1.5)
built_14	5.3 (1.5)	5.1 (1.6)	3.7 (1.3)	4.4 (1.2)
built_140	3.6 (1.8)	5 (1.7)	3 (1.3)	3.2 (1.4)
built_141	4 (1.7)	4.9 (1.4)	3 (1.2)	3.4 (1.3)
built_142	4.3 (1.7)	4.8 (1.4)	3.4 (1.2)	3.8 (1.2)
built_143	6.4 (1.8)	4 (1.9)	5.2 (1.2)	5.3 (1.3)
built_144	6.7 (1.7)	4.9 (2.2)	5.2 (1.3)	5.3 (1.3)
built_145	3.3 (1.7)	4.6 (1.7)	2.8 (1.4)	2.6 (1.4)
built_146	6.2 (2)	5 (2.1)	4.7 (1.2)	5.1 (1.3)
built_147	3.8 (1.7)	4.6 (1.4)	3 (1.2)	3 (1.3)
built_148	4.4 (1.7)	4.6 (1.4)	3.5 (1.3)	3.8 (1.2)
built_149	5.1 (2.1)	4.6 (1.8)	3.8 (1.2)	4.2 (1.5)
built_15	4.4 (1.7)	4.7 (1.6)	3.4 (1.2)	3.6 (1.3)
built_150	4.7 (1.6)	4.9 (1.9)	3.4 (1.2)	3.8 (1.2)
built_151	5.8 (1.9)	4.6 (2)	4.5 (1.3)	4.6 (1.3)
built_152	6.1 (1.8)	5.2 (2.1)	4.9 (1.3)	5 (1.3)
built_153	5.8 (1.8)	4.8 (1.9)	4.5 (1.2)	4.8 (1.3)
built_154	6.4 (1.7)	4.4 (2)	5 (1.2)	5.2 (1.1)
built_155	3.6 (1.9)	5.3 (1.9)	2.5 (1.2)	3.3 (1.4)
built_156	6.3 (1.8)	5.1 (2.1)	4.7 (1.2)	5.1 (1.2)
built_157	4.1 (1.7)	4.8 (1.6)	3.1 (1.2)	3.6 (1.3)
built_158	3.3 (1.9)	4.6 (1.7)	2.7 (1.2)	2.9 (1.3)
built_159	5.4 (1.7)	4.8 (1.5)	4.3 (1.3)	4.4 (1.4)
built_16	4.7 (1.6)	4.7 (1.3)	3.6 (1.1)	3.7 (1.2)
built_160	6.3 (1.8)	5.3 (2)	4.5 (1.4)	5 (1.4)
built_161	6 (2)	4.6 (2)	4.4 (1.3)	4.9 (1.3)
built_162	6.8 (1.8)	4.1 (2.3)	5.3 (1.2)	5.3 (1.2)
built_163	4.7 (1.8)	4.4 (1.7)	3.7 (1.5)	4.2 (1.4)
built_164	5.7 (1.8)	4.7 (1.6)	4.1 (1.2)	4.5 (1.4)
built_165	5.2 (1.9)	4.3 (1.8)	3.8 (1.5)	4.3 (1.4)
built_166	5.9 (2.2)	4.3 (2.1)	4.6 (1.6)	4.9 (1.5)
built_167	2.4 (1.4)	4.7 (2.1)	2.1 (1.1)	2.1 (1.2)
built_168	6.5 (1.7)	4.7 (1.7)	4.4 (1.2)	5 (1.2)
built_169	6.6 (1.8)	4.8 (2.1)	4.8 (1.3)	5.1 (1.4)
built_17	4.5 (1.5)	4.8 (1.1)	3.4 (1.2)	3.7 (1.1)
built_170	6.7 (1.3)	4.7 (1.8)	5.1 (1.1)	5.1 (1.1)
built_171	6 (2)	5.5 (1.8)	4.2 (1.3)	4.8 (1.3)
built_172	5.3 (2)	5 (1.7)	4 (1.4)	4.2 (1.6)

built_173	3.7 (1.7)	5.3 (1.7)	2.9 (1.3)	3.2 (1.3)
built_174	4.4 (2.1)	4.9 (1.6)	3.6 (1.4)	3.6 (1.7)
built_175	4.5 (1.7)	4.8 (1.7)	3.5 (1.3)	3.8 (1.3)
built_176	4.1 (2.1)	5 (1.6)	3.2 (1.5)	3.7 (1.6)
built_177	5.9 (2)	4.9 (2)	4.2 (1.4)	4.9 (1.3)
built_178	5.8 (1.7)	5.1 (1.5)	4.2 (1)	4.6 (1.3)
built_179	5.5 (2)	5.1 (1.6)	4.3 (1.3)	4.6 (1.6)
built_18	5 (2)	5.4 (1.7)	3.6 (1.4)	4.1 (1.4)
built_180	4.6 (2.1)	4.7 (2.1)	3.6 (1.7)	3.8 (1.7)
built_181	6 (2.2)	4.8 (2.2)	4.4 (1.6)	5 (1.5)
built_182	4.7 (1.7)	5.4 (1.4)	3.2 (1.2)	4 (1.4)
built_183	4.1 (1.8)	5 (1.6)	3.1 (1.2)	3.2 (1.4)
built_184	6 (1.5)	4.7 (1.8)	4.2 (1.2)	4.8 (1.2)
built_185	4.3 (1.8)	4.5 (1.6)	3.4 (1.2)	3.5 (1.5)
built_186	5.7 (1.7)	5.1 (1.8)	4.3 (1.2)	4.6 (1.2)
built_187	6.2 (1.9)	4.2 (2.1)	4.6 (1.4)	5 (1.4)
built_188	3.9 (1.5)	4.3 (1.6)	2.9 (1.2)	3.4 (1.3)
built_189	5.6 (1.6)	5.2 (1.6)	4 (1.3)	4.5 (1.2)
built_19	3.6 (1.8)	4.7 (1.3)	3 (1)	3.2 (1.2)
built_190	4.5 (1.9)	5.5 (1.6)	3.1 (1.3)	4 (1.4)
built_191	6.6 (1.9)	4.3 (1.9)	5.2 (1.3)	5.2 (1.2)
built_192	3.3 (1.9)	5 (2)	2.6 (1.4)	2.8 (1.5)
built_193	6.7 (1.7)	4.7 (2.3)	4.9 (1.5)	5.4 (1.3)
built_194	5.6 (2.1)	3.9 (2.1)	4.6 (1.5)	4.5 (1.5)
built_195	4.9 (2)	5 (1.8)	3.7 (1.3)	4 (1.4)
built_196	4.3 (1.9)	5 (1.6)	3.4 (1.3)	3.5 (1.3)
built_197	4.5 (2.2)	4.8 (1.7)	3.4 (1.4)	3.7 (1.6)
built_198	6 (2.1)	5 (1.9)	4.4 (1.4)	4.5 (1.4)
built_199	6.4 (1.9)	5.5 (2.1)	4.8 (1.3)	5.1 (1.3)
built_2	5.4 (2.3)	4.8 (2.1)	4.4 (1.7)	4.8 (1.7)
built_20	5.5 (1.6)	4.7 (1.7)	4 (1.4)	4.6 (1.4)
built_200	5.7 (2)	5.7 (1.6)	3.9 (1.4)	4.5 (1.3)
built_201	7.2 (1.9)	5.3 (2.5)	5.5 (1.4)	5.9 (1.2)
built_202	4.9 (1.7)	4.7 (1.6)	3.8 (1.1)	3.9 (1.1)
built_203	8.2 (1.2)	4.9 (2.8)	6 (1)	6.4 (0.9)
built_204	6.3 (2.2)	4 (2.1)	4.8 (1.6)	5 (1.5)
built_205	5.8 (2.2)	4.6 (2.2)	4.6 (1.5)	4.6 (1.5)
built_206	4.9 (2)	5.1 (1.8)	3.1 (1.4)	4 (1.5)
built_207	4.3 (1.7)	4.6 (1.4)	3.4 (1.3)	3.6 (1.3)
built_208	5.2 (2)	4.8 (2.1)	4 (1.5)	4.4 (1.5)
built_209	6.7 (1.7)	4.6 (1.9)	5.1 (1.2)	5.3 (1.3)
built_21	4.4 (1.8)	4.7 (1.5)	3.5 (1.3)	3.5 (1.4)
built_210	4.7 (2)	4.8 (1.8)	3.6 (1.6)	3.9 (1.5)
built_211	3.9 (2)	5 (1.7)	3.2 (1.3)	3.4 (1.3)
built_212	4.5 (1.8)	4.2 (1.6)	3.6 (1.2)	3.8 (1.2)

built_213	4 (1.9)	4.9 (1.6)	2.8 (1.2)	3.2 (1.3)
built_214	5.5 (1.9)	4.9 (1.9)	4.3 (1.3)	4.6 (1.3)
built_215	3.9 (1.8)	4.2 (1.7)	3.2 (1.4)	3.4 (1.4)
built_216	4.7 (1.6)	5 (1.6)	3.4 (1.1)	4.1 (1.3)
built_217	6.1 (1.5)	4.8 (1.7)	4.7 (1.1)	5 (1.2)
built_218	5.5 (1.7)	4.5 (1.6)	4.4 (1.2)	4.6 (1.3)
built_219	6.4 (2)	5.2 (2.3)	4.6 (1.4)	5.2 (1.3)
built_22	5.4 (1.9)	4.4 (1.7)	4.2 (1.3)	4.4 (1.5)
built_220	4.6 (1.7)	4.4 (1.7)	3.5 (1.2)	3.6 (1.2)
built_221	6.6 (1.6)	6 (1.8)	4.2 (1.3)	5.5 (1)
built_222	7.5 (1.8)	4.8 (2.5)	5.6 (1.2)	5.8 (1.1)
built_223	5.3 (1.7)	4.5 (1.8)	3.9 (1.5)	4.2 (1.3)
built_224	6.7 (1.8)	4 (2.2)	5.5 (1)	5.4 (1.2)
built_225	5.7 (2.1)	5.3 (1.9)	3.8 (1.4)	4.6 (1.5)
built_226	4.5 (1.5)	4.8 (1.4)	3.2 (1.1)	3.7 (1.2)
built_227	4 (1.7)	5.2 (1.8)	2.9 (1.2)	3.3 (1.2)
built_228	4.5 (1.7)	4.9 (1.4)	3.4 (1.3)	3.6 (1.3)
built_229	6 (1.7)	4.5 (2)	4.7 (1.2)	4.9 (1.2)
built_23	4.3 (1.5)	4.2 (1.4)	3.5 (1.2)	3.5 (1.1)
built_230	4.6 (1.9)	4.9 (1.6)	3.6 (1.3)	3.8 (1.4)
built_231	7.3 (1.4)	5.5 (2.5)	5.4 (1.2)	5.9 (0.9)
built_232	5.4 (1.6)	4.8 (1.5)	4.3 (1.1)	4.4 (1)
built_233	4.1 (1.9)	5.1 (1.6)	2.8 (1.1)	3.5 (1.4)
built_234	7.4 (1.7)	4.4 (2.6)	5.7 (1.3)	5.8 (1.1)
built_235	4.4 (2.1)	5.2 (1.6)	3.4 (1.4)	3.6 (1.4)
built_236	3.5 (1.7)	5.1 (1.7)	2.4 (1.3)	2.9 (1.3)
built_237	5.3 (2)	4.4 (1.7)	3.9 (1.3)	4.4 (1.3)
built_238	5.5 (2)	4.9 (1.8)	3.8 (1.5)	4.4 (1.6)
built_239	4.3 (1.8)	4.9 (1.8)	3.1 (1.3)	3.6 (1.3)
built_24	4.7 (1.8)	4.7 (1.5)	3.5 (1.2)	4 (1.1)
built_240	5.6 (1.7)	4.7 (1.6)	4.1 (1.2)	4.6 (1.3)
built_241	5.4 (2.1)	4.2 (2)	4.3 (1.5)	4.5 (1.6)
built_242	7.1 (1.5)	5.3 (2.2)	5.2 (1)	5.7 (1)
built_243	5.3 (1.8)	4.8 (1.7)	4.1 (1.3)	4.2 (1.4)
built_244	5.5 (2.3)	6 (1.9)	3.2 (1.5)	4.6 (1.5)
built_245	5 (1.8)	4.7 (1.6)	3.8 (1.3)	4 (1.4)
built_246	5.7 (1.8)	5 (1.7)	4.2 (1.4)	4.6 (1.4)
built_247	4.5 (1.6)	4.8 (1.3)	3.3 (1.1)	3.7 (1.2)
built_248	4.5 (1.7)	4.8 (1.7)	3.4 (1.3)	3.7 (1.2)
built_249	4.7 (2)	5.1 (1.5)	3.2 (1.4)	4 (1.4)
built_25	6.7 (1.8)	3.9 (2.1)	5.2 (1.3)	5.4 (1.3)
built_250	5.4 (2)	4.7 (1.7)	4.2 (1.4)	4.5 (1.4)
built_251	3.7 (1.8)	4.6 (1.5)	3 (1.2)	3.3 (1.3)
built_252	3.5 (1.9)	5 (2.1)	2.6 (1.2)	3 (1.3)
built_253	5 (1.8)	5.1 (1.6)	3.6 (1.3)	4.1 (1.4)

built_254	5.3 (1.6)	4.7 (1.5)	4.2 (1.2)	4.4 (1.3)
built_255	4.9 (1.8)	4.9 (1.6)	3.7 (1.2)	4.1 (1.3)
built_256	4.9 (1.8)	4.8 (1.6)	3.4 (1.3)	3.9 (1.3)
built_257	5 (1.8)	4.8 (1.4)	3.9 (1.2)	4.2 (1.3)
built_258	5.8 (1.8)	4.7 (1.9)	4 (1.3)	4.7 (1.3)
built_259	4.3 (1.7)	4.8 (1.3)	3.3 (1.2)	3.5 (1.4)
built_26	5.4 (1.6)	5 (1.5)	3.7 (1.2)	4.3 (1.3)
built_260	5.6 (1.7)	4.7 (1.8)	4.4 (1.2)	4.6 (1.2)
built_261	4.6 (2)	4.6 (1.7)	3.2 (1.4)	3.8 (1.3)
built_262	5.9 (1.8)	4.6 (2)	4.5 (1.4)	4.7 (1.4)
built_263	4.6 (1.5)	4.6 (1.2)	3.5 (1)	3.8 (1)
built_264	6 (1.8)	4.6 (1.8)	4.5 (1.1)	4.9 (1.2)
built_265	5.1 (2)	4.5 (1.6)	4.1 (1.2)	4 (1.4)
built_266	5.8 (1.5)	4.7 (1.7)	4.6 (1.2)	4.7 (1.2)
built_267	5 (1.6)	4.5 (1.5)	3.9 (1.1)	4 (1.1)
built_268	5.3 (1.6)	4.8 (1.6)	3.8 (1.4)	4.1 (1.3)
built_269	5.2 (1.9)	4.1 (1.7)	4.2 (1.4)	4.2 (1.3)
built_27	4.5 (1.7)	4.2 (1.3)	3.6 (1.3)	3.9 (1.3)
built_270	5.1 (1.8)	4.2 (1.9)	4 (1.5)	4.3 (1.3)
built_271	4.9 (1.7)	4.8 (1.5)	4 (1.3)	3.9 (1.5)
built_272	6.6 (1.5)	4.1 (2)	5.2 (1.1)	5 (1.2)
built_273	7.3 (1.6)	4 (2.2)	5.6 (0.9)	5.7 (1.2)
built_274	6.5 (1.8)	4.1 (1.9)	5.1 (1.2)	5.2 (1.3)
built_275	7.6 (1.5)	3.9 (2.4)	5.6 (1)	5.6 (1.3)
built_276	8 (1.2)	3.4 (2.6)	5.9 (1.2)	6.1 (1)
built_277	6.7 (1.9)	4.5 (2.2)	5.4 (1.3)	5.5 (1.2)
built_278	8 (1.6)	4.8 (3.1)	6 (1.1)	6.2 (1.1)
built_279	7.3 (1.8)	4.1 (2.6)	5.7 (1.2)	5.7 (1.1)
built_28	5.6 (1.8)	5.1 (1.4)	4.2 (1.2)	4.6 (1.4)
built_280	8.3 (1.1)	3.5 (3)	6.4 (0.8)	6.4 (0.9)
built_281	6.5 (1.8)	4.5 (2.2)	5.1 (1.3)	5 (1.6)
built_282	8.2 (1.4)	4.7 (3.1)	6 (1.1)	6.3 (1.1)
built_283	7.1 (1.8)	3.8 (2.2)	5.5 (1.2)	5.8 (1.1)
built_284	6.2 (1.9)	3.9 (2.1)	4.9 (1.3)	4.9 (1.5)
built_285	6.5 (1.7)	4.4 (2)	5.1 (1.1)	4.9 (1.2)
built_286	6.1 (1.8)	4.2 (2)	4.9 (1.2)	4.8 (1.2)
built_287	7.3 (1.4)	5.1 (2.5)	5.5 (1.1)	5.5 (1.1)
built_288	8.3 (1.1)	4 (3)	6.3 (0.9)	6.4 (0.9)
built_289	6.6 (1.8)	4.3 (2)	5 (1.2)	5 (1.4)
built_29	4.9 (2.3)	6 (1.8)	3 (1.5)	4.1 (1.5)
built_290	6.6 (1.6)	5.3 (2.2)	4.6 (1.3)	5.1 (1.2)
built_3	6.4 (1.8)	4 (1.9)	5 (1.3)	5 (1.4)
built_30	3.3 (1.8)	4.8 (1.6)	2.5 (1.1)	2.8 (1.3)
built_31	4.9 (1.5)	5.1 (1.4)	3.6 (1.2)	3.9 (1.2)
built_32	4.6 (1.7)	5.3 (1.9)	3.1 (1.3)	3.9 (1.3)

built_33	5.4 (1.7)	4.8 (1.6)	3.9 (1.2)	4.5 (1.4)
built_34	3.8 (2)	4.8 (1.7)	3 (1.2)	3.2 (1.2)
built_35	3.7 (1.6)	4.9 (1.6)	3 (1.2)	3.2 (1.3)
built_36	6.1 (1.9)	5.5 (2.1)	4.2 (1.5)	5.1 (1.4)
built_37	4.6 (1.3)	4.4 (1.5)	3.7 (1.2)	3.8 (1.1)
built_38	4.4 (1.9)	4.5 (1.5)	3.3 (1.4)	3.6 (1.5)
built_39	4.1 (1.8)	4.9 (1.3)	3.1 (1.2)	3.5 (1.2)
built_4	4.7 (2.1)	4.7 (1.7)	3.8 (1.5)	4 (1.6)
built_40	6.2 (1.8)	4.4 (2)	4.5 (1.4)	4.7 (1.2)
built_41	5.5 (1.5)	4.7 (1.5)	4.1 (1.1)	4.3 (1.1)
built_42	3.8 (1.7)	4.6 (1.7)	2.8 (1.2)	3.2 (1.2)
built_43	3.9 (1.9)	4.7 (1.7)	3.1 (1.4)	3.3 (1.4)
built_44	5 (1.8)	4.7 (1.5)	3.6 (1.4)	4 (1.5)
built_45	4.5 (1.9)	5.5 (1.5)	3 (1.3)	3.9 (1.6)
built_46	4.8 (1.5)	4.7 (1.5)	3.8 (1.1)	3.9 (1.2)
built_47	4.2 (1.8)	4.5 (1.5)	3.2 (1.1)	3.6 (1.3)
built_48	5 (1.5)	4.9 (1.7)	3.4 (1.2)	4 (1.2)
built_49	4.3 (1.6)	5 (1.4)	3.4 (1.2)	3.6 (1.3)
built_5	3.7 (1.4)	4.6 (1.4)	2.9 (1.1)	3.1 (1)
built_50	4.1 (1.5)	5.1 (1.3)	3.1 (1.2)	3.5 (1.2)
built_51	3.1 (1.8)	4.6 (1.6)	2.3 (1.3)	2.6 (1.5)
built_52	3.5 (1.7)	4.4 (1.5)	2.7 (1.1)	3.1 (1.2)
built_53	5.3 (2.1)	5.5 (1.6)	3.8 (1.5)	4.3 (1.6)
built_54	5.3 (1.9)	5.3 (1.8)	3.9 (1.3)	4.4 (1.3)
built_55	4.2 (1.6)	4.9 (1.3)	3.4 (1)	3.5 (1.1)
built_56	3.6 (1.7)	4.9 (1.8)	2.9 (1.3)	3.1 (1.3)
built_57	5.6 (1.9)	5.1 (1.7)	4.1 (1.4)	4.5 (1.4)
built_58	3.9 (1.7)	5 (1.8)	3 (1.2)	3.3 (1.3)
built_59	3.3 (2)	4.7 (1.4)	2.7 (1.3)	3.1 (1.4)
built_6	4.8 (2)	4.7 (1.7)	3.8 (1.3)	3.8 (1.4)
built_60	4.8 (1.9)	4.7 (1.5)	3.7 (1.4)	3.9 (1.3)
built_61	5.4 (1.8)	4.9 (1.5)	4.1 (1.2)	4.5 (1.4)
built_62	4.3 (1.7)	4.9 (1.6)	2.8 (1.3)	3.4 (1.4)
built_63	4.5 (1.9)	4.9 (1.6)	3.3 (1.3)	3.6 (1.4)
built_64	3.9 (1.7)	4.7 (1.7)	3 (1.3)	3.4 (1.3)
built_65	5.8 (1.7)	4.3 (1.7)	4.8 (1.2)	4.6 (1.2)
built_66	6.2 (1.9)	4.8 (2.2)	4.8 (1.5)	5.1 (1.4)
built_67	3.5 (1.8)	4.4 (1.8)	3 (1.1)	3 (1.2)
built_68	5.6 (1.5)	4.4 (1.4)	4.2 (1.2)	4.5 (1.2)
built_69	4.3 (1.7)	4.5 (1.8)	3.3 (1.2)	3.4 (1.3)
built_7	5.1 (1.9)	4.7 (1.7)	4 (1.2)	4.2 (1.4)
built_70	5.8 (1.8)	4.7 (1.8)	4.4 (1.2)	4.4 (1.4)
built_71	3.8 (2)	5.1 (1.8)	3.2 (1.3)	3.4 (1.6)
built_72	7.1 (1.6)	4.8 (2.5)	5.5 (1.2)	5.6 (1.1)
built_73	5.2 (1.7)	4.4 (1.7)	4 (1.1)	4.2 (1.2)

built_74	5.8 (2)	4.5 (1.9)	4.4 (1.2)	4.7 (1.4)
built_75	6.8 (1.5)	4.4 (2.1)	5.4 (1.1)	5.4 (1.2)
built_76	5 (1.9)	4.6 (1.9)	3.5 (1.3)	4.3 (1.5)
built_77	7.2 (1.6)	5.2 (2)	5.3 (1)	5.7 (1.2)
built_78	7.4 (1.8)	4.6 (2.5)	5.5 (1.2)	5.7 (1.2)
built_79	5.4 (1.9)	4.4 (1.9)	4.1 (1.5)	4.4 (1.4)
built_8	5.3 (2)	4.7 (1.9)	4 (1.2)	4.4 (1.4)
built_80	5.2 (1.9)	4.8 (1.7)	4.2 (1.4)	4.2 (1.6)
built_81	6.2 (1.9)	4.8 (2)	4.6 (1.2)	5 (1.4)
built_82	5.8 (1.9)	5.2 (1.7)	4.6 (1.2)	4.6 (1.4)
built_83	3.3 (1.7)	4.6 (1.7)	3 (1.3)	3 (1.3)
built_84	6.7 (2)	4.6 (2.5)	5.3 (1.4)	5.3 (1.4)
built_85	4.7 (2.3)	5 (1.7)	3.8 (1.5)	3.9 (1.7)
built_86	5.8 (2.1)	4.6 (2)	4.6 (1.5)	4.6 (1.6)
built_87	6.2 (1.9)	4.2 (1.7)	4.8 (1.1)	5 (1.3)
built_88	5.1 (1.8)	4.6 (1.9)	4.1 (1.3)	4.2 (1.3)
built_89	3.8 (1.6)	4.9 (1.5)	3.2 (1.3)	3.3 (1.5)
built_9	5.5 (1.7)	4.6 (1.5)	4 (1.3)	4.4 (1.2)
built_90	6.4 (1.7)	4.6 (2.1)	5.1 (1)	5.4 (1.1)
built_91	6.5 (1.8)	4.2 (2)	4.7 (1.4)	5.2 (1.3)
built_92	4.7 (2)	4.4 (1.7)	3.6 (1.6)	3.8 (1.6)
built_93	5.2 (1.9)	4.7 (1.6)	4 (1.5)	4.3 (1.6)
built_94	5.9 (2)	4.6 (2.1)	4.9 (1.4)	4.8 (1.5)
built_95	4.3 (1.7)	4.6 (1.5)	3.4 (1.1)	3.7 (1.3)
built_96	6.2 (1.7)	4.8 (2)	4.7 (1.2)	5 (1.2)
built_97	6.2 (2.1)	4.4 (2)	4.8 (1.5)	5 (1.5)
built_98	6.2 (1.8)	4.6 (2.1)	4.8 (1.3)	5 (1.4)
built_99	5.8 (1.7)	4.7 (1.7)	4.3 (1.3)	4.8 (1.2)
degraded_1	2.9 (2.5)	6.6 (2.2)	1.7 (1.1)	3.7 (2.2)
degraded_10	6.3 (1.9)	4.2 (2.1)	5 (1.2)	5 (1.3)
degraded_100	6.6 (2)	4.8 (2.2)	4.8 (1.3)	5.3 (1.4)
degraded_101	6.3 (2.2)	4.8 (2.1)	5 (1.5)	5.1 (1.4)
degraded_102	6 (2.2)	4.7 (2.2)	4.5 (1.6)	5 (1.6)
degraded_103	6.8 (1.9)	4.5 (2.4)	5.3 (1.3)	5.5 (1.3)
degraded_104	5.2 (2.2)	4.9 (1.7)	4 (1.6)	4.4 (1.6)
degraded_105	5.4 (2)	5 (1.7)	4.2 (1.3)	4.5 (1.4)
degraded_106	4 (2.4)	4.7 (1.9)	3.5 (1.8)	3.5 (1.8)
degraded_107	2.6 (2)	4.6 (2)	2.8 (1.6)	2.7 (1.7)
degraded_108	2.7 (1.8)	5.3 (2.2)	2.2 (1.3)	2.4 (1.3)
degraded_109	3.8 (2.3)	5.7 (2.1)	3.1 (1.7)	3.3 (1.8)
degraded_11	6.8 (1.8)	5 (2.3)	5.2 (1.3)	5.3 (1.4)
degraded_110	6.2 (2.1)	4.7 (1.9)	4.8 (1.3)	4.9 (1.3)
degraded_111	6.3 (2)	5.6 (2)	4.6 (1.5)	5 (1.4)
degraded_112	5.6 (2.5)	5.7 (2)	3.9 (1.6)	4.9 (1.7)
degraded_113	1.5 (1.1)	5.3 (2.2)	1.6 (1.1)	1.9 (1.3)

degraded_114	2.3 (1.9)	6.3 (2.2)	1.6 (1.1)	2.7 (1.9)
degraded_115	2.1 (1.7)	5.9 (2.4)	1.6 (1)	2.3 (1.7)
degraded_116	6.7 (1.9)	4.9 (2.2)	5 (1.4)	5.3 (1.4)
degraded_117	5.1 (2.4)	5.4 (1.9)	3.9 (1.7)	4.5 (1.7)
degraded_118	4.8 (2)	5 (1.7)	3.7 (1.5)	4 (1.5)
degraded_119	6.2 (2.4)	5.6 (2.2)	4.3 (1.7)	5.1 (1.8)
degraded_12	6.9 (1.6)	4.5 (2.2)	5.2 (1.2)	5.5 (1.2)
degraded_120	5.4 (2.3)	6.2 (1.7)	3.9 (1.7)	4.8 (1.6)
degraded_121	7.3 (1.5)	4.9 (2.3)	5.5 (1)	5.7 (1.1)
degraded_122	2.6 (2)	5.7 (2.3)	2.1 (1.4)	2.8 (1.7)
degraded_123	3.4 (2.3)	5.2 (2)	2.7 (1.5)	3.1 (1.7)
degraded_124	5.1 (2.1)	4.3 (1.8)	4.1 (1.5)	4.3 (1.6)
degraded_125	4.9 (2.5)	5.7 (2.1)	3.5 (1.7)	4.3 (1.8)
degraded_126	6.6 (2)	4.8 (2.3)	4.8 (1.6)	5.2 (1.6)
degraded_127	7.2 (1.8)	4.5 (2.5)	5.4 (1.4)	5.7 (1.4)
degraded_128	3.6 (2.3)	5.7 (1.7)	2.6 (1.5)	3.1 (1.7)
degraded_129	6.1 (2.3)	5.1 (2.2)	4.3 (1.7)	4.8 (1.6)
degraded_13	6.3 (2.2)	4.8 (2.4)	4.6 (1.6)	5.3 (1.5)
degraded_130	6.8 (1.9)	5 (2.2)	4.9 (1.4)	5.4 (1.3)
degraded_14	5.4 (2.1)	5 (1.9)	4.2 (1.5)	4.4 (1.6)
degraded_15	6.9 (2)	4.5 (2.4)	5.3 (1.3)	5.6 (1.3)
degraded_16	3.6 (2.2)	4.8 (1.8)	2.8 (1.4)	3.1 (1.6)
degraded_17	3.8 (2.6)	5.1 (1.9)	3.2 (1.7)	3.3 (1.8)
degraded_18	2.9 (2.4)	5.2 (1.9)	2.3 (1.5)	2.8 (1.9)
degraded_19	5.5 (2.2)	5 (2.2)	4.5 (1.5)	4.4 (1.6)
degraded_2	2 (1.8)	6.2 (2.4)	1.8 (1.5)	2.6 (2)
degraded_20	5.3 (2.7)	4.9 (2.1)	3.9 (1.8)	4.3 (1.9)
degraded_21	5.4 (1.9)	4.5 (1.8)	4.3 (1.4)	4.4 (1.4)
degraded_22	3.3 (2)	4.5 (2)	2.8 (1.4)	2.9 (1.4)
degraded_23	6.8 (1.8)	5.3 (2.3)	4.7 (1.6)	5.3 (1.5)
degraded_24	1.6 (1.4)	5.4 (2.1)	1.6 (1.1)	1.7 (1.3)
degraded_25	3.4 (2)	5.1 (1.7)	3.1 (1.3)	3.1 (1.5)
degraded_26	3.8 (1.9)	4.2 (1.9)	2.9 (1.3)	3 (1.3)
degraded_27	1.8 (1.2)	5 (1.8)	1.8 (0.9)	1.9 (1.1)
degraded_28	2.1 (1.5)	5.5 (2.1)	2.1 (1.5)	2.2 (1.4)
degraded_29	4.2 (2.1)	5.3 (1.8)	3.4 (1.4)	3.7 (1.7)
degraded_3	3.3 (2.5)	5.2 (1.9)	2.5 (1.3)	2.9 (1.7)
degraded_30	3.8 (2)	5.1 (1.5)	3.1 (1.3)	3.1 (1.4)
degraded_31	6.7 (1.9)	4.5 (2.3)	4.9 (1.5)	5.3 (1.4)
degraded_32	6 (2.5)	5.5 (2.3)	4.1 (1.8)	5 (1.8)
degraded_33	4.6 (2)	4.9 (1.8)	3.9 (1.5)	4.1 (1.4)
degraded_34	6.1 (2.3)	5 (2.2)	4.5 (1.6)	4.8 (1.6)
degraded_35	5.8 (2.3)	4.7 (2.2)	4.4 (1.7)	5 (1.6)
degraded_36	1.6 (1.3)	5.6 (2.1)	1.4 (0.8)	1.5 (1)
degraded_37	5.5 (2.2)	6 (1.8)	3.7 (1.6)	4.7 (1.5)

degraded_38	4.9 (2.1)	4.8 (1.6)	4 (1.5)	4.4 (1.5)
degraded_39	1.5 (0.9)	4.9 (2.1)	1.5 (0.9)	1.4 (0.8)
degraded_4	4.9 (1.9)	4.4 (1.7)	3.9 (1.4)	3.9 (1.3)
degraded_40	7 (2.1)	4.9 (2.6)	5 (1.6)	5.6 (1.5)
degraded_41	7 (2.2)	4.5 (2.7)	5.2 (1.6)	5.3 (1.8)
degraded_42	6.4 (1.9)	5 (1.9)	4.6 (1.4)	5.1 (1.3)
degraded_43	5.1 (2.3)	4.8 (1.9)	4 (1.4)	4.3 (1.5)
degraded_44	5.5 (1.7)	4.7 (1.7)	4.4 (1.3)	4.5 (1.4)
degraded_45	5.7 (1.9)	4.4 (1.9)	4.3 (1.4)	4.5 (1.5)
degraded_46	1.9 (1.4)	5.1 (2.1)	1.9 (1.1)	2.2 (1.2)
degraded_47	5.7 (1.8)	4.9 (1.7)	4.6 (1.3)	4.6 (1.2)
degraded_48	5 (2)	4 (1.6)	4.1 (1.3)	3.9 (1.4)
degraded_49	6.1 (2)	4.8 (2)	4.9 (1.2)	4.9 (1.4)
degraded_5	6.3 (1.9)	4.6 (2)	4.9 (1.2)	5 (1.3)
degraded_50	6.6 (1.7)	4.6 (1.9)	4.9 (1.2)	5 (1.2)
degraded_51	6.1 (2.3)	5 (2.1)	4.5 (1.5)	4.9 (1.6)
degraded_52	6.1 (2)	5.2 (2)	4.4 (1.4)	4.9 (1.5)
degraded_53	3.8 (2.1)	4.7 (1.6)	3.4 (1.5)	3.3 (1.5)
degraded_54	2 (1.6)	6.4 (2.1)	1.6 (1)	2.7 (1.7)
degraded_55	2.6 (1.7)	4.8 (1.7)	2.2 (1.2)	2.4 (1.3)
degraded_56	2.1 (1.4)	4.7 (2)	2 (0.9)	2.1 (1.1)
degraded_57	4.7 (2)	4.4 (1.8)	3.9 (1.4)	3.8 (1.5)
degraded_58	4.4 (1.9)	4.9 (1.5)	3.8 (1.5)	3.8 (1.4)
degraded_59	4.7 (1.7)	4.5 (1.4)	4 (1.2)	3.7 (1.5)
degraded_6	5.3 (2.3)	4.9 (1.7)	4.1 (1.5)	4.3 (1.5)
degraded_60	4.1 (1.8)	4.6 (1.6)	3.5 (1.3)	3.4 (1.4)
degraded_61	4.2 (2)	4.9 (1.8)	3.6 (1.4)	3.6 (1.4)
degraded_62	5.1 (2.2)	5.2 (1.7)	4 (1.4)	4.2 (1.5)
degraded_63	5 (2.3)	5.2 (1.7)	3.9 (1.5)	4.2 (1.7)
degraded_64	6.8 (2)	5.7 (2.3)	4.6 (1.6)	5.6 (1.5)
degraded_65	6 (2.2)	4.5 (2.1)	4.5 (1.6)	4.9 (1.6)
degraded_66	6.3 (2.4)	4.7 (2.3)	4.4 (1.7)	5.2 (1.6)
degraded_67	5.5 (2.1)	5.3 (1.7)	4.4 (1.4)	4.7 (1.5)
degraded_68	7.4 (1.5)	4.6 (2.2)	5.5 (1)	5.8 (1.1)
degraded_69	6.6 (1.9)	4.6 (2.1)	5.2 (1.1)	5.1 (1.3)
degraded_7	5.1 (2.2)	5.7 (1.7)	3.8 (1.5)	4.2 (1.6)
degraded_70	4.1 (2.2)	4.7 (1.8)	3.3 (1.5)	3.6 (1.6)
degraded_71	6.4 (1.9)	5 (2.2)	4.8 (1.3)	5.2 (1.4)
degraded_72	3.7 (2.1)	4.8 (2)	3.2 (1.6)	3.4 (1.5)
degraded_73	3.7 (2.2)	5.1 (2)	3 (1.4)	3.3 (1.7)
degraded_74	2.4 (1.8)	5.6 (2)	2.2 (1.3)	2.3 (1.5)
degraded_75	2.9 (2.1)	4.8 (2.1)	2.5 (1.4)	2.9 (1.7)
degraded_76	2.5 (1.6)	5.1 (2)	2.5 (1.5)	2.8 (1.5)
degraded_77	4.8 (2.4)	4.7 (1.9)	3.8 (1.7)	4.2 (1.9)
degraded_78	5.5 (2.4)	4.8 (2.2)	4.6 (1.6)	4.6 (1.8)

degraded_79	6.3 (2.3)	4.5 (2.4)	4.9 (1.5)	5.2 (1.6)
degraded_8	4 (2)	4.5 (1.4)	3.5 (1.3)	3.4 (1.3)
degraded_80	6.9 (1.8)	3.9 (2.2)	5.4 (1.2)	5.3 (1.2)
degraded_81	6.1 (2.3)	4.5 (2.3)	4.7 (1.5)	5.1 (1.6)
degraded_82	6.3 (2.1)	4.7 (2.2)	5 (1.3)	4.9 (1.5)
degraded_83	6.7 (2)	4.7 (2.3)	5.1 (1.4)	5.5 (1.5)
degraded_84	6 (1.9)	4.8 (1.9)	4.8 (1.3)	4.9 (1.3)
degraded_85	6.9 (2)	4.4 (2.6)	5.2 (1.4)	5.9 (1.3)
degraded_86	6 (1.9)	4.9 (2)	4.8 (1.2)	4.7 (1.3)
degraded_87	4.5 (2)	4.4 (1.8)	3.7 (1.5)	3.9 (1.5)
degraded_88	6 (2.2)	3.8 (1.9)	4.6 (1.6)	4.8 (1.6)
degraded_89	7.5 (1.7)	4.5 (2.7)	5.7 (1.3)	5.7 (1.3)
degraded_9	5.2 (2)	5.1 (1.8)	4 (1.4)	4.2 (1.5)
degraded_90	4.3 (2.2)	4.7 (1.6)	3.6 (1.5)	3.6 (1.7)
degraded_91	5.9 (2.1)	3.9 (2)	4.6 (1.6)	4.6 (1.5)
degraded_92	2.7 (2)	5.8 (2.1)	2.3 (1.5)	3 (1.9)
degraded_93	2.5 (1.9)	6 (2.5)	1.8 (1.3)	2.6 (1.8)
degraded_94	1.9 (1.6)	6.1 (2.3)	1.7 (1.2)	2.6 (1.9)
degraded_95	1.9 (1.6)	6.1 (2.2)	1.8 (1.4)	2.6 (2)
degraded_96	2.7 (2.4)	6 (2.6)	2 (1.6)	3.1 (2.1)
degraded_97	3.7 (2.7)	4.9 (2.2)	3 (1.9)	3.4 (2)
degraded_98	4.4 (2.4)	4.4 (2.4)	3.6 (1.7)	4 (1.9)
degraded_99	5.1 (2.7)	4.8 (2)	3.9 (1.8)	4.5 (2)

Table 2

ANOVA Results for Study 1

	<u>Descriptive Statistics</u>				<u>One-way</u>
	Built Environments	Intact Natural Environments	Degraded	Total	ANOVA
			Natural Environments		
					F(2,777)
Valence	5.3 (0.1)	6.5 (0.1)	4.8 (0.1)	5.8 (0.04)	122.4***
Arousal	4.7 (0.02)	4.6 (0.02)	5.0 (0.04)	4.7 (0.02)	29.76***
Restoration	4.1 (0.04)	5.0 (0.04)	3.8 (0.1)	4.4 (0.04)	139.3***
Preference	4.3 (0.04)	5.2 (0.04)	4.1 (0.1)	4.7 (0.03)	119.7***

*p<.05, **p<.01, ***p<.001

Table 3

Correlation Matrix for Images of Intact Environments

Variable	n	M	SD	1	2	3	4
----------	---	---	----	---	---	---	---

1. Valence	360	6.5	0.1	—	-.13*	.95***	.98***
2. Arousal	360	4.6	0.02		—	-.33***	-.05
3. Restoration	360	5.0	0.04			—	.91***
4. Preference	360	5.2	0.04				—

Note. *p* < .05, **p** < .01, ***p*** < .001

Table 4

Correlation Matrix for Images of Built Environments

Variable	n	M	SD	1	2	3	4
1. Valence	290	5.3	0.1	—	-.20***	.97***	.99***
2. Arousal	290	4.7	0.02		—	-.34***	-.18**
3. Restoration	290	4.1	0.04			—	.96***
4. Preference	290	4.3	0.04				—

Note. *p* < .05, **p** < .01, ***p*** < .001

Table 5

Correlation Matrix for Images of Degraded Environments

Variable	n	M	SD	1	2	3	4
1. Valence	130	4.8	0.1	—	-.47***	.98***	.98***
2. Arousal	130	5.0	0.04		—	-.57***	-.38***
3. Restoration	130	3.8	0.1			—	.96***
4. Preference	130	4.1	0.1				—

Note. *p* < .05, **p** < .01, ***p*** < .001

Table 6

Descriptive Statistics for Images used in Study 2

Image	Valence	Arousal	Restoration	Preference
intact_129	6.6 (1.6)	4.6 (2)	5 (1.1)	5.1 (1.2)
intact_16	7.2 (1.8)	4.5 (2.4)	5.5 (1.3)	5.6 (1.3)
intact_200	7 (1.7)	5 (2.3)	5.3 (1.3)	5.4 (1.3)
intact_226	6.2 (1.9)	4.6 (2.1)	4.7 (1.4)	4.9 (1.4)
intact_282	6.6 (1.9)	4.7 (2.3)	5.1 (1.2)	5.4 (1.3)
intact_285	7.3 (1.5)	4.8 (2.4)	5.4 (1.2)	5.5 (1.3)
intact_288	7.1 (1.6)	4.5 (2.3)	5.4 (1.2)	5.5 (1.1)
intact_314	6.6 (1.7)	4.8 (2.2)	5 (1.2)	5.1 (1.3)
intact_342	6.5 (1.9)	4.6 (2.3)	4.9 (1.5)	5.3 (1.2)
intact_35	7.3 (1.7)	4.6 (2.4)	5.5 (1.2)	5.6 (1.2)
intact_44	6.7 (2)	4.4 (2.3)	5.3 (1.2)	5.3 (1.3)
intact_74	6.8 (2)	5 (2.2)	5.1 (1.3)	5.4 (1.4)

intact_81	6.8 (1.8)	3.8 (2.5)	5.4 (1.2)	5.3 (1.3)
built_105	4.4 (1.8)	4.6 (1.9)	3.4 (1.3)	3.9 (1.3)
built_117	4.6 (2.1)	4.4 (2)	3.9 (1.5)	3.8 (1.6)
built_148	4.4 (1.7)	4.6 (1.4)	3.5 (1.3)	3.8 (1.2)
built_15	4.4 (1.7)	4.7 (1.6)	3.4 (1.2)	3.6 (1.3)
built_16	4.7 (1.6)	4.7 (1.3)	3.6 (1.1)	3.7 (1.2)
built_185	4.3 (1.8)	4.5 (1.6)	3.4 (1.2)	3.5 (1.5)
built_210	4.7 (2)	4.8 (1.8)	3.6 (1.6)	3.9 (1.5)
built_220	4.6 (1.7)	4.4 (1.7)	3.5 (1.2)	3.6 (1.2)
built_261	4.6 (2)	4.6 (1.7)	3.2 (1.4)	3.8 (1.3)
built_263	4.6 (1.5)	4.6 (1.2)	3.5 (1)	3.8 (1)
built_37	4.6 (1.3)	4.4 (1.5)	3.7 (1.2)	3.8 (1.1)
built_38	4.4 (1.9)	4.5 (1.5)	3.3 (1.4)	3.6 (1.5)
built_69	4.3 (1.7)	4.5 (1.8)	3.3 (1.2)	3.4 (1.3)
degraded_11	6.8 (1.8)	5 (2.3)	5.2 (1.3)	5.3 (1.4)
degraded_121	7.3 (1.5)	4.9 (2.3)	5.5 (1)	5.7 (1.1)
degraded_126	6.6 (2)	4.8 (2.3)	4.8 (1.6)	5.2 (1.6)
degraded_127	7.2 (1.8)	4.5 (2.5)	5.4 (1.4)	5.7 (1.4)
degraded_31	6.7 (1.9)	4.5 (2.3)	4.9 (1.5)	5.3 (1.4)
degraded_40	7 (2.1)	4.9 (2.6)	5 (1.6)	5.6 (1.5)
degraded_41	7 (2.2)	4.5 (2.7)	5.2 (1.6)	5.3 (1.8)
degraded_5	6.3 (1.9)	4.6 (2)	4.9 (1.2)	5 (1.3)
degraded_50	6.6 (1.7)	4.6 (1.9)	4.9 (1.2)	5 (1.2)
degraded_68	7.4 (1.5)	4.6 (2.2)	5.5 (1)	5.8 (1.1)
degraded_69	6.6 (1.9)	4.6 (2.1)	5.2 (1.1)	5.1 (1.3)
degraded_80	6.9 (1.8)	3.9 (2.2)	5.4 (1.2)	5.3 (1.2)
degraded_83	6.7 (2)	4.7 (2.3)	5.1 (1.4)	5.5 (1.5)

Table 7

ANOVA Results for Stimuli used in Study 2

	<u>Descriptive Statistics</u>				<u>One-way</u>
	Built Environments	Intact Natural Environments	Degraded Natural Environments	Total	<u>ANOVA</u> F(2,36)
Valence	4.5 (0.03)	6.8 (0.1)	6.8 (0.1)	6.1 (0.2)	288.9***
Arousal	4.6 (0.03)	4.6 (0.1)	4.6 (0.1)	4.6 (0.04)	0.303
Restoration	3.5 (0.1)	5.2 (0.1)	5.2 (0.1)	4.6 (0.1)	224.3***
Preference	3.7 (0.04)	5.4 (0.1)	5.4 (0.1)	4.8 (0.1)	278.4***

*p<.05, **p<.01, ***p<.001

Table 8

ANOVA Results for Study 2

	<u>Descriptive Statistics</u>			<u>Main Effects</u>		
	Time 1	Time 2	Total	Time F(1,315)	Types of Environmen ts F(2,315)	Interaction F(2,315)
Intact	8.7 (0.2)	9.0 (0.3)	8.8 (0.2)			
Built	9.0 (0.3)	9.1 (0.3)	9.0 (0.2)			
Degraded	8.6 (0.3)	8.2 (0.3)	8.4 (0.2)			
Total	8.8 (0.1)	8.7 (0.2)		0.01	2.02	1.90
	Time 1	Time 2	Total	F(1,211)	F(1,211)	F(1,211)
Intact	8.7 (0.2)	9.0 (0.3)	8.8 (0.2)			
Degraded	8.6 (0.3)	8.2 (0.3)	8.4 (0.2)			
Total	8.6 (0.2)	8.6 (0.2)		0.13	1.81	4.35*
	Time 1	Time 2	Total	F(1,210)	F(1,210)	F(1,210)
Intact	8.7 (0.2)	9.0 (0.3)	8.8 (0.2)			
Built	9.0 (0.2)	9.1 (0.3)	9.0 (0.2)			
Total	8.8 (0.2)	9.0 (0.2)		0.93	0.39	0.29
	Time 1	Time 2	Total	F(1,209)	F(1,209)	F(1,209)
Built	9.0 (0.2)	9.1 (0.3)	9.0 (0.2)			
Degraded	8.6 (0.3)	8.2 (0.3)	8.4 (0.2)			
Total	8.8 (0.2)	8.6 (0.2)		0.73	3.57	1.62

*p<.05, **p<.01, ***p<.001

Table 9

Moderated Regression Analysis Results for Study 2 – intact v degraded

Items	<i>b</i>	<i>SE_b</i>	<i>t</i>	<i>p</i>
Stress				
VAS_CEN ¹	-0.013	0.011	-1.126	.261
Time2 ² x INTACT	0.665	0.321	2.074	.039
Time2 x VAS_CEN	0.001	0.001	0.695	.488
INTACT x VAS_CEN	-0.012	0.015	-0.807	.420
Time2 x INTACT x VAS_CEN	-0.019	0.013	-1.476	.141
Nature-relatedness				
NR6_CEN	-0.120	0.328	-0.364	.716
Time2 x INTACT	0.646	0.318	2.036	.043
Time2 x NR6_CEN	-0.307	0.271	-1.133	.258
INTACT x NR6_CEN	0.711	0.457	1.556	.121
Time2 x INTACT x NR6_CEN	0.249	0.378	0.658	.511

Performance Prediction				
SOMEWHATBETTER	-0.505	0.716	-0.705	.482
MUCHWORSE	-1.555	0.794	-1.959	.051
SOMEWHATWORSE	-0.325	0.649	-0.501	0.617
Time2 x INTACT	1.086	0.507	2.140	.034
Time2 x SOMEWHATBETTER	1.009	0.599	1.685	.094
Time2 x MUCHWORSE	-1.124	0.664	-1.693	.092
Time2 x SOMEWHATWORSE	-0.035	0.543	-0.065	.948
INTACT x SOMEWHATBETTER	-0.527	0.977	-0.539	.590
INTACT x MUCHWORSE	-0.622	1.119	-0.556	.579
INTACT x SOMEWHATWORSE	-1.440	0.948	-1.518	.130
Time2 x INTACT x SOMEWHATBETTER	-0.586	0.817	-0.716	.475
Time2 x INTACT x MUCHWORSE	-0.670	0.936	-0.716	.475
Time2 x INTACT x SOMEWHATWORSE	-0.949	0.794	-1.196	.233

¹The variable was centered. ²The variable was dummy coded

Table 10

Moderated Regression Analysis Results for Study 2 updated data set – intact v built

Items	<i>b</i>	<i>SE_b</i>	<i>t</i>	<i>p</i>
Stress				
VAS_CEN ¹	-0.003	0.011	-0.274	.784
Time2 ² x INTACT	0.220	0.365	0.602	.548
Time2 x VAS_CEN	-0.014	0.011	-1.308	.192
INTACT x VAS_CEN	-0.022	0.015	-1.490	.137
Time2 x INTACT x VAS_CEN	0.002	0.015	0.121	.904
Nature-relatedness				
NR6_CEN	-0.049	0.327	-0.149	.882
Time2 x INTACT	0.210	0.363	0.578	.564
Time2 x NR6_CEN	-0.292	0.321	-0.908	.365
INTACT x NR6_CEN	0.640	0.447	1.433	.153
Time2 x INTACT x NR6_CEN	0.233	0.439	0.530	.597
Performance Prediction				
SOMEWHATBETTER	-0.455	0.609	-0.746	.456
MUCHWORSE	-1.608	0.822	-1.957	.051
SOMEWHATWORSE	-0.455	0.673	-0.675	.500
Time2 x INTACT	0.343	0.623	0.551	.582
Time2 x SOMEWHATBETTER	0.381	0.618	0.616	.539
Time2 x MUCHWORSE	-1.872	0.834	-2.243	.026
Time2 x SOMEWHATWORSE	-0.667	0.684	-0.975	.331
INTACT x SOMEWHATBETTER	-0.577	0.875	-0.659	.510
INTACT x MUCHWORSE	-0.568	1.110	-0.512	.609
INTACT x SOMEWHATWORSE	-1.310	0.939	-1.396	.164
Time2 x INTACT x SOMEWHATBETTER	0.043	0.889	0.048	.962
Time2 x INTACT x MUCHWORSE	0.078	1.127	0.069	.945

Time2 x INTACT x SOMEWHATWORSE	-0.318	0.953	-0.333	.739
--------------------------------	--------	-------	--------	------

¹The variable was centered. ²The variable was dummy coded

Table 11

Moderated Regression Analysis Results for Study 2 updated data set – built vs degraded

Items	<i>b</i>	<i>SE_b</i>	<i>t</i>	<i>p</i>
Stress				
VAS_CEN ¹	-0.013	0.012	-1.061	.289
Time2 ² x BUILT	0.438	0.370	1.183	.238
Time2 x VAS_CEN	0.007	0.011	0.604	.546
BUILT x VAS_CEN	0.010	0.017	0.567	.571
Time2 x BUILT x VAS_CEN	-0.021	0.06	-1.346	.180
Nature-relatedness				
NR6_CEN	-0.120	0.342	-0.349	.727
Time2 x BUILT	0.429	0.368	1.166	.245
Time2 x NR6_CEN	-0.307	0.311	-0.986	.325
BUILT x NR6_CEN	0.071	0.493	0.144	.886
Time2 x BUILT x NR6_CEN	0.016	0.449	0.035	.972
Performance Prediction				
SOMEWHATBETTER	-0.505	0.763	-0.661	.509
MUCHWORSE	-1.555	0.846	-1.837	.067
SOMEWHATWORSE	-0.325	0.692	-0.470	.639
Time2 x BUILT	0.742	0.597	1.243	.215
Time2 x SOMEWHATBETTER	1.009	0.699	1.443	.151
Time2 x MUCHWORSE	-1.124	0.775	-1.450	.149
Time2 x SOMEWHATWORSE	-0.035	0.634	-0.056	.956
BUILT x SOMEWHATBETTER	0.050	1.027	0.049	.962
BUILT x MUCHWORSE	-0.054	1.255	-0.043	.966
BUILT x SOMEWHATWORSE	-0.130	1.027	-0.126	.100
Time2 x BUILT x SOMEWHATBETTER	-0.628	0.941	-0.668	.505
Time2 x BUILT x MUCHWORSE	-0.748	1.150	-0.650	.516
Time2 x BUILT x SOMEWHATWORSE	-0.631	0.941	-0.671	.503

¹The variable was centered. ²The variable was dummy coded

Table 12

ANOVA Results for Study 2 updated data set

	<u>Descriptive Statistics</u>			<u>Main Effects</u>		
	Time 1	Time 2	Total	Types of		
				Time	ts	Interaction
Intact	8.7 (0.2)	9.0 (0.3)	8.8 (0.2)	F(1,306)	F(2,306)	F(2,306)
				0.00	2.48	1.63

Built	9.0 (0.3)	9.1 (0.3)	9.0 (0.2)			
Degraded	8.5 (0.3)	8.1 (0.3)	8.3 (0.2)			
Total	8.7 (0.1)	8.7 (0.2)				
	Time 1	Time 2	Total	F(1,202)	F(1,202)	F(1,202)
Intact	8.7 (0.2)	9.0 (0.3)	8.8 (0.2)			
Degraded	8.5 (0.3)	8.1 (0.3)	8.3 (0.2)			
Total	8.6 (0.2)	8.6 (0.2)		0.08	2.44	3.76
	Time 1	Time 2	Total	F(1,200)	F(1,200)	F(1,200)
Built	9.0 (0.2)	9.1 (0.3)	9.0 (0.2)			
Degraded	8.5 (0.3)	8.1 (0.3)	8.3 (0.2)			
Total	8.7 (0.2)	8.6 (0.2)		0.57	4.44*	1.35

*p<.05, **p<.01, ***p<.001

Table 13

Moderated Regression Analysis Results for Study 2 updated data set – built vs degraded

Items	<i>b</i>	<i>SE_b</i>	<i>t</i>	<i>p</i>
Stress				
VAS_CEN ¹	-0.015	0.012	-1.233	.218
Time2 ² x BUILT	0.403	0.385	1.048	.296
Time2 x VAS_CEN	0.005	0.012	0.390	.697
BUILT x VAS_CEN	0.012	0.017	0.708	.479
Time2 x BUILT x VAS_CEN	-0.019	0.016	-1.168	.244
Nature-relatedness				
NR6_CEN	-0.241	0.343	-0.704	.482
Time2 x BUILT	0.404	0.381	1.062	.289
Time2 x NR6_CEN	-0.330	0.324	-1.016	.311
BUILT x NR6_CEN	0.193	0.487	0.395	.693
Time2 x BUILT x NR6_CEN	0.038	0.461	0.082	.934
Performance Prediction				
SOMEWHATBETTER	-0.646	0.789	-0.819	.414
MUCHWORSE	-1.468	0.841	-1.746	.082
SOMEWHATWORSE	-0.176	0.702	-0.251	.802
Time2 x BUILT	0.649	0.624	1.040	.230
Time2 x SOMEWHATBETTER	1.038	0.751	1.383	.168
Time2 x MUCHWORSE	-1.218	0.800	-1.522	.130
Time2 x SOMEWHATWORSE	-0.184	0.668	-0.276	.783
BUILT x SOMEWHATBETTER	0.192	1.035	0.185	.853
BUILT x MUCHWORSE	-0.140	1.234	-0.113	.910
BUILT x SOMEWHATWORSE	-0.278	1.020	-0.273	.785
Time2 x BUILT x SOMEWHATBETTER	-0.657	0.984	-0.668	.505
Time2 x BUILT x MUCHWORSE	-0.654	1.174	-0.557	.578
Time2 x BUILT x SOMEWHATWORSE	-0.483	0.970	-0.497	.620

¹The variable was centered. ²The variable was dummy coded

Table 14

Moderated Regression Analysis Results for Study 2 updated data set – intact vs degraded

Items	<i>b</i>	<i>SE_b</i>	<i>t</i>	<i>p</i>
Stress				
VAS_CEN ¹	-0.015	0.011	-1.317	.190
Time2 ² x INTACT	0.631	0.332	1.900	.059
Time2 x VAS_CEN	0.005	0.010	0.449	.654
INTACT x VAS_CEN	-0.010	0.015	-0.653	.514
Time2 x INTACT x VAS_CEN	-0.017	0.013	-1.269	.206
Nature-relatedness				
NR6_CEN	-0.241	0.328	-0.737	.462
Time2 x INTACT	0.621	0.328	1.894	.060
Time2 x NR6_CEN	-0.330	0.281	-1.171	.243
INTACT x NR6_CEN	0.833	0.450	1.850	.066
Time2 x INTACT x NR6_CEN	0.271	0.387	0.701	.484
Performance Prediction				
SOMEWHATBETTER	-0.646	0.735	-0.879	.380
MUCHWORSE	-1.468	0.784	-1.874	.062
SOMEWHATWORSE	-0.176	0.654	-0.269	.788
Time2 x INTACT	0.992	0.528	1.878	.062
Time2 x SOMEWHATBETTER	1.038	0.640	1.621	.107
Time2 x MUCHWORSE	-1.218	0.682	-1.784	.076
Time2 x SOMEWHATWORSE	-0.184	0.570	-0.323	.747
INTACT x SOMEWHATBETTER	-0.385	0.977	-0.394	.694
INTACT x MUCHWORSE	-0.708	1.094	-0.647	.518
INTACT x SOMEWHATWORSE	-1.589	0.936	-1.697	.091
Time2 x INTACT x SOMEWHATBETTER	-0.615	0.581	-0.722	.471
Time2 x INTACT x MUCHWORSE	-0.577	0.953	-0.605	.546
Time2 x INTACT x SOMEWHATWORSE	-0.800	0.815	-0.982	.328

¹The variable was centered. ²The variable was dummy coded

Table 15

Change in change scores for participants who viewed images of degraded environments

	Original data set	Reduced data set	Change
Mean Change	-0.387	-0.361	+ 0.026
SD Change	2.320	2.368	+ 0.048
N	106	97	- 9

FIGURES

Valence and Arousal Ratings for All Environments

Category ● built ● degraded ● intact

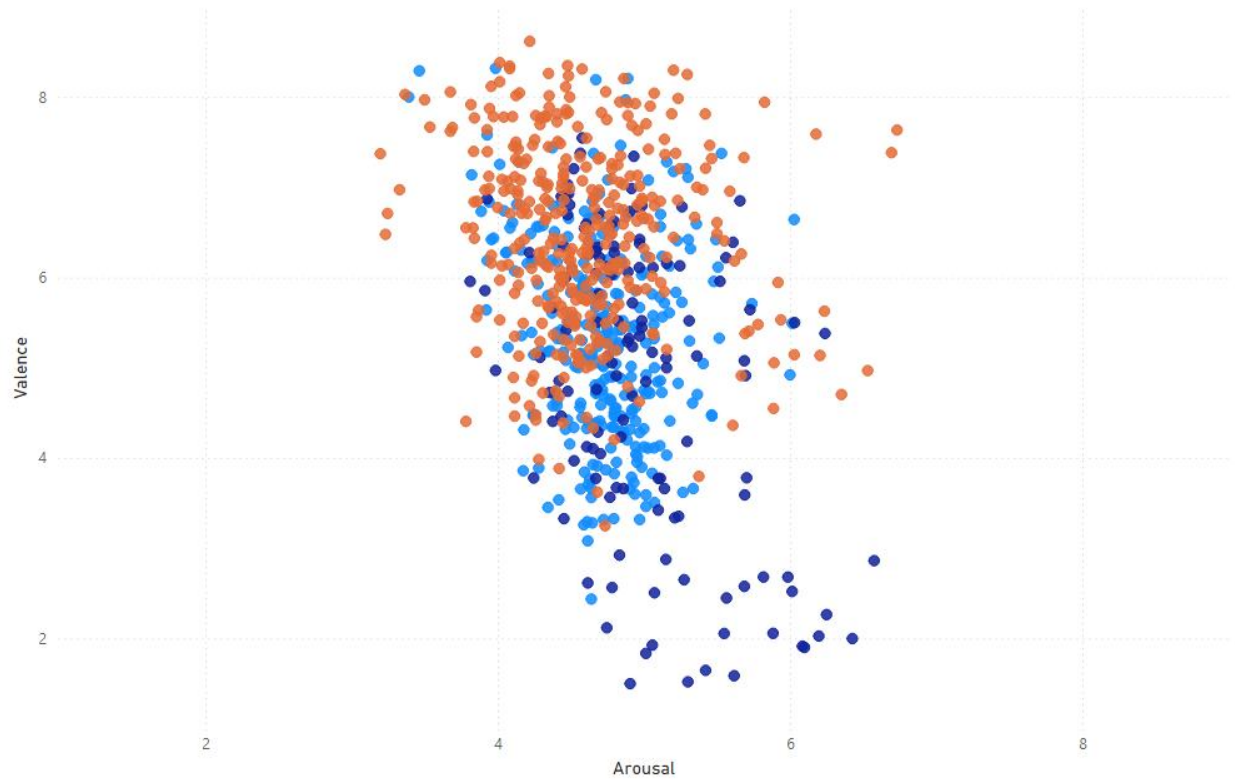


Figure 1. Valence and arousal ratings for intact, built, and degraded environments

Valence and Arousal Ratings for Intact Environments

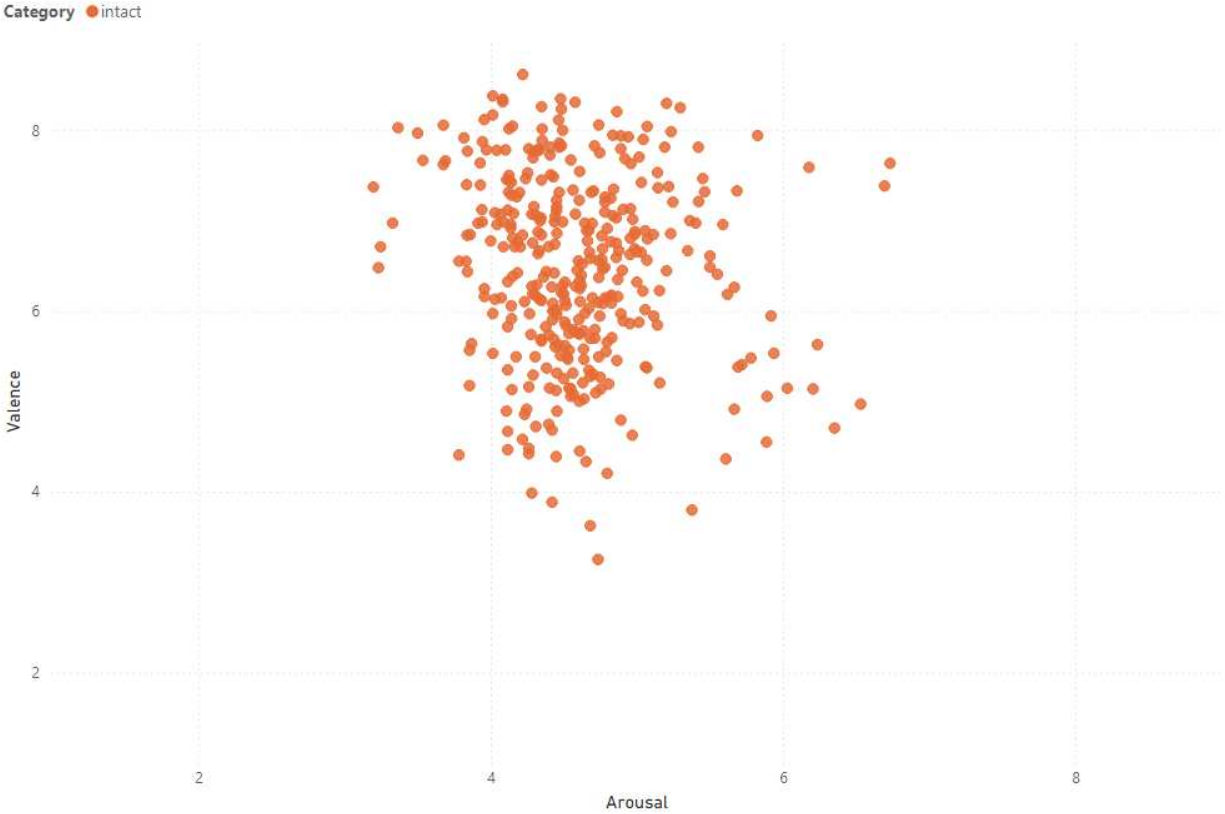


Figure 2. Valence and arousal ratings for intact environments

Valence and Arousal Ratings for Built Environments

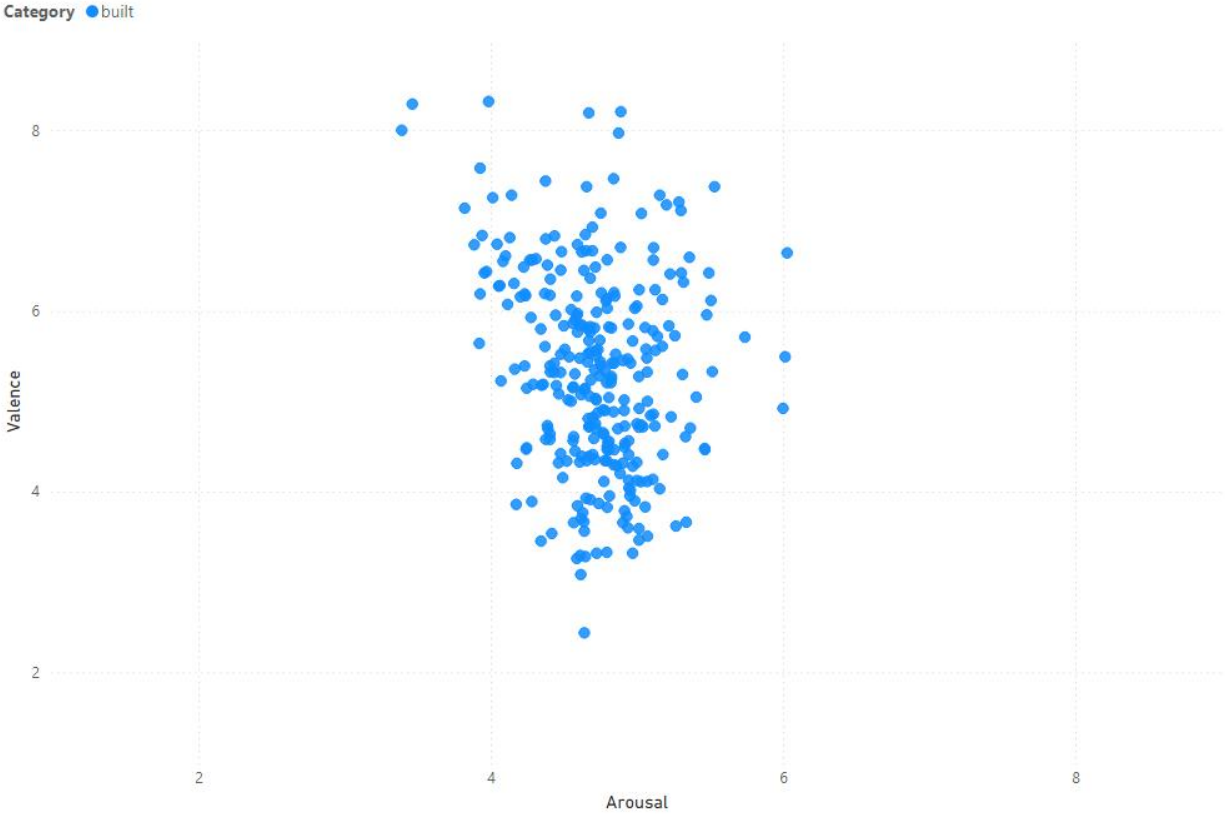


Figure 3. Valence and arousal ratings for built environments

Valence and Arousal Ratings for Degraded Environments

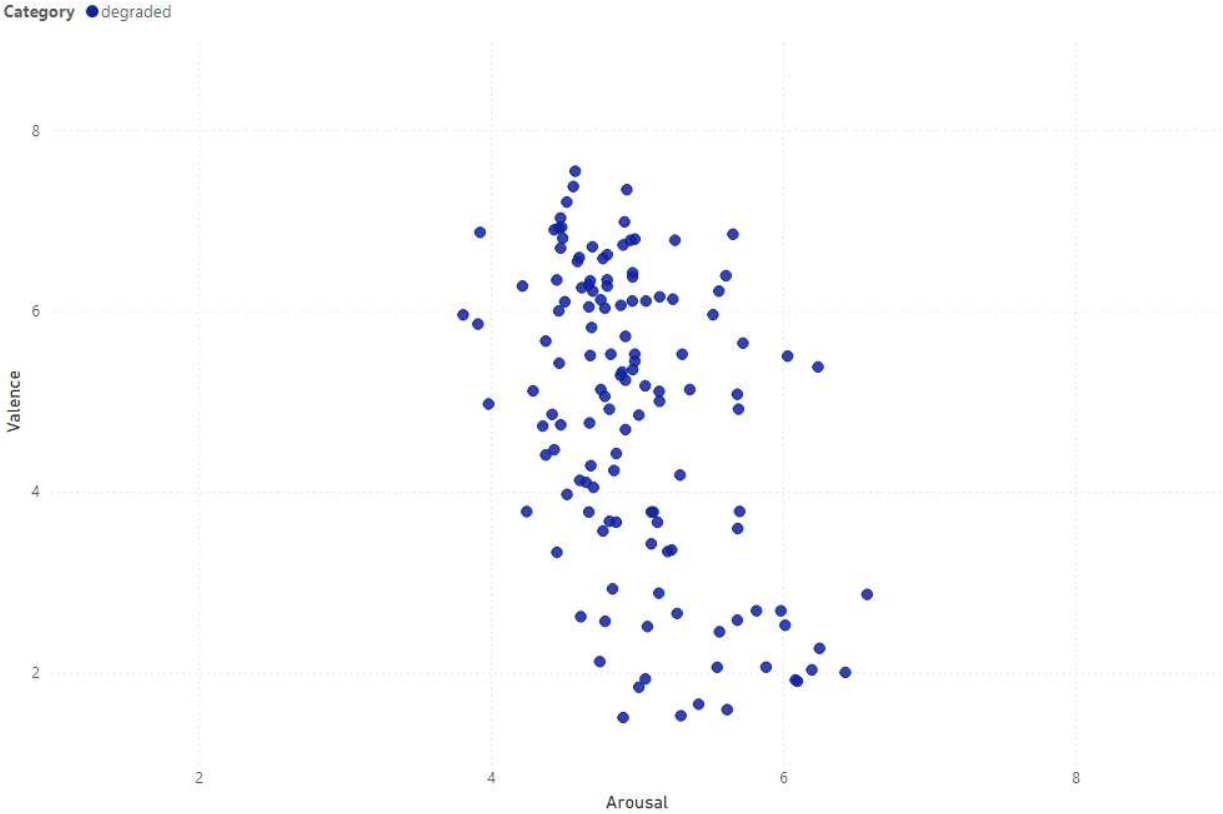


Figure 4. Valence and arousal ratings for degraded environments

Valence and Restoration Ratings for All Environments

Category ● built ● degraded ● intact

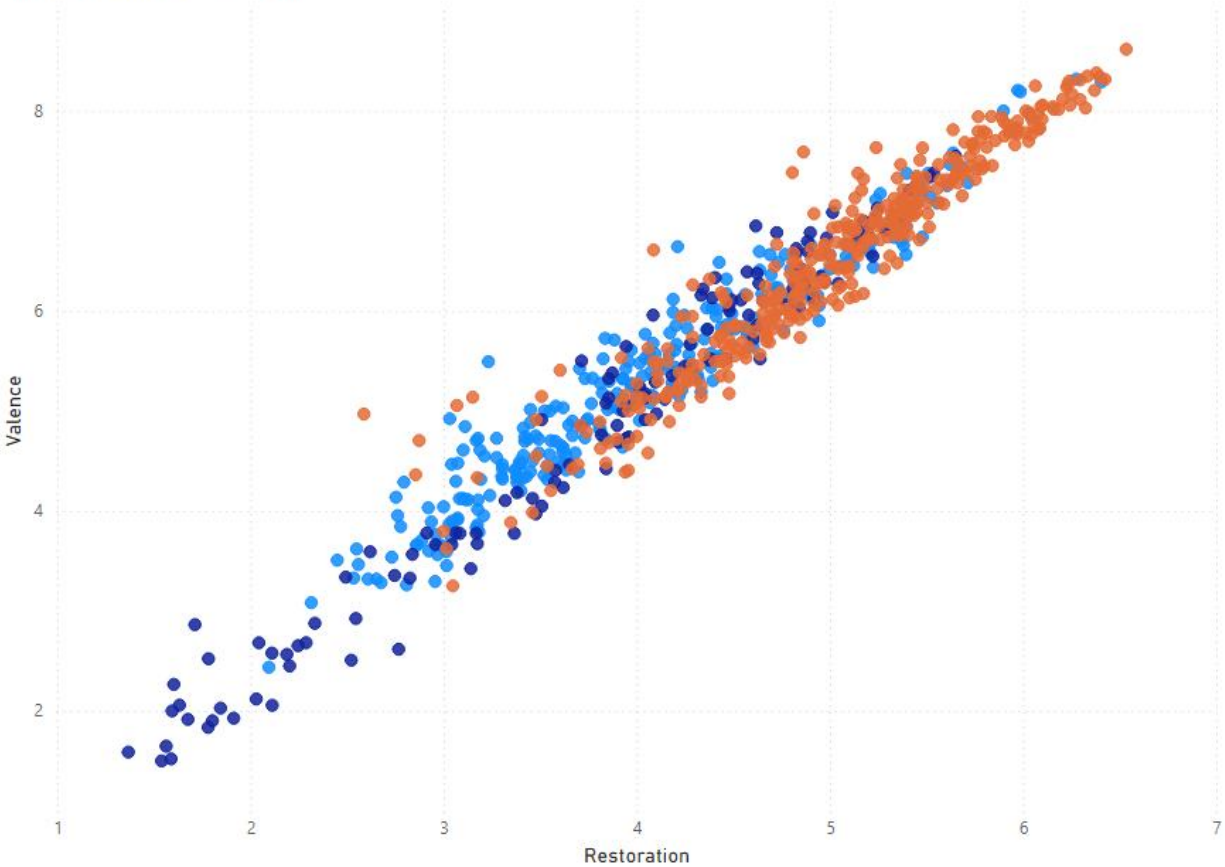


Figure 5. Valence and restoration ratings for intact, built, and degraded environments

Valence and Restoration Ratings for Intact Environments

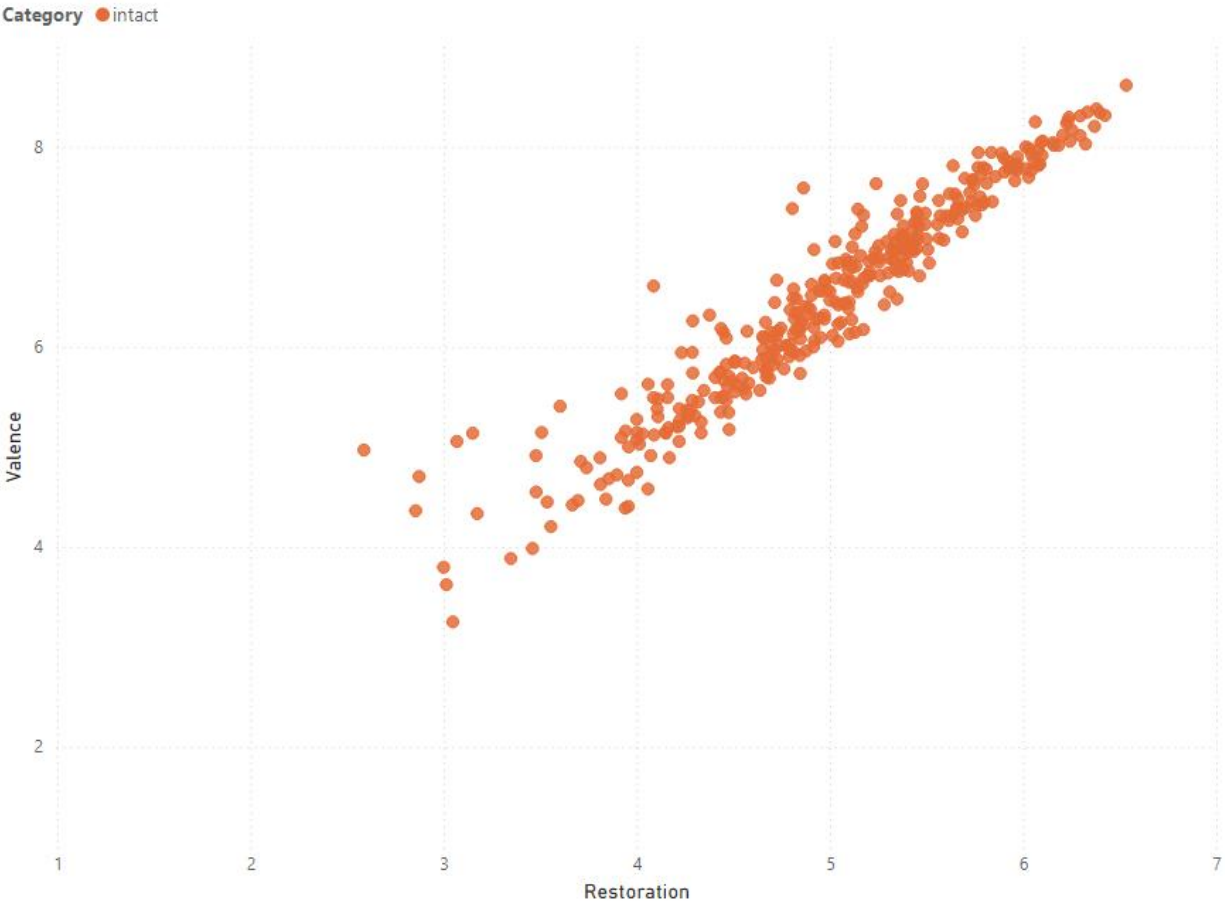


Figure 6. Valence and restoration ratings for intact environments

Valence and Restoration Ratings for Built Environments

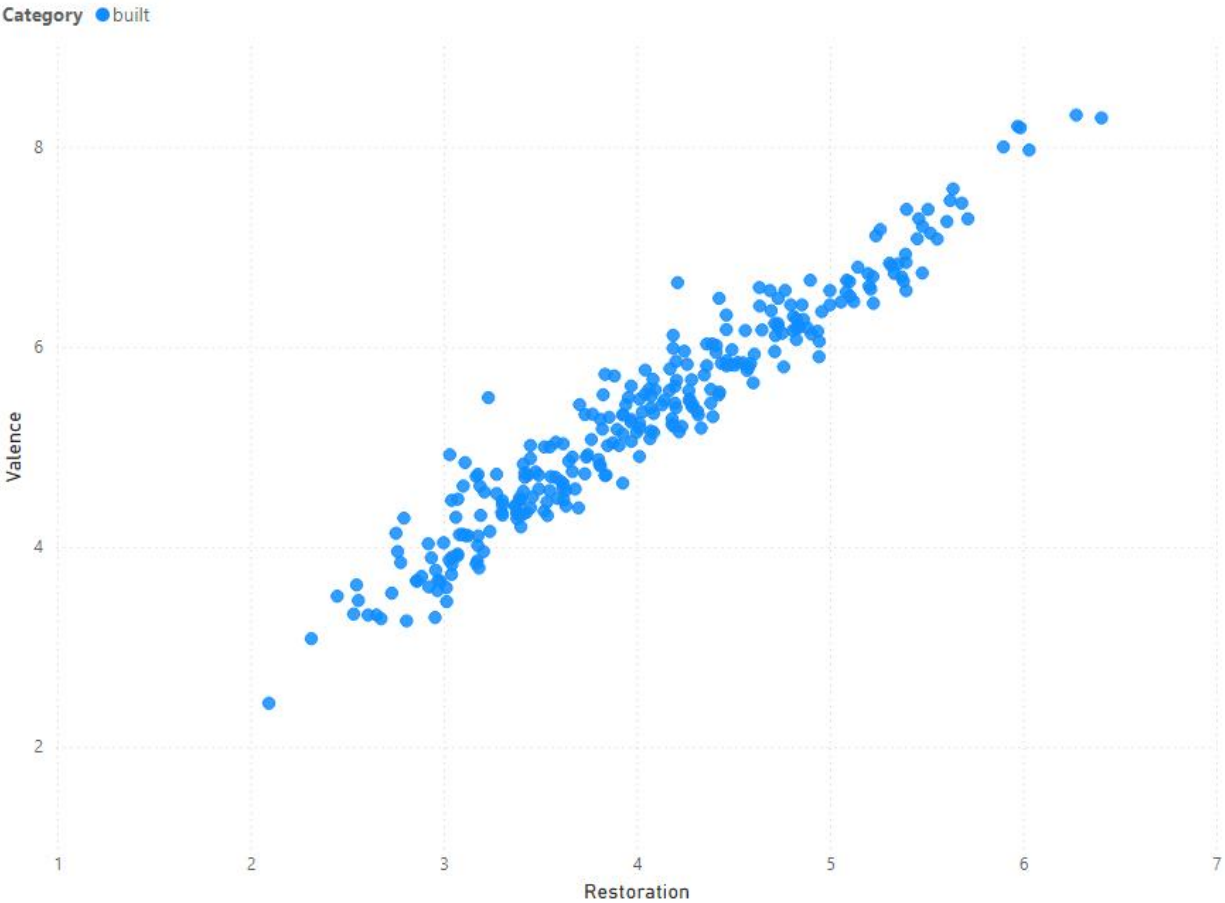


Figure 7. Valence and restoration ratings for built environments

Valence and Restoration Ratings for Degraded Environments

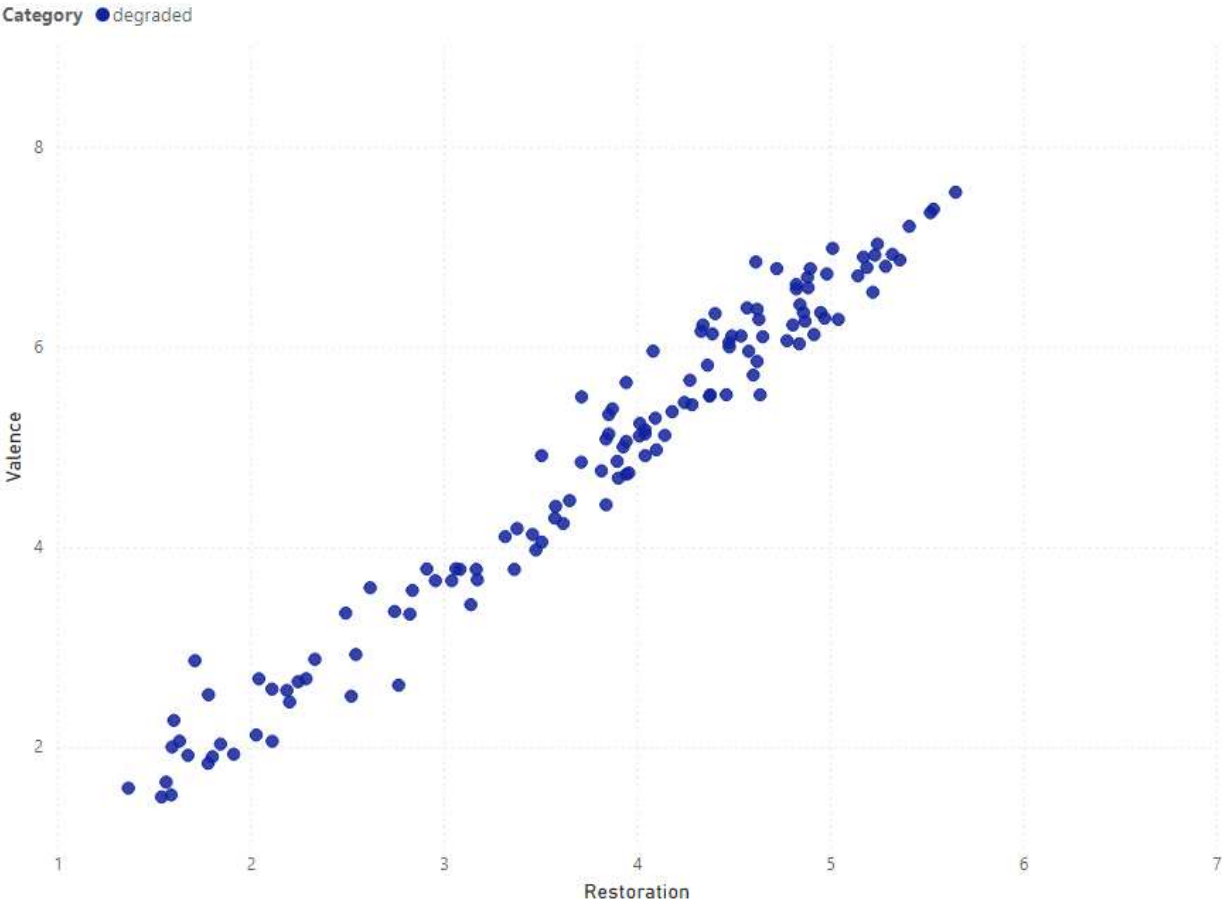


Figure 8. Valence and restoration ratings for degraded environments

Valence and Preference Ratings for All Environments

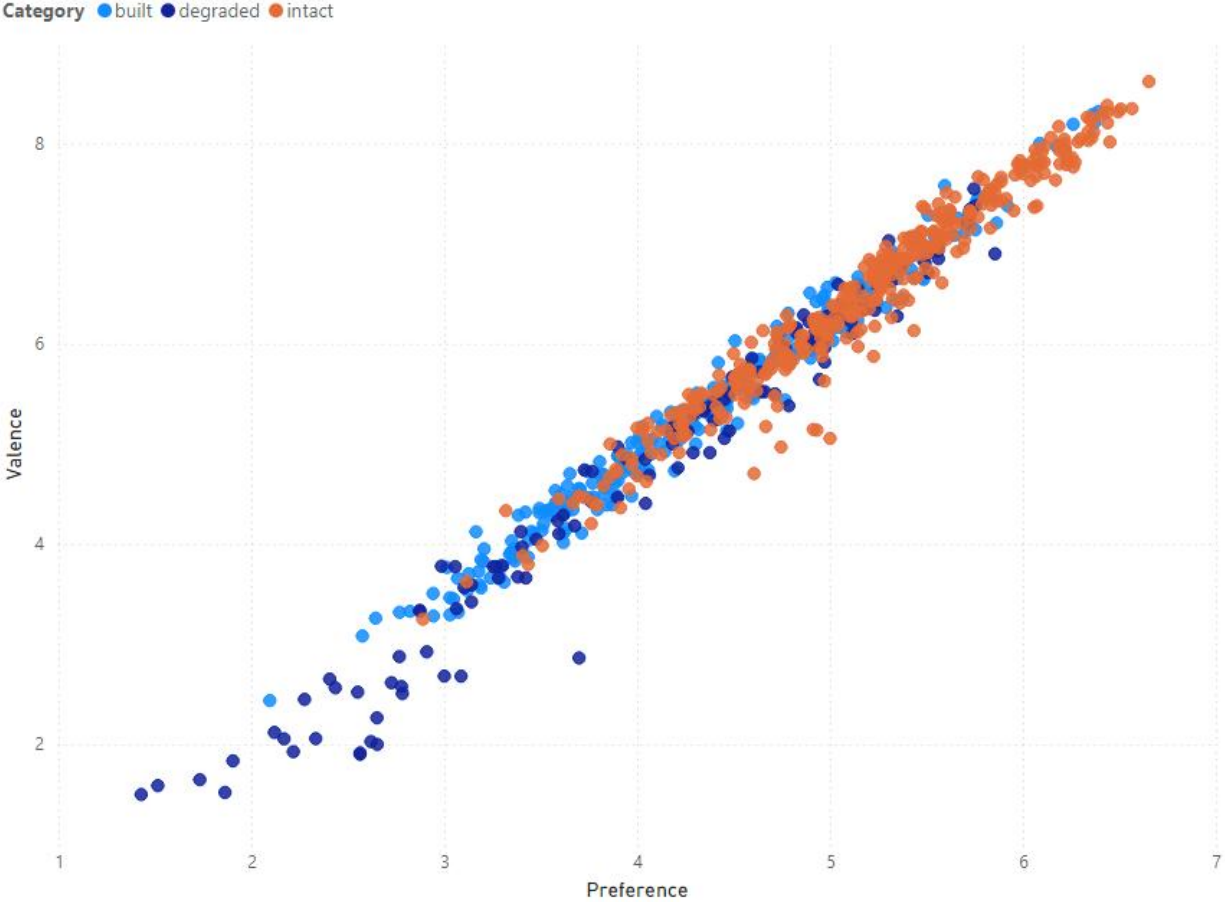


Figure 9. Valence and preference ratings for intact, built, and degraded environments

Valence and Preference Ratings for Intact Environments

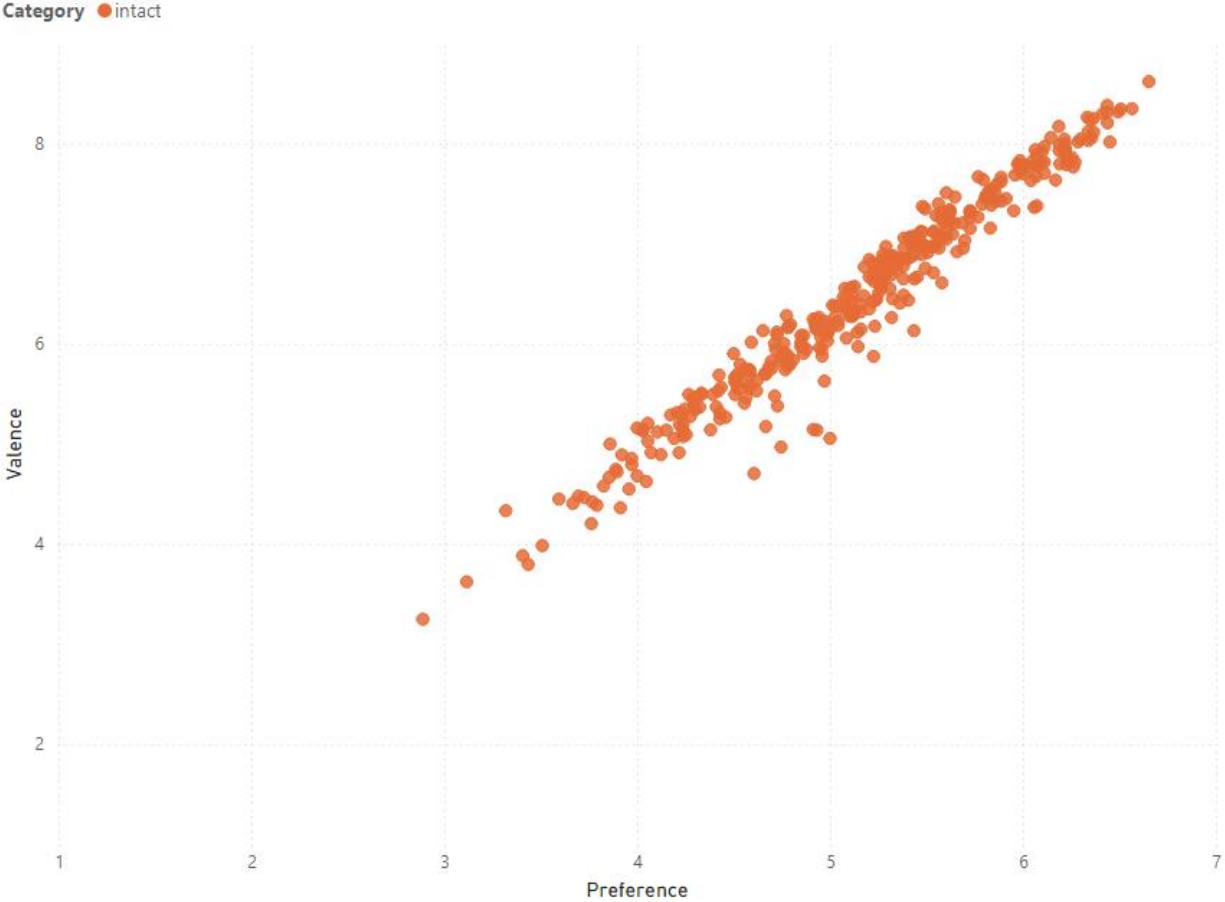


Figure 10. Valence and preference ratings for intact environments

Valence and Preference Ratings for Built Environments

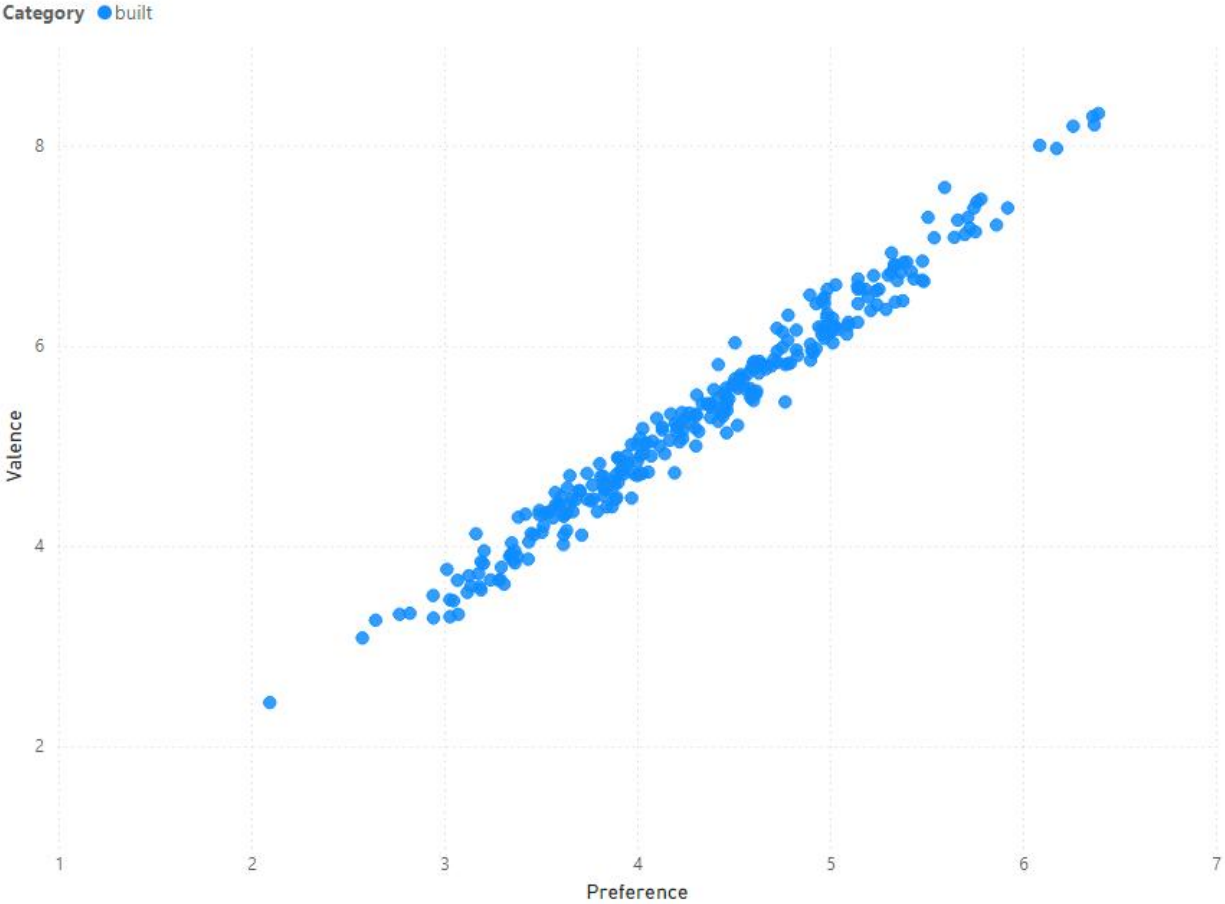


Figure 11. Valence and preference ratings for built environments

Valence and Preference Ratings for Degraded Environments

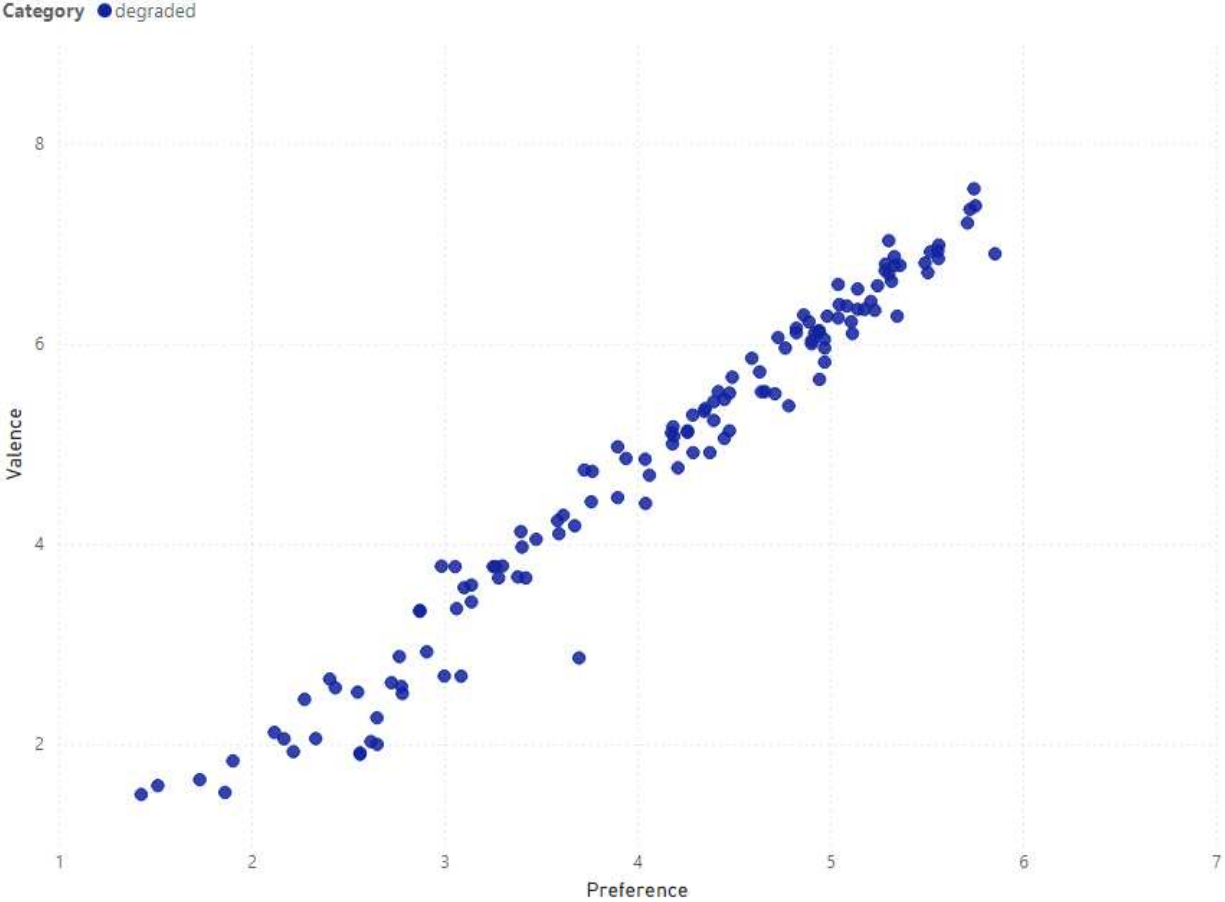


Figure 12. Valence and preference ratings for degraded environments

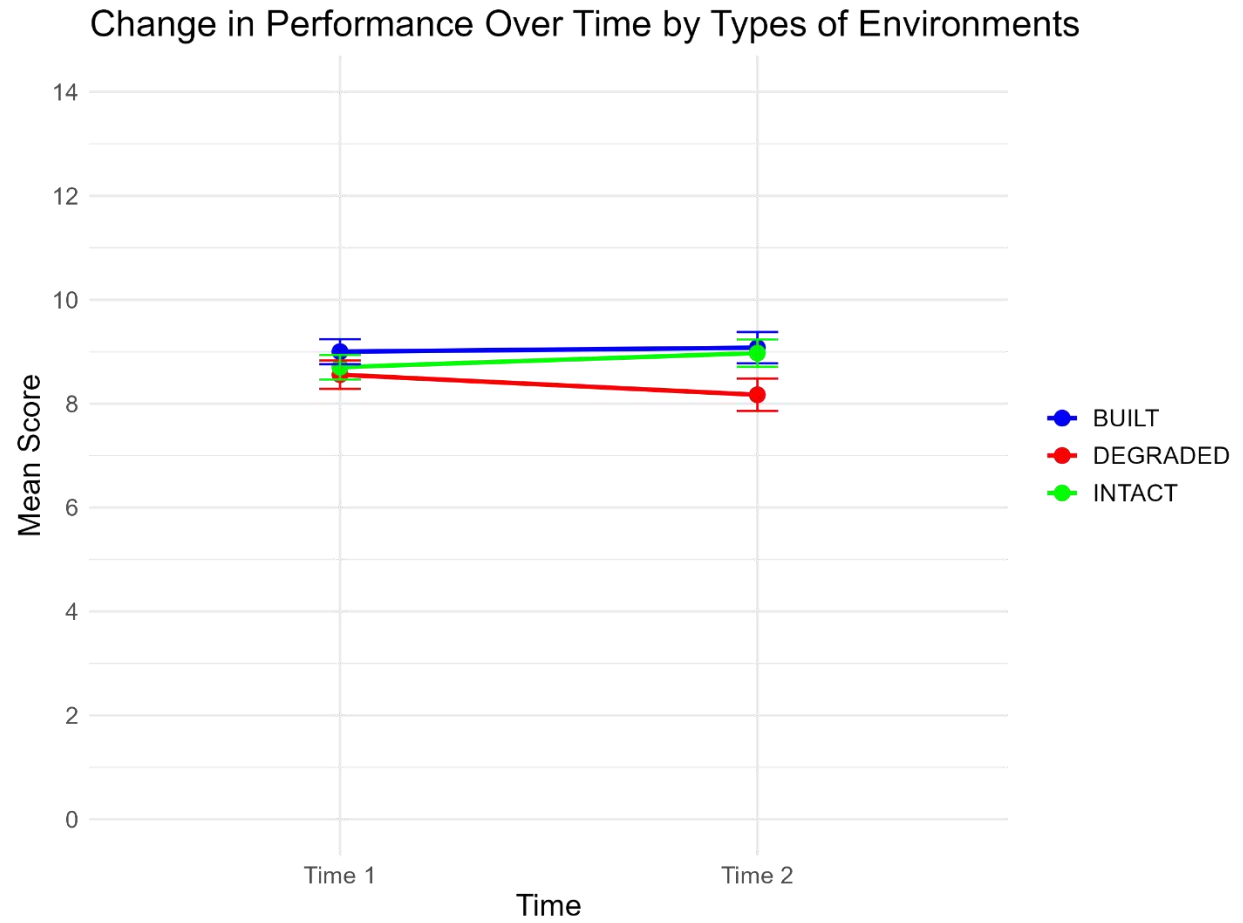


Figure 13. Change in performance over time across intact, built, and degraded environments

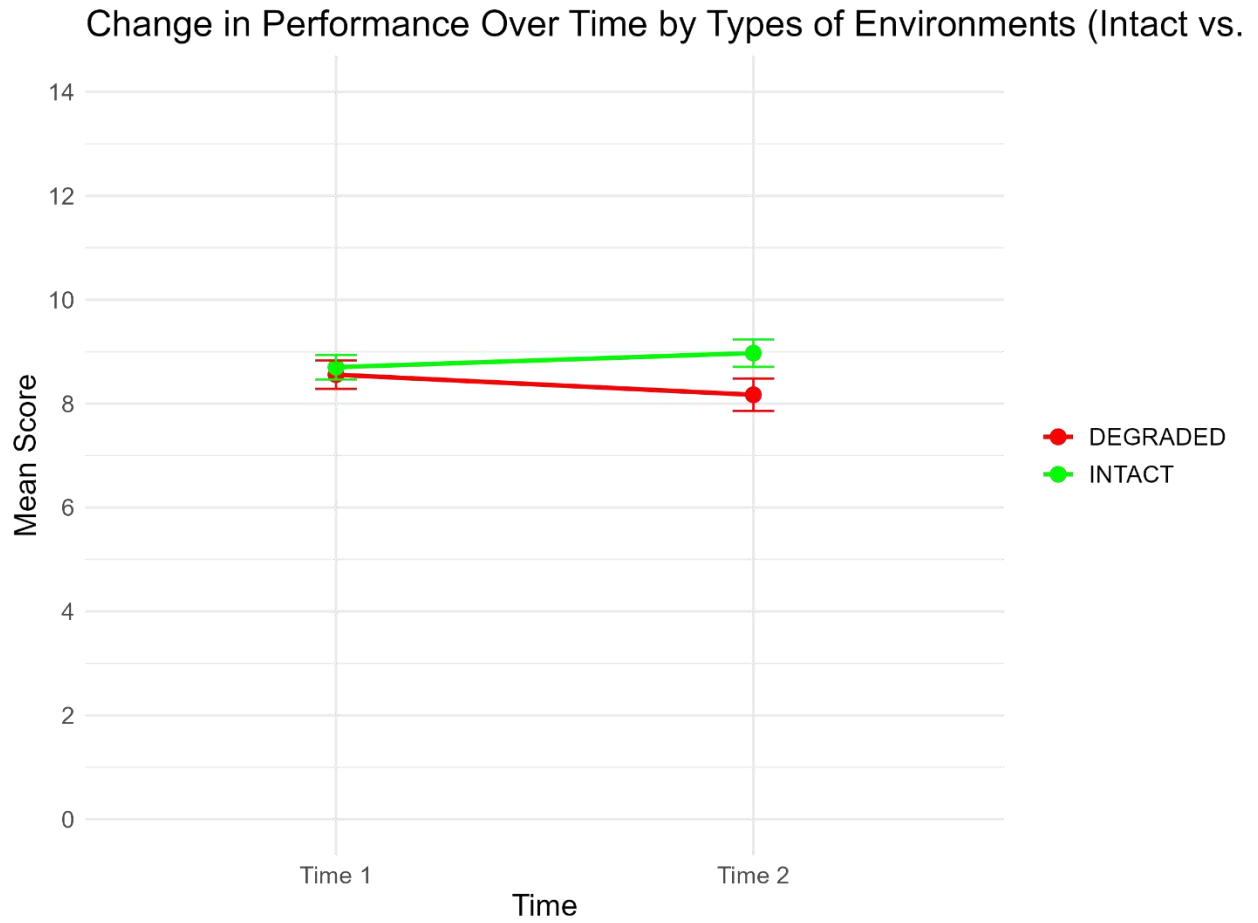


Figure 14. Change in performance over time between intact and degraded environments

REFERENCES

- Albrecht, G., Sartore, G., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., Stain, H., Tonna, A., & Pollard, G. (2007). Solastalgia: The distress caused by environmental change. *Australasian Psychiatry, 15*(1_suppl), S95-S98. <https://doi.org/10.1080/10398560701701288>
- American Psychological Association (2018). *Stress in America: Generation Z*. Stress in America™ Survey.
- Bai, X., McPhearson, T., Cleugh, H., Nagendra, H., Tong, X., Zhu, T., & Zhu, Y. (2017). Linking urbanization and the environment: Conceptual and empirical advances. *Annual Review of Environment and Resources, 42*(1), 215-240. <https://doi.org/10.1146/annurev-environ-102016-061128>
- Balundè, A., Jovarauskaitė, L., & Poškus, M. S. (2019). Exploring the relationship between connectedness with nature, environmental identity, and environmental self-identity: A systematic review and meta-analysis. *SAGE Open, 9*(2), 215824401984192. <https://doi.org/10.1177/2158244019841925>
- Barragan-Jason, G., Loreau, M., De Mazancourt, C., Singer, M. C., & Parmesan, C. (2023). Psychological and physical connections with nature improve both human well-being and nature conservation: A systematic review of meta-analyses. *Biological Conservation, 277*, 109842. <https://doi.org/10.1016/j.biocon.2022.109842>
- Basu, A., Duvall, J., & Kaplan, R. (2018). Attention restoration theory: Exploring the role of soft fascination and mental bandwidth. *Environment and Behavior, 51*(9-10), 1055-1081. <https://doi.org/10.1177/0013916518774400>

- Berman, M. G., Hout, M. C., Kardan, O., Hunter, M. R., Yourganov, G., Henderson, J. M., Hanayik, T., Karimi, H., & Jonides, J. (2014). The perception of naturalness correlates with low-level visual features of environmental scenes. *PLoS ONE*, *9*(12), e114572. <https://doi.org/10.1371/journal.pone.0114572>
- Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science*, *19*(12), 1207-1212. <https://doi.org/10.1111/j.1467-9280.2008.02225.x>
- Berman, M. G., Kross, E., Krpan, K. M., Askren, M. K., Burson, A., Deldin, P. J., Kaplan, S., Sherdell, L., Gotlib, I. H., & Jonides, J. (2012). Interacting with nature improves cognition and affect for individuals with depression. *Journal of Affective Disorders*, *140*(3), 300-305. <https://doi.org/10.1016/j.jad.2012.03.012>
- Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology*, *25*(3), 249-259. <https://doi.org/10.1016/j.jenvp.2005.07.001>
- Beute, F., & De Kort, Y. A. (2018). Thinking of nature: Associations with natural versus urban environments and their relation to preference. *Landscape Research*, *44*(4), 374-392. <https://doi.org/10.1080/01426397.2018.1457144>
- Beyer, M., Brick, T. R., & Kühn, S. (2024). Urbanicity and psychotic experiences: Social adversities, isolation and exposure to natural environments predict psychosis. *Journal of Environmental Psychology*, *96*, 102293. <https://doi.org/10.1016/j.jenvp.2024.102293>
- Bielinis, E., Takayama, N., Boiko, S., Omelan, A., & Bielinis, L. (2018). The effect of winter forest bathing on psychological relaxation of young Polish adults. *Urban Forestry & Urban Greening*, *29*, 276-283. <https://doi.org/10.1016/j.ufug.2017.12.006>

- Bloomfield, L. S., McIntosh, T. L., & Lambin, E. F. (2020). Habitat fragmentation, livelihood behaviors, and contact between people and nonhuman primates in Africa. *Landscape Ecology*, 35(4), 985-1000. <https://doi.org/10.1007/s10980-020-00995-w>
- Boluda-Verdú, I., Senent-Valero, M., Casas-Escolano, M., Matijasevich, A., & Pastor-Valero, M. (2022). Fear for the future: Eco-anxiety and health implications, a systematic review. *Journal of Environmental Psychology*, 84, 101904. <https://doi.org/10.1016/j.jenvp.2022.101904>
- Boers, S., Hagoort, K., Scheepers, F., & Helbich, M. (2018). Does residential green and blue space promote recovery in psychotic disorders? A cross-sectional study in the province of Utrecht, The Netherlands. *International Journal of Environmental Research and Public Health*, 15(10), 2195. <https://doi.org/10.3390/ijerph15102195>
- Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, 25(1), 49-59. [https://doi.org/10.1016/0005-7916\(94\)90063-9](https://doi.org/10.1016/0005-7916(94)90063-9)
- Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., de Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Kuo, M., Lawler, J. J., Levin, P. S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., ... Daily, G. C. (2019). *Nature and mental health: An ecosystem service perspective*. *Science Advances*, 5(7). <https://doi.org/10.1126/sciadv.aax0903>
- Bratman, G. N., Daily, G. C., Levy, B. J., & Gross, J. J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning*, 138, 41-50. <https://doi.org/10.1016/j.landurbplan.2015.02.005>

- Bratman, G. N., Hamilton, J. P., Hahn, K. S., Daily, G. C., & Gross, J. J. (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences*, *112*(28), 8567-8572. <https://doi.org/10.1073/pnas.1510459112>
- Braun, J., Amirshahi, S. A., Denzler, J., & Redies, C. (2013). Statistical image properties of print advertisements, visual artworks and images of architecture. *Frontiers in Psychology*, *4*. <https://doi.org/10.3389/fpsyg.2013.00808>
- Bren d'Amour, C., Reitsma, F., Baiocchi, G., Barthel, S., Güneralp, B., Erb, K., Haberl, H., Creutzig, F., & Seto, K. C. (2016). Future urban land expansion and implications for global croplands. *Proceedings of the National Academy of Sciences*, *114*(34), 8939-8944. <https://doi.org/10.1073/pnas.1606036114>
- Brown, D. K., Barton, J. L., & Gladwell, V. F. (2013). Viewing nature scenes positively affects recovery of autonomic function following acute-mental stress. *Environmental Science & Technology*, *47*(11), 5562-5569. <https://doi.org/10.1021/es305019p>
- Capaldi, C., Passmore, H., Nisbet, E., Zelenski, J., & Dopko, R. (2015). Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. *International Journal of Wellbeing*, *5*(4), 1-16. <https://doi.org/10.5502/ijw.v5i4.449>
- Cazalis, V., Loreau, M., & Barragan-Jason, G. (2022). A global synthesis of trends in human experience of nature. *Frontiers in Ecology and the Environment*, *21*(2), 85-93. <https://doi.org/10.1002/fee.2540>

- Cianconi, P., Betrò, S., & Janiri, L. (2020). The impact of climate change on mental health: A systematic descriptive review. *Frontiers in Psychiatry, 11*. <https://doi.org/10.3389/fpsyt.2020.00074>
- Cox, D. T., Hudson, H. L., Shanahan, D. F., Fuller, R. A., & Gaston, K. J. (2017). The rarity of direct experiences of nature in an urban population. *Landscape and Urban Planning, 160*, 79-84. <https://doi.org/10.1016/j.landurbplan.2016.12.006>
- Cox, D. T., Shanahan, D. F., Hudson, H. L., Fuller, R. A., & Gaston, K. J. (2018). The impact of urbanisation on nature dose and the implications for human health. *Landscape and Urban Planning, 179*, 72-80. <https://doi.org/10.1016/j.landurbplan.2018.07.013>
- Crossan, C., & Salmoni, A. (2019). A simulated walk in nature: Testing predictions from the attention restoration theory. *Environment and Behavior, 53*(3), 277-295. <https://doi.org/10.1177/0013916519882775>
- Cunsolo Willox, A., Harper, S. L., Edge, V. L., Landman, K., Houle, K., & Ford, J. D. (2013). The land enriches the soul: On climatic and environmental change, affect, and emotional health and well-being in Rigolet, Nunatsiavut, Canada. *Emotion, Space and Society, 6*, 14-24. <https://doi.org/10.1016/j.emospa.2011.08.005>
- Cunsolo Willox, A., Harper, S. L., Ford, J. D., Edge, V. L., Landman, K., Houle, K., Blake, S., & Wolfrey, C. (2013). Climate change and mental health: An exploratory case study from Rigolet, Nunatsiavut, Canada. *Climatic Change, 121*(2), 255-270. <https://doi.org/10.1007/s10584-013-0875-4>
- Davidson, R. J. (2000). Neuropsychological perspectives on affective styles and their cognitive consequences. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion* (pp. 103-123). John Wiley & Sons.

- Dodds, J. (2021). The psychology of climate anxiety. *BJPsych Bulletin*, 45(4), 222-226. <https://doi.org/10.1192/bjb.2021.18>
- Dong, F., Wang, Y., Su, B., Hua, Y., & Zhang, Y. (2019). The process of peak CO2 emissions in developed economies: A perspective of industrialization and urbanization. *Resources, Conservation and Recycling*, 141, 61-75. <https://doi.org/10.1016/j.resconrec.2018.10.010>
- Drought Policy Review Expert Social Panel (2008). *It's about people: Changing perspectives on dryness: a report to government*.
- Edwards, B., Gray, M., & Hunter, B. (2008). *Social and economic impacts of drought on farm families and rural communities: submission to the Productivity Commission's inquiry into government drought support*.
- Ellis, N. R., & Albrecht, G. A. (2017). Climate change threats to family farmers' sense of place and mental wellbeing: A case study from the western Australian Wheatbelt. *Social Science & Medicine*, 175, 161-168. <https://doi.org/10.1016/j.socscimed.2017.01.009>
- Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences*, 116(11), 5188-5193. <https://doi.org/10.1073/pnas.1807504116>
- Engemann, K., Svenning, J., Arge, L., Brandt, J., Geels, C., Mortensen, P. B., Plana-Ripoll, O., Tsirogiannis, C., & Pedersen, C. B. (2020). Natural surroundings in childhood are associated with lower schizophrenia rates. *Schizophrenia Research*, 216, 488-495. <https://doi.org/10.1016/j.schres.2019.10.012>
- Fleming, S. M., Massoni, S., Gajdos, T., & Vergnaud, J. (2016). Metacognition about the past and future: Quantifying common and distinct influences on prospective and retrospective

- judgments of self-performance. *Neuroscience of Consciousness*, 2016(1), niw018. <https://doi.org/10.1093/nc/niw018>
- Franěk, M. (2023). Landscape preference: The role of attractiveness and spatial openness of the environment. *Behavioral Sciences*, 13(8), 666. <https://doi.org/10.3390/bs13080666>
- Frank, M. J., Woroach, B. S., & Curran, T. (2005). *Error-related negativity predicts reinforcement learning and conflict biases*. *Neuron*, 47(4), 495-501. <https://doi.org/10.1016/j.neuron.2005.06.020>
- Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, 56(3), 218-226. <https://doi.org/10.1037/0003-066x.56.3.218>
- Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion*, 19(3), 313-332. <https://doi.org/10.1080/02699930441000238>
- Gehring, W. J., Goss, B., Coles, M. G., Meyer, D. E., & Donchin, E. (1993). A neural system for error detection and compensation. *Psychological Science*, 4(6), 385-390. <https://doi.org/10.1111/j.1467-9280.1993.tb00586.x>
- Gibb, R., Redding, D. W., Chin, K. Q., Donnelly, C. A., Blackburn, T. M., Newbold, T., & Jones, K. E. (2020). Zoonotic host diversity increases in human-dominated ecosystems. *Nature*, 584(7821), 398-402. <https://doi.org/10.1038/s41586-020-2562-8>
- Gladwell, V. F., Brown, D. K., Barton, J. L., Tarvainen, M. P., Kuoppa, P., Pretty, J., Suddaby, J. M., & Sandercock, G. R. (2012). The effects of views of nature on autonomic control. *European Journal of Applied Physiology*, 112(9), 3379-3386. <https://doi.org/10.1007/s00421-012-2318-8>

- Gokce, A., Zinchenko, A., Annac, E., Conci, M., & Geyer, T. (2021). Affective modulation of working memory maintenance: The role of positive and negative emotions. *Advances in Cognitive Psychology, 17*(2), 107-116. <https://doi.org/10.5709/acp-0321-7>
- Grassini, S., Revonsuo, A., Castellotti, S., Petrizzo, I., Benedetti, V., & Koivisto, M. (2019). Processing of natural scenery is associated with lower attentional and cognitive load compared with urban ones. *Journal of Environmental Psychology, 62*, 1-11. <https://doi.org/10.1016/j.jenvp.2019.01.007>
- Hanigan, I. C., Butler, C. D., Kokic, P. N., & Hutchinson, M. F. (2012). Suicide and drought in New South Wales, Australia, 1970–2007. *Proceedings of the National Academy of Sciences, 109*(35), 13950-13955. <https://doi.org/10.1073/pnas.1112965109>
- Hansen, M. M., Jones, R., & Tocchini, K. (2017). Shinrin-yoku (Forest bathing) and nature therapy: A state-of-the-Art review. *International Journal of Environmental Research and Public Health, 14*(8), 851. <https://doi.org/10.3390/ijerph14080851>
- Herzog, T. R., Black, A. M., Fountaine, K. A., & Knotts, D. J. (1997). Reflection and attentional recovery as distinctive benefits of restorative environments. *Journal of Environmental Psychology, 17*(2), 165-170. <https://doi.org/10.1006/jevpe.1997.0051>
- Herzog, T. R., & Gale, T. A. (1996). Preference for urban buildings as a function of age and nature context. *Environment and Behavior, 28*(1), 44-72. <https://doi.org/10.1177/0013916596281003>
- Holroyd, C. B., & Coles, M. G. (2002). The neural basis of human error processing: Reinforcement learning, dopamine, and the error-related negativity. *Psychological Review, 109*(4), 679-709. <https://doi.org/10.1037/0033-295x.109.4.679>

- Hopman, R. J., LoTempio, S. B., Scott, E. E., McKinney, T. L., & Strayer, D. L. (2020). Resting-state posterior Alpha power changes with prolonged exposure in a natural environment. *Cognitive Research: Principles and Implications*, 5(1). <https://doi.org/10.1186/s41235-020-00247-0>
- Hublin, J., Ben-Ncer, A., Bailey, S. E., Freidline, S. E., Neubauer, S., Skinner, M. M., Bergmann, I., Le Cabec, A., Benazzi, S., Harvati, K., & Gunz, P. (2017). New fossils from jebel Irhoud, Morocco and the pan-African origin of homo sapiens. *Nature*, 546(7657), 289-292. <https://doi.org/10.1038/nature22336>
- Ibarra, F. F., Kardan, O., Hunter, M. R., Kotabe, H. P., Meyer, F. A., & Berman, M. G. (2017). Image feature types and their predictions of aesthetic preference and naturalness. *Frontiers in Psychology*, 8. <https://doi.org/10.3389/fpsyg.2017.00632>
- IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.
- Isen, A. M. (2008). Some ways in which positive affect influences decision making and problem solving. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed.). Guilford Press.
- Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology*, 47(6), 1206-1217. <https://doi.org/10.1037/0022-3514.47.6.1206>

- Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, 52(6), 1122–1131. <https://doi.org/10.1037/0022-3514.52.6.1122>
- Isen, A. M., Rosenzweig, A. S., & Young, M. J. (1991). The influence of positive affect on clinical problem solving. *Medical Decision Making*, 11(3), 221-227. <https://doi.org/10.1177/0272989x9101100313>
- James, W. (1890). *The principles of psychology*.
- Janak, P. H., & Tye, K. M. (2015). From circuits to behaviour in the amygdala. *Nature*, 517(7534), 284-292. <https://doi.org/10.1038/nature14188>
- Jiang, B., He, J., Chen, J., Larsen, L., & Wang, H. (2020). Perceived green at speed: A simulated driving experiment raises new questions for attention restoration theory and stress reduction theory. *Environment and Behavior*, 53(3), 296-335. <https://doi.org/10.1177/0013916520947111>
- Johnson, K. J., & Fredrickson, B. L. (2005). “We all look the same to me”. *Psychological Science*, 16(11), 875-881. <https://doi.org/10.1111/j.1467-9280.2005.01631.x>
- Joye, Y., & Dewitte, S. (2018). Nature's broken path to restoration. A critical look at attention restoration theory. *Journal of Environmental Psychology*, 59, 1-8. <https://doi.org/10.1016/j.jenvp.2018.08.006>
- Joye, Y., Lange, F., & Fischer, M. (2022). Does beautiful nature motivate to work? Outlining an alternative pathway to nature-induced cognitive performance benefits. *New Ideas in Psychology*, 66, 100946. <https://doi.org/10.1016/j.newideapsych.2022.100946>

- Joye, Y., & Van den Berg, A. (2011). Is love for green in our genes? A critical analysis of evolutionary assumptions in restorative environments research. *Urban Forestry & Urban Greening*, *10*(4), 261-268. <https://doi.org/10.1016/j.ufug.2011.07.004>
- Kahn, B. E., & Isen, A. M. (1993). The influence of positive affect on variety seeking among safe, enjoyable products. *Journal of Consumer Research*, *20*(2), 257. <https://doi.org/10.1086/209347>
- Kahn Jr, P. H. (2002). Children's Affiliations with Nature: Structure, Development, and the Problem of Environmental Generational Amnesia. In P. H. Kahn Jr & S. R. Kellert (Eds.), *Children and nature: Psychological, sociocultural, and evolutionary investigations* (pp. 93-116). MIT Press.
- Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. Cambridge University Press.
- Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169-182. [https://doi.org/10.1016/0272-4944\(95\)90001-2](https://doi.org/10.1016/0272-4944(95)90001-2)
- Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. *Perspectives on Psychological Science*, *5*(1), 43-57. <https://doi.org/10.1177/1745691609356784>
- Kotabe, H. P., Kardan, O., & Berman, M. G. (2017). The nature-disorder paradox: A perceptual study on how nature is disorderly yet aesthetically preferred. *Journal of Experimental Psychology: General*, *146*(8), 1126-1142. <https://doi.org/10.1037/xge0000321>
- Kotera, Y., Richardson, M., & Sheffield, D. (2020). Effects of shinrin-yoku (Forest bathing) and nature therapy on mental health: A systematic review and meta-analysis. *International*

- Journal of Mental Health and Addiction*, 20(1), 337-361. <https://doi.org/10.1007/s11469-020-00363-4>
- Kuo, F. E., & Sullivan, W. C. (2001). Aggression and violence in the inner city. *Environment and Behavior*, 33(4), 543-571. <https://doi.org/10.1177/00139160121973124>
- Lang, P. J., Bradley, M. M. and Cuthbert, B. N. 1997. "Motivated attention: Affect, activation, and action". In *Attention and orienting: Sensory and motivational processes*, Edited by: Lang, P. J., Simons, R. F. and Balaban, M. T. 97–135. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8*. University of Florida, Gainesville, FL.
- Lee, J., Park, B., Tsunetsugu, Y., Kagawa, T., & Miyazaki, Y. (2009). Restorative effects of viewing real forest landscapes, based on a comparison with urban landscapes. *Scandinavian Journal of Forest Research*, 24(3), 227-234. <https://doi.org/10.1080/02827580902903341>
- Lehman, B., Thompson, J., Davis, S., & Carlson, J. M. (2019). Affective images of climate change. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.00960>
- Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Ballew, M., Goldberg, M., & Gustafson, A. (2018). *Climate change in the American mind: December 2018*. Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication.

- Lesage, F. X., Berjot, S., & Deschamps, F. (2012). Clinical stress assessment using a visual analogue scale. *Occupational Medicine*, 62(8), 600-605. <https://doi.org/10.1093/occmed/kqs140>
- Li, Q. (2009). Effect of forest bathing trips on human immune function. *Environmental Health and Preventive Medicine*, 15(1), 9-17. <https://doi.org/10.1007/s12199-008-0068-3>
- LoTempio, S. B., Scott, E. E., McDonnell, A. S., Hopman, R. J., Castro, S. C., McNay, G. D., McKinney, T. L., Greenberg, K., Payne, B. R., & Strayer, D. L. (2020). Nature as a potential modulator of the error-related negativity: A registered report. *International Journal of Psychophysiology*, 156, 49-59. <https://doi.org/10.1016/j.ijpsycho.2020.06.014>
- Mackay, C. M., & Schmitt, M. T. (2019). Do people who feel connected to nature do more to protect it? A meta-analysis. *Journal of Environmental Psychology*, 65, 101323. <https://doi.org/10.1016/j.jenvp.2019.101323>
- Meidenbauer, K. L., Stenfors, C. U., Bratman, G. N., Gross, J. J., Schertz, K. E., Choe, K. W., & Berman, M. G. (2020). The affective benefits of nature exposure: What's nature got to do with it? *Journal of Environmental Psychology*, 72, 101498. <https://doi.org/10.1016/j.jenvp.2020.101498>
- Mao, G., Cao, Y., Lan, X., He, Z., Chen, Z., Wang, Y., Hu, X., Lv, Y., Wang, G., & Yan, J. (2012). Therapeutic effect of forest bathing on human hypertension in the elderly. *Journal of Cardiology*, 60(6), 495-502. <https://doi.org/10.1016/j.jjcc.2012.08.003>
- Martin, G., Reilly, K., Everitt, H., & Gilliland, J. A. (2021). Review: The impact of climate change awareness on children's mental well-being and negative emotions – a scoping

- review. *Child and Adolescent Mental Health*, 27(1), 59-72. <https://doi.org/10.1111/camh.12525>
- Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition & Emotion*, 23(2), 209-237. <https://doi.org/10.1080/02699930802204677>
- Mayer, F. S., McPherson Frantz, C., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why Is Nature Beneficial? The Role of Connectedness to Nature. *Environment and Behavior*, 41(5), 607-643. <https://doi.org/10.1177/0013916508319745>
- McEwan, K., Giles, D., Clarke, F. J., Kotera, Y., Evans, G., Terebenina, O., Minou, L., Teeling, C., Basran, J., Wood, W., & Weil, D. (2021). A pragmatic controlled trial of forest bathing compared with compassionate mind training in the UK: Impacts on self-reported wellbeing and heart rate variability. *Sustainability*, 13(3), 1380. <https://doi.org/10.3390/su13031380>
- Menzel, C., & Reese, G. (2022). Seeing nature from low to high levels: Mechanisms underlying the restorative effects of viewing nature images. *Journal of Environmental Psychology*, 81, 101804. <https://doi.org/10.1016/j.jenvp.2022.101804>
- Neale, C., Aspinall, P., Roe, J., Tilley, S., Mavros, P., Cinderby, S., Coyne, R., Thin, N., & Ward Thompson, C. (2019). The impact of walking in different urban environments on brain activity in older people. *Cities & Health*, 4(1), 94-106. <https://doi.org/10.1080/23748834.2019.1619893>
- Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2008). The nature relatedness scale. *Environment and Behavior*, 41(5), 715-740. <https://doi.org/10.1177/0013916508318748>

- Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: A new brief measure of nature relatedness. *Frontiers in Psychology, 4*. doi:10.3389/fpsyg.2013.00813
- Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention restoration theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B, 19*(7), 305-343. <https://doi.org/10.1080/10937404.2016.1196155>
- Park, B., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M., & Miyazaki, Y. (2007). Physiological effects of shinrin-yoku (Taking in the atmosphere of the forest)—Using salivary cortisol and cerebral activity as indicators—. *Journal of PHYSIOLOGICAL ANTHROPOLOGY, 26*(2), 123-128. <https://doi.org/10.2114/jpa2.26.123>
- Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2009). The physiological effects of shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine, 15*(1), 18-26. <https://doi.org/10.1007/s12199-009-0086-9>
- Pauly, D. (1995). Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology & Evolution, 10*(10), 430. [https://doi.org/10.1016/s0169-5347\(00\)89171-5](https://doi.org/10.1016/s0169-5347(00)89171-5)
- Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature reviews neuroscience, 9*(2), 148-158. <https://doi.org/10.1038/nrn2317>
- Phelps, E. A. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual Review of Psychology, 57*(1), 27-53. <https://doi.org/10.1146/annurev.psych.56.091103.070234>

- Prete, G., Laeng, B., & Tommasi, L. (2022). Environmental risks to humans, the first database of valence and arousal ratings for images of natural hazards. *Scientific Data*, 9(1). <https://doi.org/10.1038/s41597-022-01370-x>
- Reber, R., Schwarz, N., & Winkielman, P. (2004). Processing fluency and aesthetic pleasure: Is beauty in the perceiver's processing experience? *Personality and Social Psychology Review*, 8(4), 364-382. https://doi.org/10.1207/s15327957pspr0804_3
- Ribeiro, F. S., Santos, F. H., & Albuquerque, P. B. (2019). How does allocation of emotional stimuli impact working memory tasks? An overview. *Advances in Cognitive Psychology*, 15(2), 155-168. <https://doi.org/10.5709/acp-0265-y>
- Rim, N., Schertz, K. E., & Berman, M. G. (2025). The affective, cognitive, and social benefits of interacting with nature. *Journal of Consumer Psychology*.
<https://doi.org/10.1002/jcpy.1456>.
- Roe, J. J., Aspinall, P. A., Mavros, P., & Coyne, R. (2013). Engaging the brain: The impact of natural versus urban scenes using novel EEG methods in an experimental setting. *Environmental Sciences*, 1, 93-104. <https://doi.org/10.12988/es.2013.3109>
- Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, 76(5), 805-819. <https://doi.org/10.1037/0022-3514.76.5.805>
- Russell, R., Guerry, A. D., Balvanera, P., Gould, R. K., Basurto, X., Chan, K. M., Klain, S., Levine, J., & Tam, J. (2013). Humans and nature: How knowing and experiencing nature affect well-being. *Annual Review of Environment and Resources*, 38(1), 473-502. <https://doi.org/10.1146/annurev-environ-012312-110838>

- Schertz, K. E., Kardan, O., & Berman, M. G. (2020). Visual features influence thought content in the absence of overt semantic information. *Attention, Perception, & Psychophysics*, 82(8), 3945-3956. <https://doi.org/10.3758/s13414-020-02121-z>
- Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human–nature interactions. *Frontiers in Ecology and the Environment*, 14(2), 94-101. <https://doi.org/10.1002/fee.1225>
- Spencer, C., & Gee, K. (2009). The roots and branches of environmental psychology. *Psychologist*, 22(2), 180-182.
- Speldewinde, P. C., Cook, A., Davies, P., & Weinstein, P. (2009). A relationship between environmental degradation and mental health in rural Western Australia. *Health & Place*, 15(3), 880-887. <https://doi.org/10.1016/j.healthplace.2009.02.011>
- Stain, H. J., Kelly, B., Carr, V. J., Lewin, T. J., Fitzgerald, M., & Fragar, L. (2011). The psychological impact of chronic environmental adversity: Responding to prolonged drought. *Social Science & Medicine*, 73(11), 1593-1599. <https://doi.org/10.1016/j.socscimed.2011.09.016>
- Stevenson, M. P., Schilhab, T., & Bentsen, P. (2018). Attention restoration theory II: A systematic review to clarify attention processes affected by exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B*, 21(4), 227-268. <https://doi.org/10.1080/10937404.2018.1505571>
- Storbeck, J., & Maswood, R. (2015). Happiness increases verbal and spatial working memory capacity where sadness does not: Emotion, working memory and executive control. *Cognition and Emotion*, 30(5), 925-938. <https://doi.org/10.1080/02699931.2015.1034091>

- Sudimac, S., Sale, V., & Kühn, S. (2022). How nature nurtures: Amygdala activity decreases as the result of a one-hour walk in nature. *Molecular Psychiatry*, 27(11), 4446-4452. <https://doi.org/10.1038/s41380-022-01720-6>
- Tellegen, A., Watson, D., & Clark, L. A. (1999). On the dimensional and hierarchical structure of affect. *Psychological Science*, 10(4), 297-303. <https://doi.org/10.1111/1467-9280.00157>
- Tennessen, C. M., & Cimprich, B. (1995). Views to nature: Effects on attention. *Journal of Environmental Psychology*, 15(1), 77-85. [https://doi.org/10.1016/0272-4944\(95\)90016-0](https://doi.org/10.1016/0272-4944(95)90016-0)
- Tinio, P. P., & Leder, H. (2009). Natural scenes are indeed preferred, but image quality might have the last word. *Psychology of Aesthetics, Creativity, and the Arts*, 3(1), 52-56. <https://doi.org/10.1037/a0014835>
- Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language*, 28(2), 127-154. [https://doi.org/10.1016/0749-596x\(89\)90040-5](https://doi.org/10.1016/0749-596x(89)90040-5)
- Tyng, C. M., Amin, H. U., Saad, M. N., & Malik, A. S. (2017). The influences of emotion on learning and memory. *Frontiers in Psychology*, 8. <https://doi.org/10.3389/fpsyg.2017.01454>
- Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman & J. F. Wohlwill (Eds.), *Human Behavior and Environment, Vol.6: Behavior and Natural Environment* (pp. 85-125). Boston, MA: Springer US.
- Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224(4647), 420-421. <https://doi.org/10.1126/science.6143402>

- Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201-230. [https://doi.org/10.1016/s0272-4944\(05\)80184-7](https://doi.org/10.1016/s0272-4944(05)80184-7)
- Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods, 37*(3), 498-505. <https://doi.org/10.3758/bf03192720>
- Valtchanov, D., & Ellard, C. G. (2015). Cognitive and affective responses to natural scenes: Effects of low level visual properties on preference, cognitive load and eye-movements. *Journal of Environmental Psychology, 43*, 184-195. <https://doi.org/10.1016/j.jenvp.2015.07.001>
- Van den Bogerd, N., Dijkstra, S. C., Seidell, J. C., & Maas, J. (2018). Greenery in the university environment: Students' preferences and perceived restoration likelihood. *PLOS ONE, 13*(2), e0192429. <https://doi.org/10.1371/journal.pone.0192429>
- Walshe, R., Law, L., & Evans, N. (. (2024). Understanding environmental generational amnesia through urban school garden learning experiences in Gimuy/Cairns, Australia. *Local Environment, 1*-16. <https://doi.org/10.1080/13549839.2024.2394678>
- Wang, J., & Ogawa, S. (2015). Fractal analysis of colors and shapes for natural and Urbanscapes URBANSCAPES. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XL-7/W3*, 1431-1438. <https://doi.org/10.5194/isprsarchives-xl-7-w3-1431-2015>
- Wang, R., Zhao, J., Meitner, M. J., Hu, Y., & Xu, X. (2019). Characteristics of urban green spaces in relation to aesthetic preference and stress recovery. *Urban Forestry & Urban Greening, 41*, 6-13. <https://doi.org/10.1016/j.ufug.2019.03.005>

- Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology*, *76*(5), 820-838. <https://doi.org/10.1037/0022-3514.76.5.820>
- Wells, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. *Children, Youth and Environments*, *16*(1), 1-24. <https://doi.org/10.1353/cye.2006.0031>
- Wen, Y., Yan, Q., Pan, Y., Gu, X., & Liu, Y. (2019). Medical empirical research on forest bathing (shinrin-yoku): A systematic review. *Environmental Health and Preventive Medicine*, *24*(1). <https://doi.org/10.1186/s12199-019-0822-8>
- Whitburn, J., Linklater, W., & Abrahamse, W. (2019). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*, *34*(1), 180-193. <https://doi.org/10.1111/cobi.13381>
- White, M. P., Pahl, S., Ashbullby, K. J., Burton, F., & Depledge, M. H. (2015). The effects of exercising in different natural environments on psycho-physiological outcomes in post-menopausal women: A simulation study. *International Journal of Environmental Research and Public Health*, *12*(9), 11929-11953. <https://doi.org/10.3390/ijerph120911929>
- Wyles, K. J., White, M. P., Hattam, C., Pahl, S., King, H., & Austen, M. (2017). Are some natural environments more psychologically beneficial than others? The importance of type and quality on connectedness to nature and psychological restoration. *Environment and Behavior*, *51*(2), 111-143. <https://doi.org/10.1177/0013916517738312>

Xiao, J., Hays, J., Ehinger, K. A., Oliva, A., & Torralba, A. (2010). SUN database: Large-scale scene recognition from Abbey to zoo. *2010 IEEE Computer Society Conference on Computer Vision and Pattern Recognition*. <https://doi.org/10.1109/cvpr.2010.5539970>

Yeung, N., & Cohen, J. D. (2006). The impact of cognitive deficits on conflict monitoring. *Psychological Science*, *17*(2), 164-171. <https://doi.org/10.1111/j.1467-9280.2006.01680.x>

APPENDIX

Images of intact environments



intact_129



intact_16



intact_200



intact_226



intact_282



intact_285



intact_288



intact_314



intact_342



intact_35



intact_44



intact_74



intact_81

Images of built environments



built_105



built_117



built_148



built_15



built_16



built_185



built_210



built_220



built_161



built_263



built_37



built_38



built_69

Images of degraded environments



degraded_11



degraded_121



degraded_126



degraded_127



degraded_31



degraded_40



degraded_41



degraded_5



degraded_50



degraded_68



degraded_69



degraded_80



degraded_83