THE ROLE OF MINDFULNESS IN EXPERIENCING RESTORATION FROM SPOKEN NARRATIVES DESCRIBING NATURE

by

Natalie Tong

Department of Psychology

Submitted in Partial Fulfilment of the requirements for the degree of Bachelor of Arts in

Honours in Psychology

Faculty of Arts and Social Science
Huron University College
London, Canada
April 30, 2024

HURON UNIVERSITY COLLEGE

CERTIFICATE OF EXAMINATION

Advisor: Dr. Stephen Van Hedger

Reader: Dr. Kathryne Van Hedger

The thesis by:
Natalie Tong

entitled:

The Role of Mindfulness in Experiencing Restoration from Spoken Narratives Describing Nature

is accepted in partial fulfilment of the requirements for the degree of Bachelor of Arts in

Honours Psychology

April 30th, 2024
Date

Dr. Irene Cheung
Chair of Department

Abstract

Interactions with nature have been associated with several restorative benefits, including decreased stress and increased positive affect. However, existing research has mostly relied on perceptual imagery (e.g., the sights and sounds of nature) to show nature's restorative qualities. As such, the ability of more conceptual representations of nature to elicit restorative effects remains understudied. Furthermore, mindfulness has been associated with enhanced positive affect, and increased connectedness to nature, meaning that mindfulness may be an important construct to measure in assessing the restorative potential of nature narratives. Participants (n = 54) were randomly assigned to listen to either narratives describing nature or urban settings. Participants completed several state mood measures before and after listening to the interventions. During the interventions, electroencephalography (EEG) was recorded, and at the end of the study, participants rated the perceived restorativeness of the narratives. It was hypothesised that participants in the nature condition would show evidence of restoration in terms of EEG and behavioural ratings of mood and perceived restoration, with mindfulness interacting with narrative condition (resulting in more pronounced restorative effects in the nature condition). This hypothesis was partially supported by the EEG recordings, specifically in the theta band. However, the behavioural measures of restoration showed nonspecific effects of mindfulness, with higher mindfulness associated with greater markers of restoration regardless of narrative condition. Factors that may have altered the result are discussed. Mindfulness was found to be a main contributor on whether there were restorative effects observed.

Keywords: restoration, nature, urban, narratives. mindfulness, EEG

Acknowledgements

I am highly thankful for my thesis advisor Dr. Stephen Van Hedger for all of his feedback, knowledge, advice and patience towards this thesis project, and all of the coding needed in the project, especially when there were many numbers involved due to the electroencephalography piece. Furthermore, I am thankful for the opportunity of having financial compensation for the in-person study, as it was able to attract much more participants. I would also like to thank Dr. Kathryn Van Hedger for her expertise, amazing writing skills and critiques to better the thesis and create what is possible today.

I am also grateful for my peer, Morgan, for co-hosting the in-person studies, and making it possible for the most recruitment that can be done. Without her, there would not be as much data collected.

Lastly, I would like to thank all of the friends and acquaintances who took the time to come take part in the studies despite a very busy schedule. Without the support, the thesis would not have as robust results.

Table of Contents

Introduction

Restorativeness is defined as the effectiveness of an object or experience is to improve recovery and relaxation, in domains such as stress, attention, and fatigue (Kaplan, 1995). Attention Restoration Theory (ART) suggests that there are four key characteristics of restorative environments, which are *being away* (a sense of getting away from one's usual environment), *fascination* (elements that can capture one's interest and attention), *extent* (a sense of space and expansiveness, encouraging feelings of immersion) and *compatibility* (works well with human preference; Kaplan, 1995). Nature is generally considered an ideal restorative environment as it fits all the characteristics of ART.

Interactions with nature often represent a psychological break from everyday activities, nature contains many perceptual features that are thought to promote soft fascination, nature is often expansive and immersive, and individuals' preferences for nature can promote intrinsic motivation to interact with nature (Kaplan, 1995). The factor of soft fascination of nature has been suggested as a way to rest directed attention, which is involved in many domains, such as problem solving. In this sense, nature recharges one's mental capacity to become less fatigued, thereby reducing stress (Kaplan, 1995). In contrast, manmade or urban environments do not typically align with these dimensions of restoration and are thus often used in juxtaposition to nature in assessing restoration (e.g., Berman et al., 2008). However, past research has not investigated the boundary conditions of the benefits of interacting with nature, such as using more conceptual depictions of nature (e.g., through spoken narratives) that do not directly provide individuals with the specific perceptual features of nature that are thought to promote the components of ART.

Past research exploring the restorative benefits of nature versus urban environments has also used Stress Recovery Theory (SRT) as a theoretical framework. SRT proposes that natural environments relieve stress, which manifests both behaviourally (e.g., through self-

report measures) and physiologically (e.g., through decreased heart rate; Ulrich et al., 1991). Stress is defined as one's physiological, behavioural, and psychological response to obstacles in their lives. It can lead to fatigue, and a higher frustration level, and decreased proficiency in task execution (Ulrich et al., 1991). Ulrich et al. (1991) induced stress in participants with a short video, then assigned participants to either view an urban or nature video for the recovery phase. The natural settings were full of vegetation and water, whereas the urban settings had less vegetation, but rather were characterised by traffic and pedestrians in varying amounts. Ulrich et al. (1991) found a faster stress recovery when observing their physiological stress response (e.g. muscle tension) in the nature video group, and overall lower heart rates during the recovery period, relative to baseline, compared to participants who watched the urban video.

Nature's restorative effects has been used in therapeutic practices, such as Shinrin-Yoku, also known as forest bathing. Shinrin-Yoku is a Japanese practice where an individual immerses themselves in nature with five senses with mindfulness. It suggests that practising Shinrin-Yoku has beneficial therapeutic effects on one's immune and cardiovascular systems, mood disorders and stress, mental relaxation, and boost feelings of gratitude (Hansen et al., 2017). The benefits of Shinrin-Yoku were shown in a study by Song et al. (2016), where they had two groups of male university students walk in an urban area and a forest area respectively for 15 minutes, and switch conditions on the following day. On both days it was shown consistently that the walk in the forest area decreased the levels of salivary cortisol, which is a stress hormone, and lowered heart rate and blood pressure. However, subjective stress was not mentioned. However, in another study also by Song et al. (2016), they evaluated the effect of the forest walk on 17 middle-aged men with hypertension, they also found a decrease in heart rate, and participants reported higher relaxation and comfortability after viewing the forest, compared to walking in the urban area. This supports the idea that

nature has restorative qualities and can cause physiological reductions of stress in participants.

Nature interventions have also been shown to improve mood. According to the SRT proposed by Ulrich et al. (1991), as viewing natural settings lead to stress recovery, it also improved the emotional state of participants compared to viewing urban environments. Tate (2011) also found that in electroencephalography (EEG) measurements, viewing natural environments were positively correlated with higher levels of calmness and meditation and lower arousal, and urban environments were associated with higher excitability and arousal. In a study that assessed implicit associations between nature and urban images, Menzel et al. (2021) found that nature was often associated with positively valenced words such as "good" and "positive mood", whereas urban images were associated with negative words such as "bad" and “negative mood”. Nature images were also rated as more restorative compared to urban environments (Menzel et al., 2021). In a separate study by Neill et al. (2019), participants took a short rest in either a windowless laboratory or on a bench outdoors in a park for five minutes. The short interaction with nature was enough to increase feelings of positivity compared to the indoor group. Therefore, these findings support the idea that natural environments increase feelings of positivity, and further suggest that participants will likely have increased positive affect after listening to narratives describing nature environments compared to narratives describing urban environments in the present study.

When investigating the restorativeness of natural environments, most existing studies have either allowed participants to become physically immersed in these environments through structured walks (e.g., Berman et al., 2008) or have presented salient perceptual features from these environments (e.g., via images, sounds, or videos) in laboratory settings (e.g., Yap et al., 2022, Menzel et al., 2021, Ulrich et al., 1991, Van Hedger et al., 2019). Currently, there is not much research that makes use of conceptual depictions of nature to

investigate elements of restorativeness. Conceptual depictions of nature (e.g., narratives describing these environments) might not engender the same restorative effects as perceptual depictions of nature, as greater cognitive effort might be needed to process and understand these depictions, which would not align with the principles of ART (Kaplan, 1995). Therefore, there is a concern on whether listening to a narrative, devoid of any direct perceptual features of nature, may cause participants to engage in deliberate, effortful processing, thereby not allowing for some elements of restoration to occur.

Even through the lens of SRT (Ulrich et al., 1991), it is also suggested that the visual and structural properties of nature largely contribute to positive mood. Therefore, conceptual depictions of nature are lacking these more direct perceptual and structural elements, and thus may not facilitate improvements in mood. One of the limited studies that used an abstract way of presenting nature had participants imagine themselves in both urban and natural environments for 30 seconds and found that mental imagery of natural environments led to more feelings of relaxation and positive psychological effects (Koivisto et al., 2022). The findings from this study support the idea that depictions of nature do not require overt perceptual stimuli in order to show restorative qualities. Hence, it is predicted that listening to descriptions of nature and urban environments would result in similar restorative effects as in Koivisto et al. (2022). The current study aims to conceptually replicate the findings of Koivisto et al. (2022), by investigating whether imagining natural environments while listening to nature narratives elicits restoration along a broader array of measures, including biological measures.

As mentioned, Shinrin-Yoku is a type of nature therapy which requires some mindfulness skills for it to be effective as one is paying attention to all details in the environment. How does mindfulness relate to enhancing the restorative effects of nature? Mindfulness is defined as the ability to be able to direct attention to the present moment

actively, and be aware, accepting, and non-judgemental of one's thoughts and mental states (Kabat-Zinn, 1994). Lindsay et al. (2018) found that the aspect of acceptance in mindfulness is the main driver in the increase in positive affect. Acceptance is practised by fully experiencing what happens, without judging or being attach to the content regardless of their emotional valence. This quality broadens one's awareness and leads one to be more receptive to positive stimuli in the present moment. Furthermore, as one accepts all emotions regardless of valence, it causes one to be more even-tempered. This causes negative feelings to be less overpowering, and subtle positive emotions to be more noticeable (Lindsay et al., 2018). In a recent study which involved inducing negatively valenced stressors in participants, Himes et al. (2021) found that those higher in the trait mindfulness had less negative emotional reactivity. This supports that those who are mindful are less susceptible to negative mood changes due to external factors. Past research has shown that mindfulness training led to increases in positive affect, trait wellbeing, self-compassion, and decreases in anxiety and negative feelings (Orzech et al., 2009). In a study that had a mindfulness training group compared to a control group in emotionally valenced word recall, the mindfulness group showed a significant improvement in the retainment of positive information. A higher positive word recall was also correlated to a better psychological well-being and lower anxiety and depression (Roberts-Wolfe et al., 2012). The study also indicated that mindfulness increases attention to positive stimuli and leads to a magnification of positive experiences (Erisman et al., 2010).

When connecting mindfulness with nature, it has been found that individuals who received mindfulness training felt a stronger connectedness with nature when going on an outdoor walk, compared to those who did not receive mindfulness training. This suggests that mindfulness could enhance the desirable effects of nature (Nisbet et al., 2019). Based on the results of Himes et al. (2021) and Lindsay et al. (2018), it is predicted that negative feelings

caused by the urban narratives would be discounted due to the lower susceptibility to negativity. These previous results also suggest that trait mindfulness may likely moderate the negative feelings that may be elicited by listening to the urban narratives and enhance the restoration effects and positive feelings after listening to the nature narratives. Relating to the current study, Kharlas et al. (2016) found that those who are high in trait mindfulness had a greater vividness with imagining and forming multisensory imagery, such as sounds and sights. It suggests that individuals high in mindfulness tend to have a heightened sensory awareness, and are more observant to senses in daily life, such as "wind in their hair" or "noticing smells and aromas". Therefore, it is predicted that those higher in mindfulness will visualise the auditory narratives vividly, which may aid in enhancing the restorative effects of the narratives in the present study.

There is also a growing body of work examining how mindfulness relates to physiological measures of restoration, including EEG. A past study by Kaushik et al. (2020) found that meditation and mindfulness was linked to theta (associated with meditative and relaxed state; Williams & Gruzelier, 1999) and alpha waves (present in state of resting and relaxation). They also found that some types of regular meditation practice (including mindfulness meditation), mindfulness cognitive therapy, and yoga increased alpha wave levels, or become an individual's dominant brain wave, which are brain waves highly related to lower stress levels and a reduction in anxiety. As a higher level of practice in meditation is positively correlated to self-reported mindfulness, it is suspected that those who score high in mindfulness would likely have longer periods of calmness, such as alpha and theta waves shown in the brain when viewing EEG data. In a study that assessed relaxation techniques with EEG, researchers found that therapeutic effectiveness was related to a greater increase in theta activity in multiple cortical regions, but not alpha activity as a reliable indicator (Jacobs et al., 2004). This suggests that increased theta activity could be a physiological indicator of

relaxation. In contrast, when measuring EEG signals in students under mild or moderate stress, the baseline EEG was characterized by dominance of alpha waves, and when stress is induced, beta waves become more dominant (Jena, 2015). It is suggested after the cognitive task that was designed to fatigue the participants, that the beta waves would be the dominant wave pattern. It is likely that urban narratives will not show any dominant brain wave changes.

The purpose of the present study is to investigate whether listening to spoken narratives describing natural environments – relative to urban environments – can improve physiological and psychological markers of restoration, in line with more direct (and perceptually-based) interactions with these environments, and whether the construct of mindfulness interacts with these effects. Prior to listening to the narratives, participants will be given a cognitive task, the n-back task, to mentally fatigue them, to observe potential restorative benefits of the environments. Despite the more conceptual representation of nature and urban environments in the present study, we predict that nature narratives, relative to urban narratives, will facilitate several facets of psychological restoration. Specifically, we predict that nature narratives will increase feelings of happiness and calmness and will decrease feelings of anxiousness, compared to urban narratives. With respect to physiological interactions of restoration, the hypothesis is that participants in the nature group will show physiological effects consistent with restoration. These will involve increases of theta and alpha EEG activity. It is also predicted that those who are higher in mindfulness will have a minimal change in the EEG activity in the urban condition. Furthermore, we predict that individuals higher in mindfulness will show an enhanced level of mood and calmness, and a higher level of restoration in the nature condition.

Method

Participants

Participants were individuals aged 17 to 46 (M =20.70, SD = 4.58). A total of 54 participants took part in this study (Nature Condition: n = 27; Urban Condition: n =27). There were 9 men, 44 women, and one preferred not to say. Participants were recruited through course announcements to relevant courses offering research credit, through physical and digital advertisements, and through convenience sampling. All participants had to be fluent in English. Participants either received monetary compensation ($15 CAD) or 1.0 course credit for eligible courses. All participants provided informed consent and were treated in accordance with the Declaration of Helsinki.

Materials

To assess EEG brain activity, the Muse-S headband (InteraXon: Toronto, ON Canada) was used. Muse-S is a wireless, consumer-grade EEG system that was designed to track physiological activities with a mobile application which is available for most smartphones. The Muse-S headband has four EEG sensors to track the brain signals. We used the application “Mind Monitor” to collect the EEG data, which provided real-time visualisation of the EEG signal and calculated EEG band power in the delts (1-4 Hz), theta (4-8 Hz), alpha (8-13 Hz), beta (13-30 Hz), and gamma (>30 Hz) frequency ranges in real-time. The EEG data used a 2 Hz sampling rate and was sent via Bluetooth from the application to a secure folder. Although the Bluetooth connection was lost intermittently, no participant was removed on the basis of insufficient EEG measurements.

Absorption was assessed using the Tellegen Absorption Scale (TAS; Tellegen, 1981). The TAS is a 34-item inventory which measures the tendency of an individual to be submerged in sensory or imaginative scenarios. An example item is: "I can be deeply moved

by a sunset." Those who score high on the scale have indicated a preference for experiences that require full attentional engagement and have a higher ability to be mentally immersed in different types of experiences, such as a movie or a song (Lifshitz et al., 2019). The items of the scale were rated on a Likert scale, ranging from 1 (*Not at all true of me*) to 4 (*Very true of me*). The TAS has found to have an internal reliability of $r = .88$ and a test-retest reliability of $r = .91$ (Tellegen & Atkinson, 1974)." The TAS for the current study has been found to have a Cronbach alpha of .63, which shows good internal consistency.

To assess participant's level of mindfulness, the Cognitive and Affective Mindfulness Scale (CAMS; Feldman et al., 2007) was used. The CAMS is a 12-item inventory that measures mindfulness categorised in four dimensions: attention, present focus, awareness and acceptance. An example statement from the scale is: "I can tolerate emotional pain." Items are rated on a Likert scale, ranging from 1 (*Rarely/Not at all*) to 4 (*Almost always*). Items 2, 6, 7 were reverse scored. A higher total score indicated a greater mindfulness level (Baer et al., 2006). In past research, the CAMS shows internal consistencies of .74 to .80, and has been found to have acceptable convergent and discriminant validity (Feldman et al., 2007). The internal consistency of the CAMS in the current study was adequate ($\alpha = .70$).

To assess one's vividness in imagination, the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) was used. The questionnaire consists of 16 items for participants to imagine specific scenarios (e.g., "A rainbow appears"), and is rated from 1 (*No image at all*) to 5 (*Perfectly clear and as vivid as normal vision*). The VVIQ has been found to have a strong internal consistency, having a Cronbach coefficient α of .88 (Campos & Perez, 2009). In the current study, the internal consistency of the VVIQ was acceptable ($\alpha = .67$).

The Bucknell Auditory Imagery Scale (BAIS) was used to measure auditory imagery. The scale has two subscales: vividness and control, and each subscale has 14 items (Gelding

et al., 2015). In the present study, only the vividness subscale was administered. The BAIS assesses for the ability to vividly imagine various auditory images (e.g., a trumpet playing happy birthday). Ratings for the BAIS were made on a Likert scale ranging from 1 (*No image present*) to 7 (*Vivid*). The scale has found to have a significant correlation to the VVIQ, showing a construct validity of .74 (Halpern, 2015), and very good internal consistency of (α = .79; Van Hedger et al., 2024). The internal consistency of the BAIS in the current study was also very good (α = .87).

In order to mentally fatigue participants, the *n*-back task (Owen et al., 2005) was used. The *n*-back task is a cognitive task which involves working memory and attentional control. The purpose of including the *n*-back was twofold. First, nature interventions (relative to urban interventions) have been reported to temporarily improve cognitive performance (e.g., Berman et al., 2008; Van Hedger et al., 2019). Second, the *n*-back is a cognitively demanding task, due to its need for inhibition, decision, and selection (Jaeggi et al., 2010), which is expected to increase participants' mental fatigue and thus provide an opportunity to assess the potential restorative effects of the narrative intervention. Argüero-Fonseca et al. (2023) has found the *n*-back task to be effective in inducing acute cognitive fatigue. The *n*-back consists of listening to streams of spoken letters, and responding to each letter depending on whether it is a repeat of the letter presented *"n"* position(s) previously.

The short-form state portion of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983) was used to determine current anxiety of participants. Participants were asked to self-report on six items (e.g., "I feel nervous"). Participants made their responses on a Likert scale ranging from 1 (*Not at all*) to 4 (*Very much so*). A higher score indicates higher anxiety (Tluczek et al., 2009). Items 2, 4 and 5 were reversed scored. The STAI has been found to have an internal consistency of .86 to .95, and a test-retest reliability of .65 to .75

(Spielberger et al., 1983). The STAI for the current study has been found to have a Cronbach alpha of .63 based on pre-intervention data, and a test-retest reliability of .46.

A brief visual analog scale (VAS) was used to assess participant's moods. Participants were asked to self-report how they were feeling at that moment with individual items for 4 adjectives (happy, sad, calm, and anxious) anchored with "Not at all" and "Extremely". The scale has been shown to show good test-retest reliability: happy: r = .85, sad: r = .73, calm: r = .75, anxious: r =.73 (Brancato et al., 2022). The current test-retest reliability for the VAS was lower than what has been previously reported (happy: r = .55, sad: r = .57, calm: r = .24, anxious: r =.44).

The nature and urban narratives were originally generated by ChatGPT, an Artificial Intelligence (AI) chatbot. The researchers prompted ChatGPT to generate short narratives in a literary style, describing the experiences of a narrator as they navigated through different environments. A total of eight narratives were selected: four depicting nature (a tropical jungle, a deciduous forest, a meadow at dawn, and a snowy field) and four depicting an urban environment (a construction site, a shopping mall, a bustling city centre, and an observation deck overlooking a vast skyline). Each narrative was edited for style, clarity, and length by three people. Narratives were then recorded by a male speaker of Canadian English.

The short version of the Perceived Restorativeness Scale (PRS-11; Pasini et al., 2014) was used to assess self-reported level of restoration with the prompt of reflecting to the narrative portion of the study. There are 3 factors being measured: *Being Away*, *Fascination* and *Extent*. The PRS-11 has 11 questions (e.g., "Listening to these narratives was an escape for me."), which are answered on a Likert scale ranging from 1 (*Very slightly or not at all*) to 7 (*Extremely*) (Simkin et al., 2021). A higher score indicates a higher restorativeness.

Procedure

Pre-Intervention Measurements

Participants were assigned to either the nature or urban narrative condition using a counterbalanced approach (e.g., Participant 001 was assigned to the nature condition, Participant 002 was assigned to the urban condition, etc.). This approach was used as opposed to complete randomization to ensure that the sample sizes in each condition were generally equivalent. After providing informed written consent, participants completed a short (2.5 minute) baseline EEG recording using the Muse-S headband.

The researcher assisted participants in putting on the Muse-S headband and ensured that the signal quality was adequate (using the Mind Monitor Application) prior to commencing the baseline recording. Once in place, participants wore the Muse-S headband for the remainder of the study.

The questionnaires, narrative listening, and cognitive tasks were carried out on a computer in a designated lab space and were programmed in jsPsych v.7 (de Leeuw, 2015). Immediately following the baseline EEG recording, participants completed a brief demographic questionnaire assessing age and gender. Following this demographic questionnaire, participants completed the state mood measures (STAI and VAS), with the task order counterbalanced across participants. Following the state mood measures, participants completed the TAS, CAMS, VVIQ, and BAIS in a randomised order.

Participants then completed the *n*-back task. The *n*-back consisted of four blocks – one block of a 2-back (which was treated as practice in the current study), and three blocks of the 3-back (which were scored). Each block consisted of 30 letters (in addition to the first *"n*" letters): 20 non-target letters and 10 target letters. The location of target and non-target letters within the block was randomly determined. Participants both heard a spoken version of the letter and saw the letter presented on the computer screen. Upon making a response (pressing

a one of two designated keys to label the letter as a target or non-target), the visual letter turned green for a correct response and red for an incorrect response, thus providing participants with real-time feedback. Letters were presented at a rate of 2.5 seconds. Following the *n*-back task, participants rated their mental fatigue on a Likert scale ranging from 1 (*Not at all*) to 7 (*Extremely*).

Intervention

Following the *n*-back and self-reported mental fatigue measure, participants completed the main intervention of the study. Participants were played four narratives, either describing natural or urban environments (depending on condition). Narratives were played through computer speakers. After each narrative, participants were given 30 seconds to put themselves in the position of the narrator and reflect on the perceptual features (e.g., sights, sounds, smells) described in the narrative. EEG data were recorded during these 30-second reflection epochs.

After each narrative and 30-second reflection epoch, participants rated how much they liked the narrative and how easily they were able to imagine each scene on a Likert scale ranging from 1 (*Not at all*) to 5 (*Extremely*).

Post-Intervention Measurements and Debriefing

After participants went through this procedure for all four narrative recordings (listening, reflecting, answering questions related to imageability and liking), they rated their mood and state anxiety using the measures previously described (VAS and STAI).

Participants then completed a second round of the *n*-back task and subsequent mental fatigue rating. Following the *n*-back and mental fatigue rating, participants completed the PRS, which was specifically worded to assess the perceived restorativeness of the narratives.

Following the PRS, participants were provided with a debriefing form describing the purpose of the study and the hypotheses. Participants were then thanked for their participation and given their preferred compensation (monetary or course credit). In total, the study procedure lasted approximately 60 minutes.

Data Analytic Plan

All analyses were performed in R 4.3 using RStudio. To address whether the nature narratives, relative to the urban narratives, increased physiological markers of restoration, EEG frequency power across five bands (delta, theta, alpha, beta, and gamma) was analysed in separate linear models with condition (nature, urban) and mindfulness entered as predictor variables. The interaction between condition and mindfulness was also included to assess whether the relative differences in EEG power across conditions differed as a function of mindfulness. Based on prior research, it was predicted that nature narratives would influence theta power, as theta has been previously associated with relaxation (e.g., Williams & Gruzelier, 1999). Baseline EEG across each frequency band was also analysed to assess whether any baseline differences existed between participants in the two conditions prior to the narrative intervention. All EEG analyses were limited to the two frontal electrode sites (AF7 and AF8 using the 10/20 system), as the two temporal electrodes were not consistent in their connectivity.

Linear mixed-effects models were used to assess whether the narratives influenced mood, as each mood measure was repeated twice (pre- and post-intervention). Separate models were created for the STAI, and each term of the mood VAS (happy, sad, calm, anxious). Each model contained time (pre-intervention, post-intervention), condition (nature, urban), and mindfulness, as well as interactions among all terms. Random intercepts were

included for each participant. It was predicted that nature narratives would decrease anxiety and improve positive mood relative to urban narratives.

To assess whether the different narrative categories differed in perceived restoration, linear regression models were used. Separate models were created for each factor of the PRS (*Being Away*, *Fascination*, *Extent*). Each model contained condition (nature, urban) and mindfulness, as well as the interaction between condition and mindfulness. Linear regression models were also used to assess participants' liking and imageability ratings of the narratives. These models also contained condition (nature, urban) and mindfulness, as well as the interaction between condition and mindfulness.

Although the current study collected visual and auditory imagery measures (VVIQ and BAIS), absorption (TAS), cognitive performance (*n*-back), and self-reported cognitive fatigue, these items were included to address a broader research question and are not considered in this thesis.

Results

EEG Measures

Baseline

Overall, there were no significant effects found in EEG baseline measurements across any of the frequency bands. For delta power, there were no significant main effects of mindfulness, $F(1, 50) = 2.59$, $p = .114$, or condition, $F(1, 50) = 0.94$, $p = .337$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 2.69$, $p = .107$. For theta power, there were no significant main effects of mindfulness, $F(1, 50) = 3.09$, $p = .085$, or condition, $F(1, 50) = 0.01$, $p = .916$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 2.83$, $p = .099$. For alpha power, there were no significant main effects of mindfulness, $F(1, 50) =$

1.78, $p = .188$, or condition, $F(1, 50) = 0.22$, $p = .643$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 0.48$, $p = .490$. For beta power, there were no significant main effects of mindfulness, $F(1, 50) = 0.21$, $p = .647$, or condition, $F(1, 50) = 1.67$, $p = .202$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 0.16$, $p = .690$ For gamma power, there were no significant main effects of mindfulness, $F(1, 50) = 0.82$, $p = .370$, or condition, $F(1, 50) = 1.09$, $p = .302$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 0.05$, $p = .826$.

Intervention

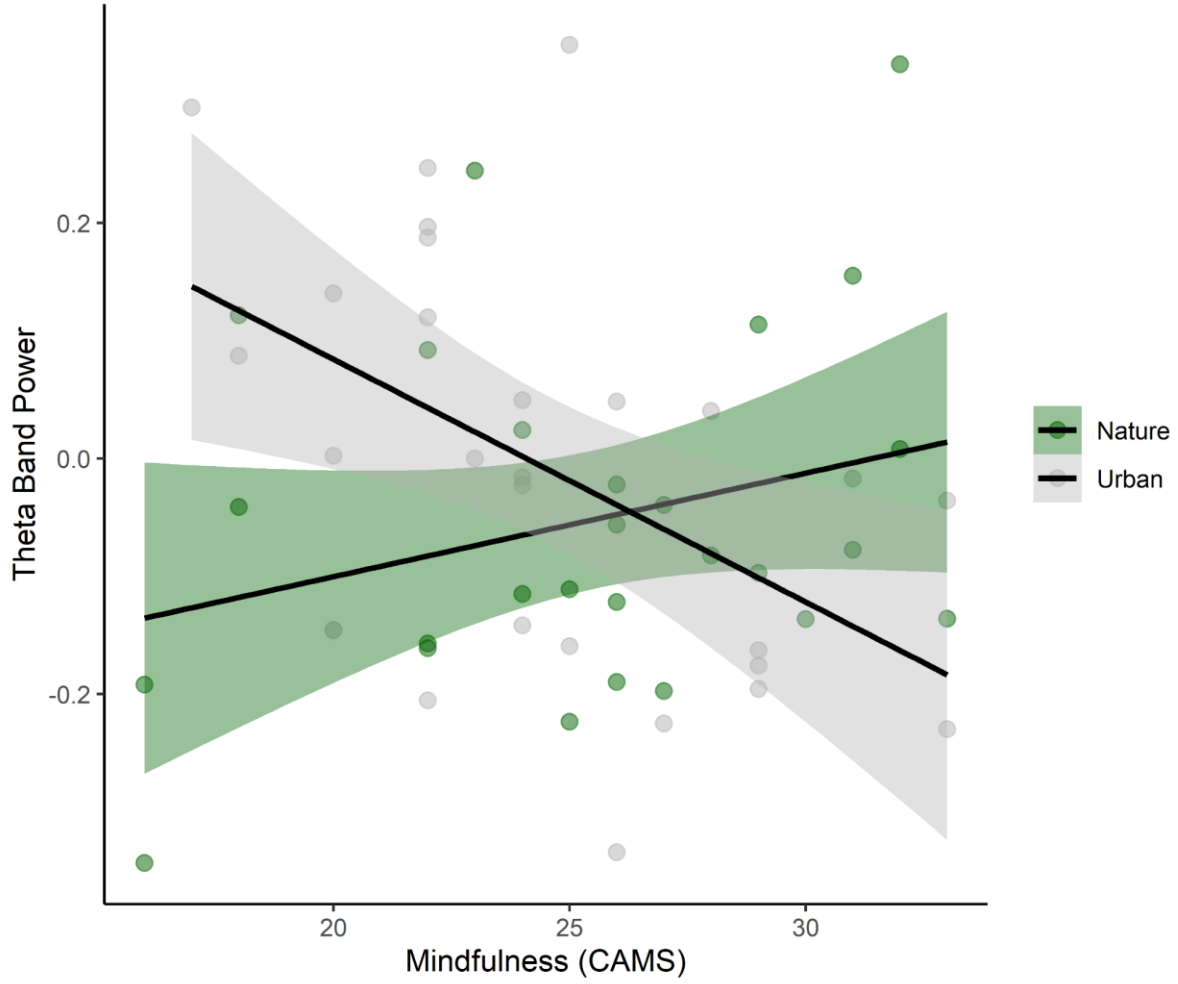
The only significant effect observed during EEG intervention recordings was in the theta band, which showed a significant interaction of condition and mindfulness, $F(1, 50) = 9.70$, $p = .003$. This interaction is plotted in Figure 1 and is characterised by a positive association between mindfulness and theta power in the nature condition, as compared to a negative association between mindfulness and theta power in the urban condition. Neither main effects of mindfulness, $F(1, 50) = 0.75$, $p = .391$, or condition, $F(1, 50) = 0.97$, $p = .329$, were significant.

For delta power, there were no significant main effects of mindfulness, $F(1, 50) = 2.70$, $p = .106$, or condition, $F(1, 50) = 0.89$, $p = .349$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 3.26$, $p = .077$. For alpha power, there were no significant main effects of mindfulness, $F(1, 50) = 0.33$, $p = .570$, or condition, $F(1, 50) = 1.12$, $p = .296$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 2.32$, $p = .134$. For beta power, there were no significant main effects of mindfulness, $F(1, 50) < 0.01$, $p = .970$, or condition, $F(1, 50) = 2.07$, $p = .157$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 1.29$, $p = .261$. For gamma power, there were

no significant main effects of mindfulness, $F(1, 50) = 0.04$, $p = .844$, or condition, $F(1, 50) = 2.41$, $p = .127$, nor was there a significant interaction between mindfulness and condition was also not significant, $F(1, 50) = 1.17$, $p = .284$.

Figure 1

Interaction of condition and mindfulness for EEG theta band power



Note: Error ribbons represent 95% confidence intervals. Values on the y-axis reflect average theta band power during the 30-second reflection periods after listening to the narratives.

Behavioural Measures

State Anxiety Measures

The STAI similarly did not show any significant main effects of time, condition, or mindfulness, nor were there any significant two-way or three-way interactions (all *p*s > .106). The anxiety question from the VAS did not show any significant main effects of time, condition, or mindfulness, nor were there any significant two-way or three-way interactions (all *p*s > .293).

Mood Measures

The VAS Calm measure showed a significant main effect of time, $F(1, 50) = 5.95$, $p = .018$, with participants reporting reduced calmness post-intervention ($M = 61.70$, $SE = 4.16$) compared to pre-intervention ($M = 65.88$, $SD = 2.94$). There was also a significant interaction of time and mindfulness, $F(1, 50) = 5.52$, $p = .023$. This interaction, which is plotted in Figure 2, is characterised by a relatively flat association between mindfulness and calmness in the pre-intervention period, compared to a positive association between mindfulness and calmness in the post-intervention period. The main effect of condition was not significant, $F(1, 50) = 2.02$, $p = .161$, nor were any of the other interaction terms (all *p*s > .240). The VAS Happy and Sad measures did not show any significant main effects or interactions (all *p*s > .060).

Perceived Restorativeness

There was a borderline significant main effect of mindfulness on the dimension of *Being Away*, $F(1, 50) = 3.95$, $p = .053$, with higher mindfulness scores associated with higher ratings of being away. The main effect of narrative condition was not significant, $F(1, 50) = 1.77$, $p = .190$, nor was the interaction between mindfulness and condition, $F(1, 50) = 0.28$, $p = .600$.

For *Fascination*, there was similarly a main effect of mindfulness, $F(1, 50) = 9.38$, $p = .004$, with higher mindfulness scores associated with higher ratings of fascination. The main effect of narrative condition was significant, $F(1, 50) = 4.19$, $p = .046$, with higher fascination scores in the nature condition ($M = 3.51$, $SD = 0.84$) compared to the urban condition ($M = 3.01$, $SD = 1.06$). The interaction between mindfulness and condition was not significant, $F(1, 50) = 0.80$, $p = .377$.

There was similarly a main effect of mindfulness on the dimension of *Extent*, $F(1, 50) = 6.00$, $p = .018$, with higher mindfulness scores associated with higher ratings of extent. The main effect of narrative condition was not significant, $F(1, 50) = 1.12$, $p = .294$, nor was the interaction between mindfulness and condition, $F(1, 50) = 0.05$, $p = .823$.

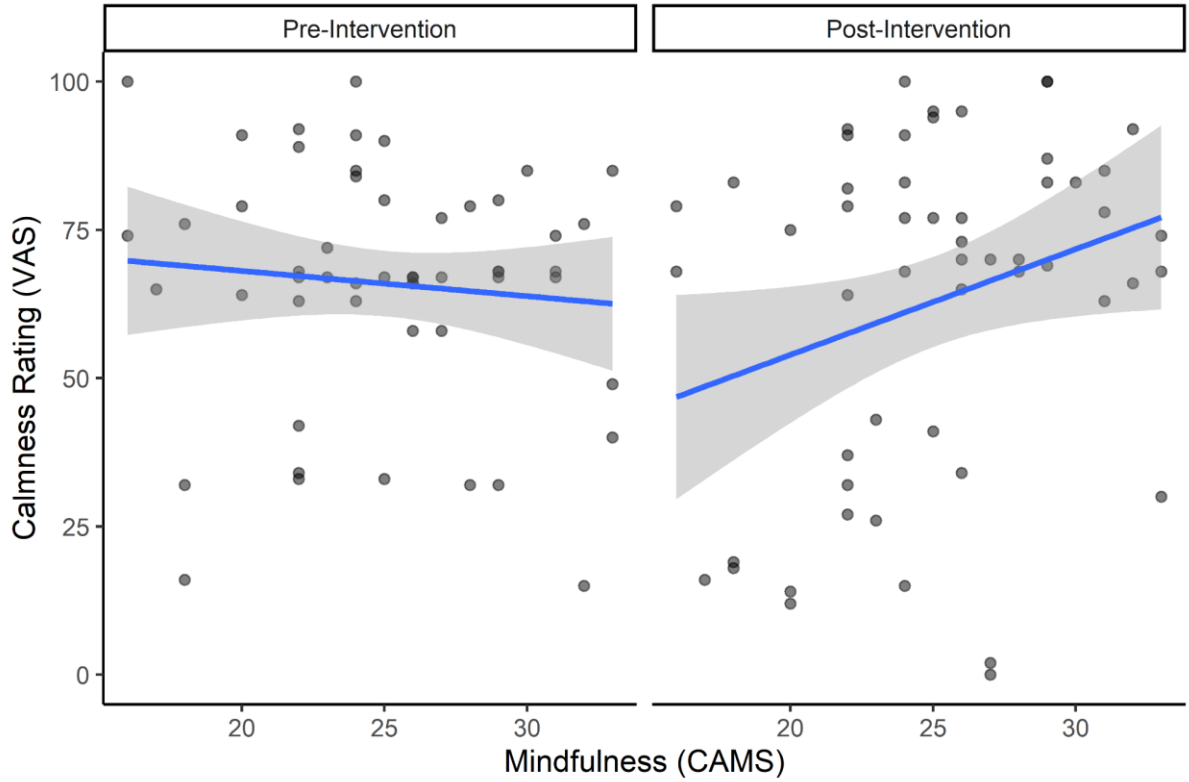
Narrative Ratings

In terms of how much participants liked the narratives, there was a main effect of narrative condition, $F(1, 50) = 4.65$, $p = .036$, with participants liking the nature narratives ($M = 60.64$, $SD = 19.36$) more than the urban narratives ($M = 49.20$, $SD = 22.59$). There was also a main effect of mindfulness, $F(1, 50) = 10.52$, $p = .002$, with more mindful participants liking the narratives more overall. There was no interaction between narrative condition and mindfulness, $F(1, 50) = 0.15$, $p = .697$.

In terms of how easily participants were able to imagine the narratives, there was no main effect of narrative condition, $F(1, 50) = 0.02$, $p = .892$. There was, however, a main effect of mindfulness, with more mindful participants reporting an easier time imagining the scene depicted in the narratives, $F(1, 50) = 21.82$, $p < .001$. There was no interaction between narrative condition and mindfulness, $F(1, 50) = 2.10$, $p = .153$.

Figure 2

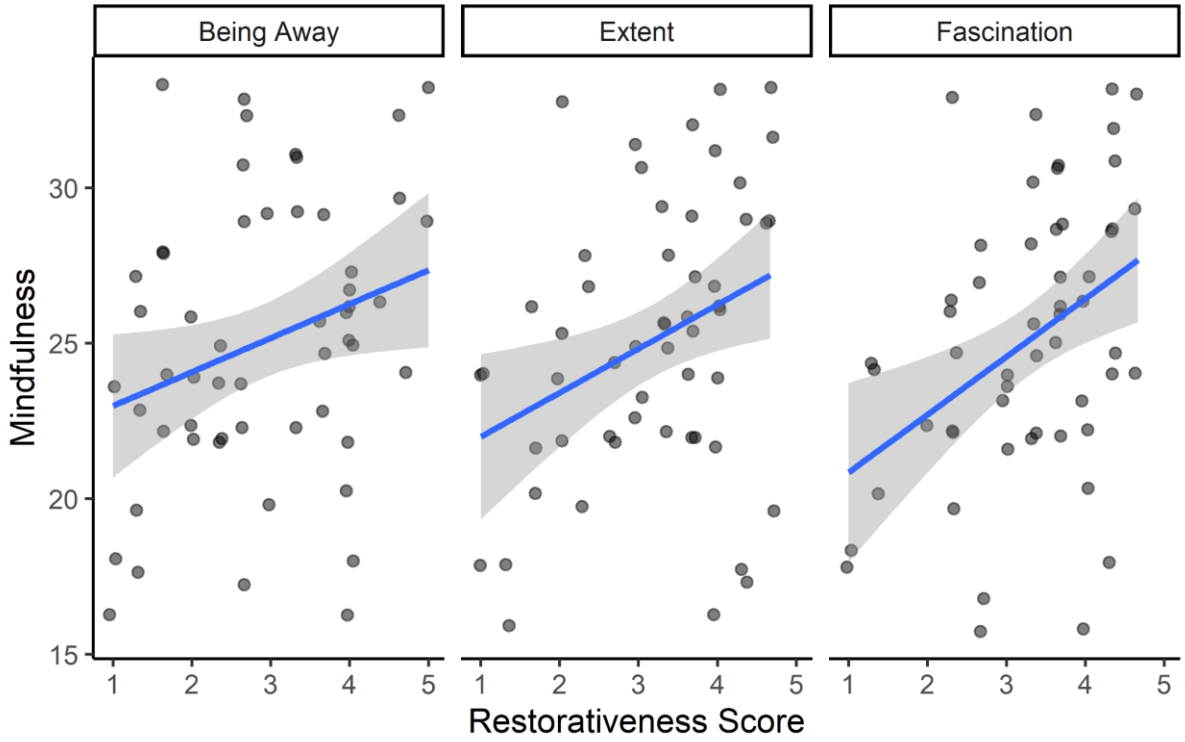
Interaction of mindfulness and time for the VAS Calm ratings



Note: Error ribbons represent 95% confidence intervals. Individual data points were given transparency to visualise potential overlap.

Figure 3

Main effects of mindfulness across the three dimensions of the Perceived Restorativeness Scale



Note: Error ribbons represent 95% confidence intervals. Individual data points were given transparency to visualise potential overlap.

Discussion

The current study assessed whether conceptual depictions of nature and urban environments would engender restorative effects, and if so, whether mindfulness would relate to the degree of restoration. The hypotheses of the study were partially supported with the EEG recordings, as the current study showed a significant interaction of narrative condition and mindfulness in the theta band of the EEG recording. The theta band of EEG reflects slow (4-7 Hz) neural oscillations that have been previously associated with being in a meditative and relaxed state (Williams & Gruzelier, 1999). In this context, greater mindfulness is seen to increase theta power, but only in the context of the nature narratives. This supports the results found by Kaushik et al. (2020) that mindfulness is associated with increased theta power. In contrast, mindful individuals were found to have lower theta power when reflecting on urban narratives, potentially indicating a lower meditative and relaxed state. As it has been suggested in past research that increase in theta activity could be a physiological indicator of relaxation (Jacobs et al., 2004), this finding supports the hypothesis that mindful individuals would have higher physiologically restorative effects in the nature condition, and less in the urban condition.

Although theta band power in EEG has been previously associated with a relaxed and meditative state, the behavioural measure of calmness in the present study showed a different relationship to mindfulness. In terms of behavioural calmness measure, it was found that mindfulness was significantly associated with greater calmness in the post-intervention period compared to the pre-intervention period. However, this positive association between mindfulness and calmness post-intervention did not depend on the narrative condition to which participants were assigned. This nonspecific effect of narrative condition on calmness scores may be due to several reasons. One possible explanation is that mindful individuals are better at being in the moment and maintaining an even-temper regardless of the content of the

narratives. Therefore, when mindful individuals can direct their attention to the narratives and reflect on them, it acts as a period to accept their feelings regardless of the condition, which shares many surface level similarities to a meditation period. As a result, mindful participants may have become calmer post-intervention, regardless of narrative condition, because both conditions offered periods for reflection, which more mindful individuals may have approached differently than less mindful individuals.

The pattern of results observed for the perceived restorativeness scale was similar to those observed for self-reported calmness - that is, mindfulness was significantly and positively associated with greater feeling of restoration along all three dimensions (*Being Away, Fascination, Extent*) in a nonspecific manner that did not interact with narrative condition. It is likely that mindful individuals found both types of narratives to be equally restorative, specifically, higher mindfulness scores were associated with higher ratings of fascination. However, as a whole, nature narratives were found to have higher fascination ratings than urban ones. As mentioned in a previous research study by Nisbet et al. (2019), it was found that mindfulness led to a stronger connection in nature during an outdoor walk. It is likely that fascination is high due to an enhancement of positive effects of nature, and a feeling of connection to the elements of nature described in the recordings. However, this framework would potentially suggest that mindful individuals should show higher ratings of fascination in the nature condition compared to the urban condition, which was not the case. It can be speculated that listening to narratives describing a scene is to some extent similar to a guided meditation and could be familiar to those who have experienced it, and lead to feelings of restoration. However, more research is needed to determine the underlying mechanisms for why mindfulness is associated with nonspecific (i.e., condition independent) perceived restoration in the present study.

Contrary to the hypotheses of the study, there were no significant effects for self-reported happiness or anxiety. It was originally hypothesised that the nature narratives would increase happiness post-intervention due to restoration. Unlike the past studies that had visual imagery that boosted participants' moods (Menzel et al., 2021), we only had audio recordings, and may limit the extent of emotional arousal, and is likely more relevant to destressing than increasing mood valence, and both recordings were spoken in a calming and neutral tone without any trace of specific feelings. It was hypothesised that some urban narratives would lead to higher anxiety due to the crowded descriptions or be reminiscent of the life in the city. Nature narratives were found to be more well liked that urban narratives. However, it is possible that those who prefer or who lived in cities may be used to the qualities of a city or might have enjoyed the recording. The two moods not being significant may have also been affected by the extent each participant is able to envision and immerse themselves in the narratives. Also, the VAS in the current study was found to have a low test-retest reliability due to each construct only being measured by one item. Furthermore, we hypothesized a change in the VAS construct as a function of the intervention, which also led to the low test-retest reliability. Separately, if one lacks the ability to vividly imagine the scenes or to feel immersed in the depicted environments, it is perhaps not surprising that one may not feel any sense of change. There were also no other frequency bands of EEG that showed any significant effects of either mindfulness or narrative condition.

As a whole, we did not find any main effects of the environment type. Referring to the ART, the four characteristics make an environment to be restorative tend to lean towards the need for visual depiction. Direct perceptual features (e.g. videos, photos) and audio features (e.g. bird noises, people talking) are much easier for individuals to associate to their daily lives, and therefore require less effort. Therefore, it is speculated that due to the lack of direct perceptual features of nature, there is a need to put more effort to imagine the

recordings. Therefore, it may be more difficult for participants to experience the restorative effects that were predicted to happen.

There are some limitations of the present study that need to be acknowledged. One limitation is that the Bluetooth connection from the Muse headband to the recording application occasionally dropped out during the recording windows. Although all participants had recorded data for the narrative reflections, this meant that some participants had fewer observations and thus mean estimates may have been less reliable. Future work might consider conceptually replicating these findings with a different EEG setup that is designed for research, as opposed to the consumer-oriented device that was used in the present study. Some participants also reported that the headband felt tighter and less comfortable as time went on, which may have affected the capacity to experience restorative effects. A second potential limitation of the present study is the heavy reliance on self-report measures, which could have created a social desirability bias (e.g., causing participants to describe themselves as a mindful person, due to it being viewed more positively than being reactive and judgmental). Another limitation is that the sample of the research is not representative, as all participants either came from an undergraduate research study pool or were friends and acquaintances of the researchers. Moreover, the sample predominantly consisted of individuals of university age and lacked other age groups. Therefore, the pool of participants may not be an accurate representation of the wider population such as those in other countries.

In future research, it may be interesting to conduct the study on older adults (i.e., >=60 years old), as it has been found that there are age related declines in working memory (Gazzaley et al., 2005), and the n-back task may fatigue them to a larger extent. Therefore, the restorative effects of nature may become more obvious due to a more pronounced fatigue. In the current research, mindfulness was measured by self-reported tools. Therefore, to

further support the effects of mindfulness, it would be beneficial to recruit individuals who train in mindfulness and meditate on a regular basis to compare to those who only self-report as being mindful. By doing so, we would be able to view whether theta activity would further increase if one actively practised mindfulness.

In summary, the present study assessed whether listening to audio recordings describing nature, in comparison to urban environments, can lead to higher levels of restoration physiologically and psychologically, as well as whether mindfulness moderated these effects. Physiologically, we found a significant interaction between narrative condition and mindfulness in the theta band of the EEG recording. In the psychological aspect, we found that mindfulness was significantly associated with greater calmness and greater perceived restorativeness in the post-intervention period compared to the pre-intervention period. However, this positive association between mindfulness and self-report measures did not depend on the narrative condition to which participants were assigned. In conclusion, while the narrative condition did not independently influence restoration in the present results, mindfulness may be a promising construct to include in future work assessing the efficacy of nature-based interventions on restoration.

References

Argüero-Fonseca, A., Martínez-Soto, J., Barrios, F. A., Villaseñor, T. D. J., Reyes-Huerta, H. E., González-Santos, L., Aguirre-Ojeda, D. P., Pimienta, P., González, O. U. R., & Marchioro, D. M. (2023). Effects of an n-back task on indicators of perceived cognitive fatigue and fatigability in healthy adults. *Acta Biomed*, *94*(6).

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

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using Self-Report Assessment Methods to Explore Facets of Mindfulness. *Assessment (Odessa, Fla.)*, *13*(1), 27–45. https://doi.org/10.1177/1073191105283504

Benning, S. D., Rozalski, V., & Klingspon, K. L. (2015). Trait absorption is related to enhanced emotional picture processing and reduced processing of secondary acoustic probes. *Psychophysiology*, *52*(10), 1409–1415. https://doi.org/10.1111/psyp.12468

Brancato, G., Van Hedger, K., Berman, M. G., & Van Hedger, S. C. (2022). Simulated nature walks improve psychological well-being along a natural to urban continuum. *Journal of Environmental Psychology*, *81*, 101779. https://doi.org/10.1016/j.jenvp.2022.101779

Campos, A., & Pérez-Fabello, M. J. (2009). Psychometric Quality of a Revised Version Vividness of Visual Imagery Questionnaire. *Perceptual and Motor Skills*, *108*(3), 798–802. https://doi.org/10.2466/pms.108.3.798-802

de Leeuw, J. R. (2015). jsPsych: A JavaScript library for creating behavioral experiments in a Web browser. *Behavior Research Methods*, *47*(1), 1–12. https://doi.org/10.3758/s13428-014-0458-y

Dimitriev, D. A., Dimitriev, A. D., Karpenko, Yu. D., & Saperova, E. V. (2008). Influence of examination stress and psychoemotional characteristics on the blood pressure and heart rate

regulation in female students. *Human Physiology*, *34*(5), 617–624. https://doi.org/10.1134/S0362119708050101

Feldman G., Hayes A., Kumar S., Greeson J., Laurenceau J.P. (2007). Mindfulness and emotion regulation: The development and initial validation of the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R). *Journal of Psychopathological Behavioral Assessment*, 29, 177-190.

Gazzaley, A., Cooney, J., Rissman, J. Esposito, M.D. (2005). Top-down suppression deficit underlies working memory impairment in normal aging. *Nature Neuroscience*, 8, 1298–1300. https://doi.org/10.1038/nn1543

Ghosh, K., Nanda, S., Hurt, R. T., Schroeder, D. R., West, C. P., Fischer, K. M., Bauer, B. A., Fokken, S. C., Ganesh, R., Hanson, J. L., Lindeen, S. A., Pruthi, S., & Croghan, I. T. (2023). Mindfulness using a wearable brain sensing device for health care professionals during a pandemic: A pilot program. *Journal of Primary Care & Community Health*, *14*, 21501319231162308. https://doi.org/10.1177/21501319231162308

Gelding, R. W., Thompson, W. F., & Johnson, B. W. (2015). The pitch imagery arrow task: Effects of musical training, vividness, and mental control. *PLoS ONE*, *10*(3), e0121809. https://doi.org/10.1371/journal.pone.0121809

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

Hartig, T., Mang, M. & Evans, G. W. (1991). Restorative effects of natural environment experience. *Environment and Behavior, 23*, 3-26.

Himes, L., Hubbard, N. A., Maruthy, G. B., Gallagher, J., Turner, M. P., & Rypma, B. (2021). The relationship between trait mindfulness and emotional reactivity following mood manipulation. *Mindfulness*, *12*(1), 170–185. https://doi.org/10.1007/s12671-020-01510-7

Halpern, A. R. (2015). Differences in auditory imagery self-report predict neural and behavioral outcomes. *Psychomusicology: Music, Mind, and Brain*, *25*(1), 37–47. https://doi.org/10.1037/pmu0000081

Jacobs, G. D., & Friedman, R. (2004). EEG Spectral Analysis of Relaxation Techniques. *Applied Psychophysiology and Biofeedback*, *29*(4), 245–254. https://doi.org/10.1007/s10484-004-0385-2

Jaeggi, S. M., Buschkuehl, M., Perrig, W. J., & Meier, B. (2010). The concurrent validity of the N-back task as a working memory measure. *Memory*, *18*(4), 394–412. https://doi.org/10.1080/09658211003702171

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

Kučikienė, D., & Praninskienė, R. (2018). The impact of music on the bioelectrical oscillations of the brain. *Acta Medica Lituanica*, *25*(2), 101–106. https://doi.org/10.6001/actamedica.v25i2.3763

Kaushik, M., Jain, A., Agarwal, P., Joshi, S. D., & Parvez, S. (2020). Role of Yoga and Meditation as Complimentary Therapeutic Regime for Stress-Related Neuropsychiatric Disorders: Utilization of Brain Waves Activity as Novel Tool. *Journal of Evidence-Based Integrative Medicine*, *25*, 2515690-. https://doi.org/10.1177/2515690X20949451

Kabat-Zinn, J. (1994). *Wherever you go there you are: Mindfulness meditation in everyday life*. New York: Hyperion.

Marks, D. F. (1973) Visual imagery differences in the recall of pictures. *British Journal of Psychology,* 64, 17-24.

Nisbet, E. K., Zelenski, J. M., & Grandpierre, Z. (2019). Mindfulness in Nature Enhances Connectedness and Mood. *Ecopsychology*, *11*(2), 81–91. https://doi.org/10.1089/eco.2018.0061

Neill, C., Gerard, J., & Arbuthnott, K. D. (2019). Nature contact and mood benefits: Contact duration and mood type. *The Journal of Positive Psychology*, *14*(6), 756–767. https://doi.org/10.1080/17439760.2018.1557242

Owen, A. M., McMillan, K. M., Laird, A. R., & Bullmore, E. (2005). N-back working memory paradigm: A meta-analysis of normative functional neuroimaging studies. *Human Brain Mapping*, *25*(1), 46–59. https://doi.org/10.1002/hbm.20131

Pasini, M., Berto, R., Brondino, M., Hall, R., & Ortner, C. (2014). How to measure the restorative quality of environments: The PRS-11. *Procedia - Social and Behavioral Sciences*, *159*, 293–297. https://doi.org/10.1016/j.sbspro.2014.12.375

Sheldon, K. M., Prentice, M., & Halusic, M. (2015). The experiential incompatibility of mindfulness and flow absorption. *Social Psychological and Personality Science*, *6*(3), 276–283. https://doi.org/10.1177/1948550614555028

Song, C., Ikei, H., & Miyazaki, Y. (2016). Physiological effects of nature therapy: A review of the research in Japan. *International Journal of Environmental Research and Public Health*, *13*(8), 1–1. https://doi.org/10.3390/ijerph13080781

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Simkin, J., Ojala, A., & Tyrväinen, L. (2021). The perceived restorativeness of differently managed forests and its association with forest qualities and individual variables: A field experiment. *International Journal of Environmental Research and Public Health*, *18*(2), 422. https://doi.org/10.3390/ijerph18020422

Tate, M. L. (2011). Engaging the Brain. In D. Sousa, *Educational Neuroscience* (pp. 143–148). Corwin Press. https://doi.org/10.4135/9781483387734.n9

Tellegen, A., & Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology*, *83*(3), 268–277. https://doi.org/10.1037/h0036681

Tellegen A. (1981). Practicing the two disciplines for relaxation and enlightenment: Comment on "Role of the feedback signal in electromyograph biofeedback: The relevance of attention" by Qualls and Sheehan. *Journal of Experimental Psychology: General*, *110*, 217–226

Tluczek, A., Henriques, J. B., & Brown, R. L. (2009). Support for the reliability and validity of a six-item state anxiety scale derived from the State-Trait Anxiety Inventory. *Journal of Nursing Measurement*, *17*(1), 19–28.

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

Van Hedger, S. C., Nusbaum, H. C., Clohisy, L., Jaeggi, S. M., Buschkuehl, M., & Berman, M. G. (2019). Of cricket chirps and car horns: The effect of nature sounds on cognitive performance. *Psychonomic Bulletin & Review*, *26*(2), 522–530. https://doi.org/10.3758/s13423-018-1539-1

Van Hedger, S. C., Halpern, A. R., Vollweiler, D. J., Smith, E. E., & Pfordresher, P. Q. (2024). Is Hey Jude in the right key? Cognitive components of absolute pitch memory. *Memory & Cognition*, 10.3758/s13421-024-01530-x. Advance online publication. https://doi.org/10.3758/s13421-024-01530-x

Williams, J. D. & Gruzelier, J. H. (2001) Differentiation of hypnosis and relaxation by analysis of narrow band theta and alpha frequencies. *International Journal of Clinical and Experimental Hypnosis*, *49*(3), 185-206, DOI: 10.1080/00207140108410070

Curriculum Vitae

Name:	Natalie Tong
Place and Year of Birth:	Hong Kong, China, 15/05/2002
Secondary School Diploma:	Brookes Westshore, Victoria, Canada
Awards:	Huron University College International Entrance Scholarship (2020), National Scholarship (2020), Dean's Honour List (2020-2023), Arts and Social Science Scholarship (2021-2023)