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Investigating the role of natural environments in the effectiveness of a mindfulness-based stress reduction (MBSR) programme

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ABSTRACT

The aims of this PhD study are to investigate the potential for enhancing one of the most popular wellbeing interventions (i.e. Mindfulness-based stress reduction: MBSR) by incorporating exposure to natural environments, and to explore the interactions leading to recovery or resilience of mental health and wellbeing.

The research includes three-phase experimental research. **Phase 1** is a scoping study of the main field experiment, examining the effectiveness of MBSR (i.e. MBSR vs. relaxation control group) and environmental conditions (i.e. woodland vs. parkland vs. urban setting vs. indoor) using simulated environments. Participants (n=122) were randomly assigned to one of two intervention groups (brief MBSR, relaxation control group) under different simulated environmental conditions during an intervention lasting three weeks. **Phase 2** is a more extended study using '*actual*' environments. In order to compare the effectiveness of the intervention in different settings, participants (n=99) were randomly assigned to a six-week MBSR programme in one of three different environments (i.e. natural outdoor, built outdoor and indoor). Finally, **Phase 3** is conducted to compare the effectiveness of MBSR between simulated and actual natural environments, using secondary data analysis – qualitative (n=64) and quantitative data (n=7) from earlier studies (phase 1 & phase 2).

This is one of the first studies to incorporate place-based assets into an intervention. This paper has provided a fine-grained insight into the enhancement of a common wellbeing intervention through exposure to natural environments via its experimental, factorial design and the multiple outcome measures. Overall findings of this PhD showed that a wellbeing intervention (i.e. MBSR) is more effective when carried out in natural environments – both simulated and

actual natural settings. The enhancement of wellbeing interventions when combined with natural environments would encourage policymakers and clinical commissioners to support the development of interventions involving natural settings.

GLOSSARY

Mental health (and wellbeing)	Mental health is defined as a state of wellbeing in which people are able to live and work without being overburdened by stress, and are able to contribute in some way to their community.
Mental health problems	Mental health problems impair functions of daily living and can range from minor everyday occurrences, such as feelings of worry or stress, to serious long-term conditions, such as anxiety or depressive disorders.
Wellbeing intervention	A wellbeing intervention consists of a programme which combines different strategies designed to improve individual mental health and wellbeing.
Natural environment	The natural environment refers to a very broad idea of a setting, including areas of vegetation in a landscape, such as forests and wilderness areas, street trees and parks, gardens and backyards, and farmland. The natural environment could be a synonym of nature and an antonym of built environment (i.e. non-natural environment) in this thesis.
Nature connectedness	Nature connectedness describes the mix of feelings, attitudes, beliefs and behaviours that people have towards nature. In this thesis, 'Nature connectedness' was measured by Natural Relatedness Scale (NR-6: Nisbet and Zelenski, 2013).
Restoration (in natural environments)	Restoration is an umbrella term that, within environmental psychology, refers to the experience of a psychological and/or physiological recovery process that is triggered by particular environments and environmental configurations.

CHAPTER ONE: INTRODUCTION

1.1 Background of study

The focus of this PhD is the deeper understanding of the relationship between humans and nature and how the relationship enhances recovery or resilience of mental health and wellbeing. To date, there is a considerable amount of evidence on the positive effects of exposure to natural environments on mental health and wellbeing, be it passive or active exposure. As this field of research does not sit within medical or health care disciplines, it has been slow to penetrate into them.

The NHS in England encounters critical financial and service burden, particularly with the growing demand for antidepressants and psychological therapy—it has become increasingly significant to address these challenges (King's Fund, 2015). Until recently, most of the main discussion on mental health care/service was emphasised on the medicalised approach, in which human health conditions and problems come to be defined and treated as medical conditions. However, the World Health Organisation (2018) defines mental health as: "*a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community*". Consequently, studies have now focused on more holistic approaches, rather than purely medical, to support mental health conditions, with the aim of creating a higher psychological resilience to mental illnesses. This can be done by providing the ideal context and environment for people to flourish in life without the need of traditional therapies or 'cures'.

Different research studies have highlighted the potential importance of prevention for recovery and wellbeing, and have documented successful preventive strategies, such as having access to professional services and support, exercising and engaging in activities or hobbies (e.g. Yanos and Rosario, 2014). In addition, many prevention and early interventions, such as Cognitive Behavioural Therapy (CBT) and Improving Access to Psychological Therapies (IAPT), are known to provide a crucial role in reducing the incidence of mental problems. Merry and Hetrick (2017) found that prevention and early intervention can reduce depressive symptoms and depression diagnoses. By doing so, they are able to shorten hospital stays and reduce a number of high-cost intensive interventions. Henceforth, leading to increase in savings of £639 million to the health system over a period of three years (Knapp *et al*., 2011). However, studies have shown that these programmes, when delivered to the general public, were not found to be effective (Merry and Hetrick, 2017).

The environment around us can influence our mental and physical health as well as impact our health-related behaviours and choices in many different and conflicting ways. Some places/spaces can promote good health and wellbeing, whilst others may have the opposite effect. In particular, natural environments are known to support mental health and wellbeing and represent a key element in the physiological mechanism behind the prevention and treatment of mental illnesses (Lachowycz and Jones, 2013). Van den Berg *et al*. (2010) found that natural environments in residential areas serve as a buffer against the adverse impact of stressful life events on residents' health. The British Household Panel Survey also showed that there was a significant improvement in the mental health of those who moved to a greener neighbourhood, as opposed to those who allocated to a less green neighbourhood (Alcock *et al*., 2014). With the increasing interest in the wellbeing benefits of natural environments, several attempts have also been made to incorporate natural environments into health promotion programmes. In some Asian countries like Japan, Taiwan and Korea, forest walking or forest bathing is already popular and is considered a type of alternative therapy due to its health benefits. Shin *et al*. (2013) showed that walking in the forest,

especially meditative walking, has greater effectiveness on certain psychological aspects, such as happiness and self-esteem, as compared to walking in the gym. Sonntag-Öström *et al*. (2015) also showed that combining forest visits with other relaxation activities (e.g. breathing and focusing on an object) supports people with mental illness in dealing with stress, and speeds up their recovery process. In the UK, local and national environmental organisations are starting to provide a wide range of nature-based activities/programmes (e.g. Wild at Heart programme by Sheffield & Rotherham Wildlife Trust, 2019) for vulnerable groups, including those suffering from mental health issues (Bragg and Atkins, 2016). Several studies have demonstrated the physical, social and psychological benefits of these nature-based activities, such as improvements in mood, self-esteem and social interaction, and reductions in stress, anxiety and depression (e.g. Adevi and Mårtensson, 2013; Sahlin *et al*., 2016).

More recently, the Public Health Research programme under the National Institute for Health Research (NIHR PHR) has recently issued a call for research bids on place-based interventions, entitled "*Understanding the Potential of Place to Impact Health and Health Inequalities*", with the goal of improving public health and minimising health inequalities. The NIHR (2019) highlighted that "*the unique and individual nature of the built and natural environment make it difficult to develop evidence-based approaches that can be universally applied, and successful practices in one community setting may not always be transferable to another*". Traditional approaches of evaluating health/wellbeing interventions have focused on the efficacy of the intervention alone and overlooked the impact of the place where they are carried out. Thus, more studies need an upstream approach (e.g. evaluations involving researchers, practitioner and policy makers) and to take a broader perspective evaluation across disciplines.

The relevance and impact of the present PhD study resides in the fact that it represents one of the first studies to incorporate place-based assets into a commonly used wellbeing intervention. The aim of the study is to investigate the potential for enhancing the effectiveness of mindfulness-

based stress reduction (MBSR) by combining it with exposure to the natural environment, and to explore the interactions leading to recovery or resilience of mental health and wellbeing with the application of this alternative therapy. This thesis provides a fine-grained insight into existing knowledge of the enhancement of natural environments through the experimental, factorial design and the multiple outcome measures.

1.2 Disciplinary orientation

The starting point and focus of this thesis is in the field of landscape architecture, but the theoretical base and methods mainly stem from other research areas. Interdisciplinary research has been proven as the most effective approach for gaining new knowledge in this area of research. The interdisciplinary approach has allowed this PhD study to borrow and combine theories, concepts and methods from different disciplines, such as environmental psychology, landscape and urban planning and mental health and wellbeing research. By integrating different perspectives across various disciplines (Botvina, 2019), this study effectively assesses the effectiveness of incorporating the beneficial effects of exposure to nature in a common wellbeing intervention (i.e. mindfulness-based stress intervention: MBSR).

1.3 Thesis structure

This section draws an overview of the contents of the present thesis (Figure 1.1).

Chapter Two reviews the literature that provides the background and theoretical framing of this study. The literature review includes an overview of the role of natural environments in mental health and wellbeing; the health and wellbeing benefits of mindfulness-based stress reduction (MBSR); and the relationship between nature environments and mindfulness practice.

Chapter Three provides an overview of the three-phased experimental research design and methodology.

Chapter Four presents Phase 1 of this study, "*Simulated natural environments bolster the effectiveness of brief mindfulness-based stress reduction (MBSR): a comparison with a relaxation-based intervention*". This is a scoping study of the main field experiment (phase 2), testing the effect of MBSR (i.e. MBSR vs. relaxation control group) and environmental conditions (i.e. woodland vs. parkland vs. urban setting vs. a room with white walls) using *simulated* environments.

Chapter Five presents Phase 2 of this study, "*Does a natural environment enhance the effectiveness of mindfulness-based stress reduction (MBSR)? Examining the mental health and wellbeing, and nature connectedness benefits*". This is the main field experiment to examine the enhancement of a natural environment on the MBSR outcomes using *actual* settings (i.e. natural outdoor vs. built outdoor vs. indoor).

Chapter Six presents Phase 3 of this study, "*Examining the effectiveness of mindfulness-based stress reduction (MBSR) in simulated environment and actual natural environments: secondary data analysis*". Here, secondary data analysis comparing the effectiveness of MBSR between a simulated and an actual natural environment is conducted to gain further knowledge of the role of natural environments in the enhancement of MBSR benefits.

Chapter Seven summaries the key findings of the three-phased study, and discusses the value of this study, being aware of its main limitations, and gives some recommendations for future research and practical implications.

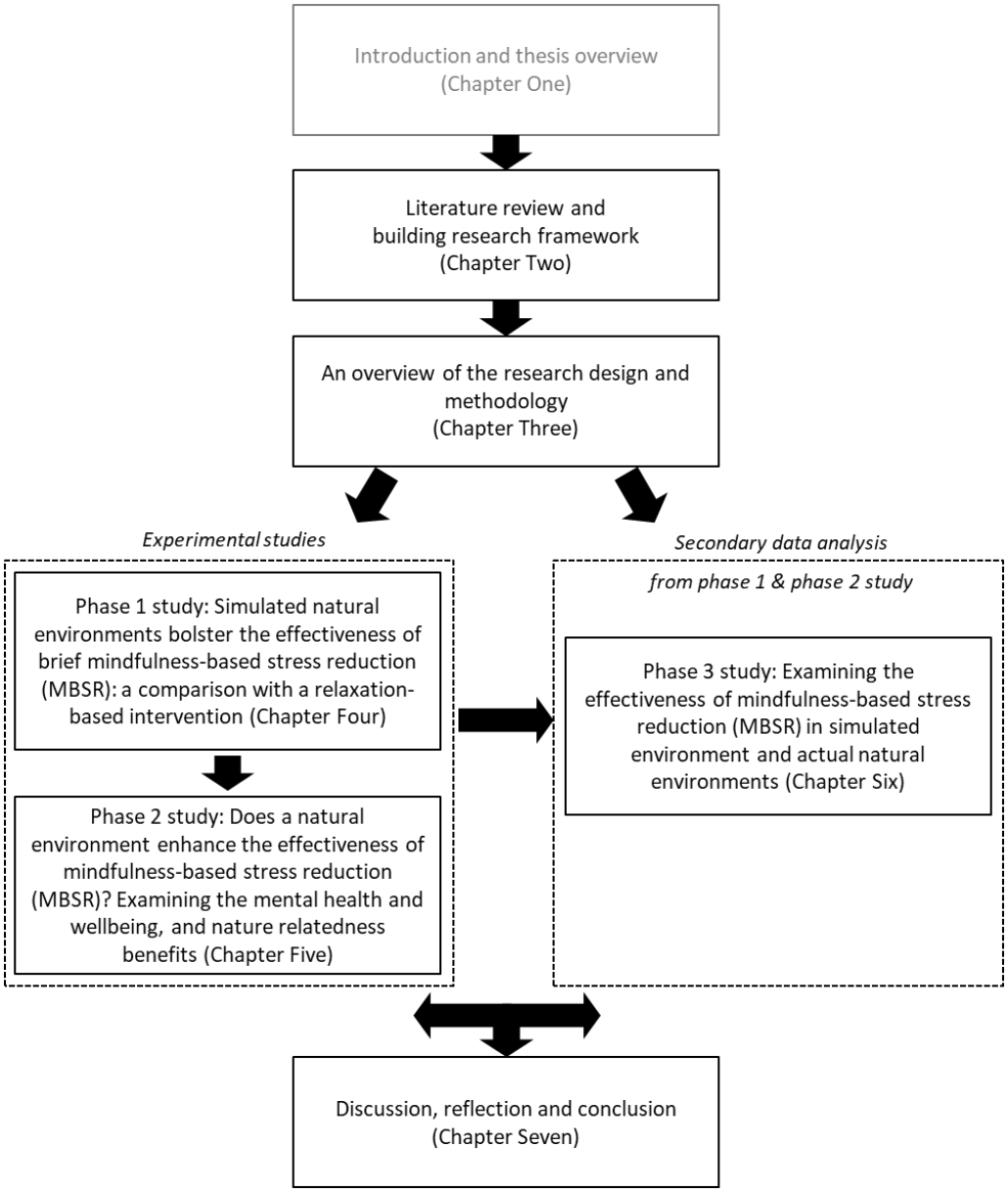

Figure 1.1 Structure of the thesis

CHAPTER TWO:
THEORETICAL FRAMEWORK

2.1 Introduction

This chapter reviews the relevant literature that establishes the underlying basis of the research framework of the current study (Figure 2.1). It first reviews the relationship between the natural environment and mental health, and also presents the mental health and wellbeing benefits of mindfulness-based stress reduction (MBSR). Following that, this chapter reviews the health-related benefits of combined activities with natural environments through 'green exercise' and 'green care', followed by a discussion on the relationship between the natural environment and mindfulness practices. Finally, the findings of literature review and the identified research gaps are summarised and the theoretical framework 'mindful natural relatedness' presented.

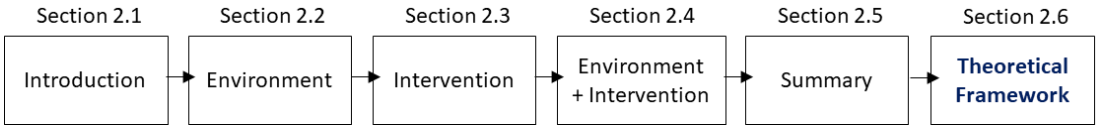

Figure 2.1 The structure of chapter two

2.2 Nature as a restorative environment

This section reviews the findings of prior studies over the past decade on the mental health and wellbeing benefits of natural environments in terms of: 1) pathways linking natural environments to improved mental health and wellbeing; 2) mental health and wellbeing benefits of exposure to natural environments; and 3) nature connectedness as a key component of the mental health and wellbeing benefits of natural environments.

2.2.1 Pathways linking natural environments to improved mental health and wellbeing

Over several decades, various potential pathways (mechanisms leading to health benefits) delivering the mental health benefits of exposure to nature have been proposed across diverse contexts, such as environmental and social epidemiology, environmental psychology, forestry, geography, landscape studies, and urban planning. The pathways have been categorised into three domains that highlight the basic functions of the natural environment (Markevych *et al.*, 2017; Von Lindern *et al*., 2017): a) minimisation of adverse effects (e.g. minimise noise and air pollution), b) enhancement of restoration opportunities (e.g. recuperation from stress and attention fatigue), and c) development of the individual's capacity to utilise resources (e.g. promote physical activity and social interaction).

Minimisation of adverse effects

Noise and air pollution have been identified as potential causes of poor mental health in urban areas. Being exposed to noise and air pollution increases annoyance and promotes social isolation (Dzhambov *et al.*, 2018), and also reduces involvement in outdoor activity (Roswall *et al.*, 2017).

The natural environment is widely known to minimise the adverse effects of noise and air pollution on mental health and wellbeing. For instance, the inclusion of the natural elements in areas that are exposed to noise pollution was found to positively influence the emotional processing of the residents (e.g. enabling them to recuperate from stress or mental fatigue) (Yang *et al*., 2011). Besides that, having trees and other vegetation in the urban residential area enhances the air quality improving the physical and mental health of the residents (Dadvand *et al.*, 2012).

Adding to that, the recent BREATHE[1] project, which assessed the relationship between the exposure to ultrafine air pollutants and brain development in school children using repeated cognitive tests, revealed that the exposure to natural environments enhanced cognitive development via the reduction of air pollution as a partial mediator (Dadvand *et al.*, 2015).

Enhancement of restoration opportunities

The positive psychological influence of exposure to natural environmental settings has been widely recognised in the context of the Attention Restoration Theory (ART) (Kaplan, 1995) and Stress Reduction Theory (SRT) (Ulrich *et al.*, 1991). Both ART and SRT focus on the benefits of restoration opportunities through exposure to natural environmental settings. However, ART emphasises the restoration of a functional capability (i.e. attention), while SRT promotes the reduction of psycho-physiological stress.

Accordingly, ART incorporates concepts of directed attention, involuntary attention, and cognitive restoration from mental fatigue. Directed attention involves mental effort to perform cognitive assignments, such as report writing or answering questions. The absence of directed attention when brain capacity is exhausted results in mental fatigue and tiredness (Kaplan, 1995). When one experiences mental fatigue, the quality of decision-making and self-control become poorer, resulting in various health-related problems (Ohly *et al.*, 2016). Unlike directed attention, involuntary attention (or fascination) is less mentally strenuous and serves to replenish the function of directed attention (Kaplan, 1995). According to ART, specific settings promote involuntary attention and offer a "*restorative environment*" in terms of (1) a feeling of escaping from daily routine, (2) involuntary "soft fascination" without cognitive effort, (3) a sense of

[1] BREATHE is a population neuroscience study involving 2,715 children (aged 7 to 10 years) in Spain to assess whether exposure to traffic-related air pollutants has a negative impact on school children's cognitive development (Sunyer *et al.*, 2015).

"extent" (i.e. physically or conceptually large enough that one's mind can wonder within it), and (4) harmonious relationship between one's predispositions and the attributes of the surroundings (Kaplan, 1995; Ohly *et al.*, 2016). These four characteristics of the restorative environment allow people to have positive and favourable experience with less disturbance; this enables them to recuperate and restore their directed attention. Besides that, visiting places with these characteristics consistently allows one to be less fatigued, experience less self-regulatory mistakes, and minimises stress by strengthening the required resources to address taxing or intimidating circumstances. Kaplan (2001) and Herzog *et al*. (2003) highlighted the significance of the natural environmental settings, compared to other settings, in offering restorative opportunities.

Meanwhile, according to SRT, changes in emotional state lead to a lowering of stress through the restorative influences of natural environmental settings. Ulrich (1984) experimentally compared the recovery from surgery of two groups of patients when they were exposed to the views of natural environment and non-natural environment (i.e. a brick wall), which revealed that the patients who had the view of natural environment required less medication, experienced lower post-surgical problems, and were discharged earlier from the hospital compared with those who had the non-natural environment. Similarly, Diette *et al*. (2003) showed that the exposure to natural environments (i.e. natural sights and sounds) effectively distracted patients from their stress and pain.

As people distinctively perceive the natural environment as non-aggressive (Wilson, 1984), it allows them to feel more positive emotion and reduces their physiological activation. Therefore, being exposed to natural environments prompts speedier recuperation from severe stress, prevents the occurrence of chronic stress, and ensures one's adaptability to varying conditions over time (Ulrich *et al.*, 1991). Numerous studies have supported SRT by linking exposure to the natural environment and restorative psycho-physiological responses, such as reduced heart rate (Lee *et*

al., 2011; Tsunetsugu *et al.*, 2013), blood pressure (Tsunetsugu *et al*., 2013), and stress hormone levels (Lee *et al.*, 2011; Ward Thompson *et al.*, 2012).

Overall, the concepts of both ART and SRT have been substantiated in various prior studies that have compared restorative benefits in the natural settings and urban settings (see Roe and Aspinall, 2011; Aspinall *et al.*, 2015; Gidlow *et al.*, 2016) and natural settings and indoor settings (see Van den Berg and Custers, 2011; Rogerson *et al.*, 2016). Several recent studies also explored differential restoration values of different natural environmental settings (see White *et al.*, 2013; Carrus *et al.*, 2014) and different ways of being exposed to natural environments (see Kjellgren and Buhrkall, 2010; Gatersleben and Andrews, 2013), which are reviewed in Chapter Three, Section 3.2.2.

Development of the individual's capacity to utilise resources

Several studies suggest that natural environments are often related to the levels of physical activities or social coherence, without a direct effect on the relationship between green space and health benefits (Richardson *et al*., 2013). Stronegger *et al*. (2010) found that residents' satisfaction with environmental quality of the living environment is associated with their regular physical activity and health-related benefits. Accommodating natural environmental settings in a neighbourhood, such as green spaces with excellent accessibility and amenities, provide pleasant environments and attractive experiences for outdoor physical activities (Hartig *et al.*, 2014). Moreover, Sugiyama *et al*. (2010) and De Vries *et al*. (2013) found that the mental health and wellbeing benefits of physical activity in natural environments are strongly mediated by social cohesion. Natural environments also provide places for contacts with neighbours, which are likely to increase social cohesion within a neighbourhood. In this context, social cohesion is typically expressed as a sense of community that emphasises trust, common norms and values, pleasant relationships, and the sense of being accepted and belonging (Forrest and Kearns, 2001). Maas *et al.* (2009) also highlighted the lack of natural environmental attributes in the living environment

corresponded to perceived solitude and inadequate social support, which result in poorer mental health and wellbeing.

Although the various pathways have been organized into the three domains (i.e. minimisation of adverse effects, enhancement of restoration opportunities, and development of the individual's capacity to utilise resources), these domains may overlap and influence one another in actual cases. For example, community gardening promotes social interaction and allows the participants to recuperate from stress. Similarly, forest bathing (*Shinrin-yoku*) is believed to exhibit health benefits of certain substances in the air and reduces stress (e.g. distance from the daily stresses) (Hartig *et al.*, 2014).

2.2.2 Benefits to mental health and wellbeing associated with exposure to natural environments

This section reviews relevant experimental studies on the mental health and wellbeing benefits of natural environmental settings, specifically a) reduced stress, b) improved emotional restoration, c) enhanced self-esteem and life satisfaction, and d) increased attention and memory.

Reduced stress

Stress is a significant health issue that is closely linked to mental health, such as depression and burnout syndrome (Tyrväinen *et al.*, 2014). The relationship between exposure to the natural environmental settings and stress reduction has been extensively demonstrated. For example, Van den Berg and Custers (2011) found lower cortisol levels after 30 minutes of outdoor gardening. Roe *et al*. (2013) and Tyrväinen *et al*. (2014) also confirmed that even a short visit to a natural area has a significant benefit on stress reduction compared to a non-natural area. Recent experimental study by Ewert and Chang (2018) found that visitors to natural environments had noticeably reduced in both physical and psychological stress levels after the visit, as opposed to

those who visited a more built-up outdoor setting or indoor sports centre. Especially, several experiments have shown physiological stress-releasing effects of forest environments, such as reduced blood pressure, pulse rate, and cortisol level[2]. The results of the physiological responses suggest that taking part in activities conducted in forests induces relaxation and reduces the adverse effects of stress (Park *et al.*, 2010; Lee *et al.*, 2011).

Natural environments may not only influence stress directly, but may also have indirect effects by serving as a buffer against the adverse health-related effects of stress. For example, Brown *et al*. (2013) found that participants who viewed the natural environment prior to being subjected to a mental stressor demonstrated greater recovery compared to those who had a view of the built environment.

Improved emotional restoration

Being exposed to the natural environment boosts relaxation and positive mood as well as minimising negative mood. Nisbet and Zelenski (2011) found that the participants of an outdoor walking group (who took a route along a canal to an arboretum) were more relaxed than the participants of an indoor walking group (who took a route along the corridor of a university building). Similarly, Roe and Aspinall (2011) also found that participants who had an hour's walk in the woodland and open countryside revealed positive mood and led better manageability of personal projects. Using an experimental design, the participants in the study by Van den Berg *et al*. (2014) were subjected to a mental stressor before they were randomly assigned to a simulated walk, either in the natural environment or built urban environment. This revealed that participants assigned to a simulated walk in the natural environment had speedier recovery from negative

[2] Cortisol is commonly known as the stress hormone. It is released via the hypothalamic-pituitary-adrenal (HPA) axis in higher doses under stressful conditions (Seplaki *et al.*, 2004).

mood and exhibited greater vitality and restorative state. Aspinall *et al.* (2015) also found that the transition from a shopping street in an urban area to an urban green space improved participants' mental state, specifically lower stimulation and annoyance.

Enhanced self-esteem and life satisfaction

Another element of mental health is self-esteem, which refers to one's sense of personal and individual worth (Barton and Pretty, 2010). High self-esteem serves as a buffer against the adverse effects of stress, depression and anxiety symptoms (Doron *et al.*, 2013). A study showed that participants who exercised on a treadmill reported higher self-esteem when they were exposed to a projection of a pleasing country view compared with the exercise-only control (Pretty *et al.*, 2006). Likewise, Barton *et al*. (2012) also found higher self-esteem and mood among the participants who took part in a natural walking group, as compared to those who took part in a social activities club and swimming.

Meanwhile, the most commonly used approach to measuring wellbeing is by assessing life satisfaction (e.g. Harrington and Loffredo, 2011; Biedenweg *et al.*, 2017). Life satisfaction is influenced by different aspects of one's life including the financial, health and career success; this is also associated with the subjective wellbeing, such as levels of happiness and flourishing life (Leung *et al*., 2011). Biedenweg *et al*. (2017) recently found a statistically significant relationship between the natural environmental settings and life satisfaction, and White *et al.* (2013) also demonstrated that individuals who live in greener areas show higher life satisfaction.

Increased attention and memory

Being exposed to natural environmental settings has a positive influence on the cognitive development and attention (Bowler *et al*., 2010). Shin *et al*. (2011) found that the cognitive function of participants improved significantly after taking a 50-minute walk in the forest (i.e.

time taken to complete the task was seven seconds faster), but not when they walked in the town. Similarly, Perkins *et al*. (2011) also found significant improvement in short-term memory among the participants who had a 20-minute walk in a wooded trail. Additionally, Berman *et al*. (2012) found that individuals who were diagnosed with major depressive disorder (MDD) demonstrated significant improvement in short-term memory and working memory capacity after they took a walk in the natural environment.

Another recent experiment explored the cognitive benefits of being exposed to the natural environment through advertisement found improved attention and memory restoration. Unlike an advertisement that displayed appealing images (such as a good-looking young couple, a contemporary living room, and a view of an urban area), the advertisement that displayed images of nature (such as lakes, forest, or a tree in a field) appeared to yield greater memory scores in both unaided recall and brand recognition (Hartmann *et al*., 2015).

Table 2.1 Selected recent experimental studies on mental health and wellbeing benefits of exposure to natural environments

Benefit	Study	N	Sample characteristics	Measurements
Reduced stress	Ewert and Chang (2018)	105	Adults	Perceived Stress Questionnaire (PSQ), Salivary cortisol, α-amylase
	Jung *et al*. (2015)	211	Adults	Maslach Burnout Inventory-General Survey (MBI-GS), Recovery Experience Questionnaire (REQ), Worker's Stress Response Inventory (WSRI), Heart rate variability (HRV), Salivary cortisol
	Tyrväinen *et al*. (2014)	77	Adults	Subjective Vitality Scale (SVS), Positive and Negative Affect Scale (PANAS), Perceived Restorativeness Scale (PRS), Salivary cortisol

	Adevi and Maartensson (2013)	5	Participants with stress disorder	Interviews: overall experiences of how the rehabilitation had implications on their health and wellbeing
	Roe *et al*. (2013)	106	Adults	Perceived Stress Scale (PSS), Salivary cortisol
	Lee *et al*. (2011)	20	Male adults	Salivary cortisol, Pulse rate
	Van den Berg and Custers (2011)	30	Adults	Salivary cortisol, Positive and Negative Affect Schedule (PANAS)
	Park *et al.* (2010)	280	Adults	Salivary cortisol, Heart rate variability (HRV), Pulse rate, Blood pressure
Improved emotional restoration	Song *et al*. (2017)	26	Adults	Blood pressure
	Aspinall *et al*. (2015)	12	University students	Electroencephalography (EEG)
	Van den Berg *et al*. (2014)	102	University students	Short form of the Profile of Mood States (POMS-SF)
	Roe and Aspinall (2011)	123	Adults	University of Wales Institute of Science and Technology (UWIST) Mood Adjective Checklist (MACL), Personal Projects Analysis (PPA)
	Nisbet and Zelenski (2011)	150	University students	Positive and Negative Affect Schedule (PANAS)
Enhanced self-esteem and life satisfaction	Lee *et al*. (2019)	9	Middle-aged women	Focus group discussions using semi-structured interviews
	Barton *et al.* (2013)	53	Participants with mental health problems	Rosenberg Self-Esteem Scale (RSE), Profile of Mood States (POMS), Total Mood Disturbance (TMD)
Increased attention and memory	Han (2017)	116	University students	Profile of Mood States (POMS), Wechsler Memory Scale (WMS-III)
	Gamble *et al*. (2016)	56	University students	Attention Network Test (ANT)
	Gidlow *et al*. (2016)	38	Adults	Backward Digit Span (BDS)
	Hartmann *et al*. (2015)	312	University students	Interview: unaided recall, recognition of the advertised product
	Berman *et al*. (2012)	20	Participants with major depressive disorder	Positive and Negative Affect Schedule (PANAS), Backward Digit Span (BDS)
	Shin *et al*. (2011)	60	University students	Trail Making Test (TMT)
	Perkins *et al*. (2011)	26	University students	Digit Span Forwards (DSF), Digit Span Backwards (DSB), Logical Memory (LM)

2.2.3 Nature connectedness: a key component of the mental health and wellbeing benefits of natural environments

About half of the growing global population lives in cities with most people spending increasing amounts of time in an enclosed building (United Nations, 2017). Wilson's (1984) "*Biophilia Hypothesis*" argues that people are inherently connected to nature, so the lack of connection to nature may be having a negative influence upon human health and wellbeing (Capaldi *et al*., 2014). Consequently, people have the need to connect with nature and it promotes mental health and wellbeing including emotional, cognitive and spiritual development when this need is satisfied.

Various concepts and measures have been formulated to examine the relationship between humans and nature, including connectedness to nature (Mayer and Frantz, 2004), connectivity with nature (Dutcher *et al.*, 2007), and nature relatedness (Nisbet *et al*., 2009). In particular, Mayer and Frantz (2004) described nature connectedness as an "*individual's experiential sense of oneness with the natural world*" (p.504), where this connection is conceptualised as the assessment of the affective component of the human-nature relationship. Dutcher *et al.* (2007) defined connectivity with nature as "*a perception of sameness between the self, others, and the natural world*" (p. 474). In other words, connectivity with nature refers to the experience of nature as a part of the community (like a sense of belonging). Besides that, nature relatedness refers to a multifaceted construct that incorporates the "*affective, cognitive, and experiential relationship individuals have with the natural world or a subjective sense of connectedness with nature*" (Nisbet *et al*., 2009, p.719). Using these measures, several studies have indicated that people who more frequently visited natural environments reported greater feeling of nature connectedness (Hinds and Sparks, 2008; Richardson and Sheffield, 2017). Additionally, experiencing the natural environment, as compared to the indoor or urban built environment, yields greater feelings of nature connectedness (Nisbet and Zelenski, 2011). Although these studies used various concepts and measures, they address a similar concept. Thus, the term 'nature connectedness' was adopted

in the present study given its link to a combination of emotion, attitude, belief, and behaviour towards the natural environment.

Individuals who are connected to nature derive a feeling of meaningful existence from that connection, leading to positive health and wellbeing (Howell *et al*., 2013). There are two types of wellbeing experience, namely hedonic and eudaimonic: hedonic wellbeing emphasises happiness, which can be defined as the presence of positive affect and the general absence of negative affect, whereas eudaimonic wellbeing is related to a sense of having a purposeful and full lifestyle (Deci and Ryan, 2008; McMahan and Estes, 2011). Previous studies have found that nature connectedness had a positive correlation with hedonic wellbeing in terms of happiness (Mayer *et al*., 2009; Nisbet and Zelenski, 2011), positive and negative affect (Howell *et al*., 2011; Nisbet *et al*., 2011), and vitality (Nisbet *et al*., 2011; Cervinka *et al*., 2012). At the same time, some other studies have shown a positive relationship between connection to nature and eudaimonic wellbeing: nature connectedness gives a sense of purpose and belonging to nature (Trigwell *et al*., 2014; Cleary *et al.*, 2017). On a similar note, Nisbet *et al*. (2011) also highlighted that an individual's nature connectedness is linked to their sense of purpose, self-determination and personal development. Cervinka *et al*. (2012) also demonstrated similar findings in which nature connectedness is strongly connected to sense of purpose. Basically, eudaimonic wellbeing is likely to be related to long-term and enduring wellbeing, whereas hedonic wellbeing comes from the short-term experience of simple pleasures (Steger *et al*., 2008).

2.3 Mindfulness practice as a wellbeing intervention

2.3.1 Understanding of mindfulness

Mindfulness practice has gained growing attention as an approach to address mental health problems and daily stress (Spijkerman *et al*., 2016). Based on Eastern beliefs (e.g. Taoism and Buddhism), mindfulness can be described as an approach that emphasises the experience of here

and now. Kabat-Zinn (1994) defined mindfulness as "*paying attention in a particular way: on purpose, in the present moment, non-judgmentally*" (p. 4). Mindfulness requires one to focus on the mind, body, and surroundings in the present moment with curiosity and compassion (Mindfulness Initiative, 2015). Mindfulness practice can be performed through various straightforward meditation practices that enhance one's attentiveness and ability to address one's thoughts, emotions, and actions. In this case, Bishop *et al.* (2004) introduced two components of mindfulness: self-regulation of attention and orientation to experience. Firstly, the self-regulation of attention focuses on sustaining present thoughts, emotions, and ambiences to heighten awareness of immediate psychological processes. Secondly, the orientation to experience focuses on the adoption of a specific attitude (i.e. curiosity, openness, and acceptance) towards the present experience, resulting in an enhanced ability to accept and respond to life's challenges/stress towards achieving greater mental health and wellbeing (Segal *et al*., 2002).

The potential salutogenic benefits of mindfulness practice have been recognized (Keng *et al*., 2011; Mindfulness Initiative, 2015), and mindfulness practice has drawn attention as an intervention in a clinical/medical setting to address specific disorders (e.g. chronic pain or anxiety). There have been various standardised Mindfulness-Based Interventions (MBIs) that incorporate the fundamentals of conventional mindfulness practice and modern psychological practice for the overall improvement of mental health and wellbeing (Gu *et al.*, 2015).

2.3.2 Mindfulness-Based Stress Reduction (MBSR)

In the 1970s, the University of Massachusetts Medical Centre proposed a group-based programme as a complementary intervention for patients with chronic physical and psychological conditions, which is still known as MBSR (Kabat-Zinn, 1982). MBSR incorporates various mindfulness practices that seek to manage the pain and stress recovery processes of the patients. The initial duration of MBSR was eight weeks, during which up to 30 participants were grouped to meet for two hours on a weekly basis to participate in mindfulness practices (e.g. sitting meditation, body-

scanning, and mindfulness movement). Besides that, this programme strongly encouraged the participants to continue their mindfulness practice at home and to participate in a rigorous mindfulness meditation programme for one day (Kabat-Zinn, 1982). Continual mindfulness practice establishes the underlying basis of MBSR, which trains the individual to be less responsive and critical towards their daily experiences and enhances the capability to defend themselves against stressful or negative events (Keng *et al*., 2011; Mindfulness Initiative, 2015).

The influence of MBSR as a wellbeing intervention has been explored in various prior studies within both clinical and non-clinical contexts. These studies mainly employed randomised controlled experiments, such as the comparison of treatment and waiting-list control. The findings of prior studies on the psychological effects of MBSR are tabulated in Table 2.2, which revealed positive results, including stress reduction (Song and Lindquist, 2015, Simpson *et al*., 2017); relief from emotional distress (Bränström *et al.*, 2010; Farb *et al.*, 2010; Lengacher *et al.*, 2014); depression (Grossman *et al.*, 2004; Song and Lindquist, 2015); and anxiety (Grossman *et al.*, 2004; Vøllestad *et al*., 2011; Song and Lindquist, 2015). Improvement of cognitive performance has also been found (Lao *et al*., 2016; Alkoby *et al*., 2019); positive mood (Bränström *et al.*, 2010); empathy (Shapiro *et al.*, 2011); mindfulness (Shapiro *et al.*, 2011; Song and Lindquist, 2015); self-compassion (Shapiro *et al*., 2011); acceptance (Goldin *et al.*, 2017); and life quality (Henderson *et al.*, 2012).

Table 2.2 Selected randomized controlled trials of MBSR

Study	N	Sample characteristics	Main outcome
Alkoby *et al*. (2019)	85	Undergraduate students	MBSR > Waiting list control: increases in executive control and cognitive flexibility
Norouzinia *et al*. (2017)	60	Nurses	MBSR > Control: improvements in burnout and job stress
Goldin *et al*. (2017)	108	Patients with social anxiety disorder (SAD)	MBSR, Cognitive-Behavioural Group Therapy (CBGT) > Waiting list control: reduction in social anxiety MBSR > CBGT: increases acceptance of anxiety

Simpson *et al*. (2017)	50	Participants with multiple sclerosis	MBSR > Waiting list control: reductions in stress and depression
Song and Lindquist (2015)	50	Undergraduate students	MBSR > Waiting list control: reductions in depression, anxiety and stress
Zhang *et al*. (2015)	60	Patients with breast cancer	MBSR > Usual care: reductions in stress and anxiety
Lengacher *et al.* (2014)	82	Post-treatment breast cancer survivors	MBSR > Usual care: reductions in fear of recurrence, stress and anxiety
Cavanah *et al*. (2013)	104	Undergraduate students	MBSR > Waiting list control: reductions in depression, anxiety and stress, and increases in mindfulness
Henderson *et al.* (2012)	172	Patients in early-stage breast cancer	MBSR > Usual care: quality of life, meaningfulness, depression, hostility, anxiety, unhappiness, and emotional control
Vøllestad *et al*. (2011)	76	Patients with heterogeneous anxiety disorder	MBSR > Waiting list control: reductions in depression and anxiety
Shapiro *et al*. (2011)	30	Undergraduate students	MBSR > Waiting list control: increases in mindfulness, subjective wellbeing and empathy
Grossman *et al*. (2010)	150	Patients with multiple sclerosis(MS)	MBSR > Usual care: reductions in depression, fatigue and anxiety
Farb *et al*. (2010)	36	Adults	MBSR > Waiting list control: reduction in negative emotion
Bränström *et al.* (2010)	71	Patients with breast cancer	MBSR > Waiting list control: reductions in stress and post-traumatic avoidance symptoms and increase in positive emotion

More recently, a brief MBSR format has been introduced to help full-time workers and students to manage time and schedule requirements (Gilmartin *et al.*, 2017). Mackenzie *et al*. (2006) found that a four-week MBSR, which involved a 30-minute group session per week and a 10-minute home practice per week, significantly reduced stress and mental fatigue, and improved the participants' life satisfaction despite its brief implementation. Similarly, Gauthier *et al*. (2015) also found that a short-term MBSR initiative, which involved a five-minute group session on a daily basis for four weeks, substantially reduced the participants' stress levels from the recorded baseline.

2.3.3 Pathways underlying the benefits of mindfulness-based stress reduction (MBSR)

This section reviews the potential psychological pathways that explain the mental health and wellbeing benefits of MBSR. It is imperative to comprehend the underlying basis of the psychological benefits of it in order to develop a framework for relationship between MBSR and restorative natural environments. The following pathways underlying the mental health and wellbeing benefits of MBSR in terms of mindful awareness, acceptance, and self-regulation were identified.

Firstly, MBSR is linked to enhanced mindful awareness, which refers to one's capability to put aside negative thinking and emotion and reflect on these thoughts in relation to the actual depiction of reality (Shapiro *et al.*, 2006). According to Kabat-Zinn (1994), non-judgemental thoughts of pain and anxiety may help one to grasp the notion that mental affairs are merely thoughts that do not necessarily accurately depict reality. For instance, anxiousness and failure are not necessarily linked because thoughts of failure are merely thoughts. Similarly, Teasdale (1999) also found that individuals with depression who commit to mindfulness practice may observe depressive thoughts and attempt to focus on other present events, such as breathing, walking, or nature sounds, resulting in enhanced mindful awareness. Furthermore, Teasdale *et al*. (1995) proposed mindfulness practice as an approach that allows early detection and treatment of mental health problems.

Secondly, MBSR is also linked to acceptance. According to Baer (2003), the fundamental concept of psychotherapy lies in acceptance. For instance, a patient who encounters panic attacks may resort to maladaptive acts in order to avoid future panic attacks, such as avoiding crucial events and demonstrating over-attentiveness and anxiety. However, if the patient is able to accept the occasional, non-threatening occurrence of panic attacks, dangerous repercussions can be

prevented. Hence, MBSR potentially enhances one's capacity to address stress without being subjected to extreme emotional responses.

Finally, several strands of research have implicated mindfulness in both successful self-regulation and psychological wellbeing (Friese and Hofmann, 2016). Self-regulation refers to the ability to control emotions, thoughts and behaviours (Shapiro *et al.*, 2006). Through self-regulation, one would be able to identify and reflect on negative emotions (e.g. panic or anxiousness), which enhances the overall mental health and wellbeing (Shapiro *et al*., 2006). In general, MBSR exhibits the potential to enhance mental health and wellbeing through enhanced mindfulness and non-judgemental acceptance and reduced extreme emotional responses, recurring negative thoughts, and self-rumination.

2.4 Combining the specific activity/intervention with natural environments

As the restorative effects of exposure to the natural environment are widely acknowledged, healthcare and social care practitioners are turning to interventions that incorporate natural environmental settings in order to improve physical and psychological health and wellbeing (Bragg and Atkins, 2016). This section reviews the enhancement of mental health and wellbeing benefits of specific activities/interventions when conducted in natural environments.

2.4.1 Physical activities in natural environments: green exercise

Various studies have demonstrated the positive influence on mental health and wellbeing of visiting the natural environment on a regular basis. The positive influence on physical and mental health of taking part in physical activities on a regular basis has also been widely reported (Scully *et al.*, 1998). Pretty *et al.* (2006) suggested possible synergistic benefit of being physically active in the natural environmental settings.

There are various experimental studies on the concept of "green exercise" that have verified the additional psychological benefits when exercising in a natural environment, as compared to just being in a natural environment or just exercising. For instance, (Rogerson *et al.*, 2016) found that a 15-minute cycling session in the natural outdoor environment, as compared to similar activity in an indoor environment, greatly improved the participants' concentration. Besides that, Bowler *et al.* (2010) found that participants who walked/ran in a natural outdoor environment reported a reduction of negative emotion, as compared to those who performed similar activities in an indoor environment. In addition, physical activities in the natural environment, as compared to the indoor environment, have been found to yield enhanced feelings of revitalisation, vitality, and positive engagement as well as reducing stress, anger and sadness (Coon *et al.*, 2011). Chapter Three, Section 3.2.1 presents more evidence of mental health and wellbeing benefits from green exercise.

2.4.2 Natural-based interventions: green care

The number of green organisations that offer diverse nature-based interventions and environmental volunteering opportunities for vulnerable groups, including those who experience mental health problems, continues to grow (Bragg and Atkins, 2016).

Addressing mental health issues, Mind[3] initiated a new green agenda in 2007 based on the growing evidence of "*an accessible, cost-effective, and natural addition to treatment*" that targets various vulnerable groups. Under the operation of Ecominds (which received a funding of £7.5 million from Big Lottery Fund), Mind promoted 130 projects, which also included the Social and Therapeutic Horticulture (STH) and Care Farming, and assisted over 12,000 mental health

[3] Mind is a mental health charity founded in 1946 as the National Association for Mental Health in England and Wales. Mind works to increase public awareness of mental health problems and offers a wide range of programmes to people with mental health issues.

patients through nature-based interventions (Bragg *et al*., 2013). For instance, professional therapists who are skilled in horticulture, healthcare, and social care administered STH, which incorporated general gardening activities in a structured and formalised programme, for vulnerable groups to cope with their problems of connecting to the physical and psychosocial situations (Sempik *et al*., 2014). There are various studies that demonstrate physical, social, and psychological benefits of nature-based interventions, such as improved mood (Hewitt *et al.*, 2013), self-esteem, and social interaction (Sempik *et al*., 2014) as well as reduced stress (Adevi and Mårtensson, 2013), anxiety, and depression (Sahlin *et al*., 2016). Unfortunately, these studies on nature-based interventions have several limitations, such as having no control group, small sample size, limited quantitative results, and ambiguously defined interventions (Bragg and Atkins, 2016).

2.4.3 Mindfulness practices in natural environments: mindfulness and nature connectedness

Recent studies have sought to define the relationship between mindfulness and nature connectedness. This discussion centres on a 'human-nature connection' being built through mindfulness practice, internal awareness, and attention to self and place (Barbaro and Pickett, 2016). Wolsko and Lindberg (2013) found that greater nature connectedness was consistently associated with greater mindfulness, more engagement in outdoor activities, and greater psychological wellbeing. Similarly, Van Gordon *et al*. (2018) suggest that the experience of mindful awareness can be used to enhance nature connectedness and the restorative qualities of natural environments, and spending time in nature can in turn enhance mindful awareness and cultivate greater insight into the self and the present moment. For instance, the sound of the wind blowing through the trees and the chirping sound of birds are mentally soothing. These are parts of the "forest bathing (*Shinrin-yoku*)" experience that promotes relaxation and helps recovery of emotional balance. In this case, the use of mindfulness to heighten awareness of the forest and personal thoughts allows the formation of a stronger and soothing experience with nature. Nisbet *et al*. (2019) also found that participants who walked in a natural environment with a guided 20

minutes' mindfulness practice reported greater awareness of their surroundings, stronger nature connectedness and less negative emotions than individuals without it. This result suggests that mindfulness practice may enhance the nature connectedness and restorative qualities of natural environments.

Similar to other training means, Lymeus *et al*. (2018) postulated the need of a substantial amount of time, effort, and cognitive resources to learn new skills and establish habits of mindfulness practice as well. Despite that, the capacity of nature to recover the exhausted directed attention (due to mindfulness practice) facilitates one's mindfulness state with ease. With that, Lymeus *et al*. (2017) assessed the concentration of the participants before and after 15-min mindfulness meditation with and without nature images, and rest with nature images (control group). Participants who just rested with nature images showed a significant improvement in their concentration after the sessions compared with their performance before mindfulness meditation. Meanwhile, the meditating participants without nature images demonstrated lower concentration, which may be due to the need for attentional effort. On the other hand, meditating participants with nature images demonstrated no improvement, which may be due to the natural stimuli that compensate the required attentional effort. Further discussion about the relationship between mindfulness and nature connectedness is comprehensively presented in Section 2.6.

2.5 Summary of the findings of the literature review for the framework

This section summarises the findings of the literature review and identifies the gaps specifically driving this study.

Mental health and wellbeing benefits of natural environments

There is increasing recognition of the important role of natural environments in health and wellbeing: as a means of supporting wellbeing and as a key element for preventing and dealing with mental illness. With growing interest in wellbeing and the benefits afforded by natural environments, local and national environmental organisations are beginning to offer different nature-based activities/programmes (e.g. the Wild at Heart programme by Sheffield & Rotherham Wildlife Trust, 2019) for a wide variety of groups, including those suffering from mental health problems. Several studies have demonstrated the physical, social and psychological benefits of these nature-based activities, resulting in improvements in mood, self-esteem and social interaction, and reductions in stress, anxiety and depression. However, the absence of a control group, relatively small sample sizes, lack of quantitative outcomes, and ambiguously defined interventions have been highlighted as limitations and weaknesses of these studies (Bragg and Atkins, 2016). This PhD research is paralleled in green exercise/nature-based intervention studies. However, this research investigates the enhancement of a 'clinical' intervention e.g. Cognitive Behavioural Therapy (CBT) or Mindfulness-Based Interventions (MBIs) through the use of natural environments. Moreover, it differs in that it investigates not only whether the effectiveness of an intervention is enhanced when combined with the experience of a natural environment, but also whether the restorative experience of natural environments is enhanced when combined with the specific activity/intervention.

The feeling of nature connectedness

The feeling of a 'connection with nature' or 'nature connectedness' is described in this research based on individuals' feelings, attitudes and beliefs towards nature. Several studies have shown that people who visit natural environments frequently reported a greater sense of nature connectedness. In addition, nature connectedness is stronger after experiencing natural environments rather than in other environments (e.g. urban built or indoor environments) (e.g. Hinds and Sparks, 2008; Richardson and Sheffield, 2017).

Several studies have revealed that a stronger connection with nature is associated with greater hedonic wellbeing, such as happiness and life satisfaction. At the same time, a feeling of connection with nature is related positively to the eudaimonic aspect of wellbeing by regulating emotions and imbuing people with both purpose and meaning in life and providing them with the feeling that they belong to the natural world. The arising benefits from natural relatedness are crucial, and Richardson and Sheffield (2017) suggest that further research is required to comprehend how to improve and facilitate people's connections with nature. The present study investigates how to enhance an individual's nature connectedness through the combination of mindfulness intervention and exposure to natural environments.

Eudaimonic wellbeing outcomes are likely to be sustained in the long term, whereas the hedonic wellbeing derived from the experience of simple pleasures are likely to dissipate after a short period (Steger *et al*., 2008). Thus, it seems that 'nature connectedness' may support the benefits of wellbeing interventions in lasting longer when conducted in natural environments. In addition, this study also investigates pathways that may be applicable towards the enhancement of mental health and wellbeing outcomes through nature connectedness.

Therapeutic intervention using mindfulness practice

Mindfulness practice has proliferated as a complementary and alternative approach to coping with common mental problems, such as depression, anxiety and stress-related illness. The development of mindfulness skills leads to non-judgemental awareness of all experiences, which in turn increases emotional balance and psychological wellbeing (Baer, 2003). The potential salutogenic benefits of mindfulness have led to the development of mindfulness-based stress reduction (MBSR), which combines the principles of traditional meditation practice with psychoeducational training to improve health and wellbeing (Gu *et al.*, 2015). MBSR offers an intensive 8-week programme or brief 4-6-week programme involving a range of mindfulness practices such as formal mindfulness meditation and mindful movement exercises. The basis of MBSR is that individuals are able to manage their stress and negative thoughts through repeated mindfulness practices (Keng *et al*., 2011; Mindfulness Initiative, 2015). Extensive research has shown the effectiveness of MBSR health and wellbeing benefits including stress reduction, relief from emotional distress, depression, anxiety and the improvement of cognitive performance (e.g. Song and Lindquist, 2015, Simpson *et al*., 2017). While there is much evidence demonstrating the significant mental health and wellbeing benefits of MBSR, there are only a few studies that have investigated the effect of combining mindfulness practice with restorative experiences, such as the exposure to nature (e.g. Kaplan, 2001; Lymeus *et al*., 2017).

Mindfulness practice in natural environments

Practising mindfulness may initially place an additional burden on attentional resources since beginners tend to struggle to manage distractions and learn new skills. However, natural environments could help to restore these attentional resources during mindfulness practice and support the achieving of mindfulness states. Other discussion centres on the 'human-nature connection' being constructed through mindfulness practice, internal awareness, and attention to self and place. Van Gordon *et al*. (2018) suggested that the experience of mindful awareness can be utilised to enhance nature connectedness and the restorative qualities of natural environments.

Likewise, spending time in natural settings can enhance mindful awareness and cultivate greater insight into the self and the present moment. This suggests that the practice of mindfulness is a tool to enhance and assist progress towards the goal of fostering a human-nature connection, leading to positive mental health and wellbeing. The relationship between 'mindfulness' and 'natural connectedness' is the basis for the development of the research framework in the following section 2.6.

2.6 Theoretical framework: mindful-nature connectedness

We now know that natural environments benefit mental health and wellbeing, and that practising mindfulness enables people to deal with their mental stress and negative thoughts. So what if the two are combined? This section brings together several theories and supporting evidence to construct a research framework for examining the synergistic effects of combining the mindfulness-based stress reduction (MBSR) programme with the exposure to natural environments.

Two main assumptions form the theoretical framework:

- Assumption 1: The benefits of MBSR could be achieved with less effort (e.g. time, attention) through the cognitive restoration provided by natural environments.
- Assumption 2: The beneficial effects of natural environments could last longer when combined with mindfulness practice (see Figure 2.2).

The first assumption is based on the Kaplan's Attention Restoration Theory (1995). At the beginning of MBSR, it requires to devote much effort and cognitive resources to learn new skills and establish practice habits. On the other hand, restorative experience gained from natural environments involves avoiding the unnecessary use of directed attention and the restoration of depleted attentional capabilities. Accordingly, attention fatigue from the mindfulness practice

could be restored faster by the restorative experience gained from natural environments; and the benefits of MBSR could be achieved with significantly less effort (e.g. less practising time and attentional resource) when MBSR is in natural environments.

The second assumption of the framework involves the concept of 'mindful-nature connectedness' which is constructed through mindful awareness (e.g. Schutte and Malouff, 2018; Van Gordon *et al*., 2018). When MBSR is in natural environments, the experience of mindful awareness increases awareness of natural surroundings. The restorative experience in natural environments (i.e. fascination) creates the allure for repetition thereby creating a positive feedback loop and deeper nature connectedness. Consequently, the effectiveness of MBSR sustains much longer through in-depth interaction with nature.

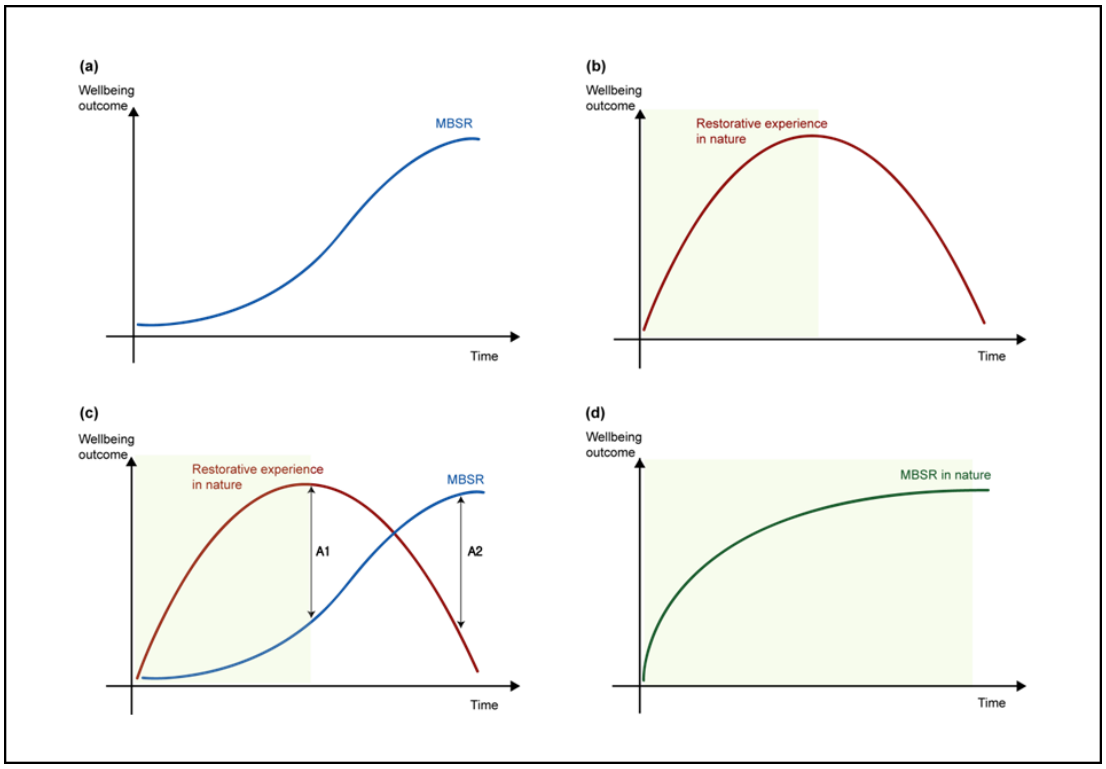

Figure 2.2 Research framework. The graphs describe the two assumptions. (a) The blue line shows the change of MBSR benefits over time. Much time is needed to achieve a certain level of mindfulness, but the efficacy of the mindfulness might continue over a long period once acquired. (b) The red line shows the change in the psychological restoration through exposure to natural environments over time. During the association with natural environments, there is both an affective and cognitive restoration, but the beneficial effects are likely to be depleted in the short-term (when returning to the everyday environment). (c) In this PhD, I attempt to close the gap between the short-term effects of natural environments and the long-term effects of MBSR. (d) The green line shows my expectation of the mental health and wellbeing outcomes of MBSR when conducted in natural environments.

CHAPTER THREE:
RESEARCH METHODOLOGY

3.1 Research aim and questions

This research aims to investigate whether the impacts of a commonly used wellbeing intervention, Mindfulness-Based Stress Reduction (MBSR), are enhanced when combined with the benefits of being exposed to natural environments. The study incorporates the restorative effect of nature into MBSR and assesses the effectiveness of the combined intervention in different settings. Based on prevailing knowledge, the following questions have been developed to guide this research.

This PhD research includes three-phase experimental research. **Phase 1** consists of a laboratory experiment in which participants were randomly assigned to a control group or to a three-week brief MBSR programme in different simulated environments. **Phase 2** is a more extended study using actual environments. Finally, **Phase 3** compared the efficacy of MBSR between simulated and actual natural environments, using secondary data analysis – qualitative and quantitative data from earlier studies.

Phase 1 study

Q1. Do participants in the MBSR programme show a greater improvement in mental health and wellbeing than those in the relaxation-based intervention group (control group)?

Q2. Are the mental health and wellbeing outcomes of the MBSR programme in simulated natural environments greater than simulated non-natural environments?

Q3. Do the characteristics of natural environments (i.e. woodland vs. parkland setting) make a difference to the health and wellbeing outcomes?

Q4. Do changes in nature connectedness mediate the effects of MBSR on mental health and wellbeing?

Phase 2 study

Q1. Does attending the MBSR programme in a natural outdoor environment result in greater nature connectedness than in a built outdoor or an indoor environment?

Q2. Does the MBSR programme achieve the best mental health and wellbeing outcomes when conducted in a natural outdoor environment?

Q3. Do changes in nature connectedness mediate the effects of MBSR on mental health and wellbeing?

Phase 3 study

Q1. Is there a difference between the mental health and wellbeing outcomes in a simulated natural environment compared with an actual natural environment?

Q2. Do participants practising MBSR in an actual natural environment show greater nature connectedness than those experiencing a simulated natural environment?

3.2 Research design

3.2.1 Methodological approaches to examine the benefits of natural environments

The mental health and wellbeing benefits of exposure to natural environmental settings, as compared to built outdoor or indoor environmental settings, have been substantially justified by a substantial body of evidence. Relevant studies have mainly employed the following methodological approaches (Bamberg *et al*., 2018): 1) comparison of outcomes of activities conducted in built outdoor environments and natural outdoor environments; 2) comparison of outcomes of activities conducted in indoor environments and natural outdoor environments; 3)

comparison of outcomes of activities conducted in built simulated environments and natural simulated environments.

Built outdoor environment versus natural outdoor environment

Berman *et al*. (2008) compared psychological restoration following a 50-minute walk in an urban environment (i.e. a street with university and office buildings) and a natural environment (i.e. an arboretum), which revealed that the natural environment greatly improved the participants' overall emotional state and directed-attention. Likewise, Roe and Aspinall (2011) also compared the restorative benefits of walking in urban and rural settings using two quasi-experiments, which consistently demonstrated significant more positive changes in the levels of energy, hedonic tone, stress, and enjoyment as well as cognitive function (e.g. control and efficacy), among the participants who took a walk in the rural area. Meanwhile, according to Gidlow *et al.* (2016), walking in a natural environment had greater benefits of cognitive function, which lasted for 30 minutes after leaving the environment, when compared to walking in an urban environment.

Adding to that, the psycho-physiological health benefits in terms of cardiovascular (e.g. heart rate or blood pressure), neuroendocrine (e.g. cortisol), and brain activity, following the exposure to the natural environmental settings, have also been substantiated. For instance, Lee *et al.* (2011) compared the psycho-physiological responses of participants following the exposure to forest and urban environments in a three-day field experiment. They revealed significant reduction in the salivary cortisol level among the participants in the forest, who also expressed calmness and peacefulness as opposed to those in the urban environment. Besides that, Aspinall *et al.* (2015) focused on the use of mobile electroencephalography (EEG) to keep track of the emotional experience of walkers on a shopping street, a green path, and a busy commercial street, which revealed that a brief walk in the natural environment greatly reduced annoyance and stimulation as well as enhancing meditation.

In addition, some research has explored the effects of repeated exposure to natural environmental settings. For example, participants who regularly (at least once per week) visited natural environments (e.g. open green space, woodland, or forest) reported a lower risk of mental ill health compared to non-users (Mitchell, 2013). In another study, an eight-week experiment, which involved 94 office employees who walked during their lunch break in the natural environment (i.e. along a path with trees, well-kept grass, and public footpaths) or the built environment (i.e. along a path through residential and industrial zones), revealed that the mental health of those who had the opportunity to take a walk in the natural environment was substantially improved, compared with the built environment group (Brown *et al.*, 2014).

Indoor environment versus natural outdoor environment

Ryan *et al.* (2010) experimentally assessed the effects of a 15-minute walk in the indoor environment (i.e. a series of secluded underground corridors and tunnels) and natural outdoor environment (i.e. a tree-lined route along a river). The study reported enhanced vitality among the participants who had the opportunity to walk in the natural outdoor environment. Likewise, Kerr *et al.* (2006) also found enhanced positive mood (e.g. exhilaration) and reduced negative mood (e.g. nervousness and stress) among those who had a 5-km run in a natural outdoor environment compared to those who performed a similar activity in an indoor environment (i.e. a treadmill in a laboratory). Meanwhile, Rogerson *et al.* (2016) found that participants who cycled for 15 minutes in the natural outdoor environment (i.e. sports ground), as compared to those who cycled for 15 minutes in the indoor environment (i.e. laboratory) demonstrated higher social engagement and cognitive restoration.

In addition, several studies have also compared the effectiveness of interventions in the indoor environment and natural outdoor environment. For instance, Van den Berg and Custers (2011) examined the effects of 30-min of outdoor gardening and indoor reading on stress reduction. First exposed to a stressful task and subsequently assigned to one of two conditions, outdoor gardening

or indoor reading activities. The results indicated that participants who participated in 30-minute outdoor gardening exhibited greater stress recovery than indoor reading. After the gardening, levels of salivary cortisol reduced and positive mood had fully restored prior to the stress induction. Similarly, Sahlin *et al.* (2016) conducted a 30-minute guided relaxation session in a natural outdoor setting (i.e. woodland in a large city park) compared to an indoor setting (i.e. small white room without wall decoration or potted plants). The result showed that relaxation activity in a natural outdoor setting had a positive effect on directed attention.

Built simulated environment versus natural simulated environment in laboratory

The laboratory may not offer full sensory experiences of the exposure to the actual environment that is being simulated but this approach allows the researcher to have complete control over the rigour of the procedure and to focus on the significance of a visual stimulus (Rogerson *et al.*, 2016). Raanaas *et al*. (2011) randomly assigned the patients who had to undergo a residential rehabilitation programme into private bedrooms with either a panoramic view of nature or a view of buildings to assess whether the bedroom window view influences patients' health and wellbeing. The study found that participants who had the view of nature demonstrated a significant improvement in their physical and mental health, compared with participants who had the view of buildings. In another study, Van den Berg *et al.* (2014) randomly allocated the participants to view one of four short video clips that simulated a walking experience in the different urban environment, and reported significant recovery from stress and enhanced mood and restorative effects in those who experienced a simulated walk in the natural setting, compared with those in the urban street setting.

Hence, considering that the present study attempted to explore the synergistic effect of a wellbeing intervention (i.e. MBSR) combined with exposure to natural environments, the above approaches were adapted: (1) Phase 1 study consists of an experiment in which participants were randomly assigned to a control group or to a three-week programme of MBSR in different simulated indoor

environments (natural vs. non-natural simulation) (see Chapter Four), and (2) Phase 2 study is a more extended study using three 'actual' environments, commonly used for interventions in urban context: natural outdoor vs. built outdoor vs. indoor environment (see Chapter Five).

3.2.2 Impact of different natural environmental settings on mental health and wellbeing

Recently, more research has expanded earlier work focusing on examining different effects between natural and synthetic environments (e.g. indoors or built settings) to compare the health and wellbeing effects between different types of natural environments. For example, White *et al.* (2013) investigated recalled feelings of restoration (e.g. calm, relaxed, revitalized and refreshed) by individuals experiencing a range of natural environments, and found that the most restorative mental state was specifically linked to coastal, woodland, and upland environments whereas the least restorative mental state was linked to towns and urban parks. Carrus *et al.* (2014) also assessed perceived restorativeness of different urban green spaces. The peri-urban protected reserve had the highest perceived restorativeness potential whereas the urban square with trees and vegetation had the lowest. However, the evidence on different restorative benefits of different types of natural environments is inconsistent and inconclusive.

According to Martens *et al.* (2011), taking a walk in a tended urban forest has better emotional outcomes than taking a walk in a wild forest. Likewise, Gatersleben and Andrews (2013) revealed that natural environments with greater ease of access and openness exhibit more restorative effects than those with limited ease of access and openness (e.g. highly dense vegetation area). This may be attributed to the threatening impression of a more confined and denser wooded area (Milligan and Bingley, 2007). Several studies also suggested a similar notion: namely that a more confined and denser vegetation area triggers stress and other negative responses, such as anxiety about physical or sexual attack (Jorgensen and Anthopoulou, 2007), going off course (Milligan and Bingley, 2007), or being trapped in thunder and lightning (Van den Berg and Ter Heijne, 2005).

Despite all these concerns, several attempts have been made to incorporate forest environments into mental health promotion programmes. For example, studies on the efficacy of forest bathing (*Shinrin-yoku*) showed that forest environments can promote lower pulse rate, lower blood pressure and lower cortisol level than urban surroundings; these physiological responses suggest that activities in forest environments can help to relax the body and manage the negative effects of stress (Lee *et al.*, 2011; Takayama *et al.*, 2014).

Experimental studies have used different ways of exposure to the natural environmental settings to examine its psychologically restorative effects, such as visiting the natural environment (e.g. White *et al.*, 2013); having a window view of the natural environment (e.g. Ulrich *et al*., 1991); or being subjected to virtual images of the natural environment (e.g. Van den Berg *et al*., 2014). Many of these studies have utilised simulated natural environmental settings as proxies for the actual natural environmental settings. However, the use of simulated natural environmental settings remains questionable, particularly in terms of experimental control and ecological validity. The use of sequential slides or video does not include sensory experiences, such as smell and touch (Gatersleben and Andrews, 2013). To date, a few studies have compared the restorative benefit of '*actual*' natural environment with that of a simulated natural environment. For example, Kjellgren and Buhrkall (2010) assessed the beneficial effect of 30-minute relaxation in simulated and actual natural environmental settings. Although both settings successfully reduced stress, the actual natural environmental settings yielded additional benefits for the level of energy that are likely to encourage restorative effects. Gatersleben and Andrews (2013) found that taking a walk in the actual natural environmental settings, as compared to the simulated natural environmental settings, led to speedier recovery from attention fatigue and significantly reduced negative mood (i.e. sadness). The evidence suggests that actual natural environment is better than simulated one but that uncertainty still exists as to optimal natural environments for restoration impacts on health and wellbeing.

Phase 1 of the study investigated whether the different kinds of natural environments (i.e. woodland vs. park setting) have different health and wellbeing outcomes (see Chapter Four). Moreover, in order to gain further knowledge of the way of exposure to natural environments, phase 3 of the study compared the effectiveness of MBSR in simulated natural environment and actual natural environments (see Chapter Six).

3.2.3 Study design

The research design consisted of three phased studies, which combined mindfulness practice with the beneficial effect of exposure to natural environments. The aim was to establish whether the natural environment could enhance mental health and wellbeing outcomes of MBSR. Phase 1 consisted of a laboratory experiment in which participants were randomly assigned to a control group or a brief MBSR programme in different simulated environments (natural vs non-natural simulated environments). Phase 2 was a more extended study using three actual environments (natural outdoor, built outdoor and indoor) to examine the impact of actually being in a natural environment on the MBSR outcomes. Lastly, Phase 3 compared the effectiveness of MBSR in simulated and actual natural environments, using quantitative and qualitative data collected from the two earlier phases.

3.2.3.1 Phase 1 study: Simulated natural environments bolster the effectiveness of brief Mindfulness-Based Stress Reduction (MBSR): A comparison with a relaxation-based intervention (Chapter Four)

This is a scoping study of the main field experiment (phase 2), examining the effectiveness of MBSR (i.e. MBSR vs. relaxation control group) and environmental conditions (i.e. woodland vs. parkland vs. urban setting vs. a room with white walls) using simulated environments. Participants (n=122) were randomly allocated to one of two intervention groups (mindfulness, relaxation control group) under different simulated environmental conditions (two natural, two non-natural)

during an intervention lasting three weeks. Participants' wellbeing outcomes and nature connectedness were measured before and after the three-week intervention, and at one-week follow-up. This study also investigates whether the characteristics of natural environments (i.e. woodland vs. parkland setting) make a difference to the health and wellbeing outcomes of the mindfulness programme.

3.2.3.2 Phase 2 study: Does a natural environment enhance the effectiveness of Mindfulness-Based Stress Reduction (MBSR)? Examining the mental health and wellbeing, and nature connectedness benefits (Chapter Five)

This study is a more extended study using actual environments. In order to compare the effectiveness of the intervention in different settings, participants (n=99) were randomly assigned to a MBSR programme in one of three different environments (i.e. natural outdoor, built outdoor and indoor) over a six-week period. Participants' wellbeing outcomes and nature connectedness were measured at four times during the research period: at baseline, after the third MBSR session, one week after completion of the six-week MBSR and one month after completion of the six-week MBSR. In addition, this examined pathways to enhancement of MBSR outcomes through nature connectedness.

3.2.3.3 Phase 3 study: Examining the effectiveness of Mindfulness-Based Stress Reduction (MBSR) in simulated natural environment and actual natural environments (Chapter Six)

Secondary data (from phase 1 and phase 2) was used in this study to explore the effectiveness of MBSR when conducted in a simulated natural environment compared to an actual natural environment. A total of 64 responses were taken into the quantitative analysis, 34 of which derived from participants who completed three MBSR sessions within the simulated natural environment (phase 1), whereas 30 responses came from those who completed three MBSR

sessions within the actual natural environments (phase 2). In an attempt to elicit rich information about the participants' experiences in their respective environments, qualitative data from focus groups were assessed in this study: three and four participants from the simulated and the actual natural environments, respectively.

3.3 Research methods

This section introduces the quantitative and qualitative methods used in the research (Figure 3.1). The further details of measures will be explained in each study chapter.

3.3.1 Quantitative method: self-reported questionnaire

Psychometrically validated questionnaires were selected to measure participants' changes in relation to their levels of mindfulness, nature connectedness and their mental health and wellbeing outcomes during the period of research.

Level of mindfulness

The Five Facet Mindfulness Questionnaire (FFMQ-SF: Bohlmeijer *et al.*, 2011) was used to indicate the level of mindfulness and other related variables, such as psychological symptoms and wellbeing (Baer *et al.*, 2006). The five facets consisted of five subscales: non-judging, non-reactivity, acting with awareness, describing and observing.

Nature connectedness

The Nature Relatedness Scale (NR-6: Nisbet and Zelenski, 2013) measures affective, cognitive, and experiential aspects of 'connectedness to nature'. NR-6 is widely used to capture the feeling of connectedness to nature and predict environmental behaviours and psychological health and wellbeing.

Mental health and wellbeing outcomes

First, the wellbeing measures were classified to represent hedonic or eudaimonic aspects of wellbeing. In this study, hedonic wellbeing focused on measuring the frequency and intensity of pleasant and unpleasant emotions using Positive and Negative Affect Schedule (PANAS: Watson *et al*., 1988). PANAS comprises two 10-item subscales designed to measure positive and negative feelings. In addition, the eudaimonic wellbeing outcomes were assessed using the Rumination-Reflection Questionnaire (RRQ: Trapnell and Campbell, 1999) which includes the 12 items rumination subscale that measures a tendency to retrace one's past actions and the 12 items reflection subscale which measures genuine curiosity about the self. Secondly, this study examined psychological health related to the negative emotional states associated with depression, anxiety and stress using the Depression Anxiety Stress Scales (DASS-21: Lovibond and Lovibond, 1995; Antony *et al*., 1998).

3.3.2 Qualitative method: focus groups

Phase 3 study used the qualitative method to gain a deeper understanding of the quantitative findings resulting from the impacts of MBSR in different natural environments. Focus groups were used to encourage open discussion amongst participants in eliciting information regarding their experiences (Krueger and Casey, 2015). The participants were invited from those who completed three sessions of MBSR in the simulated natural environment (phase 1) and the actual natural environment (phase 2) after the completion of the MBSR programme. A semi-structured focus group guide was developed to aim exploration of participants' experiences during the MBSR sessions in certain environments, focusing on enhancement of the restorative experience in natural environments.

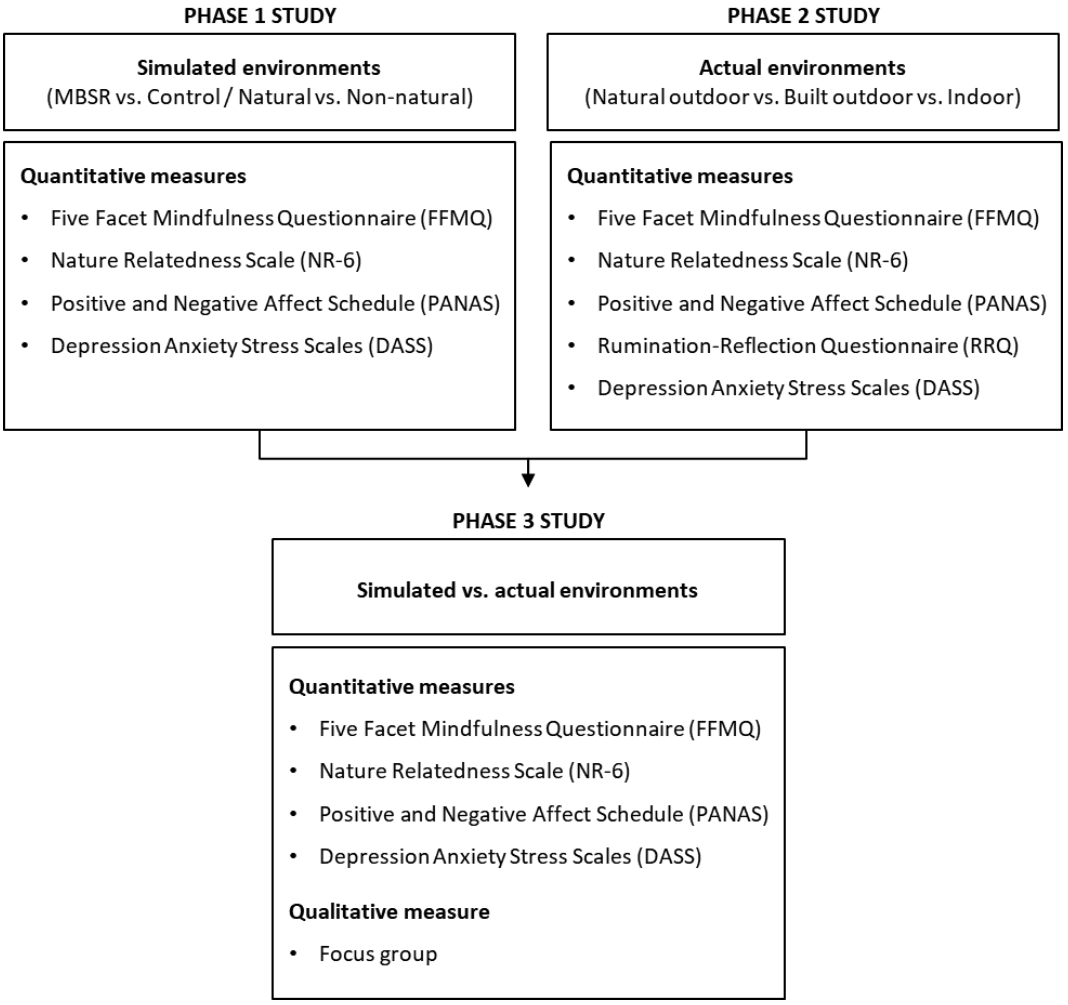

Figure 3.1 Quantitative and quantitative measures in each study

3.4 Ethical considerations

This PhD research was ethically approved by the Department of Landscape in accordance with procedures laid down by the University of Sheffield's Research Ethics Committee.

Participants were recruited from adults aged 18 and over who are staff or students in the University. This research excluded vulnerable participants, such as people with severe and enduring mental health conditions (i.e. currently receiving treatment for such conditions). Participation in the study is entirely voluntary. In the recruitment email, the details of the study were fully explained and information sheet and consent form were attached. Participants who

want to take part were invited to complete and return the consent form accessed via a link in the recruitment email, or to bring it with them to the first session. To motivate participants, all participants who completed three sessions and the three follow-up questionnaires were paid £20 (phase 1 study). For phase 2 study, all participants had the opportunity to be entered into a prize draw to win a small amount of money (e.g. 10 x prizes of £50).

To protect participants, all research data from this study were confidential and anonymous

CHAPTER FOUR: PHASE 1 STUDY
Simulated natural environments bolster the effectiveness of brief mindfulness-based stress reduction (MBSR): a comparison with a relaxation-based intervention

4.1 Introduction

This chapter describes phase 1 of the study then a scoping study of the main field experiment (phase 2) attempts to answer whether natural environments can be used to enhance the effectiveness of a wellbeing intervention. This study examined 1) the effectiveness of mindfulness-based stress reduction (MBSR), 2) the impacts of different natural environmental settings, and 3) the potential pathway to enhancement of MBSR outcomes through nature connectedness.

First, mindfulness practice has grown quickly in recent years as one of the most promising psychological interventions for those coping with common mental problems *(Spijkerman et al*., 2016). The potential salutogenic benefits of mindfulness have resulted in the development of standardised mindfulness-based interventions (MBIs), which combine the principle of traditional meditation practice with psychoeducational training in order to improve health and wellbeing (Gu *et al*., 2015). The most widely used MBIs is mindfulness-based stress reduction (MBSR: Kabat-Zinn, 1982), which offers an intensive 8-week programme involving a range of mindfulness meditation (e.g. sitting/walking meditation and body-scan meditation), gentle stretching and movement and group discussion. More recently, a brief MBSR format (shorter 4-6-week versions) has been introduced to help full-time workers and students manage time and schedule requirements (Gilmartin *et al.*, 2017). In order to examine the effectiveness of MBSR, this study consists of an experiment in which participants were randomly assigned either to a three-week

MBSR programme or to a control group (i.e. relaxation-based activities) in different simulated environments.

Second, this study also investigates whether the characteristics of natural environments (i.e. woodland vs. parkland setting) make a difference to the health and wellbeing outcomes of the interventions. Some studies have showed that differences in wellbeing outcomes are linked with different types of environment, e.g. White *et al*. (2013) found that visits to coastal, woodland, and upland environments had the most restorative mental state, whereas urban parks had the least restorative mental state. Gatersleben and Andrews (2013) found that a natural environment with a high degree of openness and accessibility was more restorative than one that was low in openness and accessibility, such as very dense vegetation. However, the evidence on different restorative benefits of different types of natural environments is inconsistent and inconclusive. This study compares the effectiveness of the intervention in the simulated woodland setting and the simulated park setting.

Finally, Bragg and Leck's (2017) emphasis on natural surroundings as the key component of effective green care raises the questions of how exposure to nature enhances the impact of the interventions being delivered; this may partly be explained by the feeling of 'connecting with nature'. The feeling of nature connectedness is explained as "*the affective, cognitive, and experiential relationship individuals have with the natural world or a subjective sense of connectedness with nature*" (Nisbet *et al*., 2009, p.719). Thus, it could be that people who are connected to nature derive a feeling of meaningful existence from that connection, leading to a boost in health and wellbeing (Howell *et al*., 2013). A high level of nature connectedness is typically related to greater happiness as well as life satisfaction, vitality and the ability to cope with a life problem (Nisbet *et al*., 2011; Capaldi *et al*., 2014). Connectedness to nature is associated positively with psychological wellbeing by regulating emotion and imbuing people with purpose and meaning in life by the feeling that they belong to the natural world (Trigwell *et*

al., 2014). The growing evidence for the benefits of exposure to natural environments on mental health and wellbeing is promising, but few studies have explored the potential for enhancing wellbeing interventions by incorporating exposure to the natural environment or explored the pathways leading to recovery or resilience (e.g. Fabjański and Brymer, 2017). This study explores pathways to enhancement of MBSR outcomes through nature connectedness.

The following questions were set for phase 1:

Q1. Do participants in the MBSR programme show a greater improvement in mental health and wellbeing than those in the relaxation-based intervention group (control group)?

Q2. Are the mental health and wellbeing outcomes of the MBSR programme in simulated natural environments greater than simulated non-natural environments?

Q3. Do the characteristics of natural environments (i.e. woodland vs. parkland setting) make a difference to the health and wellbeing outcomes?

Q4. Do changes in nature connectedness mediate the effects of MBSR on mental health and wellbeing?

4.2 Methods

4.2.1 Participants

Participants were recruited from students studying across all disciplines at the University of Sheffield though the university research volunteer email system. The experimental procedure was explained to potential participants in a recruitment email (Appendix A) which required them to give their informed consent in order to be included in the study (Appendix B). Sample size was determined a priori based on a power analysis. For power = 0.8, and an effect size of f(v) = 0.25, this study needed 113 participants. From two waves of recruitment, 355 students agreed to participate in this study. 140 participants were randomly selected by stratified random sampling to ensure a proportionate number of male (62 male, 47%) and female students (78 female, 53%). Fifteen participants who did not complete the baseline questionnaire and three participants who

did not complete the three sessions were excluded. This resulted in 122 (87%) participants who were included in the analysis (51 male, 70 female and 1 'prefer not to say'; mean age 22.80; range 18-41 years). Thirteen students (10.7%) had previous experience of mindfulness meditation and they were randomly assigned to the intervention groups as follows: four in the MBSR group with natural environments; four in the control group with natural environments; three in the MBSR group in non-natural environments; and two in the control group with non-natural environments. All participants received a payment of £20 on completion of follow-up measurements.

4.2.2 Design

The experimental design combined a MBSR programme and a relaxation-focused control group with an environmental condition (two natural, two non-natural simulated environments) to assess whether the mindfulness programme had beneficial impacts over and above other relaxation activities. Half of the participants were randomly assigned to a three-week MBSR programme under four simulated environmental conditions: woodland, parkland, an urban setting and a room with white walls. The remainder were assigned to a control group; see Figure 4.1 for a schematic overview of the experimental set-up. The participants in the mindfulness group were asked to attend a weekly one-hour MBSR session over a three-week period. The brief MBSR was modelled on the eight-week standard MBSR programme (Kabat-Zinn, 1982). It had weekly one-hour group sessions with guided mindfulness practice (see Table 4.1). All sessions were led by the same qualified mindfulness instructor. The control group spent one hour per week on relaxation activities of their choice (e.g. reading books or magazines) over a three-week period under the same four environmental conditions as the MBSR groups. Their relaxation activities were carried out individually in a group setting (six-eight participants together). Participants were allowed to bring their aids to relaxation (e.g. book or music). Some books/magazines and colouring sheets with colour pencils were also provided. Participants were asked to complete a questionnaire containing a battery of validated scales three times, immediately before and after the three-week intervention, and at one-week follow-up. The experiment was conducted over four weeks between

February and March 2017. Additional data, using the same methodology with different participants, were collected over the same months during 2018.

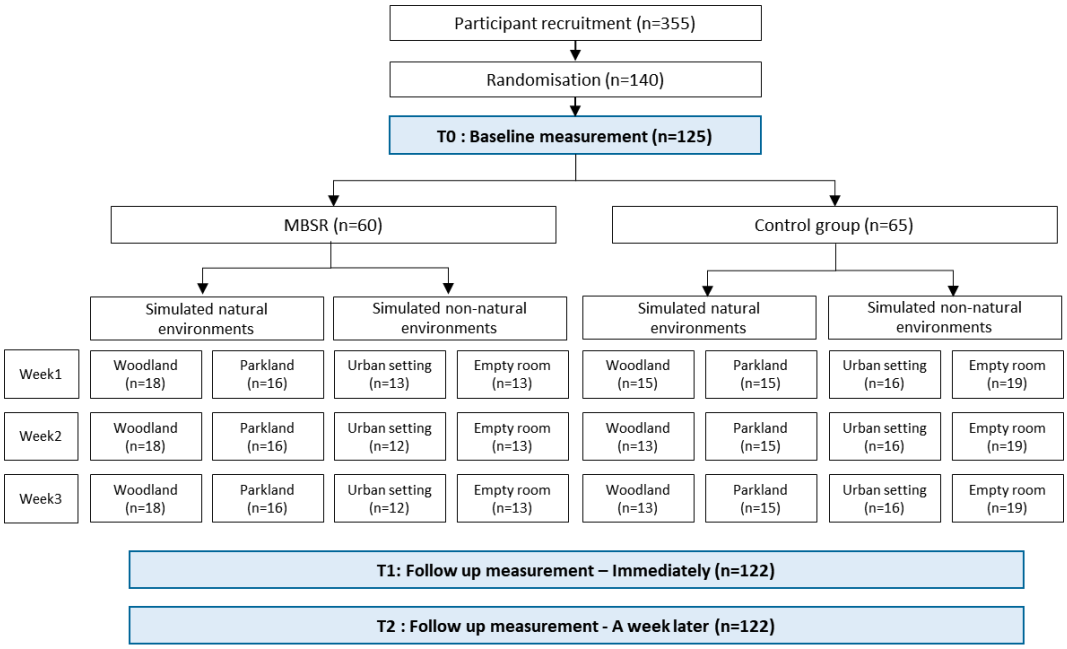

Figure 4.1 Research design

Table 4.1 Brief mindfulness-based stress reduction (MBSR) programme

Brief MBSR programme
Week 1 'An introduction into mindfulness' - An explanation of the key points/benefits of mindfulness - A short, guided meditation - The raisin practice: coming out of auto pilot - Short body scan
Week 2 'Perception and Creative Responding' - Opening meditation - Mindful movement: gentle movements to enhance relaxation and awareness. - Group exercise: example of seeing friend in the street who ignores you-make the connection between stress reactivity and acute stressors
Week 3 'The Power and pleasure of being present' - Sitting meditation - Group discussion - Befriending meditation.

4.2.3 Simulated environments

Visual simulations, as proxies for environments, are widely used in experimental research and have been effectively applied in previous studies (e.g. Lymeus *et al*., 2017). This experiment was conducted in a simulated environment laboratory with curtains closed to prevent outside views and slightly dimmed ceiling lights. Four images were shown on a 5.8m x 2.2m screen to simulate the experience of being in one of four common environments (two natural environments and two non-natural): woodland, parkland, an urban setting and a room with white walls (see Figure 4.2 & 4.3). The first image depicted a view inside woodland containing evenly distributed mature trees and a layer of ground covering vegetation, generating a sense of being surrounded by the woodland. The second image showed a view of parkland containing trees and shrubs at the edge of an open expanse of mown grass. The urban image shows an historical area in Sheffield. This setting contained no vegetation. This location was carefully chosen to avoid using busy commercial areas, to reduce the unfavourable bias to the urban setting compared with corresponding positive responses to natural environments. The last setting recreated a common setting for wellbeing interventions (e.g. a treatment room in a hospital or community setting). This setting contained no vegetation. In order to provide the ambient sounds that would be experienced in the actual settings, audio clips were used to convey the sounds of nature- such as bird song and wind rustling the leaves of trees- in the simulated natural settings; typical urban noises- such as people talking in the distance and distant traffic- in the simulated urban setting; and a ticking clock in the indoor setting.

a) Natural environment: woodland

b) Natural environment: parkland

c) Non-natural environment: urban setting

d) Non-natural environment: empty room

Figure 4.2 Images of four simulated environments

a) Natural environment: woodland

b) Natural environment: parkland

c) Non-natural environment: urban setting

d) Non-natural environment: empty room

Figure 4.3 Examples of four simulated environments

4.2.4 Questionnaire and measures

Psychometrically validated scales measured respondents' changes in relation to the health and wellbeing outcome measures during the duration of study: at baseline (T0), after completion of the three-week intervention (T1), and at one-week follow-up (T2). The baseline questionnaire at T0 contained the psychometric scales and questions eliciting personal information. The latter asked participants to indicate their gender, age, ethnicity, postcode and any previous experience of mental health problems and mindfulness practice. The questionnaire at T1 contained the same psychometric scales. At T2 the psychometric scales were repeated and participants were also asked how much they liked their simulated environment (Appendix C).

Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire- short form (FFMQ-SF: Bohlmeijer *et al*., 2011) assesses aspects such as non-judging, non-reactivity, acting with awareness, describing and observing. The FFMQ-SF contains 24 items measured on a five-point scale, ranging from 1 (never or rarely true) to 5 (very often or always true). This study followed previous studies in calculating a total mindfulness score by totalling participant responses on all 24 items, with higher scores indicating greater mindfulness (e.g. Vøllestad *et al*., 2011; Goldberg *et al*., 2013). Cronbach's α was 0.76 for the total mindfulness score.

Nature Relatedness Scale

Respondents were also asked about 'connectedness to nature' to capture several aspects of the way people viewed their relationship with the nature, using a short-form version of the nature relatedness scale (NR-6: Nisbet and Zelenski, 2013). The NR-6 contains six items, comprising 'a sense of identification with nature' and 'contact with nature' dimensions, measured on a five-point scale ranging from 1 (disagree strongly) to 5 (agree strongly). Cronbach's α was 0.86 for the NR-6 score.

Positive and Negative Affect Schedule

Changes in self-reported mood and feelings were measured using the Positive and Negative Affect Schedule (PANAS: Watson *et al*., 1988). The PANAS is a self-reported adjective checklist that contains two 10-item subscales designed to measure positive (interested, excited, strong, enthusiastic, proud, alert, inspired, attentive, determined and active) and negative affect (distressed, upset, guilty, scared, hostile, irritated, ashamed, nervous, jittery and afraid). Respondents were asked how much they felt each of the 20 emotions (1= not at all, 5= extremely). In addition, some studies suggest that different positive emotions possess varying elicitors and functions (see Gilbert *et al.*, 2008; Richardson *et al*., 2016). For example, one type of positive affects is the sense of exhilaration in some contexts (e.g. passing an exam or going out on a date), while others are associated with feelings of contentment, calmness and soothing (e.g. meditating in forests) (Depue and Morrone-Strupinsky, 2005). Thus, three different types of positive feeling words: 'relaxed, calm and safe' were added from the Types of Positive Affect Scale (Gilbert *et al*., 2008). The participants indicated the extent of their feelings for the 23 emotions (1= not at all, 5= extremely). Cronbach's α was 0.78 for the positive affect subscale, 0.76 for the negative affect subscale, and 0.80 for the additional positive emotions; relaxed, calm, and safe.

Depression Anxiety Stress Scales

The Depression Anxiety Stress Scales (DASS-21) contain psychological measures related to the negative emotional states associated with depression, anxiety and stress (Lovibond and Lovibond, 1995; Antony *et al*., 1998) in the form of 21 questions. The DASS-21 is a set of three self-report subscales designed to assess the negative emotional states of depression, anxiety and stress on a four-point scale (0= never, 3= almost always). The depression scale assesses feelings of unhappiness, hopelessness, and lack of interest. The anxiety scale measures subjective experiences of insecurity and uncertainty. The stress scale measures difficulty relaxing, being

easily upset, irritable and over reactive. Cronbach's α was 0.85 for the depression subscale, 0.73 for the anxiety subscale and 0.75 for the stress subscale.

Environmental preference

Participants were asked how much they liked/enjoyed their simulated environment using a Visual Analog Scale (VAS: Torrance *et al*., 2001) after the completion of the intervention. Participants are required to mark a point on a 100mm straight horizontal line where the left extremity is "not at all" and the right extremity is "very much". The scores are determined by measuring the distance (mm) from the left extremity to the participants' mark (from 0 to 100). A higher score suggests greater preference.

4.2.5 Procedure

Potential participants were emailed a link to a participant information sheet and asked to complete an online baseline questionnaire before taking part in the experiment. Next, they were randomly assigned to a MBSR programme or to a control group in one of four environments. A week before the study started, participants were informed about the study via email (e.g. location and time). However, to reduce potential bias from foreknowledge of the intervention, participants were not aware of the group/environment in which they were placed. After completing the three-week experiment, participants were asked to complete the initial questionnaire again. Finally, one week later, participants completed the questionnaire for the third time. The initial questionnaire was completed online, and the two follow ups were completed by the participants in person using a paper version of the questionnaire.

4.2.6 Analysis strategy

All analysis was conducted using SPSS for Windows version 24.0 using an alpha of .05. Firstly, two repeated measures MANOVAs were used to investigate the effects of both interventions in the two natural environments and the two non-natural environments. Before proceeding with the

MANOVAs, preliminary checks were carried out for normality, linearity, univariate and multivariate outliers and homogeneity of variance.

These analyses incorporated a between-subjects factor (woodland vs. parkland or urban setting vs. a room with white walls) and three time-points (baseline (T0), post-intervention (T1) and one-week follow-up (T2)) for the health and wellbeing outcomes. These analyses revealed that there were no significant multivariate interactions between environment and time on all measures, $F(21,311)= 1.02$, $p= .44$, $\eta^2= .06$. This study also found that there was no significant interaction between environment and time within the natural and non-natural conditions, for natural environments, $F(14,228)= 1.21$, $p= .27$, $\eta^2= .07$ (Research question 3), and non-natural environments, $F(14,220)= 1.58$, $p= .09$, $\eta^2= .09$. Moreover, a one-way between-groups ANOVA carried out to explore the impact of environment on participants' preference showed that there was no significant difference between environments, $F(3,118)= 0.66$, $p= .58$, $\eta^2= .02$. Accordingly, a decision was made to examine differences only between the natural (woodland and parkland) and non-natural environments (urban setting and a room with white walls).

Next, χ^2 tests and ANOVA were used to examine differences at baseline. In order to investigate the environmental impacts on the effectiveness of the intervention (Research question 1 and 2), a MANOVA was conducted to examine these interaction effects: a 2 (MBSR, control) x 2 (natural, non-natural environment) x 3 model (time: baseline (T0), post-intervention (T1) and one-week follow-up (T2)). Follow-up analysis was performed using one-way ANOVAs and t-tests. Two additional sets of analyses were carried out including gender and wave of recruitment as between-subjects factors; there were no interactions between these factors and time, group or environment. Finally, in order to understand possible interactions and explore pathways of enhancement of MBSR outcomes by nature connectedness, the mediating effect of changes in nature connectedness on the interventions' wellbeing outcomes were examined using the Process macro for SPSS (Hayes, 2012) (Research question 4).

4.3 Results

4.3.1 Preliminary analysis

Given that the effects of MBSR have been shown to differ according to age and gender, demographic and baseline data were examined (Katz and Toner, 2013). No significant differences in age (χ^2= 8.61, p= .20), gender (χ^2= 53.83, p= .37) and previous experience of mindfulness practice (χ^2= 7.67, p= .26) were found between the experimental conditions. Univariate ANOVAs revealed no baseline differences in any of the study measures by environment or group or the interaction of both, p> .05.

MANOVA found that the main effect of time (T0, T1 and T2) was significant at the multivariate level, F(14,105)= 4.66, p< .001, η^2= .38. There were no statistically significant interactions between time (at baseline, post and follow-up) and the two combined environments (natural, non-natural environments), F(14,105)= 1.30, p= .22, η^2= .15, or between time (at baseline, post and follow-up) and the two groups (mindfulness, control group), F(14,105)= 1.72, p= .06, η^2= .19, at the multivariate level. Table 4.2 shows the means and standard deviations for all measurements by group and environment at baseline, post intervention and one-week follow-up. Univariate ANOVAs examined differences for each of the study measures.

Table 4.2 Baseline, post-test and follow up mean scores by group and environment

Outcome	**MBSR group**			**Control group**		
	T0	T1	T2	T0	T1	T2
	M(SD) [95%CI*]	*M*(SD) [95%CI*]	*M*(SD) [95%CI*]	*M*(SD) [95%CI*]	*M* (SD) [95%CI*]	*M*(SD) [95%CI*]
FFMQ-SF - Mindfulness						
Natural environment	15.43(2.14) [14.68;16.18]	16.00(1.81) [15.37;16.64]	16.57(2.25) [15.79;17.36]	15.44 (1.73) [14.77;16.12]	15.71(1.61) [15.07;16.33]	15.70(1.94) [14.94;16.46]
Non-natural environment	15.54(1.30) [15.00;16.08]	15.88(1.72) [15.17;16.59]	16.09(1.49) [15.48;16.71]	15.22(1.70) [14.63;15.80]	15.20(2.04) [14.50;15.90]	14.91(2.09) [14.19;15.63]
NR-6 - Nature connectedness						
Natural environment	3.65(0.70) [3.41;3.89]	3.78(0.62) [3.56;3.99]	3.92(0.67) [3.69;4.15]	3.28(0.91) [2.93;3.63]	3.58(0.81) [3.26;3.90]	3.64(0.75) [3.34;3.93]
Non-natural environment	3.39(0.85) [3.39;3.03]	3.49(0.82) [3.14;3.83]	3.45(0.69) [3.15;3.74]	3.42(0.75) [3.16;3.68]	3.45(0.68) [3.22;3.69]	3.40(0.68) [3.17;3.63]
PANAS - Positive affect						

Natural environment	31.91 (6.42) [29.67;34.15]	34.59(5.79) [32.57;35.61]	36.06(6.73) [33.71;38.41]	30.71(4.92) [28.80;32.63]	32.75(6.35) [30.28;35.22]	32.86(5.10) [30.88;34.84]
Non-natural environment	31.64(5.59) [29.33;33.95]	33.92(6.12) [31.39;36.45]	34.36(6.86) [31.53;37.19]	31.00(7.12) [28.55;33.45]	32.57(6.13) [30.46;34.68]	32.20(5.76) [30.22;34.18]
PANAS - Negative affect						
Natural environment	25.68(6.60) [23.38;27.98]	22.85(7.09) [20.38;25.33]	20.09(5.63) [18.13;22.05]	24.36(6.83) [21.71;27.01]	21.68(6.50) [19.16;24.20]	20.82(6.51) [18.30;23.35]
Non-natural environment	24.28(6.41) [21.63;26.93]	21.84(6.48) [19.17;24.51]	21.00(5.29) [18.82;23.18]	25.66(5.56) [23.74;27.57]	23.54(6.58) [21.28;25.80]	25.37(8.28) [22.53;28.22]
PANAS – Additional positive affect (relaxed, calm and safe)						
Natural environment	9.50(2.05) [8.83;10.22]	10.15(1.88) [9.48;10.74]	10.97(1.96) [10.22;11.55]	9.82(1.76) [9.14;10.51]	10.61(1.85) [9.89;11.33]	10.11(2.13) [9.28;10.93]
Non-natural environment	10.20(1.50) [9.50;10.75]	10.60(1.96) [9.85;11.48]	10.88(1.97) [10.19;11.81]	9.89(2.19) [9.17;10.71]	9.51(2.17) [8.73;10.27]	9.71(2.09) [8.94;10.41]
DASS-21 - Depression						
Natural environment	11.18(9.40) [7.90;14.45]	6.53(6.35) [4.31;8.74]	5.06(5.44) [3.16;6.96]	10.93(6.05) [8.58;12.27]	7.21(5.06) [5.25;9.18]	6.93(6.29) [4.49;9.37]
Non-natural environment	10.16(8.33) [6.72;13.60]	7.28(4.93) [5.25;9.31]	5.68(3.95) [4.05;7.31]	8.29(5.74) [6.31;10.26]	10.23(9.12) [7.09;13.36]	11.37(10.62) [7.72;15.02]
DASS-21 – Anxiety						
Natural environment	11.71(7.78) [8.99;14.42]	9.35(6.78) [6.99;11.72]	7.59(5.52) [5.66;9.51]	9.43(6.55) [6.89;11.97]	7.79(5.89) [5.50;10.07]	8.86(5.56) [6.70;11.01]
Non-natural environment	10.80(6.65) [8.05;13.55]	9.68(7.73) [6.49;12.87]	8.96(6.85) [6.13;11.79]	9.71(6.23) [7.57;11.86]	9.20(6.53) [6.69;11.44]	9.77(8.01) [7.02;12.52]
DASS-21 – Stress						
Natural environment	15.12(8.30) [12.22;18.01]	13.88(6.91) [11.47;16.29]	10.35(7.29) [7.81;12.90]	13.21(5.99) [10.89;15.54]	12.07(7.00) [9.36;14.79]	11.36(8.15) [8.20;14.52]
Non-natural environment	13.76(6.17) [11.21;16.31]	12.32(7.13) [9.38;15.26]	12.80(6.53) [10.10;15.50]	13.43(5.93) [11.39;15.47]	15.60(6.99) [13.20;18.00]	12.57(6.82) [10.23;14.91]

*CI: Confidence Interval

4.3.2 Level of mindfulness

A time by group by environment univariate repeated measures ANOVA revealed a main effect of time on levels of mindfulness, $F(2,117)= 4.20$, $p= .02$, $\eta^2= .07$. A time by group by environment interaction was not found, $F(2,117)= 0.01$, $p= .99$, $\eta^2= .00$. However, there was a significant time by group interaction, $F(2,117)= 4.61$, $p= .01$, $\eta^2= .07$; Figure 4.4 suggests that the MBSR group showed a steady increase in mindfulness across three time periods, whereas the relaxation group did not. ANOVA revealed no differences between the groups at T0, $F(1,120)= 0.25$, $p= .62$, $\eta^2= .00$, or at T1, $F(1,120)= 2.58$, $p= .11$, $\eta^2= .02$, but the MBSR group (M=16.37, SD=1.97, CI=[15.86; 16.88]) reported greater mindfulness at T2 than the relaxation group (M=15.26, SD=2.05, CI=[14.75; 15.78]), $F(1,120)= 9.25$, $p= .03$, $\eta^2= .07$.

Paired samples t-tests were conducted to further investigate differences within the groups between times. Within the mindfulness group in natural environments, there was no statistically significant difference (using the $p < .01$ criteria) in mindfulness from T0 to T1, $t(33) = -2.10$, $p = .04$, $\eta^2 = .12$, but there was a significant increase from T0 to T2, $t(33) = -3.24$, $p = .003$, $\eta^2 = .24$. No significant difference was found from T0 to T1, $t(24) = -1.04$, $p = .31$, $\eta^2 = .04$, or from T0 to T2, $t(24) = -2.52$, $p = .02$, $\eta^2 = .21$, within the MBSR group in non-natural environments. For the relaxation group in natural environments, t-tests revealed no significant difference in mindfulness from T0 to T1, $t(27) = -0.98$, $p = .33$, $\eta^2 = .04$, or from T0 to T2, $t(27) = -0.99$, $p = .33$, $\eta^2 = .04$; there was also no significant difference from T0 to T1, $t(34) = 0.08$, $p = .94$, $\eta^2 = .00$, or from T0 to T2, $t(34) = 1.21$, $p = .24$, $\eta^2 = .04$, within the relaxation group in non-natural environments.

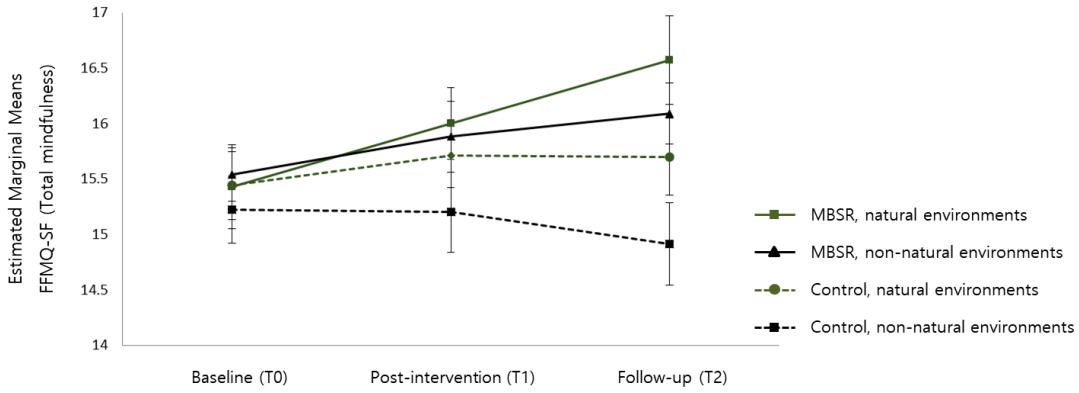

Figure 4.4 Interaction graph for mindfulness; Error bars denote using a 95% confidence interval.

4.3.3 Nature connectedness

Time had a statistically significant effect on nature connectedness, $F(2,117) = 4.86$, $p = .01$, $\eta^2 = .08$, but a time by group by environment interaction was not found, $F(2,117) = 0.87$, $p = .42$, $\eta^2 = .02$. As shown in Figure 4.5, the MBSR group in the natural setting showed a consistent improvement in nature connectedness. There was no significant time by group interaction, $F(2,117) = 0.69$, $p = .51$, $\eta^2 = .012$, but a significant interaction effect was found between time and environment, $F(2,117) = 3.14$, $p = .047$, $\eta^2 = .05$. The ANOVA revealed no differences between the groups at T0, $F(1,120) = 0.26$, $p = .61$, $\eta^2 = .00$, or at T1, $F(1,120) = 2.86$, $p = .09$, $\eta^2 = .02$, but there was a

difference at T2: the natural environment group (M=3.79, SD=0.72, CI=[3.61; 3.97]) reported greater nature connectedness than the group in the non-natural environment (M=3.42, SD=0.69, CI=[3.24; 3.60]), $F(1,120) = 8.62$, $p = .01$, $\eta^2 = .06$.

Paired samples t-tests revealed no statistically significant difference in nature connectedness from T0 to T1, t(33)= -1.67, $p = .11$, $\eta^2 = .08$, or from T0 to T2, t(33)= -2.67, $p = .012$, $\eta^2 = .18$, within the MBSR group in natural environments. Similarly, no significant difference was found from T0 to T1, t(24)= -0.95, $p = .35$, $\eta^2 = .03$, or from T0 to T2, t(24)= -0.38, $p = .71$, $\eta^2 = .00$, within the MBSR group in non-natural environments. For the relaxation group in natural environments, there was no significant difference in nature connectedness from T0 to T1, t(27)= -2.49, $p = .02$, $\eta^2 = .19$, but a significant increase from T0 to T2, t(27)= -2.91, $p = .007$, $\eta^2 = .24$; there was no statistically significant difference from T0 to T1, t(34)= -0.43, $p = .67$, $\eta^2 = .01$, or from T0 to T2, t(34)= 0.17, $p = .87$, $\eta^2 = .00$, within the relaxation group in non-natural environments.

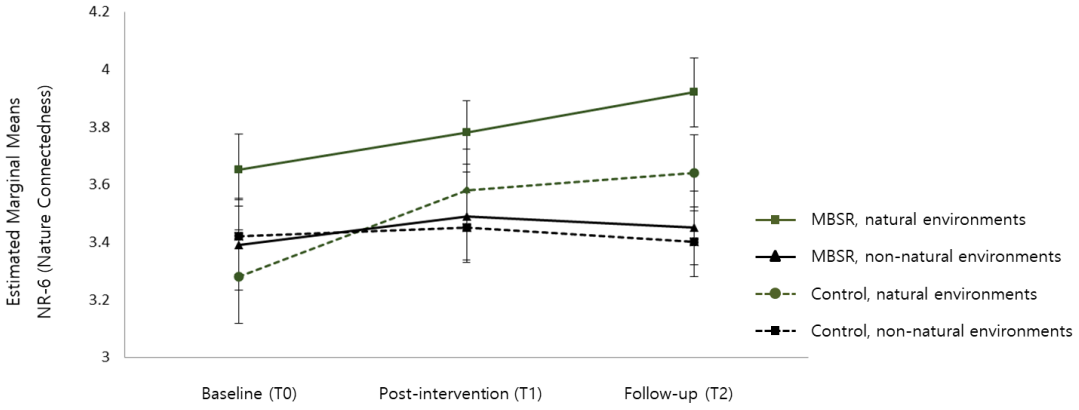

Figure 4.5 Interaction graph for nature connectedness; Error bars denote using a 95% confidence interval.

4.3.4 Positive and negative affect

Positive affect

Time had a statistically significant impact on positive affect scores, $F(2,117)= 8.71$, $p< .001$, $\eta^2= .13$, but a time by group by environment interaction was not found, $F(2,117)= 0.04$, $p= .96$, $\eta^2= .001$. The finding also showed no significant time by group interaction, $F(2,117)= 1.11$, $p= .33$, $\eta^2= .02$, and no significant interaction effect between time and environment, $F(2,117)= 0.51$, $p= .60$, $\eta^2= .01$. Although there was no statistically significant interaction, Figure 4.6 suggests a steady increase in positive emotions in all groups except the control group in a non-natural environment.

Paired samples t-tests revealed no statistically significant difference in positive affect from T0 to T1, t(33)= -2.28, $p= .03$, $\eta^2= .14$, but there was a significant increase from T0 to T2, t(33)= -3.24, $p= .003$, $\eta^2= .24$, within the MBSR group in natural environments. However, the MBSR group in non-natural environments showed no significant difference from T0 to T1, t(24)= -1.91, $p= .07$, $\eta^2= .10$, or from T0 to T2, t(24)= -2.15, $p= .04$, $\eta^2= .16$. For the relaxation group in natural environments, t-tests revealed no significant difference in positive affect from T0 to T1, t(27)= -1.62, $p= .12$, $\eta^2= .09$, or from T0 to T2, t(27)= -1.62, $p= .12$, $\eta^2= .09$; there was no statistically significant difference from T0 to T1, t(34)= -1.42, $p= .16$, $\eta^2= .06$, or from T0 to T2, t(34)= -1.05, $p= .30$, $\eta^2= .03$, within the relaxation group in non-natural environments.

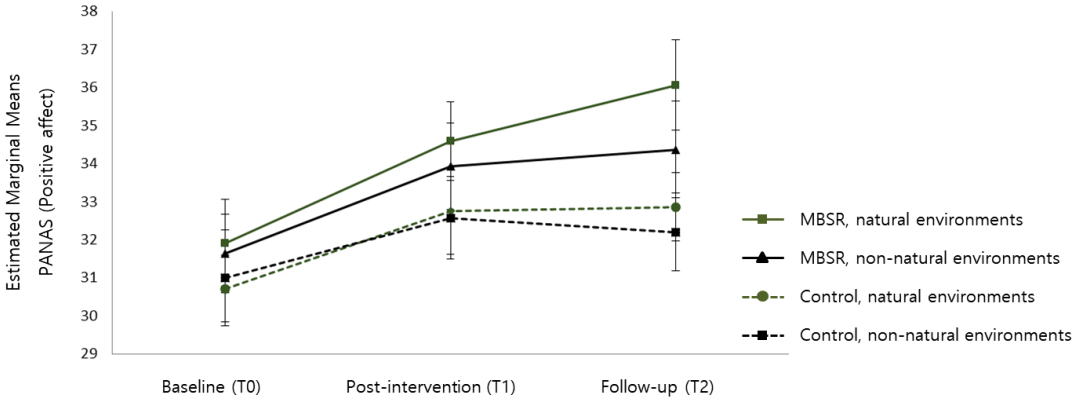

Figure 4.6 Interaction graph for positive affect; Error bars denote using a 95% confidence interval.

Negative affect

Time had a significant impact on negative affect scores, $F(2,117)= 14.89$, $p < .001$, $\eta^2= .20$, but a time by group by environment interaction was not found, $F(2,117)= 0.10$, $p= .91$, $\eta^2= .002$. There was a significant time by environment interaction, $F(2,117)= 3.57$, $p= .03$, $\eta^2= .06$. ANOVA revealed no differences between the environments at T0, $F(1,120)= 0.01$, $p= .98$, $\eta^2= .00$, or at T1, $F(1,120)= 0.18$, $p= .67$, $\eta^2= .00$, but the group in natural environments (M=20.42, SD=6.00) reported lower negative affect at T2 than the group in non-natural environments (M=23.55, SD=7.46), $F(1,120)= 6.54$, $p= .01$, $\eta^2= .05$. There was also a significant interaction between time and intervention group, $F(2,117)= 3.23$, $p= .04$, $\eta^2= .05$; Figure 4.7 suggests that the MBSR group showed a steady decrease in negative affect across three time periods, whereas the control group did not. ANOVA revealed no differences between the environments at T0, $F(1,120)= 0.00$, $p= .99$, $\eta^2= .00$, or at T1, $F(1,120)= 0.06$, $p= .81$, $\eta^2= .00$, but the MBSR group (M=20.47, SD=5.46) showed lower negative affect at T2 than the control group (M=23.35, SD=7.83), $F(1, 120)= 5.45$, $p= .02$, $\eta^2= .04$.

Paired samples t-tests revealed no statistically significant difference in negative affect from T0 to T1, $t(33)= 2.55$, $p= .02$, $\eta^2= .16$, but there was a significant decrease from T0 to T2, $t(33)= 6.50$, $p< .001$, $\eta^2= .56$, within the MBSR group in natural environments. However, the MBSR group in non-natural environments showed no significant difference from T0 to T1, $t(24)= 1.76$, $p= .09$, $\eta^2= .11$, but there was a significant decrease from T0 to T2, $t(24)= 2.83$, $p= .009$, $\eta^2= .25$. For the relaxation group in natural environments, t-tests revealed significant decreases in negative affect from T0 to T1, $t(27)= 2.77$, $p= .010$, $\eta^2= .22$, and from T0 to T2, $t(27)= 3.06$, $p= .005$, $\eta^2= .26$. However, there was no statistically significant difference from T0 to T1, $t(34)= 1.77$, $p= .09$, $\eta^2= .08$, or from T0 to T2, $t(34)= 0.20$, $p= .84$, $\eta^2= .00$, within the relaxation group in non-natural environments.

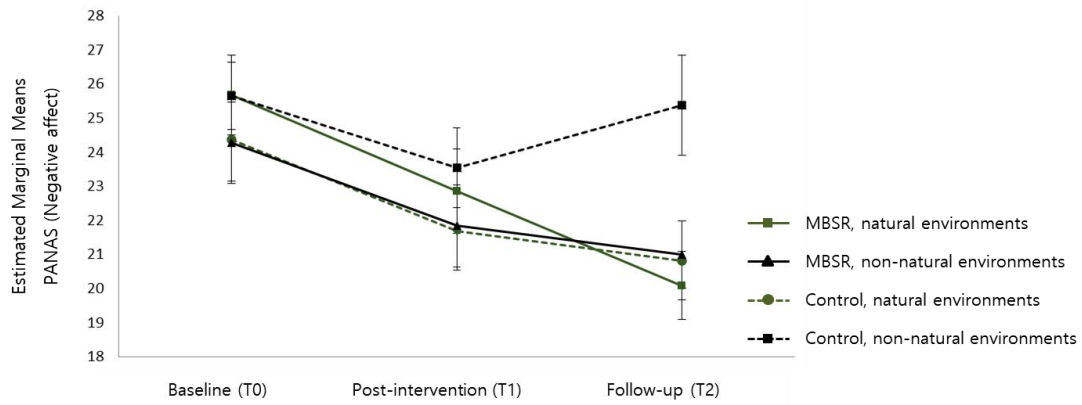

Figure 4.7 Interaction graph for negative affect; Error bars denote using a 95% confidence interval.

Additional positive affect (relaxed, calm and safe)

Time had a statistically significant impact on additional positive affect scores, $F(2, 117)= 3.58$, $p= .03$, $\eta^2= .06$, but a time by group by environment interaction was not found, $F(2,117)= 1.95$, $p= .15$, $\eta^2= .03$. There was no significant environment by time interaction, but a significant interaction effect was found between time and intervention group, $F(2, 117)= 3.33$, $p= .04$, $\eta^2= .05$. ANOVA reported no differences between groups at T0, $F(1,120)= 0.03$, $p= .86$, $\eta^2= .00$, or at T1, $F(1,120)= 0.87$, $p= .35$, $\eta^2= .00$, but the difference of participants' feelings between the MBSR group and the control group was significant at T2, $F(1, 120)= 8.06$, $p= .005$, $\eta^2= .06$ (Figure 4.8).

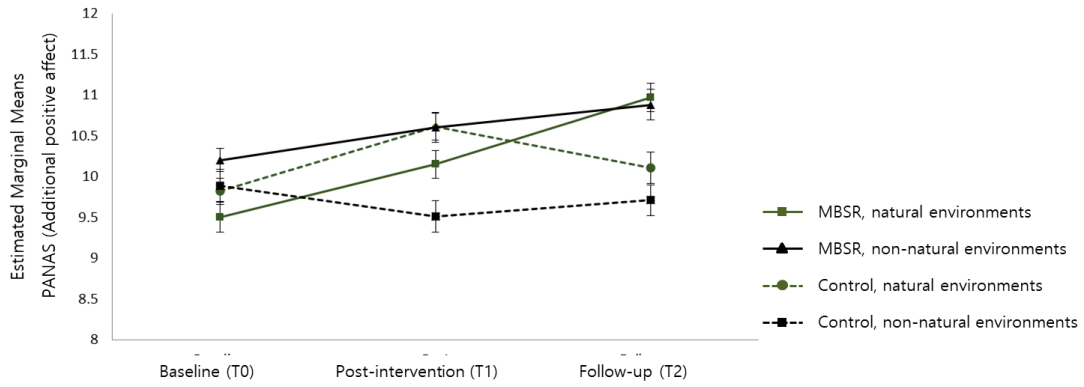

Figure 4.8 Interaction graph for additional positive affect; Error bars denote using a 95% confidence interval.

4.3.5 Depression, anxiety and stress

Depression

A time by group by environment univariate repeated measures ANOVA revealed a main effect of time on depression scores, $F(2,117)= 10.39$, $p< .001$, $\eta^2= .15$; but a time by group by environment interaction was not found, $F(2,117)= 2.08$, $p= .13$, $\eta^2= .03$. There was a significant interaction effect between time and environment, $F(2,117)= 6.89$, $p= .001$, $\eta^2= .11$. ANOVA reported no differences between environments at T0, $F(1,120)= 2.63$, $p= .11$, $\eta^2= .02$, or at T1, $F(1,120)= 3.07$, $p= .08$, $\eta^2= .02$, but the difference in participants' level of depression between the natural and the non-natural environment was greater at T2, $F(1,120)= 5.17$, $p= .03$, $\eta^2= .04$. Furthermore, there was a significant interaction between time and intervention group, $F(2,117)= 6.11$, $p= .003$, $\eta^2= .09$. ANOVA revealed no differences between the environments at T0, $F(1,120)= 0.89$, $p= .35$, $\eta^2= .00$, or at T1, $F(1,120)= 2.73$, $p= .10$, $\eta^2= .02$, but the MBSR group (M=5.32, SD=4.84) showed a lower level of depression at T2 than the control group (M=9.40, SD=9.17) in Figure 4.9, $F(1,120)= 9.24$, $p= .003$, $\eta^2= .07$.

Paired samples t-tests revealed a statistically significant decrease in depression from T0 to T1, $t(33)= 4.25$, $p< .001$, $\eta^2= .35$, and from T0 to T2, $t(33)= 5.29$, $p< .001$, $\eta^2= .46$, within the MBSR group in natural environments. Similarly, the MBSR group in non-natural environments showed no significant difference from T0 to T1, $t(24)= 2.70$, $p= .012$, $\eta^2= .23$, but a significant decrease from T0 to T2, $t(24)= 3.71$, $p= .001$, $\eta^2= .36$. For the relaxation group in natural environments, t-tests revealed significant decreases in depression from T0 to T1, $t(27)= 3.88$, $p= .001$, $\eta^2= .36$, and from T0 to T2, $t(27)= 3.41$, $p= .002$, $\eta^2= .30$. However, there was no significant difference from T0 to T1, $t(34)= -1.50$, $p= .14$, $\eta^2= .06$, or from T0 to T2, $t(34)= -1.79$, $p= .08$, $\eta^2= .09$, within the relaxation group in non-natural environments.

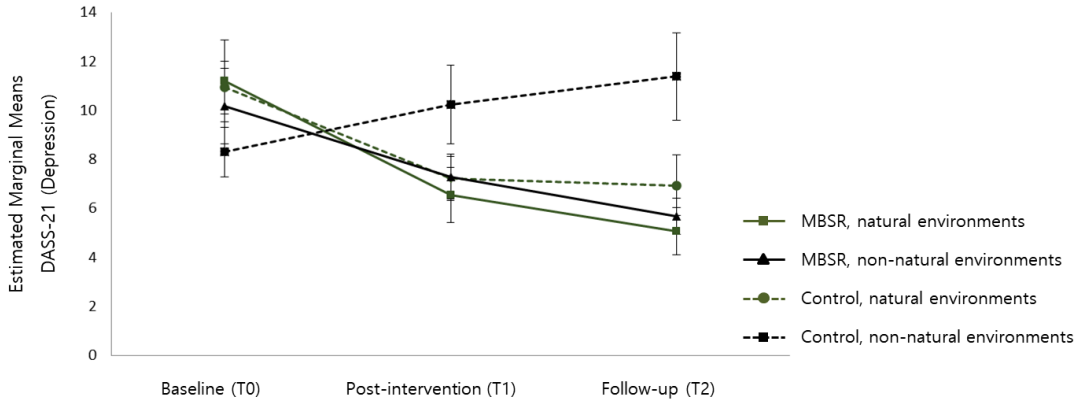

Figure 4.9 Interaction graph for depression; Error bars denote using a 95% confidence interval.

Anxiety

A time by group by environment univariate repeated measures ANOVA revealed a main effect of time on anxiety scores, $F(2,117)= 6.06$, $p= .003$, $\eta^2= .09$. A time by group by environment interaction was not found, $F(2,117)= 0.36$, $p= .70$, $\eta^2= .01$. There was no significant time by environment interaction $F(2,117)= 1.09$, $p= .34$, $\eta^2= .02$, but a significant interaction effect was found between time and intervention group, $F(2,117)= 3.45$, $p= .04$, $\eta^2= .06$; Figure 4.10 shows that the MBSR group showed a steady decrease in anxiety across three time periods, whereas the control group did not. However, a further ANOVA revealed no significant differences between the groups at T0, $F(1,120)= 0.25$, $p= .62$, $\eta^2= .01$, or at T1, $F(1,120)= 2.58$, $p= .11$, $\eta^2= .01$, or at T2, $F(1,120)= 1.01$, $p= .32$, $\eta^2= .00$.

Paired samples t-tests found no statistically significant difference in anxiety from T0 to T1, $t(33)= 2.39$, $p= .02$, $\eta^2= .15$, but a significant decrease from T0 to T2, $t(33)= 4.39$, $p< .001$, $\eta^2= .37$, within the MBSR group in natural environments. However, no significant differences were found from T0 to T1, $t(24)= 1.18$, $p= .25$, $\eta^2= .05$, or from T0 to T2, $t(24)= 1.62$, $p= .12$, $\eta^2= .10$, within the MBSR group in non-natural environments. For the relaxation group in natural environments, there were no significant difference in anxiety from T0 to T1, $t(27)= 1.99$, $p= .06$, $\eta^2= .13$, or from T0 to T2, $t(27)= 0.57$, $p= .57$, $\eta^2= .01$; there was also no significant difference from T0 to T1,

t(34)= -0.57, p= .57, η^2= .01, or from T0 to T2, t(34)= -0.05, p= .96, η^2= .03, within the relaxation group in non-natural environments.

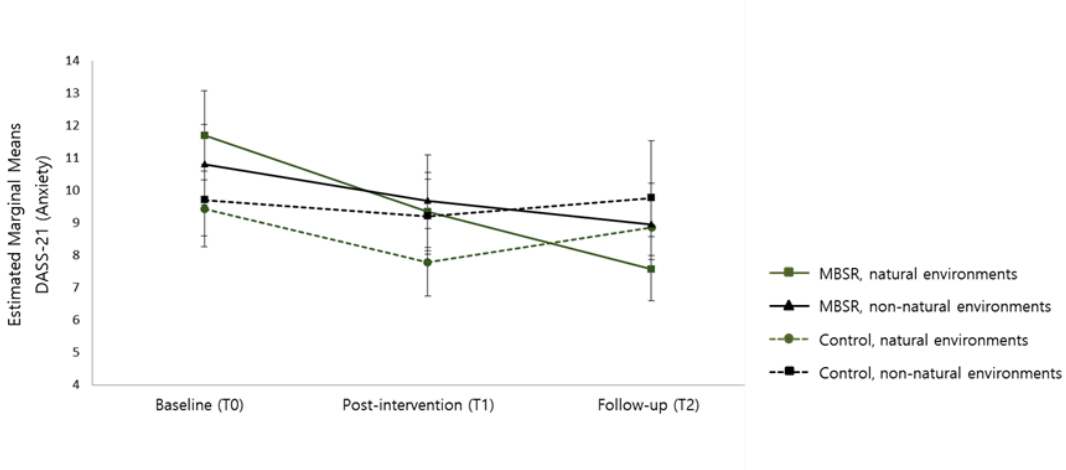

Figure 4.10 Interaction graph for anxiety; Error bars denote using a 95% confidence interval.

Stress

As shown in Figure 4.11, time had a significant effect on stress scores, F(2,117)= 5.99, p= .003, η^2= .09. The time by group by environment 3-way interaction was significant, F(2,117)= 3.91, p=.02, η^2=.06. However, there was no significant interaction effect between time and intervention group, F(2, 117)= 1.18, p= .31, η^2= .02 or between time and environment, F(2,117)= 0.94, p=.39, η^2=.02. The 3-way interaction suggests that the combined effect of the MBSR programme and the natural environment are greater than the effect of either separately. However, the examination of univariate ANOVA at each time point revealed that there were no main effects of environment or group at each time point, nor there were any significant interaction effects at each time point.

Paired samples t-tests were used to further investigate differences within the groups between times. Within the MBSR group in natural environments, there was no statistically significant difference in stress from baseline (T0) to post-intervention (T1), t(33)= 0.98, p= .33, η^2= .03, but there was a statistically significant decrease from baseline (T0) to one-week follow-up (T2), t(33)= 3.32, p= .00, η^2= .25. However, no significant differences were found from baseline to post intervention

(p= .29) or one-week follow-up (p= .50) within the MBSR group in non-natural environments. For the control group in natural environments, t-tests revealed no significant difference in stress from baseline to post intervention (p= .33) or one-week follow-up (p= .22); there was no statistically significant difference in stress from baseline to post intervention (p= .06) or one-week follow-up (p= .52) within the control group in non-natural environments.

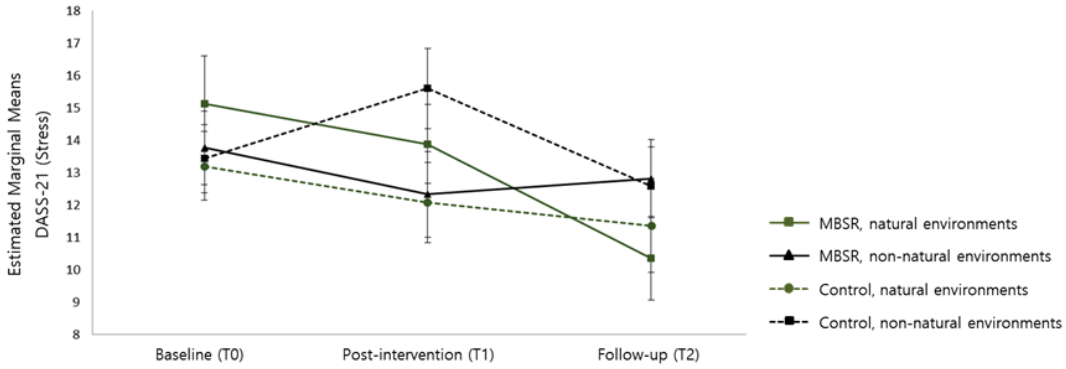

Figure 4.11 Interaction graph for stress; Error bars denote using a 95% confidence interval.

4.3.6 Summary of findings

The mindfulness group in the natural environment showed the greatest positive outcomes from the experiment against all our measures at T2, though, as the results have showed, the difference between this and other groups was not statistically significant.

As Table 4.3 shows, this study revealed that all groups experienced significant changes in mental health and wellbeing outcomes during the experiment. There was a significant 2-way interaction between time and intervention group; participants' levels of mindfulness, negative feelings, depression and anxiety showed different patterns over time depending on intervention group (mindfulness vs. relaxation control group). There was also a significant 2-way interaction between time and environment; the changes over time of participants' levels of nature connectedness, negative feelings and depression were affected by environments (natural vs. non-natural). The sole significant 3-way interaction was for stress; only participants in the mindfulness group in the

natural environment improved from baseline to one-week follow-up. To expand, the results of the one-way ANOVAs show that significant differences between environments or interventions were not observed until one week later (at T2; see Table 4.3); these differences present after participants had returned to their ordinary routine.

Table 4.3 All main and interaction effects including the results of one-way ANOVA/T-test

Measure	Effects				Significant difference	Key beneficiaries (group/environment)
	Time	Time x Group	Time x Environment	Time x Group x Environment		
FFMQ-SF - Mindfulness	√	√	-	-	at T2	MBSR in both environments
NR-6 Nature connectedness	√	-	√	-	at T2	Both intervention groups in natural environments
PANAS Positive affect	√	-	-	-	-	All the groups improved
PANAS Negative affect	√	√	√	-	at T2	Mindfulness group in non-natural environments, and both intervention groups in natural environments
PANAS – Additional positive affect	√	√	-	-	at T2	MBSR in both environments
DASS-21 - Depression	√	√	√	-	at T2	Mindfulness group in non-natural environments, and both intervention groups in natural environments
DASS-21 – Anxiety	√	√	-	-	-	MBSR in both environments
DASS-21 – Stress	√	-	-	√	-	MBSR in natural environments

Note: baseline (T0), post-intervention (T1), one-week follow-up (T2)

4.3.7 Potential pathway: does nature connectedness mediate the effectiveness of the interventions on mental health and wellbeing?

The last question in this study sought to determine whether changes in nature connectedness (calculated as T2 minus T0) mediated the effectiveness of MBSR on mental health and wellbeing (i.e. PANAS and DASS-21). However, the change in nature connectedness was not a significant multivariate co-variate (p= .07) and so nature connectedness was not a pathway in this study.

4.4 Discussion

The results of this study partly showed that the mental health and wellbeing outcomes of MBSR are enhanced through the experience of natural environments; stress is reduced when a mindfulness programme is combined with exposure to natural environment. Participants' stress levels generally decreased during the three-week mindfulness programme, but the mindfulness group in non-natural environments showed an increase in stress at one-week follow up, whereas stress levels in the group in natural environments continued to decrease even after the completion of the experiment. This indicates that the effect of the combination of the mindfulness programme and natural environments is greater than the effect of either the mindfulness programme in the non-natural environments or the control in natural environments. The findings also suggest that the MBSR programme led to greater mindfulness, lower negative feelings, and reduced depression, anxiety and stress compared with the control group (Research question 1) In addition, the natural environments had a positive effect on the outcomes of both intervention groups (mindfulness and control group). Both interventions in the natural environments led to greater nature connectedness, lower negative feelings and reduced depression and stress compared with those in the non-natural environments (Research question 2).

No significant difference was observed between the two natural environments: woodland and parkland (Research question 3). In one sense this is surprising given that differences in wellbeing outcomes have been linked with different types of environment; for example, Gatersleben and Andrews (2013) found that a natural environment with a high degree of openness and accessibility was more restorative than one that was low in openness and accessibility, such as very dense vegetation. Generally speaking however, when natural settings have been compared in recent experimental/interventional research differences between settings have tended to be small and non-significant (e.g. Van den Berg *et al*., 2014; Gidlow *et al*., 2016). In line with recent research, this study did not find significant differences in health and wellbeing outcomes between the natural environments. However, given the negative associations with some environments (e.g.

those typified by dense vegetation) further research is needed to identify the characteristics of natural environments that best promote health and wellbeing. More research on the restorative effects of specific attributes of the natural environment would help to inform the design of wellbeing interventions and policies to improve public health and wellbeing.

The mediation analysis showed that changes in nature connectedness did not mediate the effects of the mindfulness programme/natural environment intervention on mental health and wellbeing even though nature connectedness increased in the natural environment (Research question 4). However, other studies have found that mindfulness is related to nature connectedness. Wolsko and Lindberg (2013) found that greater nature connectedness was consistently associated with greater mindfulness, more engagement in outdoor activities, and greater psychological wellbeing. Similarly, Van Gordon *et al*. (2018) suggested that mindfulness can be used to enhance the restorative qualities of natural environments, and that experience in natural environments can enhance mindfulness. Nisbet *et al.* (2019) also found that individuals who practised mindfulness reported greater awareness of their surroundings, stronger nature connectedness, and better moods than individuals without mindfulness practice. Although changes in nature connectedness were not a pathway in this study, the findings do imply that exposure to nature had a role in sustaining the effects of the interventions in natural environments.

An explanation for the sustained mindfulness programme benefits in natural environments found in other studies may be the eudaimonic aspect of nature connectedness that may have been imperfectly assessed by our nature connectedness measure. Wellbeing can be broken down into two types: hedonic and eudaimonic. Hedonic wellbeing focuses on happiness, generally defined as the absence of negative affect and presence of positive affect, whereas eudaimonic wellbeing focuses on living life in a full and purposeful way (Deci and Ryan, 2008). Nature connectedness associates with several indicators of eudaimonic wellbeing, leading to sustained mental health benefits (Pritchard *et al.*, 2019). For example, Nisbet *et al*. (2011) found that nature connectedness

had a positive correlation with personal development, autonomy and purpose in life. Consistent with this finding, meaningfulness and vitality were found to be strongly linked with nature connectedness (Cervinka *et al*., 2012). Further work using eudaimonic wellbeing indicators is needed to fully understand the effects of nature connectedness, and could include other measures of nature connectedness such as the Nature Connection Index (NCI). Further study also should establish the pathways within the mindfulness – nature connectedness – mental health and wellbeing nexus. Identifying pathways for the mental health and wellbeing outcomes of interventions in natural environments is important not only because it provides evidence about how existing interventions work, but also because it directs the development of interventions that maximize the health and wellbeing benefit uplift derived from natural environments.

This study was conducted as a point of departure for the research to develop a long-term field study (phase 2). In the next chapter, phase 2 will continue to explore the role of natural environments in the effectiveness of MBSR though the field experiment.

CHAPTER FIVE: PHASE 2 STUDY
Does a natural environment enhance the effectiveness of mindfulness-based stress reduction (MBSR)? Examining the mental health and wellbeing, and nature connectedness benefits

5.1 Introduction

Phase 1 of the study confirmed that the three-week mindfulness-based stress reduction (MBSR) successfully led to greater mindfulness, lower negative feelings, and reduced depression, anxiety and stress compared with the relaxation-based intervention group. More importantly, the mental health and wellbeing outcomes of MBSR (i.e. stress) were greater and lasted longer when carried out in simulated natural environments.

Based on other empirical work concerning the restorative impacts of natural environments (see Van den Berg *et al*., 2014; Lymeus *et al*., 2017), the simulated settings in phase 1 were designed with the assumption that exposure to a simulated natural environment may offer similar outcomes to exposure to the actual natural environment. However, it raises questions about ecological validity; for example, reliance on slides or video excludes other sensory experiences, such as smell and touch (Gatersleben and Andrews, 2013). This highlights that there may be a limit to the extent that a simulated natural environment could be a satisfactory substitute for a genuine one (Kjellgren and Buhrkall, 2010).

A number of comparative studies have emphasised the benefits of the actual natural environment towards positive health and wellbeing. Kjellgren and Buhrkall (2010) assessed the restorative impact of 30-minute period of relaxation activity in an actual natural setting compared with similar activity performed in the simulated setting. The analysis demonstrated that despite stress

reduction in both settings, the actual environment had greater benefits in terms of participants' energy levels. Gatersleben and Andrews (2013) found better recovery of attention fatigue when the participants walked in the actual outdoors, when compared with video simulation of a walk within a laboratory space. This is because simulated methods cannot substitute completely for the actual setting and lack sensory dimensions (Mayer *et al*., 2009; Gatersleben and Andrews, 2013). Hence, in order to strengthening the sensory experience of the surroundings, phase 2 of the study involved an experiment, in which the participants were assigned randomly to three MBSR groups in actual settings: natural outdoor (public park), built outdoor (courtyard on the university campus), and indoor environment (seminar room).

The outcomes retrieved from phase 1 study revealed that MBSR benefits were sustained or improved continuously when participants were exposed to natural simulated environments. As set out in Chapter Two, Section 2.2.3, the experience of wellbeing is characterised by two aspects: hedonic wellbeing emphasises the emotions of pleasure, defined as the absence of negative feelings and presence of positive feelings, whereas eudaimonic wellbeing focuses on living life in a purposeful way (Deci and Ryan, 2008; McMahan and Estes, 2011). Some studies have found stronger links with nature due to greater hedonic wellbeing, such as happiness (Mayer *et al*., 2009; Nisbet *et al.*, 2011) and life satisfaction (Mayer *et al*., 2009).

Eudaimonic wellbeing exerts a positive link with nature via emotional regulation, and imbuing people with purpose and meaning in life, along with a sense of belonging to the natural world (Trigwell *et al*., 2014; Cleary *et al*., 2017). The eudaimonic wellbeing outcomes likely sustain in the long-term, whereas the hedonic wellbeing derived from the experience of simple pleasures likely dissipates after a short period of time (Steger *et al*., 2008). Thus, it seems that 'nature connectedness' may support the benefits of wellbeing interventions so that they last longer when carried out in natural environments. As such, eudaimonic wellbeing was measured in phase 2 using the Rumination-Reflection Questionnaire (RRQ: Trapnell and Campbell, 1999), which was

applied at one-month follow-up in order to assess the impact of 'nature connectedness' on sustained/long-term wellbeing benefits. Phase 2 of the study incorporated university students and staff (e.g. lecturers, researchers, and technicians) to improve the generalizability of the findings.

The following questions were set for phase 2 of the study:

Q1. Does attending the MBSR programme in a natural outdoor environment result in greater nature connectedness than in a built outdoor or an indoor environment?

Q2. Does the MBSR programme achieve the best mental health and wellbeing outcomes when conducted in a natural outdoor environment?

Q3. Do changes in nature connectedness mediate the effects of MBSR on mental health and wellbeing?

5.2 Methods

5.2.1 Participants

Participants were recruited from students and staff at the University of Sheffield though the university's volunteer email list. The experimental procedure was explained to potential participants in a recruitment email (Appendix D) which required them to give their informed consent in order to be included in the study (Appendix E). Initially, 113 students and staff agreed to participate. A sample of 99 participants was randomly selected by stratified random sampling to ensure a representative number of male (37 male, 37.3%) and female (62 female, 62.7%) university students and staff. Participation was voluntary and all participants had the opportunity to be entered into a prize draw to win one of 10 prizes of £50.

5.2.2 Design

The study consisted of an experiment in which participants were randomly assigned to an MBSR group in three different environments: natural outdoor (public park), built outdoor (courtyard on the university campus) and indoor environment (a seminar room). See Figure 5.1 for the

schematic overview of the experimental set-up. The participants were asked to attend a brief version of the MBSR programme lasting six weeks. The brief MBSR programme (e.g. Gilmartin *et al.*, 2017) included mindfulness meditation/exercises and group discussion led by a qualified mindfulness instructor. The participants were asked to complete a questionnaire containing a battery of validated scales. The questionnaires were completed four times during the research period: at baseline (T0), after the third MBSR session (T1), one week after completion of the 6-week MBSR (T2) and one month after completion of the 6-week MBSR (T3).

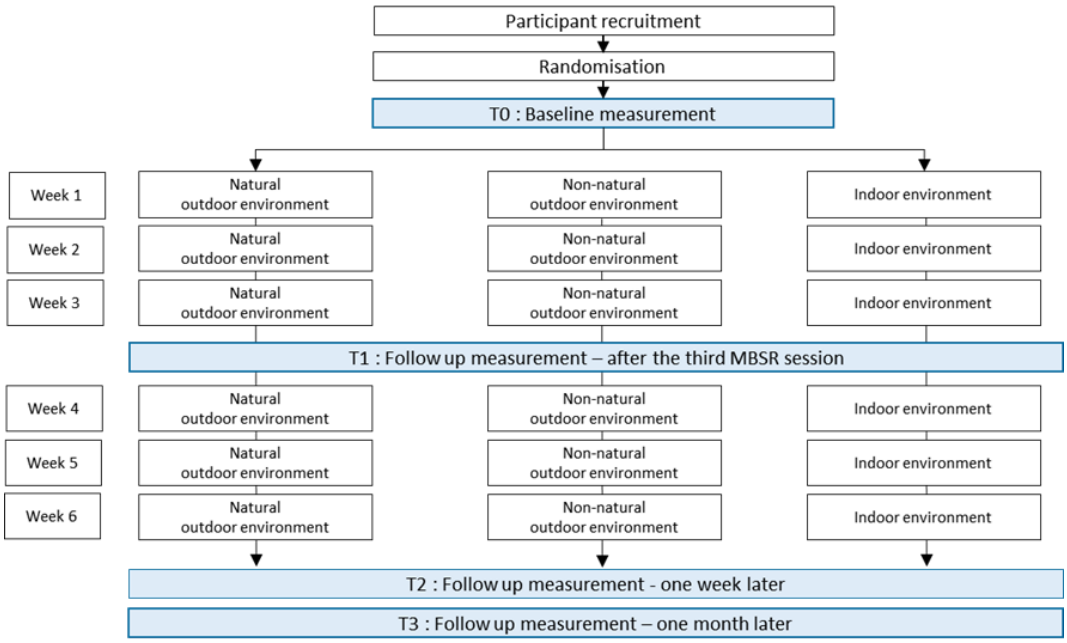

Figure 5.1 Research design

5.2.3 Environments

In order that all participants had similar easy access to our research locations, three sites were chosen for this study within a radius of 200m of the university campus (Figure 5.2): a) Weston Park, representing a natural outdoor environment, b) a courtyard on the university campus, representing a built outdoor environment, and c) a seminar room in the Octagon centre, representing an indoor environment (Figure 5.3 & 5.4). Weston Park is a public park near the university, designed in 1873, with an area of over 5 hectares. The park is a well-managed green space containing trees, shrubs, flower beds, lawns and a lake, and includes facilities such as

benches, wooden bridges, a bandstand and monuments. The experiment was carried out in a location defined by planted areas containing shrubs and small trees, with some distant views. A courtyard on the university campus was chosen as a built outdoor environment. The courtyard was surrounded by concrete and brick built walls and buildings, with no visible vegetation. The indoor setting was a seminar room: a white painted room without windows in the basement of the Octagon Centre at the University of Sheffield. It contained chairs and the other equipment, a neutral coloured picture and no vegetation. Participants in all environments were exposed to the full range of sensory experiences, such as sound (background noise) and smell.

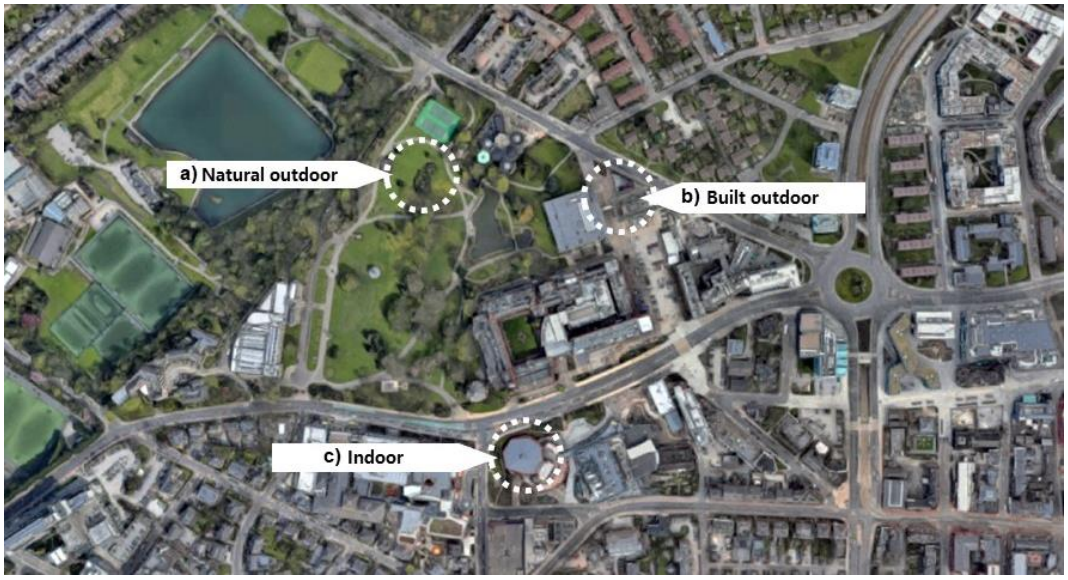

Figure 5.2 Research site locations

a) Natural outdoor environment b) Built outdoor environment c) Indoor environment

Figure 5.3 Three outdoor environments

a) Natural outdoor environment b) Built outdoor environment c) Indoor environment

Figure 5.4 Examples of experimental setting

5.2.4 Questionnaire and measures

Psychometrically validated scales were chosen to measure the effectiveness of the MBSR, and changes in the outcomes were measured during the research period. The baseline questionnaire at T0 comprised two sections containing the psychometric scales and questions eliciting personal information respectively. The latter asked participants to indicate their gender, age, ethnicity, postcode and any previous experience of mental health problems or mindfulness practice. The follow-up questionnaires at T1 and T2 contained the same psychometric scales but the personal information questions were omitted. At T3, the psychometric scales were repeated again. This questionnaire was developed and refined from phase 1 of the study (Appendix F).

Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire- short form (FFMQ-SF: Bohlmeijer *et al*., 2011) that was used in phase 1 was also administered in this study. Cronbach's α was 0.84 for total mindfulness score.

Nature Relatedness Scale

The Nature Relatedness Scale (NR-6: Nisbet and Zelenski, 2013) that was used in phase 1 was used again in this study. Cronbach's α was 0.90 for NR-6 score.

Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (PANAS: Watson *et al*, 1988) and the additional positive emotions (i.e. relaxed, calm, and safe) that were used in phase 1 was also administered in this study. Cronbach's alpha was 0.86 for the Positive affect subscale, 0.89 for the Negative affect subscale, and 0.83 for the additional positive emotions.

Rumination-Reflection Questionnaire

The eudaimonic wellbeing outcomes were determined using the Rumination-Reflection Questionnaire (RRQ) (Trapnell and Campbell, 1999). The Rumination subscale measures the tendency to retrace one's past actions, while the Reflection subscale assesses the philosophical love of self-exploration (Harrington and Loffredo, 2011). The RRQ is composed of 24 items measured on five-point scale that ranges between 1 (strongly disagree) and 5 (strongly agree). Scores range from 1 to 5 with higher scores reflect higher levels of rumination or reflection. The Cronbach's alpha values were 0.90 and 0.85 for Rumination and Reflection subscales, respectively.

Depression Anxiety Stress Scales

The Depression Anxiety Stress Scales (DASS-21: Lovibond and Lovibond, 1995; Antony *et al*., 1998) that was used in phase 1 was used again in this study. DASS-21 showed high internal consistency with Cronbach's alpha of 0.89 for the Depression subscale, 0.82 for the Anxiety subscale and 0.83 for the Stress subscale.

5.2.5 Procedure

Potential participants were emailed a web link to a participant information sheet and a baseline questionnaire (T0), which they were asked to complete before starting the experiment. Once participants had completed the questionnaire, they were randomly assigned to the MBSR programme (see Table 5.1) in one of the three different environments. A week before the study started, participants were informed about the study via email (e.g. location and time). However, to reduce potential bias from foreknowledge of the intervention participants were not informed of the group/environment in which they were to be placed. During the experiment, participants were asked three times (T1, T2 and T3) to complete the same questionnaire which they had filled in before the experiment. The experiment was conducted over 10 weeks between August and October 2017.

Table 5.1 Brief mindfulness-based stress reduction (MBSR) programme

Brief MBSR programme
Week 1 'Stepping out of Automatic Pilot' - An introduction into mindfulness- explanation of the key points/benefits/risks - Raisin practice: coming out of auto pilot - Breath and sounds meditation
Week 2 'Living in our Heads' - Body scan: using our Body to regain freedom from being caught up in our habitual thought patterns.
Week 3 'The Stress Reaction Cycle' - Looking at our habitual responses. Discussing the ABC model of behaviour. - Exploring our individual stress reactivity.' The Sea of Stress Reactions'.
Week 4 'Recognising Aversion' - Looking at our tendency to judge situations against how we want them to be rather than how they are. Practising allowing feelings/thoughts/sensations to be there. - Exploring the difficult meditation
Week 5 'Lifestyle choices' - How can I best look after myself? - Listing daily activities and asking yourself whether they are nourishing or depleting - The Breathing Space Meditation as an Action Step - Mindful movement: gentle movements to enhance relaxation and awareness.
Week 6 'Keeping your Mindfulness Alive'

- Daily mindfulness practices (e.g. sitting/walking meditation)
- The befriending meditation.

5.2.6 Analysis strategy

An intention-to-treat (ITT) analysis (Figure 5.5) was performed on MBSR outcomes in which all participants were included (n=99) with drop-outs assigned a follow-up value at baseline. ITT analysis is widely used to avoid over-optimistic results of the effectiveness of an intervention resulting from the removal of non-compliers by including noncompliance, protocol deviations and withdrawal, all of which are likely to occur in actual clinical practice (Gupta, 2011). In order to ensure the findings were robust, I also used per-protocol (PP) analysis to examine MBSR outcomes in different environments. PP analysis included only those people who strictly adhered to the protocol, i.e. among those who attended all sessions of the 6-week MBSR. Results with ITT and PP analyses were very similar, so the results reported in this chapter are those from ITT analysis; the results of PP analysis can be found in Appendix G.

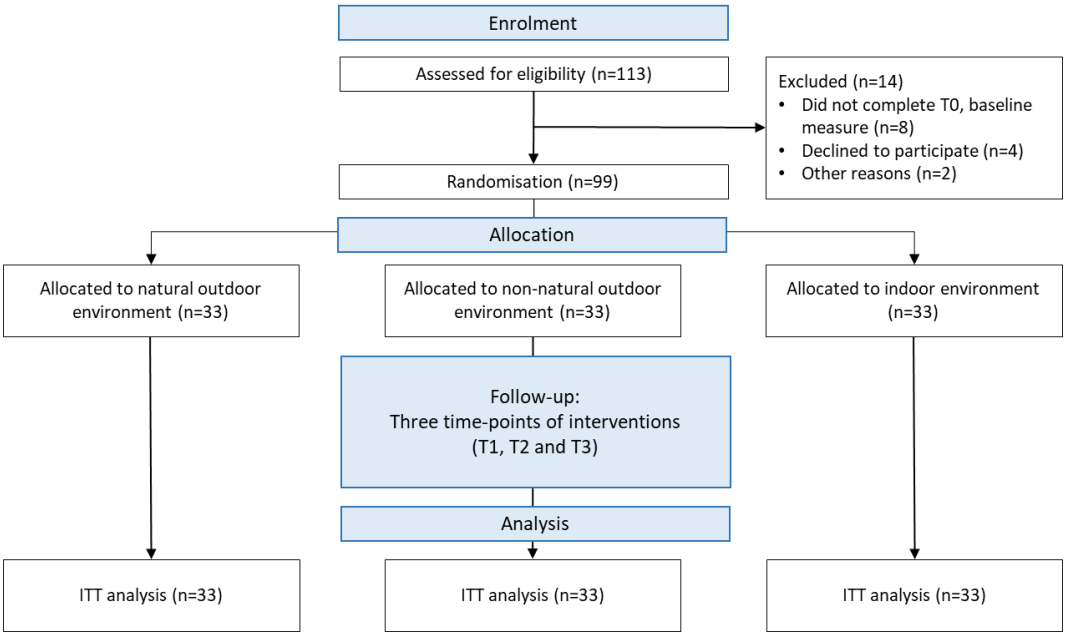

Figure 5.5 CONSORT flow chart (ITT)

All analysis was conducted using SPSS for Windows version 24.0 using an alpha of .05. Before proceeding with MANOVAs, preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, multicollinearity and equality of covariance matrices. Firstly, χ^2 tests and ANOVA were used to examine differences at baseline. Next, MANOVA was used to examine the effects of the intervention in the three different environments. These analyses incorporated a between-subjects factor (natural outdoor, built outdoor and indoor) and four time-points of interventions (T0, T1, T2 and T3) for mental health and wellbeing outcomes. If there was a significant interaction, follow-up analysis was performed using one-way ANOVAs to compare environments, and where environment was significant, this was explored using post-hoc comparisons with Tukey's HSD. Paired samples t-tests were also used to further investigate the impact of MBSR in each group. Finally, in order to understand possible interactions and explore pathways of enhancement of MBSR outcomes by nature connectedness, the mediating effect of changes in nature connectedness on the interventions' wellbeing outcomes were examined using the Process macro for SPSS (Hayes, 2012).

5.3 Results

5.3.1 Preliminary analysis

Given that the effects of MBSR have been shown to differ according to age and gender, demographic and baseline data were examined (e.g. Katz and Toner, 2013). A total of 99 participants was eligible for analysis (37 male and 62 female; mean age 36.35; range 16-62 years). No significant differences based on age (χ^2= 80.20, p= .19) and gender (χ^2=0.09, p= .96) were found between the experimental conditions. Univariate ANOVAs revealed no baseline differences in any of the study measures by environment, p> .05.

Next, MANOVA was used to examine the main effect of time and environments on all measures; it revealed the main effect of time was significant, $F(27,70)$= 4.41, p< .001, η^2= .63. There were also statistically significant interactions between the three environments (natural outdoor, built

outdoor and indoor) and four time points (T0, T1, T2 and T3), $F(54,140)= 1.44$, $p= .046$, $\eta^2= .36$, at the multivariate level. Table 5.2 shows the means, standard deviations and confidence intervals for all measurements by environment at the four time-points. Finally, the mediation effect of changes in nature connectedness on the intervention's health and wellbeing outcomes was examined using ANCOVA.

Table 5.2 Baseline, post-test and follow up mean scores by group and environment

Outcome	T0	T1	T2	T3
	M(SD) [95%CI*]	M(SD) [95%CI*]	M(SD) [95%CI*]	M(SD) [95%CI*]
FFMQ-SF - Mindfulness				
Natural outdoor environment	15.85(2.62) [14.92;16.78]	16.36(1.80) [15.72;16.99]	16.62(2.52) [15.72;17.51]	16.80(2.50) [15.92;17.69]
Built outdoor environment	16.74(2.74) [15.77;17.71]	16.52(2.49) [15.63;17.40]	16.29(1.60) [15.72;16.85]	16.90(2.47) [16.02;17.77]
Indoor environment	15.50(2.74) [14.53;16.47]	15.26(2.21) [14.48;16.04]	15.63(2.10) [14.89;16.38]	15.64(2.24) [14.85;16.44]
NR-6 - Nature connectedness				
Natural outdoor environment	3.38(0.89) [3.06;3.70]	3.79(0.82) [3.50;4.08]	3.78(0.91) [3.46;4.11]	3.79(0.92) [3.46;4.11]
Built outdoor environment	3.42(0.96) [3.08;3.76]	3.52(0.79) [3.25;3.81]	3.55(0.74) [3.28;3.80]	3.51(0.83) [3.22;3.80]
Indoor environment	3.35(0.75) [3.09;3.62]	3.39(0.73) [3.13;3.65]	3.48(0.80) [3.20;3.77]	3.39(0.85) [3.08;3.69]
PANAS - Positive affect				
Natural outdoor environment	30.55(6.94) [28.09;33.01]	31.73(7.95) [28.91;34.54]	33.24(7.99) [30.41;36.07]	33.70(8.05) [30.84;36.55]
Built outdoor environment	29.15(5.85) [27.08;31.23]	29.82(6.76) [27.42;32.12]	30.21(5.99) [28.09;32.34]	30.12(6.69) [27.75;32.49]
Indoor environment	32.00(6.20) [29.80;34.20]	33.12(7.11) [30.60;35.64]	32.61(6.77) [30.20;35.01]	33.21(6.21) [31.01;35.42]
PANAS - Negative affect				
Natural outdoor environment	25.48(8.58) [22.44;28.53]	21.97(6.79) [19.56;24.38]	20.03(6.95) [17.56;22.50]	20.12(6.85) [17.69;22.55]
Built outdoor environment	24.36(8.90) [21.21;27.57]	22.79(8.49) [19.78;25.80]	23.03(8.54) [20.00;26.06]	22.85(9.04) [19.64;26.05]
Indoor environment	25.91(7.90) [23.11;28.71]	22.39(7.01) [19.91;24.88]	21.52(5.05) [19.72;23.31]	21.76(5.53) [19.80;23.72]
PANAS – Additional positive affect (relaxed, calm and safe)				
Natural outdoor environment	8.36(2.38) [7.52;9.21]	9.30(2.54) [8.40;10.20]	9.85(2.48) [8.97;10.73]	10.24(2.24) [9.45;11.04]
Built outdoor environment	7.85(2.80) [6.85;9.84]	8.39(2.42) [7.53;9.25]	8.91(2.67) [7.96;9.86]	8.94(3.01) [7.87;10.01]
Indoor environment	8.79(2.22) [8.00;9.57]	9.52(2.14) [8.76;10.27]	9.33(2.06) [8.60;10.06]	9.45(2.27) [8.65;10.26]

RRQ-Rumination				
Natural outdoor environment	3.71(0.83) [3.42;4.00]	3.42(0.65) [3.19;3.66]	3.03(0.67) [2.79;3.26]	2.92(0.53) [2.73;3.10]
Built outdoor environment	3.65(0.73) [3.39;3.91]	3.51(0.68) [3.27;3.75]	3.43(0.60) [3.22;3.65]	3.44(0.61) [3.23;3.66]
Indoor environment	3.63(0.80) [3.35;3.91]	3.39(0.84) [3.10;3.69]	3.31(0.70) [3.06;3.56]	3.29(0.68) [3.04;3.53]
RRQ-Reflection				
Natural outdoor environment	3.23(0.71) [2.98;3.48]	3.66(0.57) [3.46;3.86]	3.66(0.60) [3.44;3.87]	3.65(0.72) [3.39;3.90]
Built outdoor environment	3.47(0.75) [3.21;3.74]	3.52(0.66) [3.29;3.76]	3.56(0.70) [3.31;3.81]	3.57(0.67) [3.32;3.80]
Indoor environment	3.43(0.78) [3.16;3.71]	3.46(0.65) [3.23;3.69]	3.48(0.65) [3.26;3.71]	3.44(0.77) [3.17;3.72]
DASS-21 - Depression				
Natural outdoor environment	10.73(8.24) [7.80;13.65]	7.94(7.48) [5.29;10.59]	6.79(6.78) [4.38;9.19]	6.55(6.86) [4.11;8.98]
Built outdoor environment	10.24(7.51) [7.85;12.91]	9.27(7.19) [6.72;11.92]	7.94(6.28) [5.71;10.16]	8.06(6.72) [5.68;10.44]
Indoor environment	9.45(8.10) [6.58;12.33]	7.15(6.33) [4.91;9.39]	6.70(6.87) [4.26;9.13]	6.73(7.98) [3.90;9.56]
DASS-21 – Anxiety				
Natural outdoor environment	9.39(7.37) [6.78;12.01]	8.06(6.59) [5.73;10.40]	6.61(6.74) [4.22;8.99]	5.94(7.06) [3.44;8.44]
Built outdoor environment	7.88(6.18) [5.69;10.07]	7.70(4.10) [6.24;9.15]	6.52(3.84) [5.15;7.88]	6.79(5.98) [4.67;8.91]
Indoor environment	9.24(9.09) [6.02;12.47]	6.91(7.02) [4.42;9.40]	6.30(5.86) [4.23;8.38]	6.12(6.32) [3.88;8.36]
DASS-21 – Stress				
Natural outdoor environment	16.61(8.05) [13.75;19.46]	11.94(5.91) [9.85;14.03]	10.48(6.98) [8.01;12.96]	9.82(6.21) [7.62;12.02]
Built outdoor environment	15.27(7.71) [12.54;18.01]	15.09(6.93) [12.63;17.55]	15.36(8.14) [12.48;18.25]	14.70(8.93) [11.53;17.86]
Indoor environment	15.12(10.02) [11.57;18.67]	12.79(7.31) [10.19;15.38]	11.58(6.08) [9.42;13.73]	12.85(6.37) [10.59;15.11]

*CI: Confidence Interval

5.3.2 Level of mindfulness

A time by environment repeated measures ANOVA revealed a main effect of time on mindfulness, $F(3,94)= 2.93$, $p= .04$, $\eta^2= .09$; there was a significant increase through the research period. However, there was no statistically significant interaction between time and environment, $F(6,188)= 0.86$, $p= .51$, $\eta^2=.03$ (Figure 5.6).

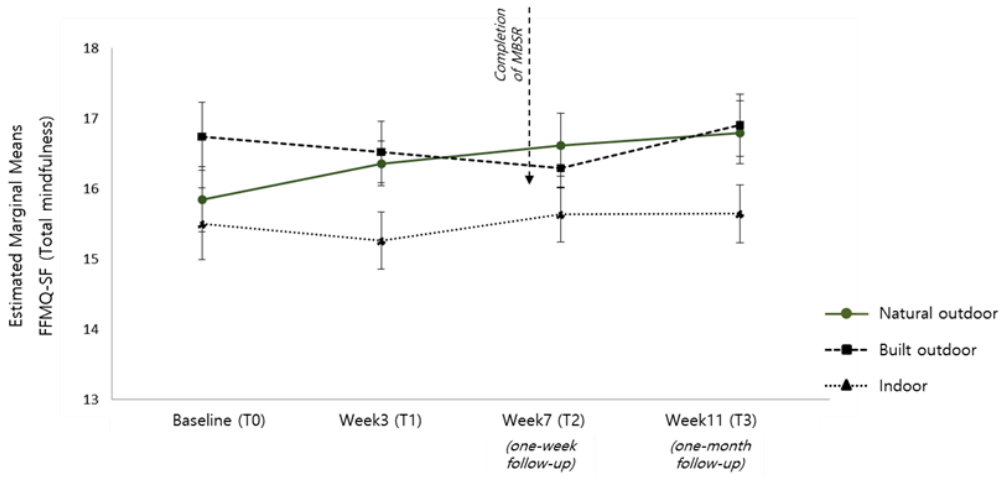

Figure 5.6 Interaction graph for mindfulness; Error bars denote using a 95% confidence interval.

5.3.3 Nature connectedness

Time had a statistically significant effect on nature connectedness, $F(3,94)= 6.89$, $P< .001$, $\eta^2= .18$. A significant interaction effect on nature connectedness was found between time and environment, $F(6,188)= 2.74$, $P= .01$, $\eta^2= .08$. The ANOVA revealed no significant differences between the environments at each time point, $p> .05$. Paired samples t-tests were used to investigate further the impact of MBSR in each environmental group. In the natural outdoor environment, there was a statistically significant increase in nature connectedness from T0 (M=3.38, SD=0.89) to T3 (M= 3.79, SD= 0.92), t(32)= -3.41, $p= .002$, $\eta^2= .27$. However, no significant differences were found in the built outdoor environment from T0 (M= 3.42, SD= 0.96) to T3 (M= 3.51, SD= 0.83), t(32)= -1.15, $p= .26$, $\eta^2= 0.04$. Similarly, in the indoor environment, t-tests revealed no significant difference in nature connectedness from T0 (M= 3.35, SD= 0.75) to T3 (M= 3.39, SD= 0.85), t(32)= -0.40, $p= .70$, $\eta^2= 0.00$. Thus, nature connectedness was improved only in the MBSR group in the natural outdoor environment, not in the other environments (Figure 5.7).

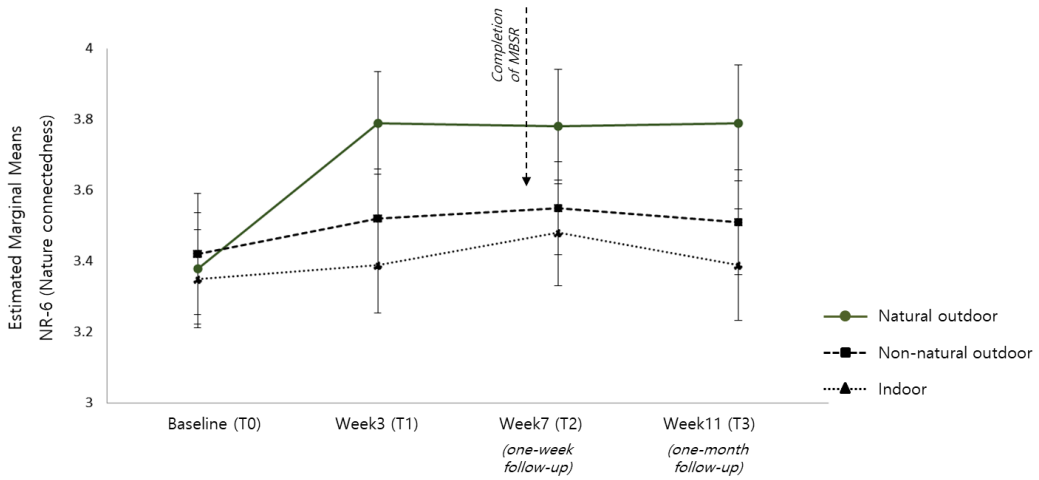

Figure 5.7 Interaction graph for nature connectedness; Error bars denote using a 95% confidence interval.

5.3.4 Positive and negative affect

Positive affect

A time by environment repeated measures ANOVA revealed that time had a significant effect on positive affect, $F(3,94)= 2.70$, $p= .049$, $\eta^2= .08$. However, there was no significant time by environment interaction, $F(6,188)= 0.82$, $p= .55$, $\eta^2= .03$ (Figure 5.8).

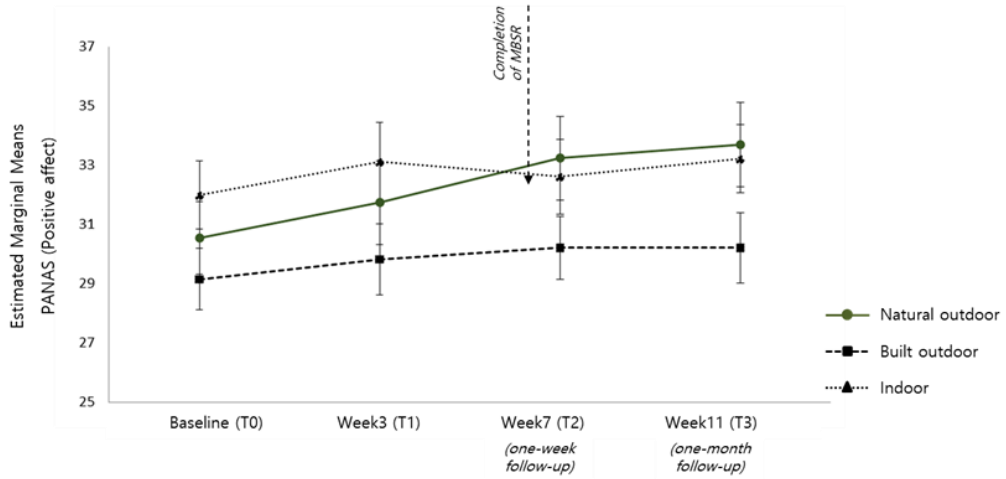

Figure 5.8 Interaction graph for positive affect; Error bars denote using a 95% confidence interval.

Negative affect

Time had a statistically significant impact on negative affect, $F(3,94)= 10.27$, $p< .001$, $\eta^2= .25$. Although there was no statistically significant interaction between time and environment,

$F(6,188)= 1.18$, $p= .32$, $\eta^2= .04$, Figure 5.9 suggests that the biggest drop of negative affect was when the interaction was conducted in the natural outdoor environment.

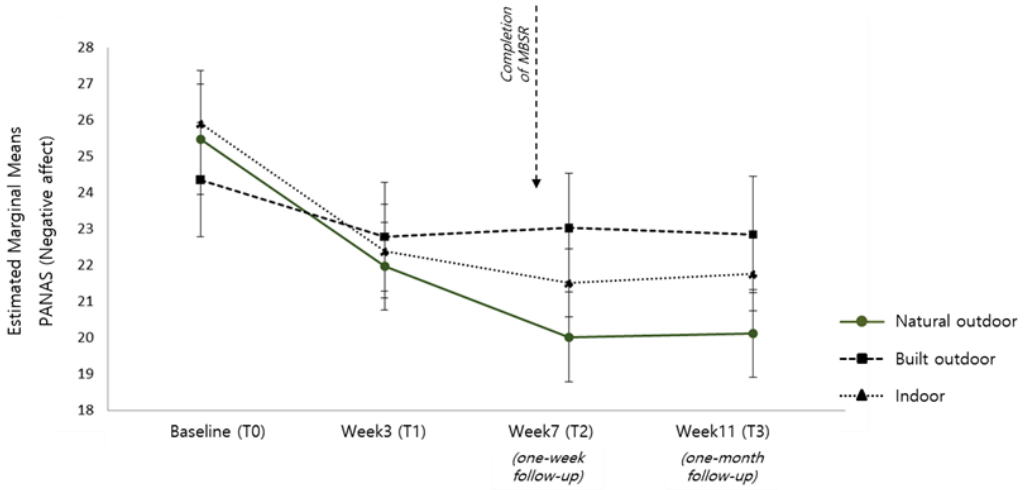

Figure 5.9 Interaction graph for negative affect; Error bars denote using a 95% confidence interval.

Additional positive affect (relaxed, calm and safe)

As shown in Figure 5.10, time had a significant effect on relaxed affect, $F(3,94)= 9.14$, $p< .001$, $\eta^2= .23$. However, there was no statistically significant interaction between environment and time, $F(6,188)= 1.32$, $p= .25$, $\eta^2= .04$.

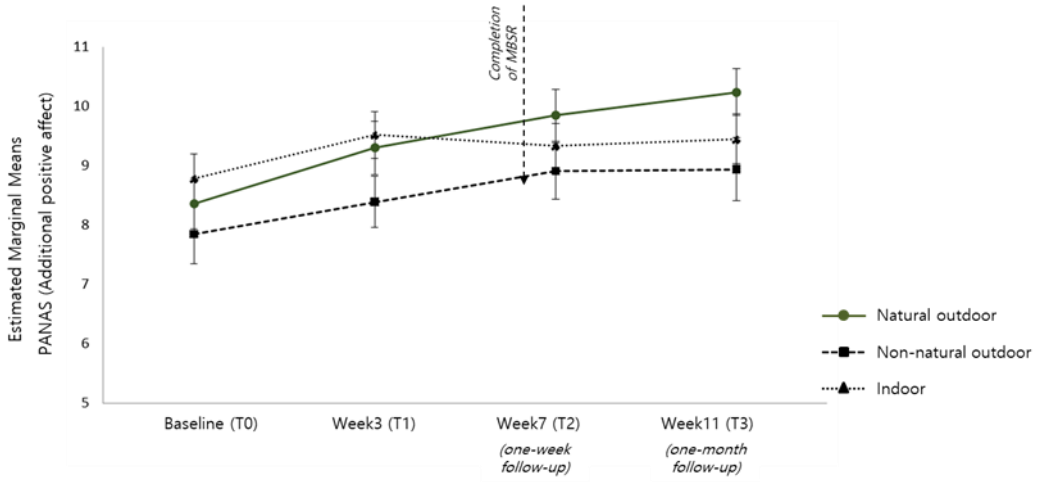

Figure 5.10 Interaction graph for additional positive affect; Error bars denote using a 95% confidence interval.

5.3.5 Rumination and reflection

Rumination

A time by environment repeated measures ANOVA revealed a main effect of time on rumination scores, $F(3,94)= 17.11$, $p< .001$, $\eta^2= .35$. There was also a significant interaction effect between time and environment, $F(6,188)= 3.23$, $P= .01$, $\eta^2= .09$. ANOVA revealed no differences between environments at T0, $F(2,96)= 0.09$, $p= .91$, $\eta^2= .001$, and at T1, $F(2,96)= 0.21$, $p= .81$, $\eta^2= .004$. However, the difference in participants' level of rumination between groups was significant at T2, $F(2,96)= 3.37$, $p= .04$, $\eta^2= .07$, and at T3, $F(2,96)= 6.42$, $p= .002$, $\eta^2= .12$. Decrease in rumination persisted at the follow-ups (T2 and T3) in the natural outdoor environment, but rumination did not decrease at T2 and T3 in the other environments. The post-hoc test indicated that the mean score for the natural outdoor group (M= 2.92, SD= 0.53) was significantly different from both the groups in the built outdoor (M= 3.44, SD= 0.61) and indoor environments (M= 3.29, SD= 0.68); the group in the built environment did not differ significantly from the indoor group at T3. Paired samples t-tests were conducted to investigate further the impact of MBSR in each group. In the natural outdoor environment, there was a statistically significant decrease in rumination from T0 (M= 3.71, SD= 0.83) to T3 (M= 2.92, SD= 0.53), $t(32)= 6.16$, $p< .001$, $\eta^2= 0.54$. A significant decrease was also found in the built outdoor environment from T0 (M= 3.65, SD= 0.73) to T3 (M= 3.44, SD= 0.61), $t(32)= 2.44$, $p= .02$, $\eta^2= 0.16$. Similarly, in the indoor environment, t-tests revealed a significant decrease in rumination from T0 (M= 3.62, SD= 0.80) to T3 (M= 3.29, SD= 0.68), $t(32)= 3.09$, $p= .004$, $\eta^2= 0.23$. Thus, all environmental groups showed a significant decrease in rumination, but the improvement in the natural outdoor environment was greater than in the other environments (Figure 5.11).

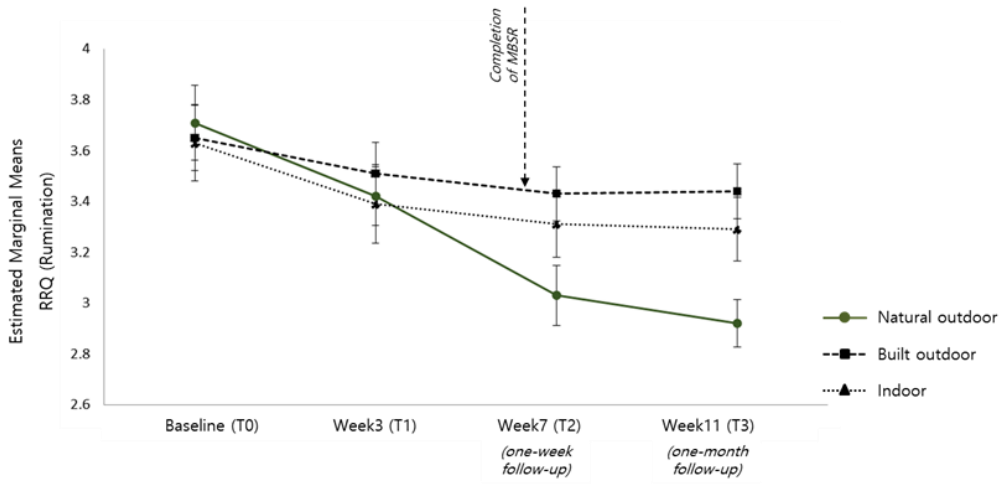

Figure 5.11 Interaction graph for rumination; Error bars denote using a 95% confidence interval.

Reflection

Time had a statistically significant effect on reflection, $F(3,94)= 4.53$, $p= .01$, $\eta^2= .13$. There was also a significant time by environment interaction, $F(6,188)= 2.31$, $p= .04$, $\eta^2= .07$. However, the further ANOVA revealed no significant differences between the environments at each time point, $p> .05$. I also conducted Paired samples t-tests to investigate the impact of MBSR in each group. In the natural outdoor environment, there was a statistically significant increase in reflection from T0 (M=3.23, SD=0.71) to T3 (M= 3.65, SD= 0.72), t(32)= -2.77, $p= .01$, $\eta^2= 0.19$. However, no significant difference was found in the built outdoor environment from T0 (M= 3.47, SD= 0.75) to T3 (M= 3.56, SD= 0.67), t(32)= -1.35, $p= .19$, $\eta^2= 0.05$. In the indoor environment group, t-tests also revealed no significant difference in reflection from T0 (M= 3.43, SD= 0.78) to T3 (M= 3.44, SD= 0.77), t(32)= -0.08, $p= .94$, $\eta^2= 0.00$. Thus, the natural outdoor environment group had greater improvement in reflection than the groups in the other environments (Figure 5.12).

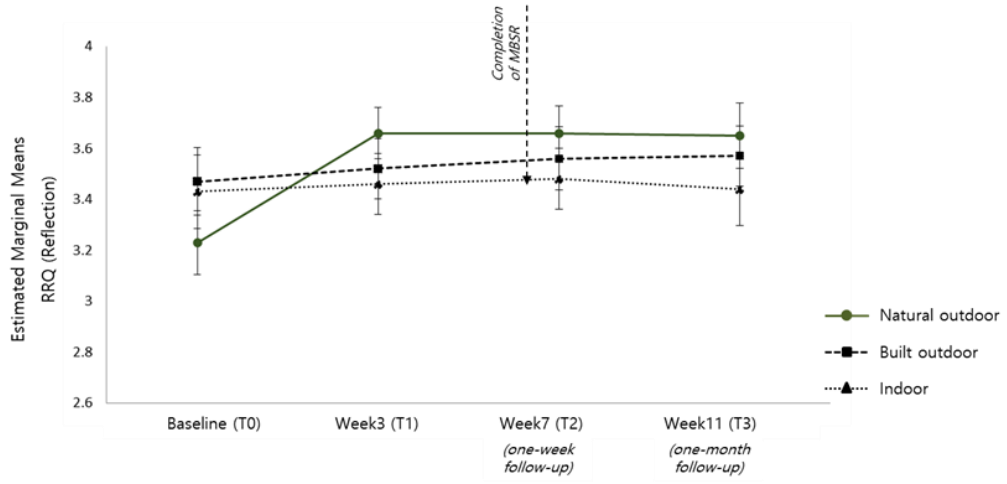

Figure 5.12 Interaction graph for reflection; Error bars denote using a 95% confidence interval.

5.3.6 Depression, anxiety and stress

Depression

A time by environment repeated measures ANOVA revealed that time had a significant effect on depression, $F(3,94)= 7.99$, $p< .001$, $\eta^2= .20$. However, there was no significant time by environment interaction, $F(6,188)=0.48$, $p=.83$, $\eta^2=.02$ (Figure 5.13).

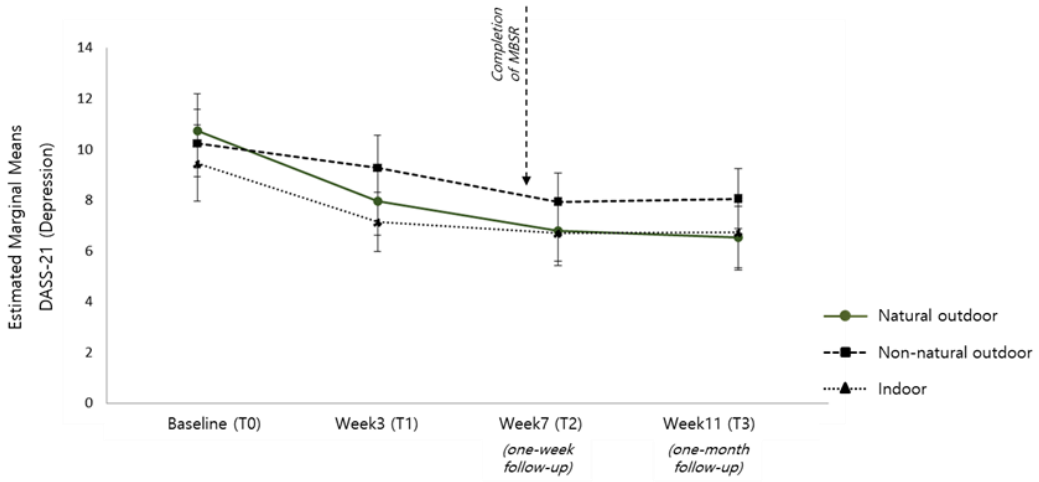

Figure 5.13 Interaction graph for the depression; Error bars denote using a 95% confidence interval.

Anxiety

As shown in Figure 5.14, time had a significant effect on anxiety, $F(3,94)= 7.45$, $p< .001$, $\eta^2= .19$; there was a significant decrease throughout the research period. However, there was no statistically significant interaction between time and environment, $F(6,188)= 0.97$, $p= .45$, $\eta^2=.03$.

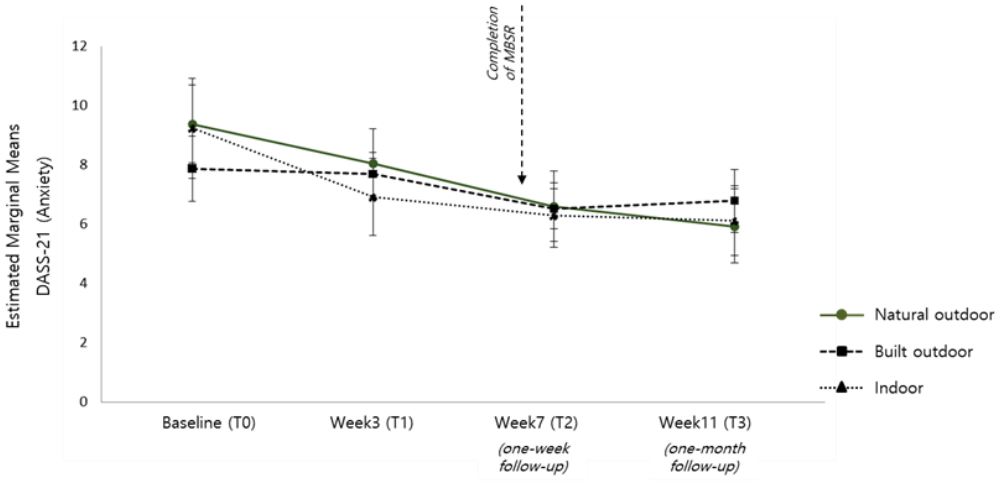

Figure 5.14 Interaction graph for anxiety; Error bars denote using a 95% confidence interval.

Stress

Time had a statistically significant impact on stress, $F(3,94)= 5.52$, $p= .002$, $\eta^2= .15$. There was also a significant time by environment interaction, $F(6,188)= 2.446$, $p=.03$, $\eta^2= .07$. ANOVA revealed no differences between the environments at T0, $F(2,96)= 0.35$, $p= .71$, $\eta^2= .01$, and at T1, $F(2,96)= 1.93$, $p= .15$, $\eta^2= .04$, at T2, $F(2,96)= 2.69$, $p= .07$, $\eta^2= .05$. However, there was a significant difference at T3; the natural outdoor environment group showed greater stress reduction than the groups in the other environments, $F(2,96) = 3.78$, $p= .03$, $\eta^2= .07$. Our post-hoc test indicated that the mean score for the natural outdoor group (M= 9.82, SD= 6.21) was significantly different from the group in the built outdoor environment (M= 14.70, SD= 8.93); the indoor group (M= 12.85, SD= 6.37) did not differ significantly from either of the groups in the natural outdoor or the built outdoor environments at T3. As shown in Figure 5.15, there was a steady decrease in stress, in the natural outdoor environment, unlike in built outdoor and indoor environments. Paired samples t-tests were used to further investigate the impact of MBSR in each

group. In the natural outdoor environment, there was a statistically significant decrease in stress from T0 (M=16.61, SD=8.05) to T3 (M= 9.82, SD= 6.21), t(32)= 5.42, $p< .001$, $\eta^2= 0.03$. However, no significant differences were found in the built outdoor environment from T0 (M= 15.27, SD= 7.71) to T3 (M= 14.70, SD= 8.93), t(32)= 0.37, $p= .71$, $\eta^2= 0.002$. In the indoor environment, t-tests also revealed no significant difference in stress from T0 (M= 15.12, SD= 10.02) to T3 (M= 12.85, SD= 6.37), t(32)= 1.79, $p= .08$, $\eta^2= 0.05$. Thus, the MBSR in the natural outdoor environment resulted in greater improvement in stress than in the other environments.

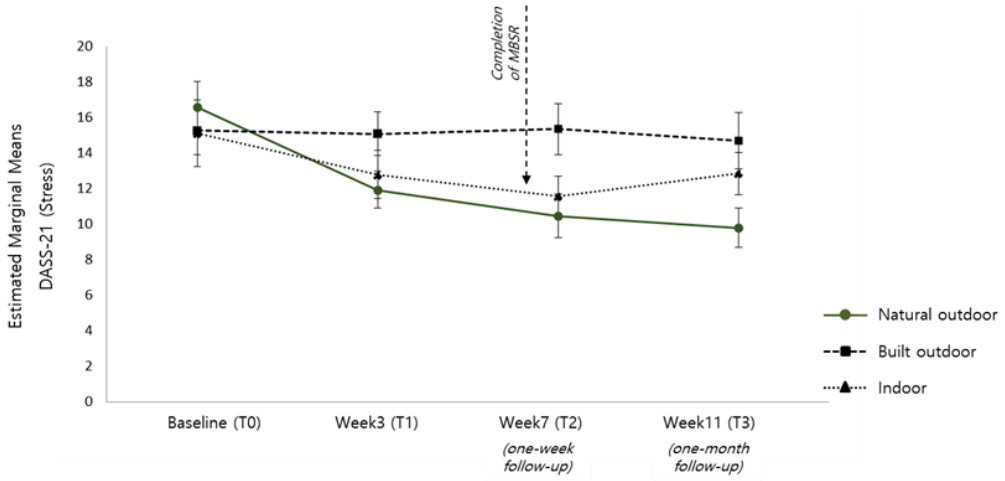

Figure 5.15 Interaction graph for the stress; Error bars denote using a 95% confidence interval.

5.3.7 Summary of findings

As shown in Table 5.3, this study found that all three groups experienced significant changes in mental health and wellbeing outcomes during the intervention. There was a significant 2-way interaction of time and environment; the changes over time of participants' levels of nature connectedness, rumination and reflection and stress were affected by environments (natural outdoor vs. built outdoor vs. indoor). However, the results of further analysis showed that only participants in the MBSR programme in the natural outdoor environment had improved nature connectedness, ruminative and reflective attitudes as well as experiencing stress reduction over the course of the intervention (including one-month follow-up).

Table 5.3 All main and interaction effects including the results of further analysis

Measure	Effects		Results of further analysis (one-way ANOVA/T-test)
	Time	Time x Environment	Significant difference between environments
FFMQ-SF - Mindfulness	√	-	-
NR-6 - Nature connectedness	√	√	Only significant improvement in a natural environment (T0-T3)
PANAS - Positive affect	√	-	-
PANAS - Negative affect	√	-	-
PANAS – Additional positive affect	√	-	-
RRQ - Rumination	√	√	Significant improvement in all environments (T0-T3), but only improved in a natural environment (T2-T3)
RRQ - Reflection	√	√	Only significant improvement in a natural environment (T0-T3)
DASS-21 - Depression	√	-	-
DASS-21 – Anxiety	√	-	-
DASS-21 – Stress	√	√	Only significant improvement in a natural environment (T0-T3)

Note: baseline (T0), after the third MBSR session (T1), one week after the completion of the 6-week MBSR (T2) and one month after the completion of the 6-week MBSR (T3)

5.3.8 Potential pathway: does nature connectedness mediate the effectiveness of the interventions on mental health and wellbeing?

The final question in this study sought to determine whether change in nature connectedness (calculated as T3 minus T0) affects changes in the mental health and wellbeing outcomes of MBSR. As previously indicated, the results of a time by environment interaction analysis showed that the changes over time of participants' levels of nature connectedness, rumination and reflection and stress were affected by environments. Thus, mediation analysis focused on the outcomes that showed different changes by environment over time (i.e. rumination, reflection and stress). The PROCESS macro (Hayes, 2012) was used to estimate the mediating effects of both direct and indirect effects based on 10,000 bootstrapping samples at 95% biased-corrected confidence intervals.

Rumination

The mediation analysis indicated that the effect of environment manipulation on rumination remained significant after including nature connectedness in the model, *b*= 0.51 (SE=0.14), *t*= 3.63, *p*< 0.001. The indirect path of environment manipulation affects rumination (Environment→ Nature connectedness→ Rumination), which was showed in Figure 5.16, exhibited statistically no significant effect. The obtained result on the bootstrap lower limit confidence interval (BootLLCI= -0.11) and bootstrap upper limit confidence interval (BootULCI= 0.09) straddle between zero with indirect effects of 0.001; thus, there was no significant indirect effect of environment manipulation on rumination through nature connectedness.

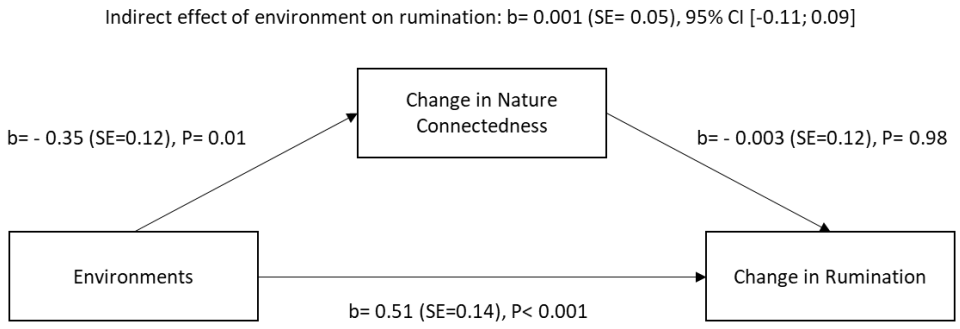

Figure 5.16 Model of environment manipulation as a predictor of rumination, mediated by nature connectedness.

Reflection

The mediation analysis indicated that the effect of environment manipulation on reflection was no longer significant after including nature connectedness in the model, *b*= - 0.16 (SE=0.15), *t*= -1.01, *p*= 0.31. The indirect path of environment manipulation affects reflection (Environment→ Nature connectedness→ reflection), which was showed in Figure 5.17, showed statistically a significant effect. The obtained result on the bootstrap lower limit confidence interval (BootLLCI= -0.44) and bootstrap upper limit confidence interval (BootULCI= -0.05) did not

straddle between zero with indirect effects of -0.21; thus, there was a significant indirect effect of environment manipulation on reflection through nature connectedness.

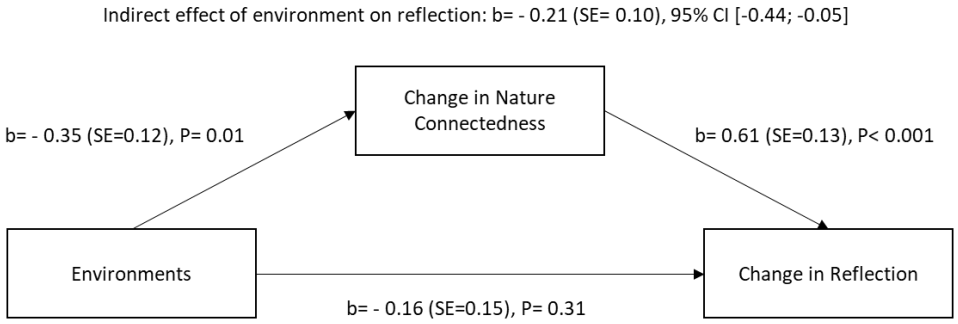

Figure 5.17 Model of environment manipulation as a predictor of reflection, mediated by nature connectedness.

Stress

The mediation analysis indicated that the effect of environment manipulation on stress remained a significant after including nature connectedness in the model, *b*= 4.25 (SE= 1.59), *t*= 2.68, *p*= 0.01. The indirect path of environment manipulation affects stress (Environment→ Nature connectedness→ Stress), which was showed in Figure 5.18, exhibited statistically no significant effect. The obtained result on the bootstrap lower limit confidence interval (BootLLCI= -0.52) and bootstrap upper limit confidence interval (BootULCI= 1.45) straddled between zero with indirect effects of 0.35; thus, there was no significant indirect effect of environment manipulation on stress through nature connectedness.

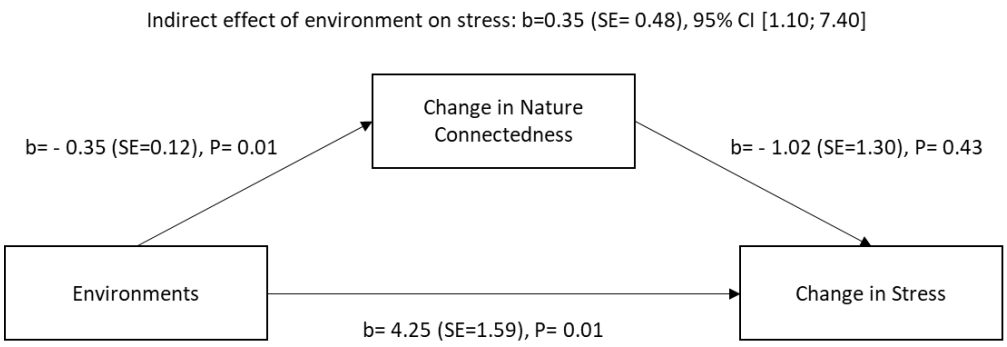

Figure 5.18 Model of environment manipulation as a predictor of stress, mediated by nature connectedness.

5.4 Discussion

Phase 2 of the study found that attending the MBSR programme in a natural environment resulted in greater nature connectedness than in a built outdoor or an indoor environment (Research question 1). This confirms that nature connectedness was stronger after experiencing natural environments in contrast to urban built environments (Mayer and Frantz, 2004; Nisbet *et al.*, 2011). In addition, people feel closer and more connected to nature when more frequently exposed to natural environments (Hinds and Sparks, 2008; Richardson and Sheffield, 2017a). This finding provides primary evidence for the mediation effect of nature connectedness on the MBSR outcomes.

The second question in this study sought to determine whether the MBSR programme achieves the best mental health and wellbeing outcomes when conducted in a natural environment (Research question 2). Firstly, the results showed that conducting MBSR in natural environments had more positive effects on stress relief compared to the other environments (i.e. built outdoor and indoor). This result is consistent with those of Tyrväinen *et al.* (2014) and Roe and Aspinall (2011), who found that visits to natural environments helped to reduce stress and enhance psychological recovery compared with visits to built-up environments. Similarly, studies on the efficacy of forest bathing (*Shinrin-yoku*) showed that forest environments can promote lower pulse rates, lower blood pressure and lower concentrations of cortisol than urban surroundings. The results of the physiological responses suggest that activities in forest environments can help to relax the body and manage the negative effects of stress (Lee *et al.*, 2011; Takayama *et al.*, 2014). Secondly, this study found that attending the MBSR programme in the natural outdoor environment resulted in reduced rumination and more reflective attitudes - aspects of eudaimonic wellbeing - compared with the other environments. However, the study did not find significant

effects of the different environments on the hedonic aspects of wellbeing, such as positive or negative feelings. These results further support the ideas of Capaldi *et al*. (2014) and Trigwell *et al*. (2014) that being physically or psychologically connected with nature involves a sense of meaningful co-existence with something larger than oneself; this is strongly related to eudaimonic wellbeing e.g. feelings of meaningful/worthwhile life. Thirdly, the effects of MBSR lasted longer when it was conducted in the natural outdoor environment. Most of the participants in all environmental conditions showed improvements in mental health and wellbeing during the 6-week experiment. However, there were significant differences between environments at one-month follow-up (after participants had returned to their ordinary routine). For example, all participants' rumination levels decreased during the 6-week experiment, but the participants in the built outdoor and the indoor environments showed no change in rumination levels between follow-ups (T2-T3), whereas the group in the natural outdoor environment continued to improve even after the experiment. The longevity of the positive effects following MBSR in natural environments may be explained by the promotion of the eudaimonic aspects of nature connectedness, leading to more sustained outcomes (McMahan and Estes, 2011).

In order to examine the effect of nature connectedness on the MBSR outcomes, this study also examined whether change in nature connectedness (T0-T3) mediates the effectiveness of MBSR on mental health and wellbeing (Research question 3). The results found that changes in nature connectedness mediated the effect of environment manipulation on participants' levels of reflection, at least in part. This partially supports other studies that have found that mindfulness is related to nature connectedness. Wolsko and Lindberg (2013) showed that individuals who have stronger feelings of nature connectedness also had with greater trait mindfulness and psychological wellbeing. Similarly, Nisbet *et al*. (2019) also found that individuals who practised mindfulness reported greater awareness of their surroundings, stronger nature connectedness, and better moods than individuals without mindfulness practice.

CHAPTER SIX: PHASE 3 STUDY
Examining the effectiveness of mindfulness-based stress reduction (MBSR) in simulated natural environment and actual natural environments: secondary data analysis

6.1 Introduction

Phase 1 and phase 2 of this PhD showed that the mental health and wellbeing outcomes of mindfulness-based stress reduction (MBSR) are enhanced through the experience of natural environments. This chapter presents phase 3 that is designed to gain further knowledge pertaining to the exposure to actual and simulated natural environment in the effectiveness of MBSR. This study compared the MBSR outcomes retrieved from simulated and actual natural environments by employing the qualitative and quantitative data obtained from earlier studies (phase 1 and phase 2).

A study of activity patterns in the UK found that people were spending an average of 95.6% of their time staying indoors, and up to 100% of their time in the case of vulnerable individuals including the elderly and people with disabilities (Vardoulakis *et al.*, 2015). The indoor lifestyles are often related with reduced physical activities and increased obesity and diabetes leading to higher prevalence of mental health problems (Depledge *et al.*, 2011). Moreover, the indoor lifestyles have disconnected people from nature. Based on Wilson's Biophilia Hypothesis (1984), the lack of connection to nature may have been the cause of poor mental health and wellbeing as people are inherently connected to nature (Capaldi *et al.*, 2014). Thus, connection with nature will consequently benefit human wellbeing and mental development. Recently, Fields in Trust (2018) reported that green spaces (e.g. parks, woods and playing fields) across the UK offer over

£34 billion of health and wellbeing benefits. However, the need for nature and natural elements often is in conflict with the type of setting we are in, e.g. the workplace, hospital or a residence where an actual natural environment is not always available. We often accept some kind of alternatives or simulation of nature (e.g. potted plants, artificial plants or pictures of nature).

Simulated or virtual environments have been widely used to study the restorative effect of the environmental exposures. Brown *et al*. (2013) applied slideshow images to depict scenes of natural and built environments, which revealed that viewing natural images enhanced stress recovery. Van den Berg *et al*. (2014) made use of short slideshows combined with video presentations that simulated the experience of walking through built and natural urban spaces. Their participants exhibited strong mood stress recovery, as well as better restorative state in the natural setting, when compared to the urban street setting. Virtual reality (VR), a cutting-edge technology, has also been applied to offer more immersive experience of exposure to natural settings. Valtchanov *et al*. (2010) discovered that the participants exposed to virtual computer-generated forest setting had reduced stress and more positive effects compared with those who viewed art paintings.

Despite the benefits offered by simulated/virtual natural environments on health and wellbeing, the extent to which such simulated settings can act as a substitute for the actual setting has not been fully evaluated. Some limitations of the simulated natural setting have been identified in light of their variance to real nature, for instance, limited sensory aspects, constricted interactivity with the environment, and image resolution. These shortcomings degrade the realism of the simulated environment and may adversely affect users' experience when compared to being exposed to the actual setting. Kahn *et al.* (2008) assessed physiological responses to embedding a real-time natural view via plasma display "window". They discovered that working in an office space with an actual window, a natural scene exerted a better restorative effect than working in an office with a blank wall; and the "plasma window" failed to induce a similar effect. Gatersleben

and Andrews (2013) reported that a walk in an actual natural environment gave better recovery from attention fatigue and greater reduction in feelings of sadness than a simulated walk did. Some evidence therefore describes differences between simulated/virtual and actual natural environments on health and wellbeing. So far, however, much uncertainty still exists about the differences. There has been little discussion about the different ways of exposure to natural environments' (be it passive or active) influence on the health and wellbeing outcomes of the activities/interventions. It seems that more research is needed to determine the beneficial features of natural environments that are linked to human health and wellbeing. Improving this understanding would also be helpful for those who have limited access to natural outdoor environment; in particular, the elderly and infirm, who spend most or all of their time indoors. Thus, this study compared the effectiveness of MBSR in simulated and actual natural environments, and explored the difference of individual experience (i.e. nature connectedness).

The following questions were set for phase 3 of the study:

Q1. Is there a difference between mental health and wellbeing outcomes in a simulated and an actual natural environment?

Q2. Do participants practising MBSR in an actual natural environment show greater nature connectedness than those experiencing a simulated natural environment?

6.2 Methods

6.2.1 Study design and data selection

A secondary data analysis was conducted (Hinds *et al*., 1997) by incorporating data retrieved from phase 1 and 2 of this study. Figure 6.1 illustrates the data selection process. A total of 64 responses were taken into the quantitative analysis (29 males, 35 females; mean age of 28.17; 18-57 age range), 34 of which (53.1%) derived from participants who completed three MBSR sessions within the simulated natural environment (phase 1), whereas 30 responses (46.9%) came from those who completed three MBSR sessions within the actual natural environments (phase

2). In an attempt to elicit rich information about the participants' experiences in their respective environments, qualitative data from focus groups were assessed in this study: three and four participants from the simulated and the actual natural environments, respectively (3 males, 4 females; mean age of 33.14; 26-52 age range).

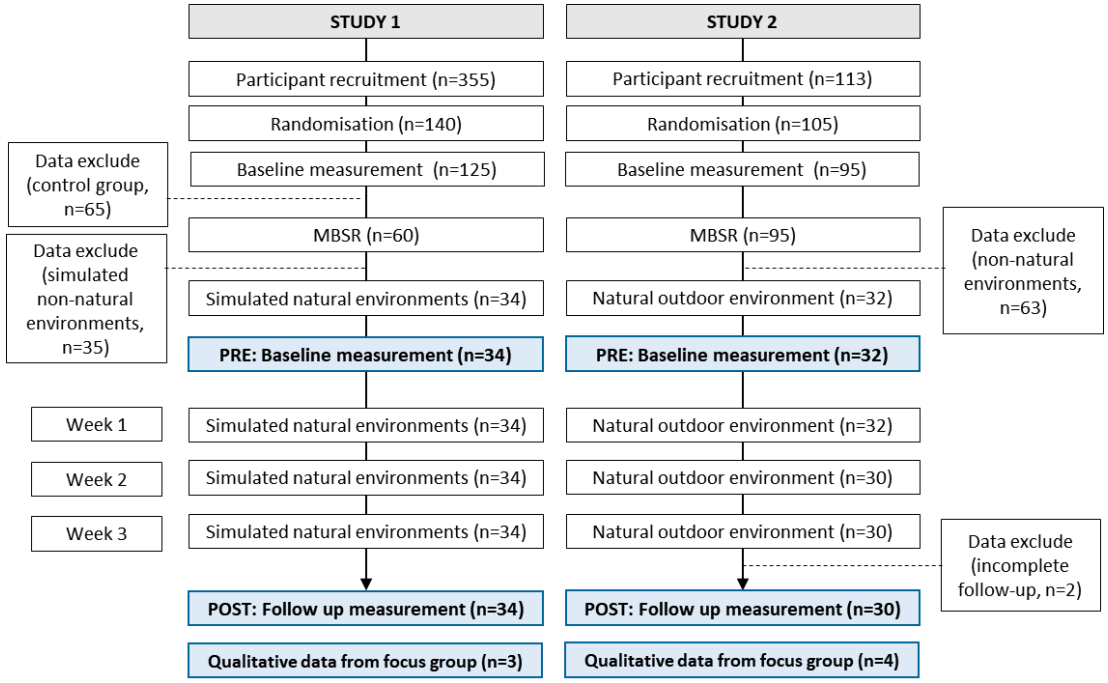

Figure 6.1 Flow diagram of the data selection process

6.2.2 Measures

Quantitative measures: self-reported questionnaire

The quantitative data were derived from the four validated scales: Five Facet Mindfulness Questionnaire (FFMQ-SF) and Nature Relatedness Scale (NR-6), Positive and Negative Affect Schedule (PANAS) and Depression Anxiety Stress Scales (DASS-21) at baseline and after the third MBSR session (see Chapter Four).

Qualitative measures: focus groups

The use of focus groups in qualitative research encourages shared discussion between participants (Krueger and Casey, 2015). The study included two focus groups with three to four participants.

The participants were invited from those who completed three sessions of MBSR in the simulated natural environment (phase 1) and the actual natural environment (phase 2) after the completion of the MBSR programme. Focus groups were arranged in a quiet room at the University of Sheffield and refreshments were provided for participants. Each focus group lasted for 1.5 hours. The focus groups were facilitated by me with a mindfulness teacher. The focus groups were run as follows: firstly there was a mindfulness session of 10 minutes designed to help the participants relax and reconnect with the mindfulness activities and thus facilitate discussion. There was then a focus group discussion of approximately one hour and then a follow-up mindfulness activity to relax the participants and thank them for their participation. The moderator followed that a semi-structured focus group guide (Figure 6.2) was designed to structure the discussion to explore the participants' experiences of and attitudes towards the MBSR sessions in the different environments. The guide presents two primary concepts: 1) the effectiveness of MBSR, and 2) participants' experience in their environments (i.e. simulated and actual natural environments). In assessing the effectiveness of MBSR, open-ended questions were designed to encourage answers with more depth regarding the views and perceptions of the participants about MBSR (e.g. "*In what way did this mindfulness programme affect you?*"), as well as the changes that the participants felt during and after the experiment (e.g. "*Have you experienced changes in your routines, habits or thoughts?*"). Next, the guide solicited narratives from the participants about their experiences in the environments (e.g. "*How did you find your experiences in the environment to which you were assigned?*"). The participants were also asked about the barriers and motivators to continue practising MBSR in the specified setting (e.g. "*Was there anything about the environment that distracted/helped you to focus on mindfulness practise?*"). The aim, with permission, was to audio-record the focus groups. One assistant took hand-written notes of the discussions.

Focus group: moderator's guide

Research Question 1.
Is there a difference between mental health and wellbeing outcomes in a simulated and an actual natural environment?

Key question A. General benefits of MBSR
- Is anyone still using mindfulness practices and if so, which mindfulness practices are you continuing? and why is this?
- In what way did this MBSR programme affect you, if at all?

Key question B. Habit formation
- Let's think now about any changes during or after the MBSR programme.
- Have you experienced changes in your routines or habits?
- What has helped in your changes? What made them difficult?

Research Question 2.
Do participants practising MBSR in an actual natural environment show greater nature connectedness than those experiencing a simulated natural environment?

Key question A. Participants' experience in their environments
- Please tell us which environment you were in.
- How did you find your experiences in the environments which you were assigned?
- In what ways do you think this context had a particular bearing on your practice/ health and well-being? Have you noticed any changes in your mental health and wellbeing?

Key question B. Environmental challenges
- How did you find attending MBSR and taking the time out to do so?
- We are really interested if there was anything that made it difficult/easy to keep attending.
- Did you find any difficulties during the time you were attending MBSR?
- Was there anything about the context that distracted / helped you to focus on MBSR?

Figure 6.2 Focus group: moderator's guide

6.2.3 Environments

Simulated natural environment

In the simulated environment laboratory located at the university campus, an image was displayed on a 5.8 m x 2.2 m screen to simulate the experience of being exposed to the natural environment. The image was a view of parkland containing trees and shrubs at the edge of an open expanse of

mown grass (Figure 6.3). Background sound was added using audio clips to convey nature-related sounds, for example, birds tweeting and wind rustling the leaves of trees.

Actual natural environment

Weston Park, a public park situated near the university, was selected for the actual natural environment. Similar to the simulated natural environment, this park reflects a well-managed green space that is filled with trees, shrubs, flower beds, lawns, and a lake, along with facilities, such as benches, wooden bridges, a bandstand, and monuments. The experiment was performed in a location defined by planted areas that contained shrubs and small trees, as well as overlooking several distant views. Background sound was also present during the experiment, for instance, birds chirping and people talking in the distance.

a) *Simulated* natural environment b) *Actual* natural environment

Figure 6.3 MBSR setting of simulated vs. actual natural environment

6.2.4 Analysis strategy

Quantitative measures: self-reported questionnaire

The study analyses were conducted using SPSS for Windows version 24.0 with .05 alpha. Before proceeding with the ANCOVAs, preliminary checks were carried out for normality, linearity, homogeneity of variances, and the reliability of covariates. Chi-square and ANOVA approaches

were employed to examine differences at baseline (i.e. pre-MBSR). After that, a one-way ANCOVA was performed to compare the impacts the two environments had on MBSR outcomes, whilst controlling for their pre-MBSR scores. Next, paired samples t-tests were carried out to evaluate the effect of MBSR in each group.

Qualitative measures: focus groups

The transcripts retrieved from the focus groups were analysed deductively. The deductive approach refers to a 'top down' approach that determines whether the data are indeed consistent with prior assumptions, theories, and hypotheses outlined by the researcher (Thomas, 2006). In this study, the analysis was carried out manually by the researcher. Initially, data obtained from the focus groups were transcribed by a professional transcriber. The transcripts were then read a few times by the researcher to comprehend the whole context and to become familiar with the content. The content that provided answers to the research questions was identified: '*Is there a difference between mental health and wellbeing outcomes in a simulated and an actual natural environment?*' and '*Do participants in actual natural environment show greater nature connectedness than in a simulated natural environment?*' Once all the data was grouped by the research questions, these identified statements were categorised into codes that were suggested by the data; the codes represented the properties of a particular category. The analysis continued by going through the transcripts, identifying sections of text which were relevant to the research questions, and marking them with codes and sub-codes.

6.3 Quantitative results: self-reported questionnaire

6.3.1 Preliminary analysis

No significant variance was noted for age (χ^2= 35.56, p= .10) and gender (χ^2= 0.64, p= .42) between the two assessed environments (simulated and actual natural environments) at baseline. The one-way ANCOVA was performed to compare the impacts the two environments had on MBSR outcomes, whilst adjusting for pre-MBSR scores. Table 6.1 shows the values of mean and

standard deviation for all the measurements of environment before and after the three-week MBSR intervention.

Table 6.1 Mean scores (and standard deviation) on measures at pre-post MBSR

Outcome	MBSR group		
	Pre MBSR	Post MBSR	'Adjusted' Post MBSR
	M(SD) [95%CI*]	*M*(SD) [95%CI*]	*M*(SE) [95%CI*]
FFMQ-SF - Mindfulness			
Simulated natural environment	15.43(2.14) [14.68;16.18]	16.01(1.81) [15.38;16.64]	16.02(0.28) [15.47;16.58]
Actual natural environment	15.52(2.47) [14.60;16.45]	16.15(1.77) [15.49;16.82]	16.14(0.30) [15.54;16.73]
NR-6 - Nature connectedness			
Simulated natural environment	3.65(0.69) [3.41;3.90]	3.78(0.62) [3.56;4.00]	3.69(0.08) [3.53;3.94]
Actual natural environment	3.35(0.91) [3.01;3.69]	3.85(0.76) [3.86;4.14]	3.96(0.08) [3.79;4.12]
PANAS - Positive affect			
Simulated natural environment	31.91(6.42) [29.67;34.15]	34.59(5.79) [32.57;36.61]	34.46(0.98) [32.50;36.42]
Actual natural environment	31.47(6.99) [28.85;34.08]	32.60(8.27) [29.51;35.69]	32.75(1.05) [30.66;34.84]
PANAS - Negative affect			
Simulated natural environment	25.68(6.59) [23.38;27.98]	22.85(7.09) [20.38;25.33]	22.76(0.99) [20.76;24.76]
Actual natural environment	25.13(8.43) [21.99;28.28]	20.80(5.43) [18.77;22.83]	20.90(1.06) [18.78;23.03]
PANAS – Additional positive affect (relaxed, calm and safe)			
Simulated natural environment	9.50(0.35) [8.79;10.21]	10.15(1.88) [9.49;10.80]	9.87(0.33) [9.21;10.53]
Actual natural environment	8.47(0.46) [7.53;9.41]	9.60(2.69) [8.60;10.60]	9.91(0.35) [9.21;10.62]
DASS-21 – Depression			
Simulated natural environment	11.18(9.35) [7.90;14.45]	6.53(6.35) [4.31;8.74]	6.20(0.81) [4.58;7.83]
Actual natural environment	9.73(7.64) [6.88;12.59]	6.67(6.22) [4.34;8.99]	7.04(0.87) [5.31;8.77]
DASS-21 – Anxiety			
Simulated natural environment	11.71(7.78) [8.99;14.42]	9.36(6.78) [6.99;11.72]	8.63(0.84) [6.94;10.31]
Actual natural environment	8.13(5.80) [6.23;10.44]	6.93(4.26) [5.34;8.52]	7.76(0.90) [5.96;9.55]
DASS-21 – Stress			
Simulated natural environment	15.12(8.30) [12.22;18.01]	13.88(6.91) [11.47;16.29]	14.05(0.89) [12.28;15.83]
Actual natural environment	16.20(7.71) [13.32;19.08]	10.47(4.19) [8.90;12.03]	10.27(0.95) [8.38;12.16]

*CI: Confidence Interval

6.3.2 Level of mindfulness

After adjusting for pre-MBSR score, there was no significant difference between the two environments on post-MBSR score on mindfulness (FFMQ-SF), $F(1,61)= 0.08$, $p= .78$, $\eta^2= .001$ (Figure 6.4).

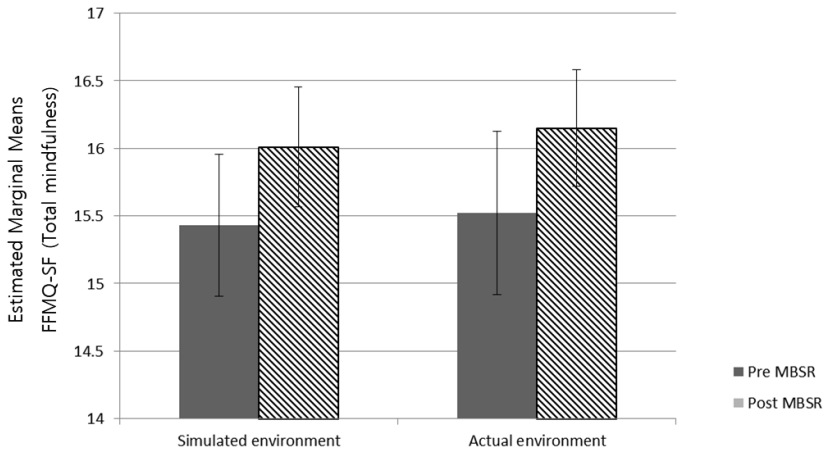

Figure 6.4 Change in mindfulness by environment; Error bars denote using a 95% confidence interval.

6.3.3 Nature connectedness

There was a significant difference between the two environments on post-MBSR score on natural relatedness (NR-6) after controlling for pre-MBSR score, $F(1,61)= 5.70$, $p= .02$, $\eta^2= .085$. This indicates that the actual natural environment was more effective in increasing natural connectedness than the simulated environment (Figure 6.5). Paired samples t-tests were carried out to further investigate the impact of MBSR within the group. Within the group in the actual environment, there was a statistically significant increase in nature connectedness from pre-MBSR (M=3.35, SD=0.91) to post-MBSR (M=3.85, SD= 0.76), $t(29)=-4.65$, $p< 0.01$, $\eta^2= 0.43$. However, no significant difference was found within the group in the simulated environment from pre-MBSR (M=3.65, SD=0.69) to post-MBSR (M=3.78, SD=0.62), $t(33)= -1.67$, $p= .11$, $\eta^2= 0.08$.

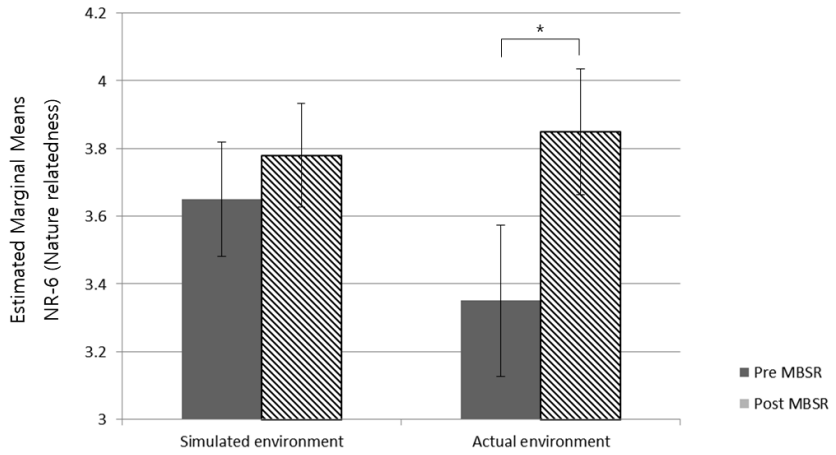

Figure 6.5 Change in nature connectedness by environment; Error bars denote using a 95% confidence interval. *P< .05.

6.3.4 Positive and negative affect

Positive affect

After adjusting for pre-MBSR score, no significant difference between the two environments on post-MBSR score on positive affect (PANAS) was found, $F(1,61)= 1.42$, $p= .24$, $\eta^2= .023$ (Figure 6.6).

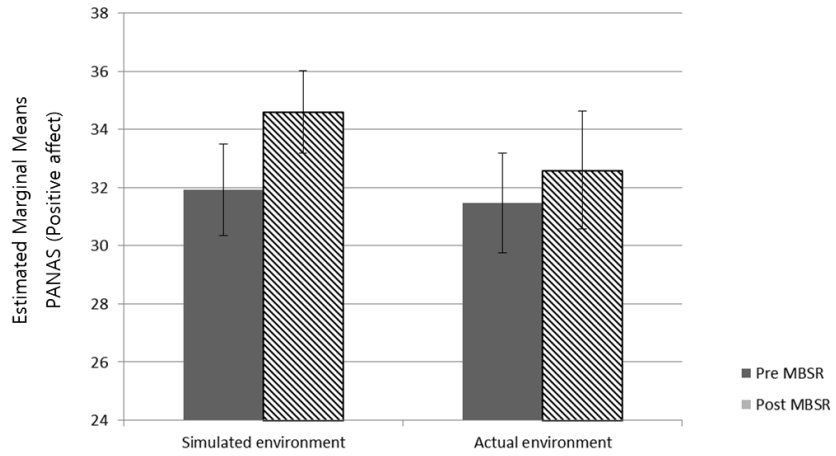

Figure 6.6 Change in positive affect by environment; Error bars denote using a 95% confidence interval.

Negative affect

There was no significant effect of environment on post-MBSR score on negative affect (PANAS) after controlling for pre-MBSR scores, $F(1,61)= 1.62$, $p= .21$, $\eta^2= .026$ (Figure 6.7).

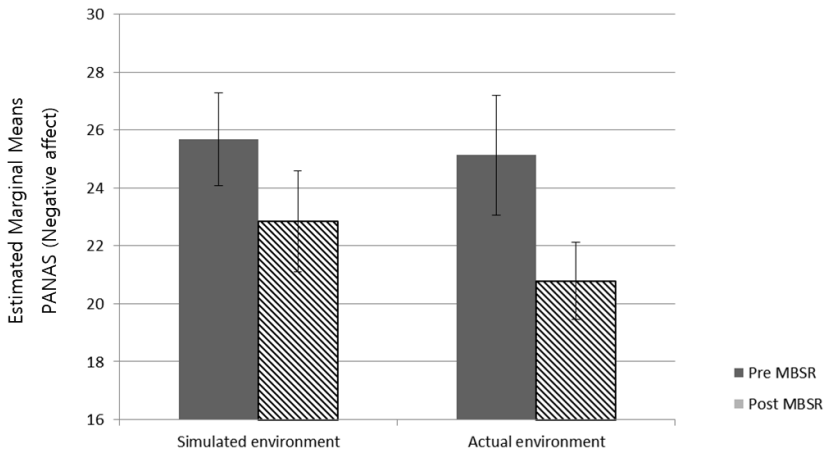

Figure 6.7 Change in negative affect by environment; Error bars denote using a 95% confidence interval.

Additional positive affect (relaxed, calm and safe)

After adjusting for pre-MBSR score, no significant difference between the two environments on post-MBSR score on additional positive affect (relaxed, calm and safe) was found, $F(1,61)= 0.01$, $p= .93$, $\eta^2= .001$ (Figure 6.8).

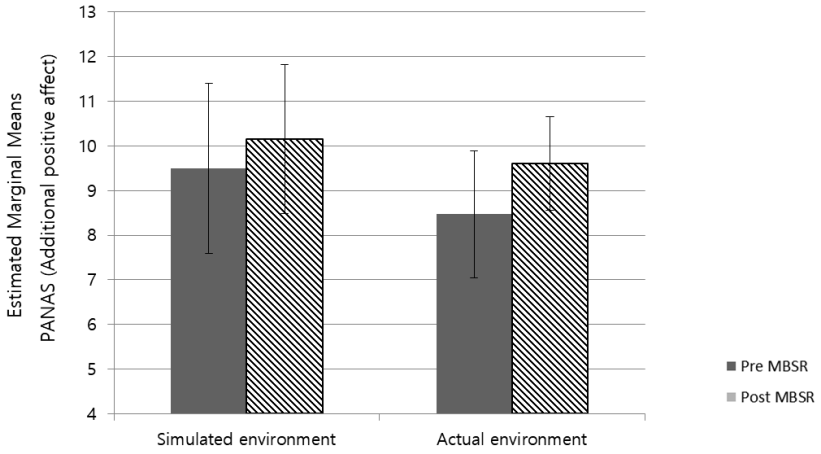

Figure 6.8 Change in additional positive affect by environment; Error bars denote using a 95% confidence interval.

6.3.5 Depression, anxiety and stress

Depression

After adjusting for pre-MBSR score, no significant difference between the two environments on post-MBSR score for depression (DASS-21) was found, $F(1,61)= 0.50$, $p= .48$, $\eta^2= .008$ (Figure 6.9).

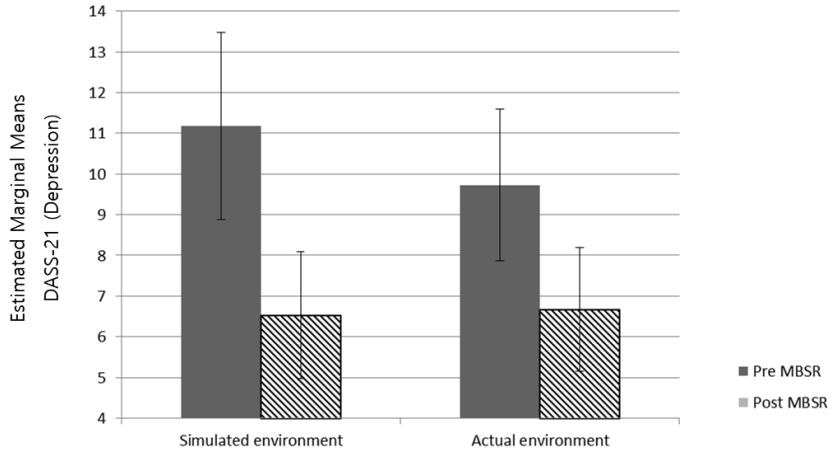

Figure 6.9 Change in depression by environment; Error bars denote using a 95% confidence interval.

Anxiety

There was no significant difference between the two environments on post-MBSR score for anxiety (DASS-21) after adjusting for pre-MBSR score, $F(1,61)= 0.49$, $p= .49$, $\eta^2= .008$ (Figure 6.10).

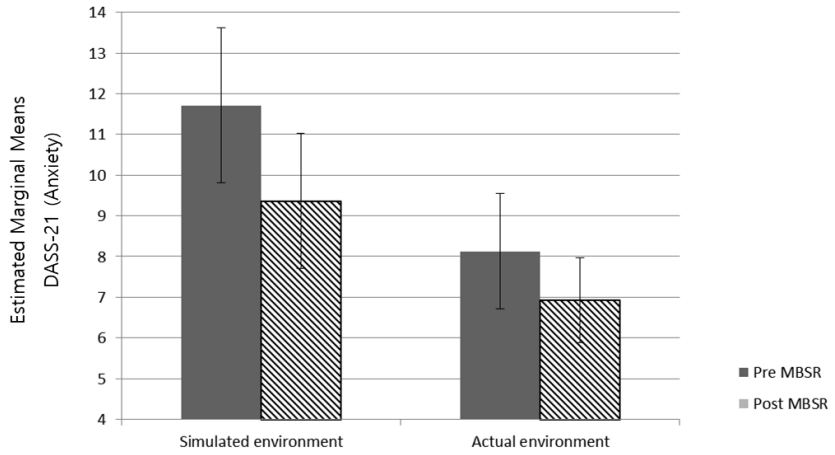

Figure 6.10 Change in anxiety by environment; Error bars denote using a 95% confidence interval.

Stress

The results of the ANCOVA indicated that there was a significant difference between the two environments on post-MBSR score for stress (DASS-21) after controlling for pre-MBSR score, $F(1,61)= 8.47$, $p= .01$, $\eta^2= .122$. Paired samples t-tests were used to further investigate the impact of MBSR within the group. Within the group in the actual environment, there was a statistically significant decrease in stress from pre-MBSR (M=16.20, SD= 7.71) to post-MBSR (M=10.47, SD= 4.19), $t(29)= 4.21$, $p< .01$, $\eta^2= 0.38$. However, no significant differences were found within the group in the simulated environment from pre-MBSR (M= 15.12, SD= 8.30) to post-MBSR (M= 13.88, SD= 6.91), $t(33)= 0.98$, $p= .33$, $\eta^2=0.08$. Figure 6.11 shows that the actual environment was more beneficial in reducing stress than the simulated environment.

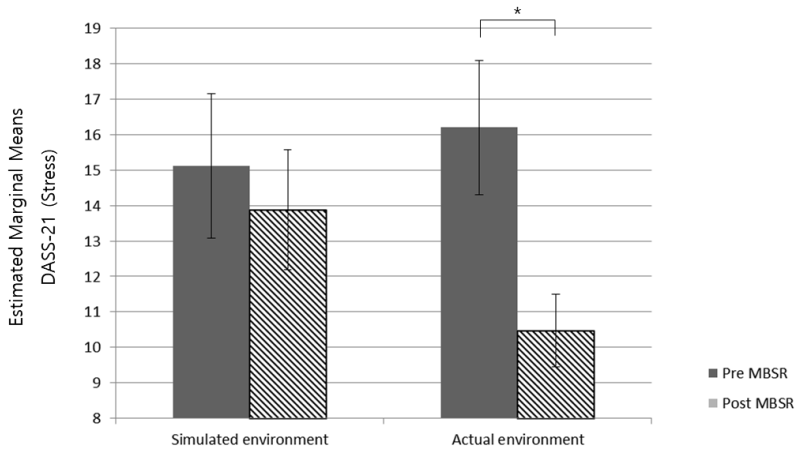

Figure 6.11 Change in stress by environment; Error bars denote using a 95% confidence interval.*$P< .05$.

6.4 Qualitative results: focus groups

Seven participants (3 males, 4 females; mean age of 32.71; 26-50 age range) who attended the initial three MBSR sessions, either simulated or actual natural environment, took part in focus groups (see Table 6.2).

Table 6.2 Demographic information for the seven participants in focus groups

	Focus group	Gender	Age	Experienced environment
Participant 1 (P1)	FG 1	Female	50	Actual natural environment
Participant 2 (P2)	FG 1	Male	35	Simulated natural environment
Participant 3 (P3)	FG 1	Female	26	Actual natural environment
Participant 4 (P4)	FG 1	Female	27	Simulated natural environment
Participant 5 (P5)	FG 2	Female	31	Simulated natural environment
Participant 6 (P6)	FG 2	Male	28	Actual natural environment
Participant 7 (P7)	FG 2	Male	32	Simulated natural environment

The outcomes from the deductive analysis fell into two primary categories related to the research questions: 1) Is there a difference between the mental health and wellbeing outcomes of a three-week MBSR programme in a simulated natural environment compared with an actual natural environment?; and 2) Do participants practising MBSR in an actual natural environment show greater nature connectedness than those experiencing a simulated natural environment?. As for the category of 'Mental health and wellbeing benefits of MBSR in natural environments', three sub-categories were outlined: 'Improved cognitive performance', 'Enhanced mood/feelings', and 'Reduced stress'. Within the category of 'Experience of nature connection', two sub-categories were identified: 'Multisensory experiences' and 'Noticing (visual) surroundings and sounds' (see Table 6.3, p.112). The results are presented below, and where appropriate, direct quotes from the focus group discussion are presented. The quotes are denoted by individual code numbers with the assigned environments.

6.4.1 Mental health and wellbeing benefits of MBSR in natural environments: *Is there a difference between the mental health and wellbeing outcomes in a simulated and an actual natural environment?*

Improved cognitive performance

Improved cognitive performance, such as attention and awareness, appears to be one of the many MBSR benefits (Lao *et al*., 2016). Two participants from each environment described that the MBSR approach did assist them to place more focus on their work, apart from achieving outcomes more efficiently and productively.

> *"I'm more productive in my work hours. I can think straight and just focus on that exact moment, while not being worried about all process. There was a gain in productivity, quality as well." (P4 from simulated environment)*

> *"I'm not rushing as much as I was before … I feel myself, more able to cope with things or even just accept things*" *(P1 from actual environment)*

Enhanced mood/feelings

Two participants exposed to the actual natural environment claimed that they discovered happiness and enjoyment in their routine after the three-week MBSR intervention. This suggests that MBSR had increased the aspect of mindful awareness amongst the participants, so that they began enjoying their moments more.

> *"There are things that we notice more when we're going about our day to day life that actually makes us happy and we didn't realise that they were making us happy before." (P1 from actual environment)*

"I normally have a to do list spinning like a tumble dryer in my head constantly, but … now in a morning I really enjoy being outside." (P3 from actual environment)

In particular, two participants from the simulated natural environment emphasised that the environment did help them to gain relaxation and destress during the MBSR intervention. This shows that even a simulated natural environment can positively influence the MBSR outcomes.

"When we were working in that environment, it was very, very relaxing" (P7 from simulated environment)

"There were nice sounds of birds and sounds of leaves. It actually helped me a lot to relax, destress" (P5 from simulated environment)

Reduced stress

Participants in both simulated and actual natural environments described changes in the way they dealt with their stressful situations, which were through acceptance and awareness of negative thoughts.

"…every day you can be in front of situations that can be very stressful and you will be able to live with the stress and, for example in lectures and when you are going to present something to a group. It (MBSR) is a very good exercise for yourself to be calm and relaxed and then to prepare for your presentation." (P2 from simulated environment)

"…like somewhat stressful environment, I was more aware than I was before the course… I've been like a bit panicky. (But after the course) I think it's just completely slipped from my mind basically." (P6 from actual environment)

6.4.2 The experience of nature connection: *Do participants practising MBSR in an actual natural environment show greater nature connectedness than those experiencing a simulated natural environment?*

Multisensory experience

Experiences of the actual natural environment included noticing visual surroundings and sounds, as well as multisensory experience, such as 'standing on grass in your socks', 'breathing in air', and 'feeling the fresh air and movement'. Multisensory natural experiences seemed to offer a boost and more holistic awareness of the natural environment, and to help build a personal and meaningful relationship with the natural world.

"...It's just things like standing on grass in your socks. I don't think I've done that since I was a child...There were trees, leaves, insects (in the park). I just love that kind of sense of space all around us and, I think it was really good for me and just feeling like you're breathing in like air rather than recycled air in a room." (P1 from actual environment)

"...what I liked that it was outside so you did feel fresh air and movement." (P6 from actual environment)

Noticing (visual) surroundings and sounds

Contrarily, those exposed to the simulated natural environment seemed to focus only on seeing the projected image and listening to the background sounds, such as birds chirping and wind rustling the leaves of trees.

"It helped me to relax by seeing this setting (natural simulated setting) and also there were nice sounds of birds and sounds of leaves." (P5 from simulated environment)

"I like nature and I really enjoy the sound of the birds, the sound of nature." (P7 from simulated environment)

Overall, this qualitative analysis is not enough to find the differences in the effectiveness of MBSR between a simulated and an actual natural environment. However, some differences in participants' experience of environment emerged from the qualitative analysis (i.e. multisensory experiences).

Table 6.3 Summary of quotations describing the experiences of MBSR in simulated and actual natural environments

Code	Sub-code	Simulated natural environment	Actual natural environment
Effectiveness of MBSR	Improved cognitive function	"more productive on my work hours" "think straight and just focus on that exact moment"	"more able to cope with things" "not rushing as much as I was before"
	Enhanced mood/ feelings	"be calm and relaxed" "it actually helped me a lot to relax, destress" "it was very, very relaxing"	"actually makes us happy" "really enjoy being outside"
	Reduced stress	"be able to live with the stress"	
Experience of nature connection	Multisensory experiences		"it's just things like standing on grass" "love that kind of sense of space all around us" "breathing in like air rather than recycled air in a room" "feel fresh air and movement"
	Noticing (visual) surroundings and sounds	"relax by seeing this setting"	"there were trees, leaves"
		"It helped me to relax ... there were nice sounds of birds and sounds of leaves" "really enjoy the sound of the birds, the sound of nature"	

6.5 Discussion

This study compared the MBSR outcomes retrieved from simulated and actual natural environments by employing the qualitative and quantitative data obtained from phase 1 and phase 2.

First, the findings exhibited that both simulated and actual natural environments offer similar benefits on MBSR outcomes (Research question 1). Nevertheless, the actual natural environment provided an enhanced greater effect on stress reduction, whereby the participants reported a greater decrease in their stress level in the actual natural setting than in the simulated one. Kjellgren and Buhrkall (2010) and Gatersleben and Andrews (2013) revealed that activities performed in actual natural environments gave greater benefits than the same activities performed in simulated natural environments, such as increase in energy and reduction in negative feelings. Based on Kaplan's Attention Restoration Theory, Kjellgren and Buhrkall (2010) suggest that the simulated environment is incomplete in 'actual' natural scenery, therefore it provides less fascination (one of the characteristics for restorative environment), and people need more effort in a simulated environment to focus on the simulation, as opposed to an actual natural environment. The evidence seems inadequate to reach a general agreement on whether actual natural environments have greater benefits that the simulated ones.

The most striking outcome from this study is that the participants in the actual natural environment showed greater nature connectedness than those exposed to the simulated natural environment (Research question 2). The result of this quantitative analysis indicates that the participants in the actual natural environment had a significant increase in nature connectedness after the three-week MBSR intervention. The qualitative description of the participants' experiences of the actual natural environment as opposed to the simulated natural environment supports this quantitative result. For example, the participants in the actual natural environment experienced their natural surroundings in a more intense manner: "*standing on grass in your socks*"/ "*love that kind of sense of space all around us*"/"*feeling fresh air and movement*". This highlights that participants' multisensory experiences in the actual natural environment might enhance their awareness of their surroundings in those moments suggesting that it is this heightened awareness of nature that leads to enhanced nature connectedness. In contrast, participants in the simulated natural environment

described only seeing and hearing experiences: "*the sound of the birds*"/"*It helped me to relax by seeing this setting*"/ "*nice sounds of birds and sounds of leaves*". Although the disposition of seats for MBSR may obstruct the view of the projected image on one side of the wall (while sitting in a circle), a participant in the simulated environment claimed: "I have this idea of bright green but I was always on my back through it". Visual simulation can therefore help people to feel calm and relaxed, but fails to deliver the same multisensory experience that the actual environment can offer. Simulation only induces general relaxation, instead of offering a more intense natural experience that can lead to a feeling of connection to nature. If the debate is to move forward, further research is needed to identify the cues and hints from the actual natural environments that can lead to psychological benefits – including sounds (e.g. birds singing or water flowing), scents of nature (e.g. the scent of flowers or wet grass), air movement, humidity, and light. Indeed, the application of virtual environments appears to be in its infancy within the scope of environmental science and technology, especially in creating sustainable healthy everyday living environments. In a pilot study conducted by Depledge *et al*. (2011), simulated natural environments were used to enhance mental health and wellbeing as part of the Virtual Restorative Environment Therapy (VRET).

As such, more studies on simulated environments can benefit the elderly or others with mobility difficulties by providing access to natural environments within their home or care units.

CHAPTER SEVEN: DISCUSSION, REFLECTION AND CONCLUSION

This final chapter represents a summary of the overall results of the three studies, with particular focus on new questions which arise from the results, and recommendations for bridging any gaps through relevant future research. In addition, the strengths and limitations of this study are explained. Beyond the purpose of academic literature, these findings have implications for practice; I discuss the place-based approach currently promoted in the UK with recommendations for future research.

7.1 Summary of findings

The overall aim of this PhD research was to investigate the potential for enhancing the effectiveness of mindfulness-based stress reduction (MBSR) by incorporating exposure to the natural environment and to explore the interactions which would lead to recovery or resilience of mental health and wellbeing. In order to improve understanding of the enhancement of natural environments, this study also examined the differing impacts of intervention outcomes in simulated natural environments compared to actual natural environments. The discussion proceeds with a focus on the key findings from phase 1-3 studies in the three sections below.

7.1.1 The impact of natural environments on MBSR outcomes

The results from phase 1 study confirm that the MBSR programme has a greater effect on mental health and wellbeing, such as lower negative feelings, and reduced depression, anxiety and stress, compared with the relaxation-based intervention (e.g. reading books or magazines). The overall

results of phase 1 and 2 showed that the impacts of MBSR were enhanced when combined with the benefits of exposure to natural environments, even simulated natural environments. In phase 1 study, both interventions (MBSR, relaxation-based intervention) in simulated natural environments led to lower negative feelings and reduced depression and stress than those in non-natural simulated environments. Notably, however, participants' stress levels were shown to decrease significantly from baseline to one-week follow-up only in the MBSR group in simulated natural environments. These results were more marked in phase 2 study, which showed that MBSR in the natural outdoor environment improved ruminative and reflective attitudes, and was associated with greater level of stress reduction compared with other environments (i.e. built outdoor and indoor settings). Moreover, the impacts of MBSR lasted longer when conducted in the natural environment; the outcomes of the MBSR group in the natural environment continued to improve, even after the intervention was completed (at one-month follow-up). From the literature review, it is assumed that the longevity of the positive effects following MBSR in natural environments can be influenced by the eudaimonic aspects of nature connectedness, leading to more sustained outcomes (McMahan and Estes, 2011).

7.1.2 Mediation effect of natural relatedness on the MBSR outcomes

Phase 2 study found that nature connectedness mediated the changes in participants' levels of reflection. This partially suggests that natural relatedness is an important contributor to enhancing the effectiveness of MBSR when carried out in natural environments. However, phase 1 study did not find any mediation effect of natural relatedness on MBSR outcomes. It may be that sensory experience was augmented by the experimental setting of '*actual*' natural surroundings and that this had a greater influence on the results of phase 2 of the study.

7.1.3 Mental health and wellbeing outcomes in a simulated natural environment compared with an actual natural environment

Phase 3 of the study examined the MBSR outcomes when carried out in a simulated natural environment compared to an actual natural environment. The results showed that both simulated and actual natural environments can provide a similar impact on MBSR outcomes. However, the actual natural environment was shown to have a greater effect on stress reduction, with participants' stress levels decreasing more in an actual natural setting as opposed to a simulated one. The actual natural setting, rather than a simulated one, seemed to be more conducive to psychological restoration by offering the experience of 'fascination' (Kaplan and Kaplan, 1989). Participants in the actual natural environment also reported greater 'nature connectedness' than those in the simulated natural environment. In the actual natural environment, participants experienced their natural surroundings in more intense ways, highlighted by expressions such as "*standing on grass in your socks*"/ "*feeling fresh air and movement*". This suggests that participants' multisensory experiences in the actual natural environment have the effect of boosting their feelings of nature connectedness. It can be concluded that, at least for this study, a simulated natural environment was no substitute for the 'real thing', although this does not rule out the benefits of a simulated natural environment where a real one is not economically possible or impractical; for example, for those with mobility problems who are confined to their homes or care homes.

7.2 Research reflections: strengths and limitations

A key strength of this PhD research is that the experiments were carried out in common urban environments which could be widely used for wellbeing interventions (e.g. MBSR). The results, therefore, give an indication about the potential effects of natural environments on the outcome of wellbeing interventions in the context of everyday life. At the same time, the findings are reflective of current wellbeing interventions in use today. However, the study has some limitations,

which are outlined in the next section. Reflecting on the study's limitations could greatly help to develop the research design and methodology for further research.

7.2.1 Realities of the research design

Brief MBSR formats

The original intention was to conduct a full-length standard MBSR programme involving an intensive 8-weeks of 2.5-hour weekly group sessions in addition to an all-day intensive mindfulness meditation retreat (Kabat-Zinn, 1982). The benefits of the standardised full-length MBSR curriculum are well documented. MBSR is effective in fostering emotional wellbeing and reducing psychological distress among nonclinical healthy individuals, as well as people with chronic psychological disorders. However, the time commitment is substantial. Most people do not have the time or resources needed to participate in extensive meditation programmes. For students, the time commitment needed to participate in the standard MBSR programme represents a significant strain in an already overcommitted schedule, and the time requirements are a key reason why some do not engage with such programmes (Bergen-Cico *et al*., 2013). The conditions of some clinical populations, such as those with chronic physical and/or psychological health problems, mean they are unable to participate due to the demands of MBSR in its standard form. Different formats therefore have to be considered in order to match the needs of particular user groups and recently brief MBSR has been introduced to overcome the time and schedule requirements of full-time workers and students (Gilmartin *et al.*, 2017). Some studies have noted the effect of brief MBSR ($\leq$5-week) on improvements in mindfulness and psychological wellbeing (Mackenzie *et al*., 2006; Josefsson *et al*., 2014).

Given the time constraints facing my sample populations, I considered the length and structure of effective brief MBSR programmes in crafting the present study, with the primary aim of measuring the outcomes of a brief MBSR programme in different environments. In order to recruit

and retain more participants in my research, phase 1 of the study was designed using a 3-week MBSR programme, and phase 2 a 6-week MBSR programme.

Sample characteristics and generalisability

This study recruited participants from university students and staff populations and excluded individuals with severe or enduring mental health issues. In a survey by YouGov (2016), more than a quarter of UK students (27%) reported having a mental health problem, and 63% reported experiencing levels of stress which affected their day-to-day lives. However, less than 20% made use of university counselling and support services. The gap between self-identified emotional distress and receiving professional treatment demonstrates an increasing need for professional/clinical services and well-being focused interventions. This study supports using nature-based interventions as part of a suite of measures to improve the mental health of university students and staff under academic and social pressures, confirming previous work by Hunt and Eisenberg (2010). Whilst the implications for approaches to supporting the mental health of university students and staff are clear, these findings cannot necessarily be generalised to the wider population. Interventions provided by universities are relatively easy for users to access in the sense that they are more likely to be available close to where users are working, and may be provided free of charge. Both university students and staff also have some degree of control over their daily programmes. Furthermore, potential settings for interventions in campus environments and their surroundings are likely to be familiar to potential users.

An interesting finding of phase 1 of this PhD research was the absence of changes for negative affect and depression in the relaxation group in non-natural environments, i.e. participants trying to relax without mindfulness practice in non-natural environments reported no reduction in negative affect and more depression. With increasing rates of poor mental health in the UK student population (Universities UK, 2015), students may try to 'switch off' or destress in built environments, such as rooms without views of nature, in darkness or low light levels. This finding

therefore has important implications for promoting campus green spaces to provide more opportunities for recovery from stress. Previous studies have reported the positive effects of the natural environment in the university campus on students' quality of life (Hipp *et al.*, 2016) and emotional restoration, such as decreasing stress and anxiety (Lau and Yang, 2009). However, it is debatable whether the relaxation activities provided in the non-natural environments in this study have a direct bearing on what students voluntarily decide to do to switch off in their student accommodation. It may be that the levels of familiarity, security and comfort experienced in those settings compensate for the lack of 'being away' to alternative restorative environments (Kaplan, 1995), such as those found in natural settings. This is an interesting area for further research.

Practical implication challenges

Although this PhD research showed that the effectiveness of MBSR was enhanced when carried out in natural environments, conducting therapeutic interventions outdoors presents challenges to both practitioner and client/patient. There are successful examples of nature being used as part of psychotherapy practice conducted in parks or forests (Hansen *et al.*, 2017; Vujcic *et al.*, 2017), and evidence that mindful walking can enhance the psychological benefits gained from outdoor exercise (Teut *et al.*, 2013). Careful attention, however, needs to be paid to the therapeutic frame of reference and the impacts of how this might be altered by moving outside (Greenleaf *et al.*, 2014). Jordan and Marshall (2010) discussed how taking the interventions into the outdoors not only changes the relationship between therapist and client, but can have an impact on the associated confidentiality issues and organisational difficulties. For example, the group of participants might be exposed to the public during the session. Also, what about the weather? Are we out no matter what, even if in heavy rain or strong winds? If not, who decides? Phase 2 of this PhD study was conducted during relatively stable weather in August-October, but at least once during the research period, the groups in the natural and built outdoor settings had to move inside when it rained. Whilst some of participants actively enjoyed the rain, this acceptance of the weather may not have been unanimous throughout the group/ widely shared by the whole group.

These variable weather conditions might have affected the results of my experiment. Implementing this kind of practice in outdoor settings requires sensitive and careful planning and indicates the need for specially designed therapeutic settings. For example, an ideal setting might provide both privacy and partial shelter from rainy or windy conditions: shelter that allows participants to remain warm and dry whilst still experiencing nature.

7.2.2 Determination of research locations

This thesis also examined the impact of certain environments on the effectiveness of MBSR. Phase 1 of the study was carried out in a controlled laboratory setting, using four images from two common natural environments and two non-natural environments: woodland, parkland, an urban setting, and a room with white walls. While an obvious advantage of using such a lab setting is the ease of controlling the experimental conditions, it was limiting in the sense of not providing participants any full sensory experience. Phase 2 of the study was, therefore, designed with a goal of the participants directly interacting with actual environmental settings, to see if the laboratory-based findings (from phase 1) were fully applicable to the real world.

Although the field experiment for the phase 2 study allowed participants' multisensory experiences in the actual environments, there were limitations for the participants at university in terms of possible research locations. The research sites had to be chosen within walking distance of the campus due to time constraints and all participants needed to have similar access to the research locations during their lunchtime or before/after work. The location of the university campus being close by the park could be regarded as a strength as this gave opportunities for suitable research locations. However, it is difficult to find a place without any vegetation on the campus, so the built environmental condition in particular was a compromise with a courtyard on the university campus having obstacles for the mindfulness programme, such as traffic signal sounds (beeping sounds), and the proximity of a lecture theatre.

7.2.3 Measures for restorative experiences in environments

A strength of this PhD research is that it set about measuring the 'actual' restoration of participants during the experiments. 'Actual' restoration is integral to mental health and wellbeing strategies, for this study, the importance of considering moods and reflecting on life problems, which are important implications for psychological health. In this study, psychometrically validated scales measured respondents' changes in relation to the health and wellbeing outcome measures during the duration of study, i.e. changes in mood using the Positive and Negative Affect Schedule (PANAS); the negative emotional states associated with depression, anxiety and stress using the Depression Anxiety Stress Scales (DASS-21); and different directions of self-awareness using the Rumination-Reflection Questionnaire (RRQ).

However, phase 1 and 2 were based on quantitative approaches and may have missed some fundamental layers of information about the participants' experiences and thoughts which may have helped to increase understanding. With this in mind, a clear strength of phase 3 was the combination of using quantitative measures with qualitative focus groups. Phase 3 involved two analysis phases: (1) an initial quantitative data analysis (i.e. questionnaires) and then (2) a qualitative data analysis phase (i.e. focus groups), which sought to develop and expand the results of (1). Findings from quantitative data about the different MBSR outcomes between simulated and actual natural environments could be explored further with focus groups to better understand how participants' individual experiences matched up to the quantitative results.

7.2.4 Differences between different experiments

This PhD research included two experiments: comparing the effectiveness of MBSR in built and natural simulated settings (phase 1); and comparing its effectiveness in actual built and natural outdoor settings (phase 2). The results of my study showed that the mental health and wellbeing outcomes of MBSR were enhanced through the experience of natural environments – across both

simulated and actual natural settings. However, there are some differences in trends across and between the two different experiments (see Table 7.1). In the phase 1 study, the changes over time of participants' levels of nature connectedness, negative feelings and depression were enhanced by natural environments; and in the phase 2 study, the participants' levels of nature connectedness, rumination, reflection and stress were enhanced by the natural environments. This apparent inconsistency may be due to differences in the experimental set-ups: differences in participants (e.g. students- Phase 1, and students and staff- Phase 2), different research periods/ MBSR duration or different environmental conditions. However, the reason or reasons are still not clear.

Table 7.1 Key differences and similarities between experiments

Measure	**Time x Environment Effects**		**Key difference and similarity between experiments**
	Phase 1	Phase 2	
FFMQ-SF - Mindfulness	-	-	Not affected by environment in either experiment
NR-6 - Nature connectedness	√	√	Environmental effect in both experiments
PANAS - Positive affect	-	-	Not affected by environment in either experiment
PANAS - Negative affect	√	-	Only environmental effect in phase 1
PANAS – Additional positive affect 'relaxed, calm and safe'	-	-	Not affected by environment in either experiment
RRQ - Rumination	NA	√	Missing a rumination measure in phase 1
RRQ - Reflection	NA	√	Missing a reflection measure in phase 1
DASS-21 - Depression	√	-	Only environmental effect in phase 1
DASS-21 – Anxiety	-	-	Not affected by environment in either experiment
DASS-21 – Stress	-	√	Only environmental effect in phase 2

Note: check mark '√' indicates whether environment affected each measure.

As shown in Table 7.1, no environmental effect on level of mindfulness (measured by FFMQ-SF) was observed in either experiment. This finding was unexpected as previous studies have sought to define the relationship between mindfulness and nature connectedness. Van Gordon *et al*. (2018) suggest that nature can be used to enhance mindful awareness, allowing certain qualities of nature to guide the content and direction of meditation. For example, one meditative technique that is often used involves enhancing mindful awareness by observing and contemplating specific objects in the natural environment – *such as observing a tree or a flowing river*. A common

meditative technique - *sitting in meditation in a natural environment with a panoramic view* - can help to cultivate an expansive mental view that is conducive to settled meditation and to gaining insight into the open and limitless nature of the mind. In the current study, the mindfulness meditation did not take these approaches (i.e. engaging with natural elements as part of the mindfulness programme). Instead, the experiments examined the effectiveness of the standard form of MBSR in different settings. In future, it would be useful to compare the effectiveness of standard MBSR with MBSR utilising natural elements as part of the programme.

Despite no effects of the natural environment on the level of mindfulness in either experiment, I found that the experience of the natural environment increased nature connectedness (measured by NR-6) in both experiments. It is difficult to explain this result of the current PhD study, but it might be related to quality time in natural environments. For example, forest bathing studies showed the use of mindfulness (or meditative walking) increased awareness of nature and promoted a stronger and more soothing experience with nature (Lee *et al.,* 2011). Similarly, meaningful activities can deliver sustained increases in people's connection with nature (Richardson and Sheffield, 2017). A further study could explore whether this is repeatable or implicational for a range of different applications e.g. in educational as well as therapeutic settings.

In order to quantify the impact of natural environments on the effectiveness of MBSR, psychometrically validated scales measured changes in respondents' health and wellbeing during the duration of the study: Positive and Negative Affect Schedule (PANAS), Depression Anxiety Stress Scales (DASS-21), and Rumination and Reflection Questionnaire (RRQ). First, both experiments used PANAS to measure for changes in self-reported mood and feelings. However, no environmental effect on positive emotions was observed in either experiment, but an environmental effect on negative emotions was found in phase 2. PANAS is one of the most common ways to measure general affective states. However, some positive emotions, such as contentment, affiliation and safeness, are absent from the measurement. Meditating/walking in

forests is known to be associated with feelings of contentment, calmness and feeling soothed, rather than feelings of excitement and vitality (Depue and Morrone-Strupinsky, 2005). Thus, in this PhD study, additional items measuring the positive affects 'relaxed, calm and safe' were added. Although I had considered these two different aspects of positive affect, my research did not show the benefits of nature related to either aspect. This result may be because aspects of subjective wellbeing vary in their relationship with nature connectedness, and/or also because nature can elicit mixed feelings of ecstasy and wonder, as well as fostering feelings of comfort. This could make it difficult for participants to define their current emotional state – *neither one thing nor the other*. Further work using other measurements are needed to fully understand the emotional restoration experienced in natural environments. For example, the three circle model, suggested by Richardson *et al*. (2016), outlines drive, contentment and threat dimensions of affect regulation based on a review of emotion regulation systems. Secondly, this PhD research examined psychological health related to the negative emotional states associated with depression, anxiety and stress using the Depression Anxiety Stress Scales (DASS-21). As shown in Table 7.1, the environmental effect on depression was observed in phase 1, while the environmental effect on stress was found in phase 2. Further studies should examine more precisely the timing of the accrual and diminution of benefits in larger samples, and use the self-report questionnaire in combination with other forms of assessment, such as physiological measures.

7.3 Conclusion: implications for practice and further research

In recent years, a range of health and wellbeing programmes and interventions have been developed and their effectiveness assessed. However, the individual characteristics of the environment (e.g. natural or built setting) make it difficult to evaluate the efficacy of health and wellbeing interventions that can be equally effective. What works well in one community may not always work when transferred to another (NIHR, 2019). Consequently, there is increased in interest in place-based approaches which can span disciplinary boundaries to understand the potential impacts of the environment on the outcomes of wellbeing interventions.

This PhD research is one of the first studies to incorporate placed-based assets into a commonly used wellbeing intervention. It provides a fine-grained insight into the enhancement of an intervention through exposure to natural environments via its experimental, factorial design and the multiple outcome measures. The results showed that the effectiveness of MBSR in the natural environment was greater than in other environments (i.e. built outdoor or indoor environment). It is particularly notable that the effectiveness of the MBSR group in the natural environment was sustained even after the intervention was completed (after the participants had returned to their ordinary routines). The findings of this research can help healthcare practitioners to carefully choose suitable locations for intervention delivery and to develop new wellbeing interventions involving natural environments. On a broader level, this study also suggests that national or local government planning departments and land-use developers should consider the mental health and wellbeing of residents in designing neighbourhoods.

The National Institute for Health Research Public Health Research (NIHR PHR) Programme has recently issued a call for research bids on a place-based approach, entitled, '*Understanding the potential of place to impact health and health inequalities*'. The programme highlights a number of new avenues that could be explored in further research, based on the findings from my PhD. Firstly, further research should look at the integrated impact of place, rather than just individual

elements of place. In this thesis, the natural environments enhanced the effectiveness of the MBSR intervention. More broadly, further work is needed to include other local infrastructure (e.g. housing, neighbourhoods and transportation for active travel) and to develop a framework for healthy environments to maximise the impact of interventions and reduce health inequalities. Secondly, further studies are required to consider how appropriate stakeholders and decision-makers may engage in broader perspective evaluations of interventions. Involving planning practitioners, policymakers and local politicians can help to examine the wider health/economic/social impacts of interventions and suggest new intervention designs to improve public health and wellbeing. Finally, more research regarding restorative environments for vulnerable groups (e.g. those with limited mobility) is essential. In phase 3 of this thesis, it was found that both simulated and the actual natural environments could provide similar impacts on MBSR outcomes (although natural relatedness was greater in actual natural environments). Further research should also continue to explore the potential of simulated/virtual natural environments for providing restorative experiences in other contexts such as homes and offices, in addition to medical and clinical settings.

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APPENDICES

Appendix A. Recruitment email (phase 1 study)

Title: Receive 20 GBP for an experiment about mindfulness relaxation in different settings

Dear all,
We are currently seeking participants for an experiment about mindfulness relaxation in different settings. The study will take place in the Department of Landscape (The Arts Tower, Western Bank, S10 2TN) at the University of Sheffield.

You will be randomly assigned to ordinary relaxation activities/ mindfulness stress reduction session in four different simulated environments. You will be asked to spend one hour taking part in the relaxation activity, three times (e.g. every Monday at 4:00 pm) over the research programme, which lasts three weeks. We will also ask you to complete a questionnaire each time and we will measure your heart rate before and after each session (i.e. each complete session will take 1 hour 20 minutes). A week before and after the programme you will be also emailed a link to a simple questionnaire, which will ask a range of questions (e.g. concerning your personal state of mind and opinions), and will take around 15 minutes to complete. Upon completing three sessions and follow-up one week later each participant will be paid 20 GBP.

For a copy of the participant information sheet containing further information, please click on the following link: https://goo.gl/forms/WAZLSf7gUiUn78m83. If you would like to take part in the study, please confirm your participation and sign up for a time slot https://goo.gl/forms/VmqF08HTUtSbdODi1 clicking on the following link or pasting it into your browser. You will be contacted with further information prior to your participation dates.

This study is being conducted by Eun Yeong Choe, a PhD student in Department of Landscape. If you have any questions about this study, please email me at eychoe1@sheffield.ac.uk. All responses will be kept strictly anonymous and confidential. You may withdraw from the study at any point before or during your participation. This study has been approved by the Department of Landscape Research Ethics Committee and is being carried out under the supervision of Dr Anna Jorgensen (a.jorgensen@sheffield.ac.uk).

Many thanks,
Eun Yeong Choe

Appendix B. Participant information sheet and consent form (phase 1 study)

You are being invited to take part in this research project. Before you decide to partake, it is important that you understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like further information. Please take some time to decide whether or not you wish to take part. Thank you for reading this.

1. What is the project's purpose?

This research aims to find out whether relaxation activities are enhanced by the setting in which they are carried out.

2. Why have I been chosen?

You have been chosen because our research participants are being recruited from university staff and students. Whilst research suggests that 1 in 4 people suffer from common mental health problems (e.g. stress or mild depression), and we are interested in the impact of relaxation activities on the general population including those with common mental health problems, our research is not aimed at people who are currently receiving treatment for severe and enduring mental health conditions (e.g. a psychotic disorder). This is because we are not studying the effects of relaxation activities on this user group. If you are currently receiving this type of treatment, we would therefore ask you to withdraw from this study.

3. Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be asked to indicate your agreement by completing the consent form accessed via a link in the email. You are welcome to keep a copy of this information sheet. You can still withdraw at any time after completing and returning the consent form. You do not have to give a reason.

4. What will happen to me if I take part?

In order to examine the changes in your mental health and wellbeing, you will be asked to complete a questionnaire before, after and as follow up to the sessions. The first will be a pre-intervention baseline measurement. After the three sessions you will be expected to complete two follow-up questionnaires immediately after the last session and one week later. These questionnaires will ask a range of questions concerning your personal state of mind and opinions and take around 10 minutes to complete. In addition, we will ask you to participate in an optional focus group at the end of the programme. Upon completing three sessions and all follow-up questionnaires you will be paid 20 GBP.

5. What are the possible disadvantages and risks of taking part?

Participating in the research is not anticipated to cause you any disadvantage or discomfort.

6. Will my taking part in this project be kept confidential?

Your taking part will be kept confidential by the research team. All sessions will be run in small groups, and all participants will also be asked to respect each other's confidentiality. The questionnaires you complete will be kept completely confidential and will be stored securely. Date extracted from your questionnaires will be stored online and protected by passwords and other relevant security procedures.

7. What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

In order to evaluate the effects of mindfulness relaxation in different settings, the questionnaire will ask you a range of questions (e.g. concerning your personal state of mind and opinions).

8. What will happen to the results of the research project?

The data we collect from you will be anonymised and aggregated for use in reports and publications. This means you will not be identified or identifiable in any of these publications. If you wish to be given a copy of any research publications, please ask us to put you on our circulation list.

9. Who has ethically reviewed the project?

The project has been ethically reviewed by the Department of Landscape in accordance with procedure laid down by the University of Sheffield's Research Ethics Committee, which monitors the application and delivery of the University's Ethics Review Procedure across the University.

10. Contacts for further information

PhD Eun Yeong Choe, Department of Landscape, University of Sheffield,
email: eychoe1@sheffield.ac.uk
Dr Anna Jorgensen, Department of Landscape, University of Sheffield,
email: a.jorgensen@sheffield.ac.uk

The following questions aim to ensure that you are aware of my role as researcher and how the information you share with me will be used in the research project. If you wish to take part, please tick the boxes beside the statements you agree with, and sign and date the bottom of the page. I will leave you with your own copy of this information sheet and consent form.

☐	I confirm that I have read and understand the information sheet and I am aware that I can ask questions about it any time.
☐	I confirm that I am not currently receiving treatment for a severe and enduring mental health condition.
☐	I understand that participation is voluntary and that I am free to withdraw at any time, without giving any reason and without any consequences.
☐	I understand that my responses will be anonymised and that I will not be identifiable in any publications.
☐	I agree that the data collected will be used for a research study and the findings will be published in a range of formats including academic publications and social media.
☐	I agree to the data being used in follow-up research studies provided the previously outlined conditions including those about anonymity are respected.
☐	I agree to take part in the above study.

Name of Participant	Date	Signature
Researcher	Date	Signature

Appendix C. Questionnaire (phase 1 study)

Summary of different measures will be used in this questionnaire

	Content	Measure
Part A	Mindfulness	Five Facet Mindfulness Questionnaire – short form (FFMQ –SF)
	Connectedness to nature	Nature Relatedness Scale (NR-6)
	Outcome measures	Positive and Negative Affect Schedule (PANAS)
		Depression, Anxiety and Stress Scales (DASS-21)
Part B	Personal information	Gender, age, postcode, experience of mental problem/meditation practice and ethnicity
Part C	Preference	

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Part A

A-1. How would you describe your present state of mind?

Below is a collection of statements about your everyday experience. Using the 1–5 scale below, please circle one number indicating how frequently or infrequently you have had each experience OVER THE PAST WEEK. Please answer according to what really reflects your experience rather than what you think your experience should be.

	Never	Infrequently	Sometimes	Often	Very often
I'm good at finding the words to describe my feelings.	1	2	3	4	5
I can easily put my beliefs, opinions, and expectations into words.	1	2	3	4	5
I watch my feelings without getting carried away by them.	1	2	3	4	5
I tell myself that I shouldn't be feeling the way I'm feeling.	1	2	3	4	5
It's hard for me to find the words to describe what I'm thinking.	1	2	3	4	5
I pay attention to physical experiences, such as the wind in my hair or sun on my face.	1	2	3	4	5
I make judgments about whether my thoughts are good or bad.	1	2	3	4	5
I find it difficult to stay focused on what's happening in the present moment.	1	2	3	4	5
When I have distressing thoughts or images, I don't let myself be carried away by them.	1	2	3	4	5
Generally, I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.	1	2	3	4	5
When I feel something in my body, it's hard for me to find the right words to describe it.	1	2	3	4	5
It seems I am "running on automatic" without much awareness of what I'm doing.	1	2	3	4	5
When I have distressing thoughts or images, I feel calm soon after.	1	2	3	4	5
I tell myself I shouldn't be thinking the way I'm thinking.	1	2	3	4	5
I notice the smells and aromas of things.	1	2	3	4	5
Even when I'm feeling terribly upset, I can find a way to put it into words.	1	2	3	4	5

	Never	Infrequently	Sometimes	Often	Very often
I rush through activities without being really attentive to them.	1	2	3	4	5
Usually when I have distressing thoughts or images I can just notice them without reacting.	1	2	3	4	5
I think some of my emotions are bad or inappropriate and I shouldn't feel them.	1	2	3	4	5
I notice visual elements in art or nature, such as colours, shapes, textures, or patterns of light and shadow.	1	2	3	4	5
When I have distressing thoughts or images, I just notice them and let them go.	1	2	3	4	5
I do jobs or tasks automatically without being aware of what I'm doing.	1	2	3	4	5
I find myself doing things without paying attention.	1	2	3	4	5
I disapprove of myself when I have illogical ideas.	1	2	3	4	5

A-2. How do you feel about nature?

For each of the following, please circle one number that best describes how closely the statement matches your feeling about nature OVER THE PAST WEEK. Please respond as you really feel, rather than how you think "most people" feel.

	Disagree strongly	Disagree	Neither agree or disagree	Agree	Agree strongly
My ideal vacation spot would be a remote, wilderness area.	1	2	3	4	5
I always think about how my actions affect the environment.	1	2	3	4	5
My connection to nature and the environment is a part of my spirituality.* **spiritually does not necessarily imply religious belief*	1	2	3	4	5
I take notice of wildlife wherever I am.	1	2	3	4	5
My relationship to nature is an important part of who I am.	1	2	3	4	5
I feel very connected to all living things and the earth.	1	2	3	4	5

A-3. How have you felt over the past week?

Below is a list of words that describe feelings people have. Please read each one carefully. Then, for each word, circle one number that indicates how closely the word matches the way you have felt OVER THE PAST WEEK.

	Not at all	A little	Moderately	Quite a bit	Extremely
Interested	1	2	3	4	5
Distressed	1	2	3	4	5
Excited	1	2	3	4	5
Upset	1	2	3	4	5
Strong	1	2	3	4	5
Guilty	1	2	3	4	5
Scared	1	2	3	4	5
Hostile	1	2	3	4	5
Enthusiastic	1	2	3	4	5
Proud	1	2	3	4	5
Relaxed	1	2	3	4	5
Irritable	1	2	3	4	5
Alert	1	2	3	4	5
Ashamed	1	2	3	4	5
Inspired	1	2	3	4	5
Nervous	1	2	3	4	5
Determined	1	2	3	4	5
Attentive	1	2	3	4	5
Jittery	1	2	3	4	5
Active	1	2	3	4	5
Afraid	1	2	3	4	5
Calm	1	2	3	4	5
Safe	1	2	3	4	5

A-4. Are you troubled by the following?

Please read each statement and select a number which indicates how much the statement applied to you OVER THE PAST WEEK. There are no right or wrong answers.

	Not at all	Sometimes	Often	Almost always
I found it hard to 'wind down'.	0	1	2	3
I was aware of dryness of my mouth.	0	1	2	3
I couldn't seem to experience any positive feelings at all.	0	1	2	3
I experienced breathing difficulty (e.g. breathlessness or excessively rapid breathing without physical exertion).	0	1	2	3
I found it difficult to work up the initiative to do things.	0	1	2	3
I tended to over-react to situations.	0	1	2	3
I experienced trembling (e.g.in the hands).	0	1	2	3
I felt that I was using a lot of nervous energy.	0	1	2	3
I was worried about situations in which I might panic and make a fool of myself.	0	1	2	3
I felt that I had nothing to look forward to.	0	1	2	3
I found myself getting agitated.	0	1	2	3
I found it difficult to relax.	0	1	2	3
I felt down-hearted and blue.	0	1	2	3
I was intolerant of anything that kept me from getting on with what I was doing.	0	1	2	3
I felt I was close to panic.	0	1	2	3
I was unable to become enthusiastic about anything.	0	1	2	3
I felt I wasn't worth much as a person.	0	1	2	3
I felt that I was rather touchy.	0	1	2	3
I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase).	0	1	2	3
I felt scared without any good reason.	0	1	2	3
I felt that life was meaningless.	0	1	2	3

Part B : Personal information

B-1. Gender

□ Male □ Female □ Other

B-2. Age : _____

B-3. Job

□ Student

□ Staff: Clerical and support staff

□ Staff: Managers

□ Staff: Manual staff

□ Staff: Teaching/ academic staff

□ Staff: Researchers

□ Staff: Technicians

B-4. Have you ever sought help in connection with a mental health problem (e.g. psychological therapy, counselling or visiting your GP)?

□ Yes □ No □ Prefer not to answer

If yes, please specify your mental health problem :

_____

B-5. Do you belong to any environmental organisation? □ Yes □ No

If yes, please give the name of any organisation you belong to:

_____

B-6. Have you done mindfulness practice before? □ Yes □ No

If yes, please specify when this was and how long you did mindfulness practice for:

_____

B-7. Ethnicity

Choose one section from (a) to (e), then tick the appropriate box to indicate your ethnic background.

(a) White

□ English / Welsh / Scottish / Northern Irish / British □ Irish □ Gypsy and Traveller

□ Any other White background, please write in : _____

(b) Mixed / Multiple ethnic groups

□ White and black Caribbean

□ White and Black African

□ White and Asian

□ Any mixed background/ multi ethnic background, please write in: _____

(c) Asian / Asian British

□ Indian □ Pakistani □ Chinese □ Bangladeshi

□ Any other Asian background, please write in: _____

(d) Black / African / Caribbean / Black British

□ African □ Caribbean

□ Any other Black / African / Caribbean / Black British background, please write in: _____

(e) Other ethnic background

□ Arab

□ Any other background, please write in: _____

Part C: Preference

C-1. How enjoyable do you find the simulated environment during the session? Please mark (I) on the line to represent how closely the word matches the way you think.

Not at all Very enjoyable

C-2. How interesting do you find the simulated environment during the session? Please mark (I) on the line to represent how closely the word matches the way you think.

Not at all Very interesting

C-3. How comfortable do you find the simulated environment during the session? Please mark (I) on the line to represent how closely the word matches the way you think.

Not at all Very comfortable

Thank you.

Appendix D. Recruitment email (phase 2 study)

Title: Free mindfulness course for taking part in study about its effectiveness in different settings

Dear all,

We are currently seeking participants for an experiment about mindfulness-based stress reduction (MBSR) in different settings. This research will take place in different areas (i.e. Weston Park, the basement area outside the Arts Tower and a seminar room) at the University of Sheffield in August and September. All participants will be offered a free six-week MBSR course and entered in a prize draw with 10 prizes of 50GBP.

What is Mindfulness?

Mindfulness is a mind body approach to life that helps people become aware of their own thoughts and feelings through simple practices, empowering you to deal with stress more effectively. The application of Mindfulness based therapies in healthcare has been expanding rapidly as more evidence is gained supporting its effectiveness. Dr John Kabatt Zinn of the University of Massachusetts Medical School was the originator of the Mindfulness Based Stress Reduction Clinic, which helps people cope with stress, anxiety, pain and illness.

The six week course - 22 August to 29 September 2017

Pilates and Mindfulness teacher, Rosalind Hoyes, will be running a six week course introducing participants to some of the key principles of mindfulness. This course is designed to combine tools and techniques developed to help incorporate Mindfulness into everyday life. Structured guidance helps develop your personal Mindfulness practice in a supportive environment, so that you can incorporate it more easily into everyday life. The course will also include meditation practices, gentle stretching and movement and group dialogue and discussion.

How to take part

The free mindfulness course is a part of PhD research in the Department of Landscape at the University of Sheffield. If you take part, you will be randomly assigned to a small group doing MBSR in different environments, or to a control group. You will be asked to attend a weekly one hour MBSR session over a six week period at a location at or close to the University of Sheffield.

In order to examine the changes in your mental health and wellbeing, you will be asked to complete a questionnaire before, after and as follow up to the sessions (three times altogether). These

questionnaires will ask a range of questions concerning your personal state of mind and opinions and take no more than 10 minutes to complete. Upon completing the sessions and the follow-up we will give you the opportunity to be entered into a prize draw to win 50GBP.

You may be assigned to the control group. If you are, you will not be provided any MBSR sessions straight away but you will be required to complete the same questionnaires as the MBSR group. Upon completing the sessions and the follow-up we will give you the opportunity to be entered into a prize draw to win 50GBP. You will be also offered a free programme of six-week MBSR in October and November. For a copy of the participant information sheet containing further information, please click on the following link: https://goo.gl/forms/WN4blR7uc60JcEfJ3.

If you would like to take part in the study, please read the information sheet and then confirm your participation and sign up for a time slot clicking on the following link or pasting it into your browser: https://goo.gl/forms/sueIsnjaLDDQ55MD3. You will be contacted with further information prior to your participation dates.

More about Rosalind Hoyes
Rosalind has been a qualified Body Control teacher for over 13 years, becoming increasingly aware, through her teaching, of the connection between mind and body, and qualifying as an NLP (Neurolinguistic Programming) Practitioner in 2012 before training in Mindfulness-Based Stress Reduction with Bangor University's Centre for Mindfulness Research and Practice.

This study is being conducted by Eun Yeong Choe, a PhD student in Department of Landscape. If you have any questions about this study, please email me at eychoe1@sheffield.ac.uk. All individual responses will be kept strictly anonymous and confidential. You may withdraw from the study at any point before or during your participation. This study has been approved by the Department of Landscape Research Ethics Committee and is being carried out under the supervision of Dr Anna Jorgensen a.jorgensen@sheffield.ac.uk.

Many thanks,
Eun Yeong Choe

Appendix E. Participant information sheet and consent form (phase 2 study)

You are being invited to take part in this research project. Before you decide to participate, it is important that you understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like further information. Please take some time to decide whether or not you wish to take part. Thank you for reading this.

1. What is the project's purpose?

This research aims to find out whether the outcomes of mindfulness-based stress reduction (MBSR) is enhanced by the setting in which it is carried out.

2. Why have I been chosen?

You have been chosen because our research participants are being recruited from university staff and students. Research suggests that 1 in 4 people suffer from common mental health problems (e.g. stress or mild depression), and we are interested in the impact of MBSR on the general population, including those with these common mental health problems. However, our research is not aimed at people who are currently receiving treatment for severe and enduring mental health conditions (e.g. a psychotic disorder). This is because we are not studying the effects of MBSR on this user group. If you are currently receiving this type of treatment, we would therefore ask you to withdraw from this study.

3. Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be asked to indicate your agreement by completing the consent form accessed via a link in the email. You are welcome to keep a copy of this information sheet. You can still withdraw at any time after completing and returning the consent form. You do not have to give a reason.

4. What will happen to me if I take part?

The study will consist of a series of mindfulness-based stress reduction (MBSR) sessions. You will be randomly assigned to one of three different environments (i.e. natural outdoor space and non-natural outdoor space and indoor space). You will be asked to attend a weekly one hour MBSR session over a six week period (i.e. six sessions in total) at a location in the University of Sheffield. In order to examine the changes in your mental health and wellbeing, you will be asked to complete a questionnaire before, after and as follow up to the sessions. The first will be a pre-intervention baseline measurement. After the six sessions you will be expected to complete two follow-up questionnaires at one week later and one month later. These questionnaires will ask a range of questions concerning

your personal state of mind and opinions. In addition, we will ask you to keep a brief diary about your daily experiences as a homework exercise (i.e. it will take only a few minutes). Finally we will also request you to participate in an optional focus group at the end of the programme. Upon completing six sessions and the follow-up we will give you the opportunity to be entered into a prize draw to win 50GBP.

5. What are the possible disadvantages and risks of taking part?

Participating in the research is not anticipated to cause you any disadvantage or discomfort.

6. What are the possible benefits of taking part?

Recently, mindfulness-based stress reduction (MBSR) has grown very quickly as one of the sustainable approaches to coping with everyday stress as well as certain forms of mental illness and symptoms of mental and physical ill health. It is hoped that participation in this research will have a beneficial impact on your health and well-being.

7. What if something goes wrong?

If you have any concerns about the project please contact a member of the research team.

8. Will my taking part in this project be kept confidential?

Your taking part will be kept confidential by the research team. The mindfulness-based stress reduction (MBSR) will be run in small groups, and all participants will also be asked to respect each other's confidentiality. The questionnaires you complete will be kept completely confidential and will be stored securely. Date extracted from your questionnaires will be stored online and protected by passwords and other relevant security procedures.

9. What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

In order to evaluate the effects of mindfulness-based stress reduction (MBSR) in different settings, the questionnaire will ask you a range of questions (e.g. concerning your personal state of mind and opinions). You will also ask to record your daily thoughts and feeling to explore in-depth and wide-ranged your experience during the research period.

10. What will happen to the results of the research project?

The data we collect from you will be anonymised and aggregated for use in reports and publications. This means you will not be identified or identifiable in any of these publications. If you wish to be given a copy of any research publications, please ask us to put you on our circulation list.

11. Who has ethically reviewed the project?

The project has been ethically reviewed by the Department of Landscape in accordance with procedure laid down by the University of Sheffield's Research Ethics Committee, which monitors the application and delivery of the University's Ethics Review Procedure across the University.

12. Contacts for further information

PhD Eun Yeong Choe, Department of Landscape, University of Sheffield,
email: eychoe1@sheffield.ac.uk
Dr Anna Jorgensen, Department of Landscape, University of Sheffield,
email: a.jorgensen@sheffield.ac.uk

The following questions aim to ensure that you are aware of my role as researcher and how the information you share with me will be used in the research project. If you wish to take part, please tick the boxes beside the statements you agree with, and sign and date the bottom of the page. I will leave you with your own copy of this information sheet and consent form.

□	I confirm that I have read and understand the information sheet and I am aware that I can ask questions about it any time.
□	I confirm that I am not currently receiving treatment for a severe and enduring mental health condition.
□	I understand that participation is voluntary and that I am free to withdraw at any time, without giving any reason and without any consequences.
□	I understand that my responses will be anonymised and that I will not be identifiable in any publications.
□	I agree that the data collected will be used for a research study and the findings will be published in a range of formats including academic publications and social media.
□	I agree to the data being used in follow-up research studies provided the previously outlined conditions including those about anonymity are respected.
□	I agree to take part in the above study.

_____	_____	_____
Name of Participant	Date	Signature

_____	_____	_____
Researcher	Date	Signature

Appendix F. Questionnaire (phase 2 study)

Summary of different measures will be used in this questionnaire

	Content	**Measure**
Part A	Mindfulness	Five Facet Mindfulness Questionnaire – short form (FFMQ –SF)
	Connectedness to nature	Nature Relatedness Scale (NR-6)
	Outcome measures	Rumination-Reflection Questionnaire (RRQ)
		Positive and Negative Affect Schedule (PANAS)
		Depression, Anxiety and Stress Scales (DASS-21)
Part B	Personal information	Gender, age, experience of mental problem/meditation practice and ethnicity

Eun Yeong Choe, Department of Landscape, University of Sheffield
email: eychoe1@sheffield.ac.uk
Dr Anna Jorgensen, Department of Landscape, University of Sheffield
email: a.jorgensen@sheffield.ac.uk

Part A

A-1. How would you describe your present state of mind?

Below is a collection of statements about your everyday experience. Using the 1–5 scale below, please circle one number indicating how frequently or infrequently you have had each experience OVER THE PAST WEEK. Please answer according to what really reflects your experience rather than what you think your experience should be.

	Never	Infrequently	Sometimes	Often	Very often
I'm good at finding the words to describe my feelings.	1	2	3	4	5
I can easily put my beliefs, opinions, and expectations into words.	1	2	3	4	5
I watch my feelings without getting carried away by them.	1	2	3	4	5
I tell myself that I shouldn't be feeling the way I'm feeling.	1	2	3	4	5
It's hard for me to find the words to describe what I'm thinking.	1	2	3	4	5
I pay attention to physical experiences, such as the wind in my hair or sun on my face.	1	2	3	4	5
I make judgments about whether my thoughts are good or bad.	1	2	3	4	5
I find it difficult to stay focused on what's happening in the present moment.	1	2	3	4	5
When I have distressing thoughts or images, I don't let myself be carried away by them.	1	2	3	4	5
Generally, I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.	1	2	3	4	5
When I feel something in my body, it's hard for me to find the right words to describe it.	1	2	3	4	5
It seems I am "running on automatic" without much awareness of what I'm doing.	1	2	3	4	5
When I have distressing thoughts or images, I feel calm soon after.	1	2	3	4	5
I tell myself I shouldn't be thinking the way I'm thinking.	1	2	3	4	5
I notice the smells and aromas of things.	1	2	3	4	5
Even when I'm feeling terribly upset, I can find a way to put it into words.	1	2	3	4	5

	Never	Infrequently	Sometimes	Often	Very often
I rush through activities without being really attentive to them.	1	2	3	4	5
Usually when I have distressing thoughts or images I can just notice them without reacting.	1	2	3	4	5
I think some of my emotions are bad or inappropriate and I shouldn't feel them.	1	2	3	4	5
I notice visual elements in art or nature, such as colours, shapes, textures, or patterns of light and shadow.	1	2	3	4	5
When I have distressing thoughts or images, I just notice them and let them go.	1	2	3	4	5
I do jobs or tasks automatically without being aware of what I'm doing.	1	2	3	4	5
I find myself doing things without paying attention.	1	2	3	4	5
I disapprove of myself when I have illogical ideas.	1	2	3	4	5

A-2. How do you feel about nature?

For each of the following, please circle one number that best describes how closely the statement matches your feeling about nature OVER THE PAST WEEK. Please respond as you really feel, rather than how you think "most people" feel.

	Disagree strongly	Disagree	Neither agree or disagree	Agree	Agree strongly
My ideal vacation spot would be a remote, wilderness area.	1	2	3	4	5
I always think about how my actions affect the environment.	1	2	3	4	5
My connection to nature and the environment is a part of my spirituality.* **spiritually does not necessarily imply religious belief*	1	2	3	4	5
I take notice of wildlife wherever I am.	1	2	3	4	5
My relationship to nature is an important part of who I am.	1	2	3	4	5
I feel very connected to all living things and the earth.	1	2	3	4	5

A-3. How would you describe your present state of mind?

Below is a list of statements that describe states of mind that people have. Please read each one carefully. Then, for each statement, circle one number that best describes how closely the statement matches your state of mind OVER THE PAST WEEK.

	Disagree strongly	Disagree	Neither agree or disagree	Agree	Agree strongly
My attention is often focused on aspects of myself I wish I'd stop thinking about.	1	2	3	4	5
I always seem to be rehashing in my mind recent things I've said or done.	1	2	3	4	5
Sometimes it is hard for me to shut off thoughts about myself.	1	2	3	4	5
Long after an argument or disagreement is over with, my thoughts keep going back to what happened.	1	2	3	4	5
I tend to "ruminate" or dwell over things that happen to me for a really long time afterward.	1	2	3	4	5
I don't waste time rethinking things that are over and done with.	1	2	3	4	5
Often I'm playing back over in my mind how I acted in a past situation.	1	2	3	4	5
I often find myself re-evaluating something I've done.	1	2	3	4	5
I never ruminate or dwell on myself for very long.	1	2	3	4	5
It is easy for me to put unwanted thoughts out of my mind.	1	2	3	4	5
I often reflect on episodes in my life that I should no longer concern myself with.	1	2	3	4	5
I spend a great deal of time thinking back over my embarrassing or disappointing moments.	1	2	3	4	5
Philosophical or abstract thinking doesn't appeal to me that much.	1	2	3	4	5
I'm not really a meditative type of person.	1	2	3	4	5
I love exploring my "inner" self.	1	2	3	4	5
My attitudes and feelings about things fascinate me.	1	2	3	4	5
I don't really care for introspective or self-reflective thinking.	1	2	3	4	5

I love analysing why I do things.	1	2	3	4	5
People often say I'm a "deep," introspective type of person.	1	2	3	4	5
I don't care much for self-analysis.	1	2	3	4	5
I'm very self-inquisitive by nature.	1	2	3	4	5
I love to meditate on the nature and meaning of things.	1	2	3	4	5
I often love to look at my life in philosophical ways.	1	2	3	4	5
Contemplating myself isn't my idea of fun.	1	2	3	4	5

A-4. How have you felt over the past week?

Below is a list of words that describe feelings people have. Please read each one carefully. Then, for each word, circle one number that indicates how closely the word matches the way you have felt OVER THE PAST WEEK.

	Not at all	A little	Moderately	Quite a bit	Extremely
Interested	1	2	3	4	5
Distressed	1	2	3	4	5
Excited	1	2	3	4	5
Upset	1	2	3	4	5
Strong	1	2	3	4	5
Guilty	1	2	3	4	5
Scared	1	2	3	4	5
Hostile	1	2	3	4	5
Enthusiastic	1	2	3	4	5
Proud	1	2	3	4	5
Relaxed	1	2	3	4	5
Irritable	1	2	3	4	5
Alert	1	2	3	4	5
Ashamed	1	2	3	4	5

Inspired	1	2	3	4	5
Nervous	1	2	3	4	5
Determined	1	2	3	4	5
Attentive	1	2	3	4	5
Jittery	1	2	3	4	5
Active	1	2	3	4	5
Afraid	1	2	3	4	5
Calm	1	2	3	4	5
Safe	1	2	3	4	5

A-5. Are you troubled by the following?

Please read each statement and select a number which indicates how much the statement applied to you OVER THE PAST WEEK. There are no right or wrong answers.

	Not at all	Sometimes	Often	Almost always
I found it hard to 'wind down'.	0	1	2	3
I was aware of dryness of my mouth.	0	1	2	3
I couldn't seem to experience any positive feelings at all.	0	1	2	3
I experienced breathing difficulty (e.g. breathlessness or excessively rapid breathing without physical exertion).	0	1	2	3
I found it difficult to work up the initiative to do things.	0	1	2	3
I tended to over-react to situations.	0	1	2	3
I experienced trembling (e.g.in the hands).	0	1	2	3
I felt that I was using a lot of nervous energy.	0	1	2	3
I was worried about situations in which I might panic and make a fool of myself.	0	1	2	3
I felt that I had nothing to look forward to.	0	1	2	3
I found myself getting agitated.	0	1	2	3
I found it difficult to relax.	0	1	2	3

I felt down-hearted and blue.	0	1	2	3
I was intolerant of anything that kept me from getting on with what I was doing.	0	1	2	3
I felt I was close to panic.	0	1	2	3
I was unable to become enthusiastic about anything.	0	1	2	3
I felt I wasn't worth much as a person.	0	1	2	3
I felt that I was rather touchy.	0	1	2	3
I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase).	0	1	2	3
I felt scared without any good reason.	0	1	2	3
I felt that life was meaningless.	0	1	2	3

Part B : Personal information

B-1. Gender

□ Male □ Female □ Other

B-2. Age : _____

B-3. Have you ever sought help in connection with a mental health problem (e.g. psychological therapy, counselling or visiting your GP)?

□ Yes □ No □ Prefer not to answer

If yes, please specify your mental health problem :

_____

B-4. Do you belong to any environmental organisation? □ Yes □ No

If yes, please give the name of any organisation you belong to:

_____

B-5. Have you done mindfulness practice before? □ Yes □ No

If yes, please specify when this was and how long you did mindfulness practice for:

_____

B-6. Ethnicity

Choose one section from (a) to (e), then tick the appropriate box to indicate your ethnic background.

(a) White

□ English / Welsh / Scottish / Northern Irish / British □ Irish □ Gypsy and Traveller

□ Any other White background, please write in : _____

(b) Mixed / Multiple ethnic groups

□ White and black Caribbean

□ White and Black African

□ White and Asian

□ Any mixed background/ multi ethnic background, please write in: _____

(c) Asian / Asian British

□ Indian □ Pakistani □ Chinese □ Bangladeshi

□ Any other Asian background, please write in: _____

(d) Black / African / Caribbean / Black British

□ African □ Caribbean

□ Any other Black / African / Caribbean / Black British background, please write in: _____

(e) Other ethnic background

□ Arab

□ Any other background, please write in: _____

Thank you.

Appendix G. Results of per-protocol (PP) analysis

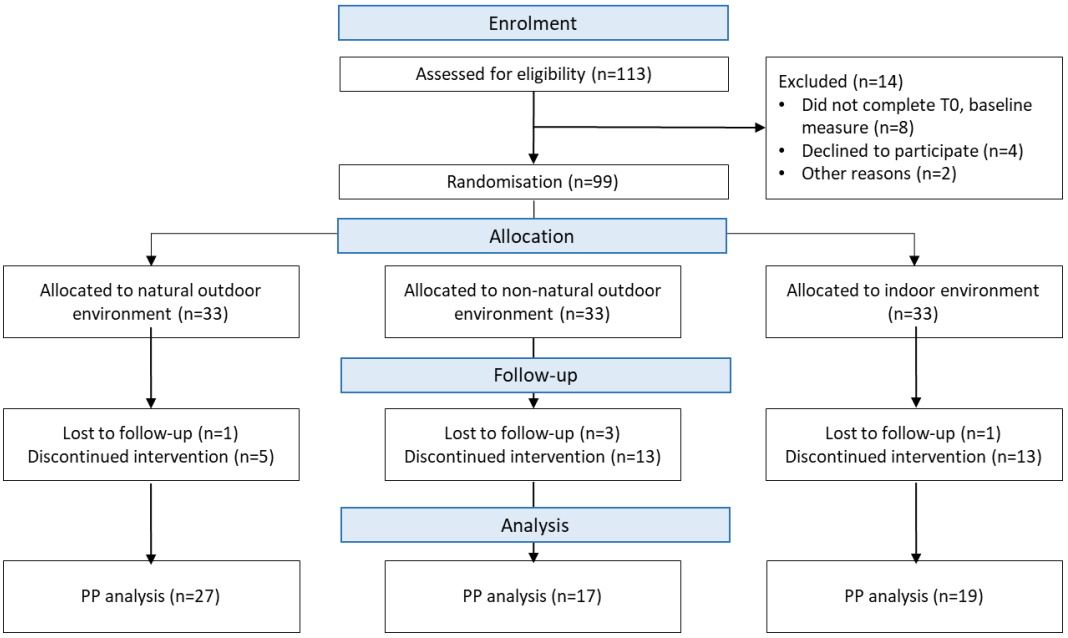

Figure 1. CONSORT flow chart (PP)

The results of per-protocol (PP) analysis found that all three groups experienced significant changes in mental health and wellbeing outcomes during the intervention. There was a significant 2-way interaction of time and environment; the changes over time of participants' levels of nature connectedness, $F(4,108)= 2.61$, $P= .04$, $\eta^2= .08$, and rumination, $F(4,116)= 3.57$, $P= .01$, $\eta^2= .11$, were affected by environments (natural outdoor vs. built outdoor vs. indoor).

1. Level of mindfulness

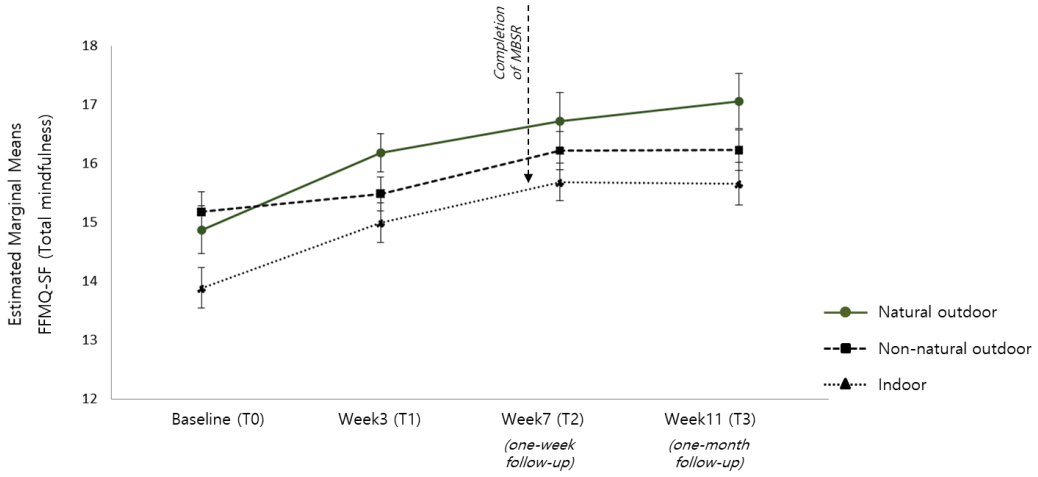

Figure 2. Interaction graph for mindfulness; Error bars denote using a 95% confidence interval.

2. Nature connectedness

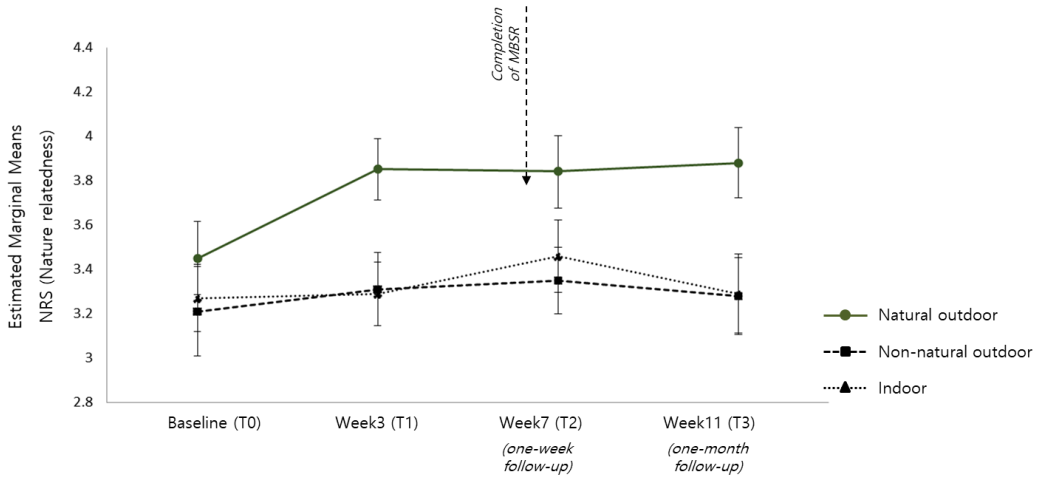

Figure 3. Interaction graph for nature connectedness; Error bars denote using a 95% confidence interval.

3. Positive and negative affect

Positive affect

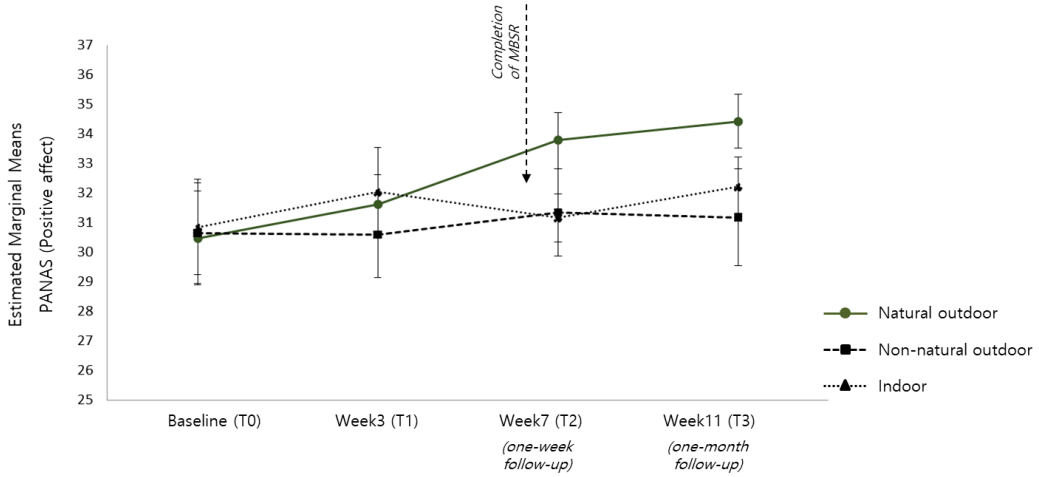

Figure 4. Interaction graph for positive affect; Error bars denote using a 95% confidence interval.

Negative affect

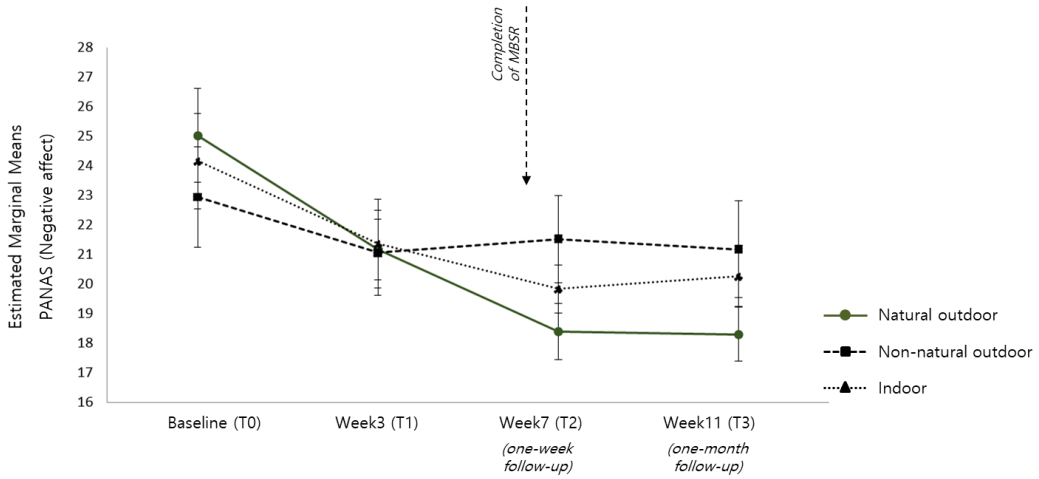

Figure 5. Interaction graph for negative affect; Error bars denote using a 95% confidence interval.

Additional positive affect (relaxed, calm and safe)

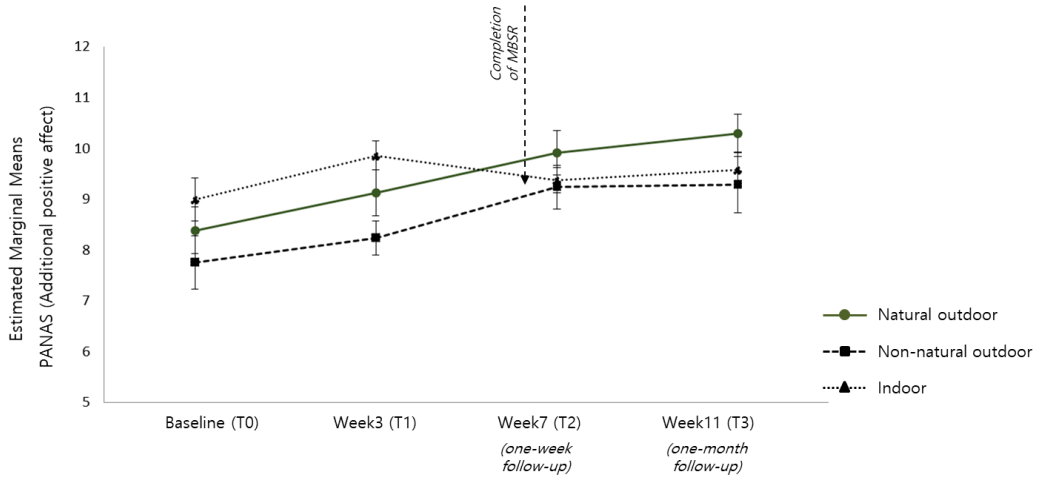

Figure 6. Interaction graph for additional positive affect; Error bars denote using a 95% confidence interval.

4. Rumination and reflection

Rumination

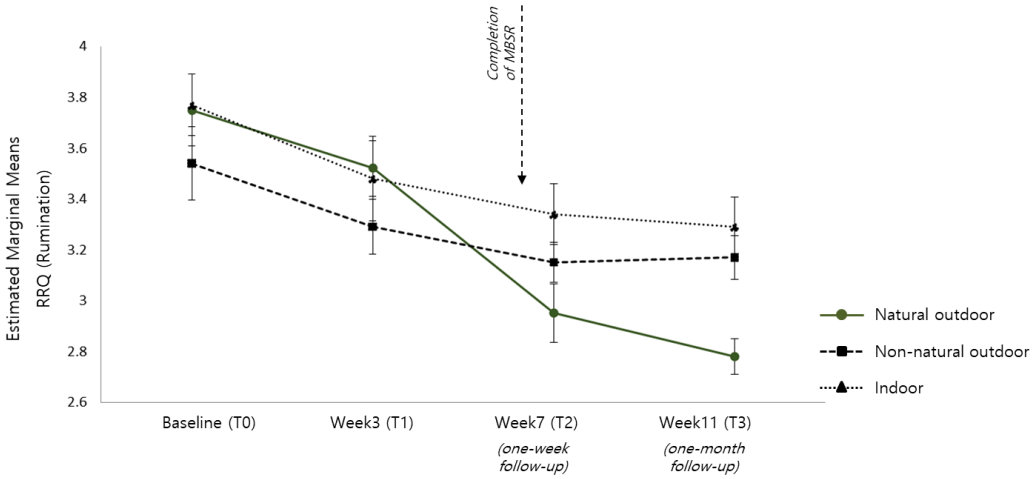

Figure 7. Interaction graph for rumination; Error bars denote using a 95% confidence interval.

Reflection

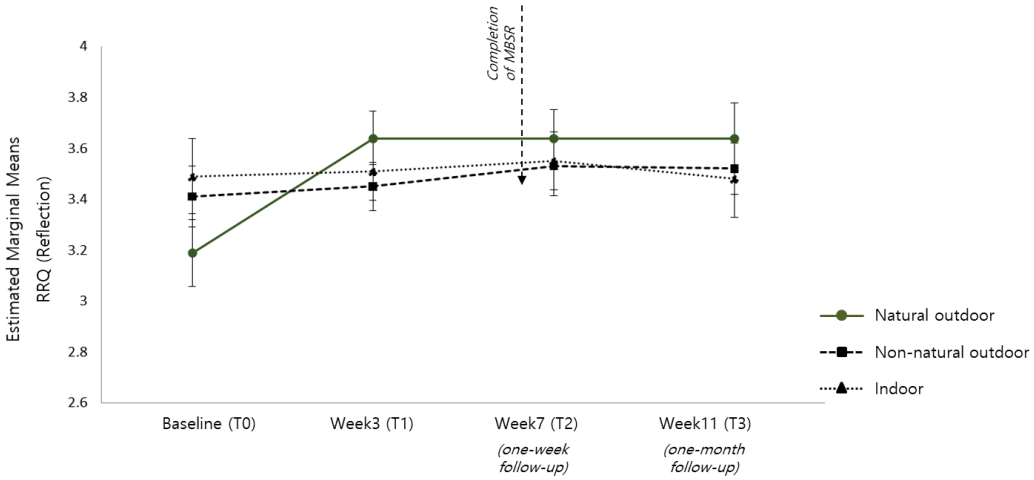

Figure 8. Interaction graph for reflection; Error bars denote using a 95% confidence interval.

5. Depression, anxiety and stress

Depression

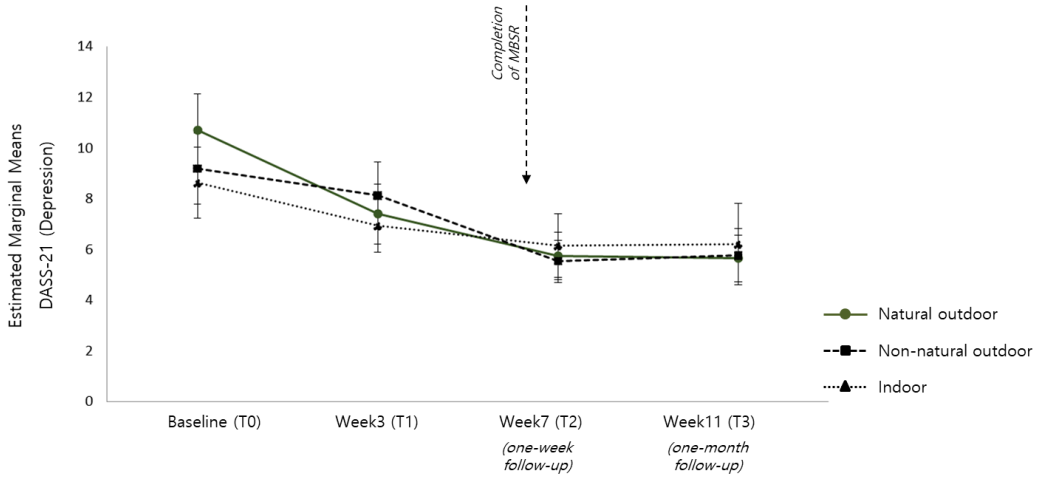

Figure 9. Interaction graph for the depression; Error bars denote using a 95% confidence interval.

Anxiety

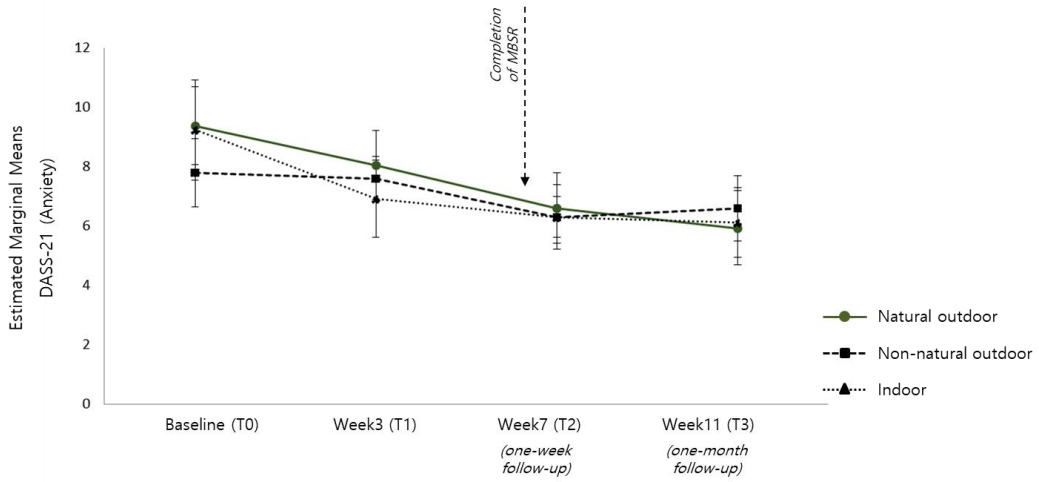

Figure 10. Interaction graph for anxiety; Error bars denote using a 95% confidence interval.

Stress

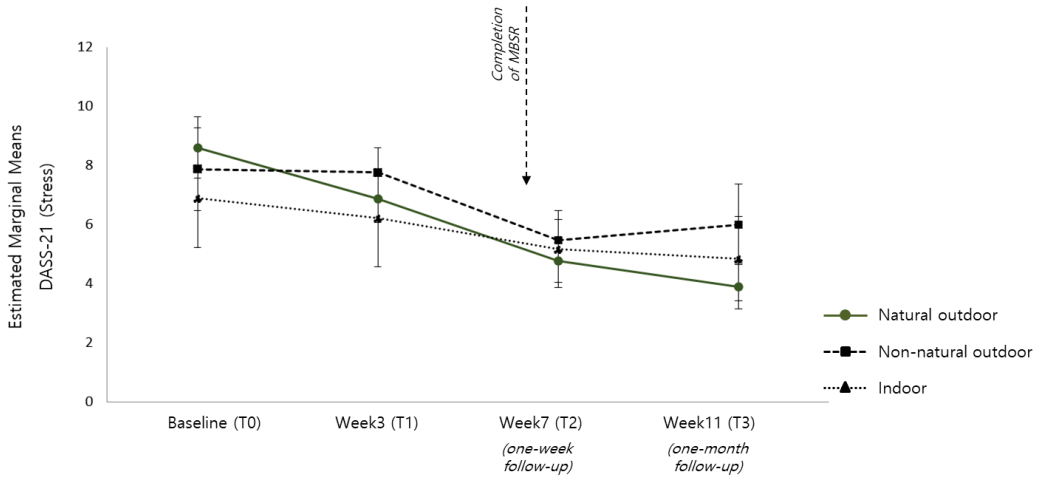

Figure 11. Interaction graph for the stress; Error bars denote using a 95% confidence interval.