resonate
RESILIENCE THROUGH
NATURE-BASED THERAPIES

Study protocol v.3

Case study 7

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INTRODUCTION

Links between nature contact and health outcomes have been extensively researched since the 1990's (Zhang et al., 2020). Nature-based therapies (NbT) draw on those links in various activities and experiences conducted in natural environments to achieve defined treatment goals (Corazon et al., 2010). Spanning from undemanding leisure activities in green prescriptions to targeted programs integrating conventional and nature-based therapeutic techniques to address specified health processes, NbT:s can help combat the mental health crisis (White et al., 2023).

The societal burden of poor mental health and stress is immense (OECD/EU, 2018; Patwary et al., 2023). Prevalence figures continue to go up driven by increased numbers affected by mild to moderate symptoms (McCracken et al., 2020; Steel et al., 2014). These represent ca 75% of the population with any mental illness (NIMH, n.d.). For this growing group, however, the accessibility (Kohn et al., 2004) and effectiveness (Brakmeier & Herpetz, 2019) of conventional mental health care and psychotherapy is often limited. Without timely and effective treatment, symptoms may escalate and have chronic consequences in personal life (e.g., social withdrawal, poor health habits) and on the labor market (e.g., students may drop out of higher education, employees may underperform and fail to advance)(Kohn, 2004; Kazdin, 2017), and threaten physical health through multiple pathways (Cohen & Herbert, 1996; Segerstrom & Miller, 2004).

Among the possible causes of the mental health crisis, scholars have particularly pointed to major environmental, social, technological, cultural, and economic changes. At a nexus of these interconnected trends, global urbanization shows staggering increase from fewer than 1 billion people living in urban areas in 1950 to more than 6.5 billion by 2050 (United Nations, 2018). Such systemic changes affect many aspects of how people live, think and feel (Barash, 1986 in Carver & Scheier, 2012; Dye, 2008; Fukuyama, 1999; Lambert et al., 2015; Rosa, 2013). Common concerns include chronic stress, low physical activity, social disconnectedness (Hartig et al., 2014) and poor opportunities for contact with healthy ecosystems (Hartig & Kahn, 2016; Soga & Gaston, 2016) – each factor associated with major mental health risks.

Nature-based biopsychosocial resilience

Strong epidemiological evidence connects access to natural environments with mental health benefits (Bratman et al., 2019; Cox et al., 2017; Hartig et al., 2014; Shanahan et al., 2016; White et al., 2019; WHO, 2021). A recent meta-analysis concluded that although the evidence is still limited, nature contact may reduce medical prescriptions and overall healthcare expenditure (Patwary et al., 2023). Intervention studies and experiments have established causal effects of nature contact on mental health symptoms, mood and cognitive functioning, and several aspects of physical health (Coventry et al., 2021) and built confidence in specific causal pathways (Hartig et al., 2014). Among the pathways, much of the psychological research on nature-health links have focused on restoration from stress and directed attention fatigue.

Restorative environments research assumes adaptive resources such as the ability to self-regulate attention (e.g., to concentrate) are limited so prolonged demands deplete the ability leading to reduced performance and increased signs of stress (Hartig, 2007; 2021; Kaplan, 1995). Restoration is the replenishment of such resources, where adaptive capabilities are reinstated. Kaplan and Kaplan (1989; Kaplan, 1995) theorized that restoration of depleted attention regulation capabilities can take place in the absence of demands, when a person is free from stressors and mental routines, and that it can proceed more readily in the presence of pleasantly interesting features and processes that draw and hold attention effortlessly to present moment experiences. Called being away and soft fascination, respectively, these key processes are thus thought to mediate restoration outcomes (Hartig, Kaiser, et al., 1997; Hartig, Korpela, et al., 1997). Looking beyond restoration in a single nature experience, however, more recent developments seek to explain how benefits can accumulate to produce lasting health impacts in individuals over repeated contacts and in communities with good structural and cultural opportunities to engage with nature.

Updating and extending the earlier theoretical frameworks (e.g., Kaplan & Talbot, 1983; Markevych et al., 2017; Ulrich et al., 1991), the nature-based biopsychosocial resilience theory (NBRT, White et al., 2023) proposes that nature-based solutions and therapies improve mental health on the individual level by building and maintaining biopsychosocial resilience resources (e.g. cardiovascular fitness, regulation of cognitive and emotional processes, access to social support) as well as on systemic, social-ecological levels where nature-based resilience resources are shared within communities and ecosystems. Resilience resources can be mobilized in different phases of a stress reaction process 1) to minimize stressful exposures (preventive resilience), 2) to increase efficient coping responses in times of stress (response resilience), and 3) to support the restoration of resources that were depleted in the course of responding to stressors (recovery resilience). NBRT also recognizes how nature contact can initiate or reinvigorate positive attitudes to nature, including pro-environmental motivations and abilities (Brügger et al., 2011; Mayer & Frantz, 2004; Nisbet & Zelenski, 2011; Steg & Vlek, 2009; Van den Berg et al., 2007) and a sense of connectedness to nature (Mayer et al., 2009; Otto et al., 2017), presumably supporting positive feedback loops between the individual and social-ecological resilience levels.

However, some of the benefits of nature depend not only on the presence of accessible nature but on how often people actually engage with nature (Hartig et al., 2014; White et al., 2023); for instance, White et al. (2019) saw that independent of greenspace availability, physical activity levels and other factors, Englishmen who engaged with regular nature activities for 120+ minutes per week experienced health and well-being benefits. Furthermore, the individual amount of nature contact can accrue more or less benefit depending on the type and intensity of engagement with nature (Macaulay et al., 2022); for instance, Lymeus et al. (2018) saw that students participating in regular nature-based mindfulness training gradually learned how to draw more efficiently on the environment to increase its cognitively restorative effects. Hence, even if most people have little control over the amount and quality of nature that they can access in their daily lives, they can often increase their nature-based habits and skills, and engage in practices that better promote

biopsychosocial resilience processes. NbT:s commonly draw on these potentials by scheduling and guiding relevant activities in nature. One of the most common types of activities that NbT:s seek to promote is mindfulness (Burger et al., 2024).

Mindfulness

Since the 1990:s, mental health care has increasingly included mindfulness and acceptance-based elements into treatment principles and practices (Creswell, 2017). The focus has moved away from traditional cognitive behavioral methods aimed to change patients' thoughts, emotions and behaviors directly (e.g., by challenging maladaptive assumptions) to practices that target how people relate to their thoughts and emotions (e.g. experiential avoidance, identification with thoughts, Hayes et al., 1999). This transition to so-called "third wave treatments" is associated with a more holistic, non-medical view of mental health problems, as it conceptualizes psychological distress not as a disordered state but as something normal and unavoidable, yet transient and essentially harmless; and shifts the focus of interventions to promotion of value-oriented, meaningful ways of engaging with one's situation regardless of transient emotional pain. This builds on secularized adaptations of Buddhist philosophy and mindfulness meditation (Hayes et al., 1999; Kabat-Zinn, 2011; Nathoo, 2016).

Mindfulness practice is most commonly defined as "paying attention in a particular way: on purpose, to the present moment, non-judgmentally" (Kabat-Zinn, 1994, p.4) and has two key elements (Bishop et al. 2004): 1) self-regulation of attention, which includes sustained attention to the present moment, redirecting attention when the mind wanders and limiting elaborative processing of mental events by just letting them pass; and (2) a certain orientation to experiences, which is characterized by the qualities of curiosity, acceptance and decentering (i.e., psychological detachment). The first and still most studied secular mindfulness-based intervention (MBI) is Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1990) which is based on extensive meditation practice over 5 – 12 weeks, in which participants learn to focus their attention on specific internal or external experiences (e.g., the sensations associated with breathing) and calmly return attention whenever they notice that the mind has wandered elsewhere. Building on notions of "brain training" and neural plasticity, theorists have assumed that regular engagement in such effortful focused attention exercises (Lutz et al., 2008) can alter the structure and functions of the central nervous system to produce lasting and generalized improvements in attention regulation (e.g., Chiesa et al., 2011; Fox et al., 2014; 2016; Lutz et al., 2008; Malinowski, 2013; Tang et al., 2015). Following initial emphasis on focused-attention practices, the MBSR program increasingly turns towards less effortful open monitoring exercises (Lutz et al., 2008) in which participants mindfully follow the natural shifts in their experience as attention becomes drawn to and released from the multitude of transient internal and external events with minimal regulatory effort. Skills in open monitoring are thought to support more efficient distribution of attentional resources, increase cognitive flexibility and reflexive awareness, promote creativity and therapeutic insights, and support stress management (Berkovich-Ohana et al., 2017; Britton et al., 2018; Fujino et al., 2018; Lebuda et al., 2016; Slagter et al., 2007; Wielgosz et al., 2016).

Mindfulness-based approaches have been shown to be effective in relieving several mental health conditions, including depression, anxiety disorders, substance use, and maladaptive ways of coping with pain (Wielgosz et al., 2019). Examining RCT:s, recent meta-analyses (Goldberg et al., 2018, Goldberg et al., 2021) found that MBI's are on average effective compared to both waitlist conditions and active comparison conditions, and similarly effective as dominant evidence-based treatments (e.g., cognitive behavioral therapy or medication) in reducing and preventing a wide range of mental health symptoms. In addition, emerging evidence suggests that training in mindfulness skills can improve a person's ability to engage with and draw restorative benefits during nature contacts (Kaplan, 2001; Lymeus et al., 2017; Macaulay et al., 2022), promote a general sense of connectedness to nature (Aspy & Proeve, 2017; Schutte & Malouff, 2018; van Gordon et al., 2018) and increase pro-environmental motivations (Fischer et al., 2017; Geiger et al., 2019; Huynh & Torquati, 2019; Panno et al., 2018; Wang et al., 2019). However, effects on pro-environmental behavior have been inconsistent (see Geiger et al., 2019). MBI:s may thus not only be relevant in terms of psychological but also socio-ecological resilience.

One important challenge in the real life implementation of MBI's is that they require a strong commitment to regular, often effortful meditation exercise. Many people struggle to maintain focus during conventional mindfulness exercises (Abdoun et al., 2019; Baer et al., 2019; Frewen et al., 2016; Hasenkamp et al., 2012; Lutz et al., 2015). This is problematic as those who experience mental health symptoms and stress – who could in principle benefit most from mindfulness training – often have limited cognitive resources to invest in training and are more likely to drop out (Banerjee et al., 2018; Crane & Williams, 2010; Lymeus et al., 2017; 2022). Thus, adapting mindfulness programs to be less cognitively demanding might be a promising new direction to make such interventions accessible for a wider population, including those in greatest need. Restorative nature experiences may facilitate mindful states and learning processes, which in turn may support restorative processes and engagement for nature-based values. These links motivated the development of an integrated nature- and mindfulness-based intervention called Restoration skills training (ReST; Lymeus, 2019).

Integrating nature and mindfulness

Restorative nature contact and mindfulness have similarities as well as differences which suggest different possibilities for their integration (Kaplan, 2001; Lymeus, 2019, 2022; Macaulay et al., 2022). Apparent conceptual overlap suggests potential for synergistic processes where both nature contact and mindfulness can facilitate stress reduction and distraction management including reduced influence of intrusive and repetitive mental contents: nature experience can promote a sense of being away from stressors and mental routines while mindfulness promotes a decentered way of relating to internal and external events as transient and impersonal, not necessarily requiring any reaction or elaboration. Environmental support for a sense of being away can presumably facilitate decentering, and mindfulness practices that enhance decentering can presumably facilitate a sense of being away even in suboptimal environmental conditions (Lymeus, 2019; Lymeus et al., 2019; Macaulay et al., 2022). Nature contact and mindfulness also support a positively toned

attention to present experiences, by drawing and holding attention to softly fascinating natural features and processes or by practicing in volitional attention regulation and curiosity towards present experience regardless of its nature. Presumably, a fascinating setting can ease curiosity and mindfulness practice in curiosity can in turn enhance fascination even in suboptimal conditions (Lymeus, 2019; Lymeus et al., 2019; Macaulay et al., 2022). Furthermore, nature experience and mindfulness practice can both promote a sense of connectedness to nature, aligned with Buddhist notions of subject-object non-duality and dissolution of perceived self-boundaries. It is a long-standing assumption that immersion in nature during meditative practice can facilitate such perspective shifts and transformations (Coleman, 2010; Fisher, 2014; Lymeus, 2019; Macaulay et al., 2022; Van Gordon et al., 2018).

Kaplan (2001) indicated likely synergies between nature contact and meditative practices, aligned with the above, but also pointed out possibilities for complementarity between the two. He suggested meditation could improve a person's ability to notice and act on restoration needs, and to find and utilize appropriately supportive settings for restoration as well as meditation. Lymeus and colleagues (Lymeus, 2019; 2022a; 2022b; Lymeus et al., 2018; 2019) identified additional possible complementarities. Both nature contact and mindfulness training can enhance attentional functioning, as discussed above, though on different time scales and through different presumed mechanisms: nature contact through restoration where quick and spontaneous processes momentarily provide more complete access to existing attention regulation capabilities and mindfulness through willful engagement in training with regular meditation exercises that presumably load and stimulate gradual enhancements in the involved neural networks. In addition, the attentional effort required to initiate and maintain regular mindfulness practice may be prohibitive for some groups, specifically those who have low attention regulation capabilities and thus much to gain from a program that could strengthen such capabilities. In fact, initial attention-related problems predicted drop-out and/or low compliance with conventional mindfulness training in a few studies (Banerjee et al., 2018; Crane & Williams, 2010; Lymeus et al., 2017; though also see Lymeus, 2022b). The effortless and relatively quick attention restoration benefits of nature contact, on the other hand, are thought to particularly attract and benefit needing groups (Hartig, 2007; Hartig & Staats, 2006; Kaplan, 1995). Potential for complementarity lies in how nature contact could help motivate and support the investment in mindfulness training by compensating depletion in connection with practice, thus making mindfulness training and its well-documented benefits more accessible for needing groups. In turn, mindfulness skills and mindfulness-based interventions can promote capabilities that are more versatile and that extend beyond recovery resilience, building broadly applicable preventive resilience resources and response capabilities.

The identification of potential synergies and complementarities drove the development of the Restoration skills training (ReST) intervention (Lymeus, 2019), which merges the progressive structure and selected practice elements from the established MBSR programs with nature-based practices and experiences in a 5 week intervention with weekly group meetings and daily homework exercises. We conducted 4 small RCT:s comparing ReST to conventional mindfulness training with a total sample of 139 university students with stress

and concentration problems. Analyses of the pooled data showed that ReST was attended by similar mental health benefits as conventional mindfulness training (Lymeus et al., 2020; 2022) while it was less cognitively demanding and supported attention restoration, at least towards the end of the course period (Lymeus et al., 2018). Furthermore, ReST was more acceptable as indicated by observations that it was attended by a lower drop out rate and more consistent homework practice habits (Lymeus et al., 2019). In contrast to conventional mindfulness training, ReST particularly benefited those participants who had more pronounced attention regulation problems (Lymeus, 2022b), which indicates a potential to reach and benefit larger numbers. These findings support several assumptions about complementarity between nature experience and mindfulness. Looking at mechanisms of change, the data also supported some assumptions about synergies in that ratings of state mindfulness and perceived restorativeness during the group meetings interacted to support continued engagement with the training across the course weeks (Lymeus et al., 2019).

As a pilot for the present study, we also conducted a small randomized controlled trial with 33 participants comparing ReST to a Green prescription intervention that had the same dose of nature contact but without any active therapeutic component (Palm and Stjernberg, 2022; Toth, 2022). The results showed that both ReST and the Green prescription intervention were attended by decrease in psychological distress, attentional lapses, and perseverative cognition, and increase in nature connectedness and in some facets of trait mindfulness. The general pattern was that ReST produced such benefits faster – as measured directly after the course in reference to the 5-week course period – but that participants in the Green prescription intervention caught up in the subsequent 1-month follow-up period. Hence, the integrated intervention may more efficiently promote desired outcomes as suggested by the outline of synergies and complementarities above. Unexpectedly, however, the Green prescription was attended by increase in specific aspects of mindfulness even in the absence of any mindfulness-based instructions: Green prescription participants reported gradually increasing experiences of body awareness (but not awareness of mental events) during their nature visits and that they generally were more conscious of their actions and posture after the five weeks. This seems to support the understanding that mere nature contact can support certain aspects of mindfulness. However, these preliminary results should be interpreted with caution due to the small sample size.

Rationale for the fatigue induction and restoration procedure

As described in the above, much of the theory concerning beneficial health- and resilience-related effects of nature experience and of mindfulness training focus on how such interventions may improve central attention regulation capabilities. Such capabilities, in turn, underlie the efficient regulation also of the autonomic nervous system, of emotions and behavior and so, by extension, can impact a person's long-term health, wellbeing and ability to contribute to the world in line with their personal values. Resource-based models suggest a limited ability to direct attention can be subject to overload, where the current demands require more mental bandwidth to cope with than a person has available (Hockey, 1997; Kahneman, 1973; Lavie, 2010; Milgram, 1970), as well as to depletion following

prolonged load, where declining self-regulatory ability reflects in reduced task performance and impulse control, negative emotional valence, and over-activation of the sympathetic nervous system (Baumeister et al., 2000; Cohen, 1980; Hockey, 1997; Kaplan & Berman, 2010; Posner et al., 2010). Fatigue inductions are experimental manipulations that produce such states in a controlled manner (Borragán et al., 2016; O'Keeffe et al., 2020). Depletion is also the presumed antecedent condition necessary for restoration needs and potential to occur (Hartig, 2007; 2021).

NbT activities presumably support self-regulation through restoration of depleted self-regulation resources, as outlined earlier. Hence, spending time in a natural break setting after a fatigue induction should result in enhanced recovery resilience as marked by faster or larger HRV increase, reduced subjective fatigue and improved attention task performance. The NBRT also proposes a positive feedback loop driven by successful coping with various challenges, including a well-balanced allostatic response and effective mitigating action (i.e., response resilience) as well as timely and sufficient restoration following such efforts (i.e., recovery resilience) (White et al., 2023). Preventive resilience is supposedly built gradually with repeated instances of such successful coping, and reflects in a better homeostatic baseline condition (e.g., higher baseline HRV; cf. Laborde et al., 2017; Thayer & Lane, 2009) and a higher base level of coping resources (e.g., attention regulation capacity). With a better baseline condition, a person can presumably meet future demands more efficiently, resulting in less frequent and intense experiences of overload and psychophysiological stress.

Some mindfulness studies have measured change in attention or some other assay of central self-regulation capabilities in immediate connection with a meditation exercise (e.g., Dunn et al., 2013; Frewen et al., 2016; Friese et al., 2012; Hasenkamp et al., 2012; Johnson et al., 2015). However, the theoretical bases for hypotheses have been inconsistent; for example, some researchers have referred to the practice as a "centering exercise" or similar and expected improved performance following practice, others tested counteracting effects of meditation on expected ego depletion, and yet others tracked signs of increasing fatigue (attentional lapses) across meditation sessions. The literature generally does not consider restoration, or any closely related resource-based construct, as a possible factor. Instead, it tends to consider the practices as a form of top-down regulation in themselves, assuming disruptive thoughts, stress, and other signs of dysregulation are suppressed by the practices as such rather than through some intermediary restoration process. This aligns with the understanding that mindfulness practices can be effortful, and specifically relates to the notions of attention network training and attention state training (Tang & Posner, 2009, 2014).

Attention network training refers to the type of effortful meditation practices that involve a specific attentional target to which a person patiently continues to direct and re-direct their attention over several minutes or more (so-called focused attention exercises; Lutz et al., 2008). Repeatedly loading the attention system this way presumably stimulates neuroplastic growth in the involved brain networks (e.g., Chiesa et al., 2011; Fox et al., 2014; 2016; Lutz et al., 2008; Malinowski, 2013; Tang et al., 2015), thus strengthening the person to be better

able to handle future attentional demands, akin to the NBRT notion of building preventive resilience in the form of a better homeostatic baseline condition. Mindfulness-based programs that deliberately and specifically train relevant capabilities could presumably be more efficient in this regard than NbT:s that do not involve any mindfulness-based or other directed training elements. However, the resource-based understanding that NBRT and several earlier theories in the nature-health field build on suggests that the short-term effect of engaging with an effortful focusing exercise should be negative; that is, it should interfere with restoration compared to merely spending time in nature, or potentially even exacerbate signs of fatigue.

Attention state training, in contrast, can presumably proceed with minimal effort (Tang & Posner, 2009). Here, the presumed mechanism is experiential learning during guided and unguided open monitoring meditation, where a person observes without controlling or engaging with the natural flow of their moment-to-moment experience (Lutz et al., 2008). In doing so they can presumably become aware of how they can cultivate and balance a mind-body state where they have access to their full attentional capabilities. This type of learning is thus assumed to proceed effortlessly and restore access to existing attentional capabilities, and thus support recovery resilience as proposed in NBRT. Viewed as a part of a learning process that proceeds with repetition over time, however, a common assumption in mindfulness theory and practice is that beginners should train their minds in effortful focused attention exercises before they can proceed to prolonged open monitoring – otherwise they would easily become distracted or dull when their field of awareness is left unchecked – so MBSR and other mindfulness training programs for beginners tend to emphasize focused attention practice and only carefully introduce relatively short periods of open monitoring (Kabat-Zinn, 1990; Lutz et al., 2008; Malinowski, 2013).

In contrast, the ReST program builds heavily on open monitoring practices even though it caters to beginners. Such practices are compatible with a rich natural setting that can help draw and hold attention to environmental features and processes and ease detachment from mental contents that could distract from the direct experience, which allows even beginning practitioners to steady their field of awareness and take on more advanced meditative practices at an earlier stage (Lymeus, 2019; Macaulay et al., 2022). Focused attention practices that involve a specified attentional target – normally sensations that arise with the breath – may instead be disturbed by, and in turn disturb, fascination in relation to attentionally stimulating surroundings.

Hence, we expect that participation in either of the mindfulness-based interventions will help build proactive resilience as indicated by higher baseline HRV and attention task performance, and lower task related subjective stress, more than the Green prescription that does not involve any targeted training. We also expect that the mindfulness-based interventions will enhance reactive resilience as indicated by attenuated reduction in HRV and attention task performance during the fatigue induction, and by lower subjective fatigue ratings after the fatigue induction. For the Green prescription intervention, we expect it to enhance recovery resilience as indicated by faster HRV restoration during the break and greater reduction in subjective fatigue ratings afterwards. However, we expect recovery

resilience to be more enhanced with the integrated nature- and mindfulness-based ReST intervention that combines nature's restorative effects with targeted training in relevant skills.

AIMS & RESEARCH QUESTIONS

Aim 1: Impactful evidence

We aim to contribute to a more robust and clinically impactful evidence-base for nature-based therapies, and specifically for the ReST and Green prescription (Häng med oss ut) NbT:s that are included as trial arms. We seek to achieve this by using a robust research design informed by developments in the clinical trial tradition and involving relevant active as well as passive comparison conditions, by targeting main outcomes of clear clinical relevance with accepted measures and change specifications, and by striving to include a large sample of participants.

Associated research questions:

- *Are the mental health benefits attending the active interventions greater than those of the waitlist condition?* We expect that they will be. All three active interventions (ReST, Green prescription, conventional mindfulness training) are bona fide health interventions with pre-existing evidence behind them and provided in the study by trained professionals who have the good of the participants first in mind.
- *Are the mental health benefits of the three active interventions similar or different?* For the two NbT:s, we consider it fully satisfactory if they outperform waitlist and produce similar outcomes as the more established conventional mindfulness-based intervention. We will, however, check for any difference in the magnitude and distribution of improvements across the domains of depression, anxiety, stress and health-related quality of life between the three active interventions.
- *How helpful and safe are the interventions?* We will determine and compare the proportions of participants who show clinically significant improvement, but also the proportions who show clinically significant deterioration, in the mental health outcomes. The expectations are that the likelihood of improvement will be higher in each of the active interventions compared to the waitlist condition, while the risk of deterioration will be negligible across the three active interventions and similar as the risk observed among waitlist participants.
- *Are the nature-based interventions more acceptable than the conventional mindfulness-based intervention?* We expect that they will be, given the background described in the introduction. We specifically expect signs of higher acceptability in terms of ratings of the effort required to participate, and in terms of lower drop-out and more consistent homework completion. Other aspects represented in the Theoretical framework of acceptability (see Measures) will also be compared.
- *Are the interventions sustainable in terms of their resource requirements and impacts on the local ecosystems?* These research questions refer to work led by other RESONATE work packages and so are not fully elaborated or motivated here. We expect the NbT:s will involve some health economic tradeoffs that need to be considered but that they can be worthwhile compared to feasible alternatives (i.e.,

conventional mindfulness training or no intervention). We also expect that the interventions will be environmentally sound even at larger scale, at least in the current social-ecological system.

Aim 2: Complementarities and synergies between nature and mindfulness

We aim to identify unique and interactional effects of the nature-based and mindfulness-based components that are represented in the three active interventions. We seek to achieve this through the factorial design that allows analyses of how the factors Nature and Mindfulness alone and in combination contribute to explaining intervention outcomes in the different relevant domains (i.e., mental health, resilience, human-nature relations).

Associated research questions:

- *Do the nature-based, mindfulness-based and integrated interventions promote different aspects of mindfulness?* We expect that nature-based intervention elements can enhance awareness aspects of mindfulness (e.g., Observing and Acting with awareness facets of trait mindfulness), but not decentering aspects (e.g., Non-judging and Non-reactivity facets of trait mindfulness). We also expect that the ReST and conventional mindfulness training interventions will improve all measured mindfulness traits.
- *Beside mindfulness, do the nature-based, mindfulness-based and integrated interventions promote different other aspects of resilience?* We expect that ratings of state and trait resilience, of day-to-day cognitive lapses, of value-oriented engagement, and of loneliness will all improve with the interventions. Where we do expect differences between the active interventions is regarding cognitive lapses, which should decrease more with the mindfulness-based interventions that involve a form of cognitive training. Regarding intervention differences in the other outcomes we will explore emerging effects.
- *Which aspects of participant's relationship with nature are more strongly promoted by the nature-based interventions than by conventional mindfulness training? And which aspects of participant's relationship with nature can conventional mindfulness training without nature contact promote?* We expect that the nature-based interventions will generally be attended by improvements in the measures of human-nature relations, which include nature habits, nature connection, pro-environmental behavior and environmental concern. However, the reviewed literature indicates that even conventional mindfulness training without any nature contact can sometimes promote nature connection and environmental concerns or attitudes. We reason that such effects could be due to improvements in general aspects of a sense of connectedness and non-egoistic concerns, rather than specifically nature-oriented connectedness and concern. We will compare patterns of voluntary donations and ratings reflecting biospheric, altruistic and egoistic environmental concerns, and expect the nature-based interventions promote biospheric concerns while the mindfulness-based interventions promote biospheric

and altruistic concerns equally. We also expect that conventional mindfulness training will not be attended by increased pro-environmental behavior.

Aim 3: Compare proposed processes

We aim to determine the relative importance for intervention outcomes of several proposed processes. We seek to achieve this by tracking aspects of participant's experiences and habits related to the intervention activities, with the intention of examining how such experiences and habits develop over time in the interventions as well as how they contribute to explaining the eventual health outcomes of participating.

Associated research questions:

- *Do the nature-based interventions promote stronger experiences of perceived restorativeness than the conventional mindfulness intervention?* We expect that they do, and will look at the general levels in the ratings of restorative processes (fascination, being away, compatibility) as well as trends of development over the intervention weeks. Furthermore, we expect that ReST – the integrated intervention – compared to the Green prescription, will be attended by higher perceived restorativeness in the first intervention weeks, reflecting that the ReST practices can enhance restorative processes. We expect Green prescription to catch up in the later weeks as they gain more experience in restorative nature-based activities.
- *Do the mindfulness-based interventions promote stronger experiences of state mindfulness than the Green prescription without mindfulness?* We expect to see a pattern where the ReST intervention yields highest ratings of state mindfulness in the first intervention weeks, reflecting that the integration of the mindfulness practices with a restorative natural environment can facilitate meditation even when participants have low skills. We expect that the conventional mindfulness intervention will catch up in the later weeks as those participants gain mindfulness skills. However, we also expect that the Green prescription participants will show some increase in their state mindfulness ratings over the weeks, but only in awareness aspects of state mindfulness.
- *Do the nature-based, mindfulness-based and integrated interventions differ in how strongly they elicit a sense of nature connectedness and group cohesion?* We have argued higher up that mindfulness training, even without nature contact, can promote a general sense of connectedness that could span nature connectedness as well as human-to-human connectedness, while a Green prescription intervention without mindfulness elements should promote specific nature connectedness – not human-to-human connectedness. However, we do not expect this to necessarily hold for the participant's immediate experience in the intervention group meetings. That is partly due to the fact that the Green prescription intervention includes a larger variety of different types of activities and less formal structure around the group and person-to-person interactions that can take place, which is likely to contribute to social contacts and bonds. The mindfulness-based interventions, being oriented

mainly towards the particular form of training in question and relatively structured in terms of activities and conversation topics, may thus fall behind the Green prescription in terms of group cohesion. In terms of nature connectedness, we expect the nature-based interventions to promote it more strongly than conventional mindfulness training.

- *How do the proposed processes contribute to explaining the mental health outcomes of the interventions?* We consider all of the proposed processes as feasible and non-redundant contributors to health. Entered as parallel mediators and therefore competing for variance to be explained, however, we may see that the related constructs of perceived restorativeness, state mindfulness and state nature connectedness may be differently dominating in the different interventions. We expect perceived restorativeness and nature connectedness to mediate stronger pathways in the nature-based interventions, and state mindfulness to mediate a stronger pathway in mindfulness-based interventions. Mapping such differences will help distinguish the mechanisms through which the different interventions work to achieve health outcomes. Group cohesion and homework compliance should be similarly important regardless of the intervention type.

Aim 4: Demonstrate effects on preventive, response and recovery resilience

We aim to demonstrate the potential of repeated (e.g., pre- and post) fatigue induction and restoration procedures as a method for evaluating the effects of NbT:s on preventive, response and recovery resilience. The procedure reflects common thinking and practice in the nature-health field but it is innovative to use it to evaluate NbT interventions. As we have described in the introduction, one might note that preventive, response and recovery aspects of resilience are represented in such procedures so improvement in one or more of those aspects of resilience following participation in a NbT should predictably result in corresponding changes in how a person goes through the procedures. In this case, we target aspects of resilience that are situated on psychological and physiological levels and relate closely to common reasoning and methods in restorative environments studies. The paradigm could potentially be adapted to reflect other levels of resilience (e.g., relational, ecological).

Associated research questions:

- *What are the patterns of fatigue and effort that will be uncovered by the joint monitoring of attention task performance and heart rate during the fatigue induction?* Experimental fatigue inductions have been relatively uncommon in restorative environments studies. When they have been used the methods and the magnitude of the inductions have varied vastly and their success has been unpredictable. Here, we test a method based on a task that was developed for similar purposes in another research field and where we intend to capture the gradual unfolding of effects of the very high cognitive load in the task on task performance and at the same time monitor the psychophysiological correlates of the compensatory effort (or subsidiary self-regulatory impairment, as it is considered in

some theories) that is expected to co-occur with and interact with performance. These trends can also be viewed in relation to the subjective ratings of different dimensions of fatigue, including cognitive and physiological fatigue. The methods as well as the results could be important for future restorative environments studies.

- *How will heart rate variability respond to the respective recovery phase conditions? And how will that response relate to ratings of experienced restoration processes?* We will determine the trends in physiological recovery in relation to realistic break environments that are commonly used by the population in their daily activities on campus, and expect that the botanic garden environment will support faster and/or more complete recovery than the indoor common areas of the campus building. To learn more about those trends, we plan to examine how participant's ratings of experiences of perceived restorativeness, state mindfulness and state nature connectedness contribute to explaining recovery efficiency.
- *How will resilience indicators change with the interventions?* We will identify differences between the procedures before and after the participants go through the intervention period. Such possible differences reflect preventive resilience (i.e., lower stress appraisals in relation to the fatigue induction task, higher maximum performance on the fatigue induction task, and higher baseline HRV), reactive resilience (i.e., slower and lower HRV reduction during the fatigue induction task, improved endurance on the fatigue induction task, and lower subjective fatigue), and recovery resilience (i.e., faster and larger increase in HRV during the restoration phase, larger reduction in subjective fatigue). We will compare how those changes differ between the nature-based, mindfulness-based and integrated interventions and the waitlist condition to better understand how nature- and mindfulness-based intervention components alone and together promote aspects of psychological resilience outlined in NBRT.

Aim 5: Learn more about participant's experiences in the interventions

We aim to use the interview data to extend and develop our understanding of what motivates people to seek nature-based and mindfulness-based interventions, what they experience as beneficial or difficult in the interventions and how they make sense of those experiences. In contrasts to surveys, interviews can give insights that researchers did not know they should ask about and of course yield richer information. We will collaborate with the representatives of the respective RESONATE work packages in drawing on this information.

STUDY DESIGN

The study is a randomized controlled superiority trial with 4 parallel arms, a mixed factorial design, and 1:1 allocation ratio between interventions. Two treatment arms are nature-based interventions: Restoration skills training and Green prescription. Restoration skills training integrates the nature-based component with mindfulness training, and the third treatment arm is mindfulness-based without any nature-based components: Conventional mindfulness training. The fourth arm is a waitlist control condition. The four treatment arms covering the four combinations of nature contact vs. no nature contact and mindfulness training vs. no mindfulness training ensure ability to disentangle effects of the environment and the mindfulness training. Comparing three bona fide health interventions also minimizes effects of reactivity to treatment allocation as well as ethical problems associated with sham interventions.

Main study design

Intervention type is thus a randomized between-subjects factor with 4 levels. A second, non-randomized between-subjects factor is Initial psychological health status, where participants will be classified based on their screening results into “minimal or mild” vs “moderate” symptom severity groups (volunteers with more severe symptoms will be excluded). Randomization to Intervention type will be stratified by Initial psychological health status. Assessments obtained before, directly after, one month after and six months after the interventions constitute the within-subjects factor. The main hypotheses for which the study is powered concern interaction between Intervention type and Time, where three separate tests will evaluate change from before the intervention to the assessments directly after, one month, and six months after, respectively.

The design is non-blinded. To minimize treatment allegiance effects and related biases, the Green prescription and Conventional mindfulness interventions will be delivered by hired professionals with specific training and experience in delivering the respective interventions and without previous affiliation to the project or specific knowledge of the hypotheses. The ReST intervention that was developed by our group will be delivered by instructors trained by the researchers. The researchers will monitor the instructors’ fidelity to the planned interventions as well as their adaptations to unforeseen constraints and emerging needs. The interventions are provided as a complement to any other care that participants take part in and so will not replace any regular treatment.

Participants who are assigned to waitlist control will be offered to self-select into one of the three active interventions after completing the one-month follow-up. Their choice between the interventions will be noted and analyzed.

Fatigue induction and restoration design

In an extension of the main design, a subset of 100 participants will go through a fatigue induction and restoration procedure before and after the interventions. The purpose is to evaluate the effects of the interventions on aspects of resilience laid out in NBRT (preventive, response and recovery resilience). Participants will be asked during the

enrollment if they wish to take part in these extra procedures until 25 from each treatment arm have completed them. This design component involves assessments of physiological and psychological indices of stress in connection with continuous performance under cognitive load followed by a recovery period reflecting the setting and practice components of participants' respective intervention conditions. The design component thus involves the between-subjects factors Nature and Mindfulness. It includes two within-subjects factors reflecting time in relation to the intervention (Occasion: before vs after intervention) and in relation to the involved experimental phases (Time: before fatigue induction, after fatigue induction, after restoration). HRV will be monitored on both Occasions, continuously across Time but the data will be averaged over 1 – 5 minute epochs as needed to achieve the needed temporal resolution to describe emerging trends in the data. The number of levels of the Time factor for the HRV analyses will thus be determined post hoc. Some variables (e.g., subjective fatigue ratings) will be obtained twice on each Occasion and so have Time (two levels: after the fatigue induction and after the restoration phase) nested under Occasion. Other variables (e.g., stress appraisals) will only be assessed once per Occasion and so lack a nested Time factor. Initial psychological health will be included as a continuous covariate in the subsequent analyses of this design component.

Semi-structured interviews

Participants will also be asked during the enrollment if they wish to participate in a semi-structured interview scheduled in the month after the intervention. We will ask participants as part of the enrollment procedures for the larger study if they would like to also take part in the interview, until ca 12 participants per active intervention condition have accepted. The questions concern participants motivations and expectations for the intervention and their experiences of participating.

PARTICIPANTS

University students will be recruited as participants. In line with international findings, the Public Health Agency of Sweden (2018) described university students as a vulnerable occupational group where existing preventive and treatment options are insufficient: one quarter report stress-related symptoms and almost half struggle with anxiety or worry. Such problems often hamper academic success and jeopardize major personal and societal investments. We will recruit continuously through posters on university campuses, relevant social media platforms, student health services, etc.

Inclusion criteria

- Enrolled in courses for at least 75% of full time during the study period;
- <40 years old;
- Motivated to participate in a health intervention and able to plan for participating in accordance with the given schedule.

Exclusion criteria

- Current severe mental health symptoms, suicidal ideation or self-harm;
- Current or previous psychotic or bipolar symptoms;
- Other health issues that could interfere with participation (e.g., moderate to severe allergies that can be triggered in nature visits);
- Recent (<1 months) initiation or adjustment of regular medication that is expected impact psychological health;
- Previous participation in a nature- or mindfulness-based health intervention (minor unstructured engagement with nature activities, meditation, yoga, etc. are acceptable).

Randomization

Following screening and informed consent, participants will be stratified by initial psychological health status defined as minimally or mildly vs moderately elevated psychological distress. Within each study location (university town), participants within each psychological health status group will be randomized in equal numbers between the four conditions using a random number generator. We will continuously adapt our outreach and recruitment efforts to pursue equal psychological health status groups as well as gender balance by prioritizing processing of volunteers from underrepresented groups.

Sample sizes

The main part of the study involves the full sample of participants going through the 2x2 Nature (yes/no) and Mindfulness (yes/no) intervention design. The factorial nature of this design makes it very efficient in terms of power. The hypothesis tests involve the main effects and interactions (i.e., Nature x Mindfulness) while controlling for initial values. Initial values on the DASS also underlie the symptom severity classification (minimal to mild vs moderate) which we use as a stratification variable in the allocation to conditions, with the intention that any effects of Nature or Mindfulness will be further investigated for interaction with Symptom severity in follow-up analyses; again, this refers to 2x2 interactions to investigate whether the nature-based and mindfulness-based intervention

elements, respectively, make interventions particularly supportive for subgroups with more pronounced mental health problems. Sex (2 levels) and Age (continuous) will be included in all analyses if needed to control for their effects. The desired level of power is the conventional 1-β >.80 at α <.05 (two-tailed). For moderate sized (i.e., partial eta squared ≥ .06) main and interaction effects with 1 degree of freedom, this will require n = 32 per intervention condition and a total sample of *N* = 128. Based on observed effects from our previous comparisons between ReST and conventional mindfulness training, and between ReST and a Green prescription intervention, however, we have secured ethical approval for and will pursue a total sample of n = 65 per intervention group (*N* = 260) in order to power the analyses for sensitivity to effects of partial eta squared = .03. This will be helpful in detecting even relatively minor differences between the three active interventions.

A random subset of participants will also be asked to complete the fatigue induction and restoration procedure. The power calculations for the fatigue induction and restoration procedures was based on the weakest (power-wise) design component which is the contrast between groups in their degree of change between two measurement points (e.g., in stress appraisals or baseline HRV between the occasions before and after going through the interventions). Given 1-β >.80 at α <.05, a mixed (repeated measures) ANOVA for 4 groups and 2 measurement points and correlations of r = .50 between repeated measures, will require n = 12 per intervention condition and a total sample of *N* = 48 to detect moderate effects (i.e., partial eta squared ≥ .06). Based on previous observations in similarly designed studies, however, we have secured ethical approval for and will pursue a total sample of n = 25 per intervention group (N = 100) in order to power the analyses for sensitivity to effects of partial eta squared = .03. Again, the purpose is to be able to detect even relatively minor differences between the three active interventions. Analyses of HRV reactivity and restoration, and of subjective fatigue reduction with the restoration activities, will involve a larger number of measurement points and so have more power.

Reimbursement

For interest in and engagement with the active interventions, we will rely on motivated volunteers who see value in the opportunity to participate and feasibly benefit. To help ensure sufficiently complete data across the study, gift certificates will serve as reimbursement for time and effort spent completing assessments and other non-intervention procedures, regardless of whether they complete the interventions. As part of the research design, we will offer participants to donate a voluntary part of their reimbursement to charity. The remaining sum will be put on a gift certificate for their own use at a wide range of stores and service providers.

All participants who complete the pre- and post-intervention assessments and the 1-month follow-up will receive gift certificates at a value of ca €50. At this point, waitlist participants may choose which of the three active interventions they wish to join. All participants will be asked to complete a follow-up six months after the end of the intervention, for which they will receive an additional €50 in gift certificates.

The subset of 100 participants who also complete the fatigue induction and restoration procedure before and after the intervention will receive an additional €50 value.

The subset of ca 34 participants who complete the semi-structured interview will receive an additional €25 value.

TRIAL ARMS / INTERVENTIONS

The interventions and other aspects of study participation will be given as a complement to any other care that participants take part in and so will not replace any regular treatment. We will monitor changes in participants' mental health throughout the intervention period via weekly reports and if needed advice participants to discontinue the intervention or seek relevant healthcare services.

The three active interventions all span five weeks with one instructor-led 2-hour group meeting (with up to 12 participants) per week and 20-minute homework assignments to be completed independently once per day. This structure is common for brief mindfulness-based treatments in the tradition of Mindfulness-Based Stress Reduction (MBSR; Carmody & Baer, 2009; Crane et al., 2017) and the standard around which we previously developed the Restoration skills training course (Lymeus, 2019). Precedents for green prescription interventions are more diverse in length as well as other structural aspects but we assume that such a structure is sufficient and suitable based on findings that a minimum of two hours of nature-based activities per week is associated with generalized health benefits (White et al., 2019) and that 20 minute exposures normally produce noticeable short-term outcomes indicative of stress reduction and restoration (Barton & Pretty, 2010; Hunter et al., 2019). Each intervention is framed as an introductory course and explicitly aimed at establishing basic understandings and habits that participants can then continue to develop independently.

Restoration skills training

ReST integrates nature- and mindfulness-based components building on a theoretical framework and treatment protocol that was developed over 10 years by members of the research group (unpublished protocol; see Lymeus, 2019; Lymeus et al., 2020; 2022; Toth, 2023). The weekly ReST group meetings will take place in easily accessible and non-challenging, city adjacent natural settings. They will involve motivational and educational conversations on core concepts of mindfulness and human-nature relations, practical training in meditation exercises aimed to cultivate mindfulness in relation to the environment, and personalized advice on how to establish independent nature-based mindfulness habits. Group and homework exercises follow a specific learning progression founded in the sensory modalities (touch, smell and taste, hearing, vision) and balancing of focused-attention and open-monitoring practice components. The groups will be led by F. Lymeus and several psychologists who first train as assistant instructors before leading groups under supervision.

Green prescription

The Green prescription intervention builds on an established nature-based mental health program – Häng med oss ut (approximately meaning "Go out with us") – developed by Therese Rosenkvist and integrated with the Swedish Outdoor Association (Friluftsfämjandet) who host the training of instructors and organizational support. Häng med oss ut group meetings will take place in the same settings as the ReST meetings. They will also involve

motivational and educational conversations on core concepts of human-nature relations, inclusive and non-demanding nature-based activities, and personalized advice on how to establish independent nature-based habits. Importantly, they will not involve any mindfulness or meditation concepts or practices, nor any other specific therapeutic components. Group and homework exercises entail mildly engaging activities such as non-vigorous walking, relaxing, and observing natural phenomena. The groups will be led by healthcare professionals who have gone through training in Häng med oss ut certified through the Swedish Outdoor Association, and have previous experience leading such groups.

Conventional mindfulness training

The Conventional mindfulness training intervention will build on the established Mindfulness-Based Stress Reduction program. The weekly MBSR group meetings will take place in indoor settings with minimal views and decorations, furnished with comfortable seating arrangements. They will involve motivational and educational conversations on core concepts of mindfulness, practical training in exercises aimed to cultivate mindfulness in relation to bodily sensations, emotions and thoughts; and personalized advice on how to establish independent mindfulness meditation habits. Importantly, they will not involve any nature-based concepts or practices, nor any outdoor activities. Group and homework exercises follow a specific learning progression founded in the MBSR tradition – including body scanning, mindfulness of breath practice and mindful walking – and balancing of focused-attention and open-monitoring practice components. The groups will be led by healthcare professionals who have gone through mindfulness teacher training certified by a recognized mindfulness organization (e.g., the Mindfulness-Based Teacher Association of Sweden).

Waitlist condition

The waitlist condition will not involve any intervention activities over the five-week intervention period and the following one-month follow-up period. The participants will not be specifically informed that other participants commence with interventions immediately but will get to choose which of the three active interventions (ReST, Conventional Mindfulness Training, Green prescription) they want to join and receive a starting date 10+ weeks in the future. Their psychological health status during the waiting time will be monitored through the three assessments ending with the one-month follow-up.

PROCEDURES

When presumptive participants provide their contact information in an expression of interest, we will send them a link to access online information about the study and a screening survey. Those who do not pass the screening survey will receive an automated message thanking them for their interest and including information about relevant healthcare services. Those who pass the screening survey will also be able to select a time for an enrollment interview. The online interview will involve questions aimed to ascertain their suitability to participate through follow-up questions about the exclusion and inclusion criteria, as needed, and opportunities to ask questions about the study. It will also involve discussion about the possibility to participate in either the fatigue induction and restoration procedures or the semi-structured interview in addition to the intervention and main outcome assessments, where the presumptive participants may express interest and receive more detailed information about these before providing informed consent. Participants who proceed past this stage will be asked to provide their informed consent and then, with stratification based on their previously provided screening data, allocated a treatment arm through a random number draw. Participants allocated to the waitlist arm, with a delayed start date for the active intervention, will be asked to select which intervention they prefer. All participants will receive their exact intervention and assessment schedule and other practical information pertaining to the treatment arms and main outcome assessments (described just below) while those who also consented to it will also be scheduled for the fatigue induction and restoration procedures or semi-structured interview (see further below).

Main study procedures

All participants will be contacted one week before the intervention period and asked to complete the online pre-intervention assessment comprised of questions about baseline characteristics as well as the primary and secondary intervention outcomes (Measure set A) before their first group meeting. During the intervention period, participants in the three active arms will be asked to complete assessments of their intervention compliance and experiences (Measure set B) in connection with the group meetings and completion of homework activities.

Directly after the last group meeting of the interventions the active arm participants will be asked to complete measure set A again, within one week, as well as an intervention evaluation with questions aimed to assess their perceptions of quality in different aspects of the intervention. One month and six months after the last group meeting, active arm participants will again be asked to complete measure set A, within one week, these times with added questions about continued intervention-related activities (e.g., mindfulness practice, nature visits as relevant for each arm) in the respective follow-up periods. Waitlist participants will only be asked to complete measure set A, at the same times as the active arm participants.

Upon completing the 1-month and 6-month follow-ups, all participants will receive reimbursement for time spent completing assessments and other non-intervention

procedures. Directly upon completing these assessments, participants will be asked to indicate in the online platform how they wish to distribute their reimbursement across multiple nature-related vs health-related and self-directed vs altruistic gift certificate options.

Fatigue induction and restoration procedures

The subset of participants who consented to the fatigue induction and restoration will be scheduled to complete the first of those procedures in the time window between the enrollment and intervention start. All measures that are part of these procedures are described under Measure Set C.

Upon arriving to the test site located in a campus building, they will be guided to a test room where they will be instructed in how to apply a Bittium FarosTM 180 wearable electro-cardiogram device (Bittium, n.d.) suited for ambulatory monitoring and non-invasive field research. Following instructions, the participants will be left in private to mount the small device on their chest with a glued patch, without any physical examination or handling by a researcher. [PENDING APPROVAL OF ETHICAL REVIEW AMENDMENT 2024-04984-02, ABOVE TEXT MARKED IN YELLOW WILL BE REPLACED WITH: "…where they will be instructed in how to apply a Polar Verity Sense photoplethysmographic armband (Polar Global, n.d.) suited for ambulatory monitoring and non-invasive field research. Following instructions, the participants will apply the armband on their lower non-dominant arm without any physical examination or handling by a researcher."] The researcher will check the output of the device to confirm correct application. Then participants will be asked to rest in a seated position for 5 minutes and offered magazines to read while baseline heart rate parameters are established.

Following the baseline assessment, participants will receive instructions for the fatigue induction task and go through a ca 30-minute training and calibration sequence with the task. Having established familiarity and participants' maximum performance capacity, they will be asked to provide stress appraisal ratings pertaining to the upcoming fatigue induction, knowing that they will work on the fatigue induction task at their maximum capacity for 16-minutes, and then commence with the fatigue induction. After 16 minutes with the task, they will be asked to complete ratings of subjective fatigue.

Following the fatigue induction, participants will get a 20-minute break. The researcher will motivate the break as "time for you to regain your focus in preparation for another test". They will get a small timer set to signal when the break is over. Participants assigned to the nature-based interventions (ReST, Häng med oss ut) will be guided for a 50 meter walk out to an adjacent botanic garden where they will be told to spend the break in the outdoor parts and/or in a tropical greenhouse that provides shelter from possible unpleasant weather. Participants assigned to the non-nature-based conditions (Conventional mindfulness training, waitlist control) will be guided for a 50 meter walk to another part of the campus building where they will spend the break in the common areas of the building. All participants will be told to find a nice place to sit and, if they begin to get bored or uncomfortable to take a gentle stroll and look for another nice place to sit. A predominance

of seated activity is emphasized in order to obtain undisturbed heart rate data for as much of the time as possible. Allowance for gentle strolling serves to minimize possibly aversive constraints and to support participants in engaging dynamically with attractive features in the environment and in managing any environmental disruptions (e.g., transient crowding) in an intuitive way. All will be told to avoid any distractions (e.g., interactions with other people) and specific activities (e.g., studying). The timer will buzz after 20 minutes, signaling participants to return to the test room. Back in the test room, the participants will be asked to complete additional survey items regarding experiences of perceived restorativeness, state mindfulness and nature connectedness during the break and regarding current subjective fatigue.

In the period between the end of the intervention and the one-month follow-up, the same participants will be scheduled to repeat the same procedures again, seeking to match the second occasion as closely as possible to the weekday and time of day as the first occasion. This time, the active arm participants' instructions for the fatigue induction will include a prompt to "try to use what you learned in the intervention to perform your best on the task", and for the restoration phase they will be prompted to "try to use what you learned in the intervention to regain your focus in preparation for another test". Waitlist participants will receive the same instructions as in the first procedure.

Interview procedures

The subset of participants who consented to the semi-structured interview will be scheduled to complete the interview in the period between the end of the intervention and the one-month follow-up. The interviews will be conducted online, recorded, and transcribed for analysis.

MEASURES

Screening

The screening is structured in steps where presumptive participants only progress to the next part if they passed the subsequent steps, in order to avoid needlessly collecting sensitive data and taking up presumptive participants' time. Step 1 – 5 are completed in an online survey with automatic evaluation and termination.

Step 1 involves questions about motivation and ability to take part in a health intervention in the relevant time period, and about inclusion-relevant socio-demographic characteristics: age, sex and gender, and student status.

Step 2 involves questions about any unspecified medical conditions or treatments that are expected to have substantive effects on their psychological health in the relevant time period (any stable conditions and maintenance treatments are exempt and accepted). It also involves questions about any unspecified allergies that cause them major discomfort in outdoor activities.

Step 3 involves questions about nature- and meditation-related habits. It involves single item questions about recent nature contacts drawn from the People & Nature Survey (2023) and Gu et al. (2023), where exclusion will be based on reports of higher than weekly nature exposure as this leaves little room for increase with nature-based interventions. It also involves questions about experience of regular meditation in any structured training programs, retreats, or self-directed efforts.

Step 4 comprises the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995; also see Alfonsson et al., 2017) which measures psychological distress levels on the eponymous dimensions. Exclusion will be based on scores corresponding to established ranges for severely elevated distress in either of the dimensions (depression: 21 or higher; anxiety: 15 or higher; stress: 26 or higher). For those who proceed to eventually provide informed consent to participate, the DASS scores will be used for stratification based on psychological health status: those with moderately elevated distress in either of the dimensions (depression: 14 – 20; anxiety: 10 – 14; stress: 19 – 25) will be assigned to conditions separately from those with minimal or mild distress in all dimensions.

Step 5 comprises the DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure, Adult (DSM-XC; American Psychiatric Association, 2013; also see Bravo et al., 2018; Mahoney et al., 2020) which assesses symptoms in 13 domains: depression, anger, mania, anxiety, somatic symptoms, suicidal ideation, psychosis, sleep problems, memory, repetitive thoughts and behaviors, dissociation, personality functioning, and substance use. It will not be used for direct exclusion but responses exceeding its' set cutoff levels will be used to guide follow-up questions in Step 6.

Step 6 involves an online interview that follows up on any indicated DSM-XC domains with selected questions from the MINI International Neuropsychiatric Interview (MINI; Lecrubier et al., 1997) and the Columbia Suicide Severity Rating Scale (C-SSRS; Posner et al., 2008).

Baseline characteristics

The following additional socio-demographic and other baseline characteristics of the participants will be collected with single bespoke questionnaire items before the start of the intervention period: long-standing illness or disability, marital status, work status, ethnicity, dog ownership, car access, public transport accessibility, social contact, household size/composition, highest educational achievement, perceived financial strain, birth country, current and past nature-related work/studies, childhood nature experiences, landscape type preference.

Measure set A: Primary and secondary outcomes

Measure set A is an online survey composed of eleven pre-existing rating scale measures – many of them in a validated short form to minimize time demand and measurement fatigue – as well as a section with some bespoke questionnaire items regarding health care use, summing to 157 questions in total. The included measures reflect a range of constructs that we consider feasible and relevant potential biopsychosocial outcomes of participating in each of the active interventions and will therefore be used before, directly after, one month after and six months after the intervention period.

The following two measures reflect aspects of participant's health status, and constitute the primary outcomes of the study:

The Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995) is a primary outcome measure (introduced above under Screening). We will use a 21-item version (Alfonsson et al., 2017) where participants rate the degree to which different symptom descriptions applied to them during the past month. In addition to the three dimension scores representing factorially distinct constructs of depression, anxiety and stress, respectively, the total score across the dimensions is an index of generalized psychological distress. We will analyze change with the interventions in this total score for the primary hypothesis test. Secondary hypothesis tests will be conducted on the dimension scores as well as the scores of the following measures.

The Short Form Health Survey, 12-item (SF-12; Jenkinson et al., 1997) is a primary outcome measure. It measures several aspects of health-related quality of life in a way that allows it to be translated to an estimate of the health economic impact of an intervention by calculating a person's quality adjusted life years (QuALY; Brazier et al., 2002; Walters & Brazier, 2005). We will analyze change in QuALY with the interventions.

The following measures reflect aspects of participant's resilience and constitute a secondary outcome domain:

The State/Trait Assessment of Resilience (STAR, Lock et al., 2020) measures a person's ability to bounce back from adverse life events. Participants rate how much they agree with 6 items about current perceptions and experiences in relation to life events (state resilience) and 7 items about more distal and enduring personality characteristics (trait resilience). We will analyze change in both state and trait resilience with the interventions.

The Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982) measures general aspects of cognitive functioning as evidenced by slips and lapses in daily life activities. It was presented by Broadbent et al. as an indicator of cognitive vulnerability to stress (also see Kaplan, 1995). It has 25 questions about how often in the last month a person made mistakes in the areas of perception, action, and memory. We will analyze change in the total score with the interventions.

The Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) measures aspects of mindfulness evidenced as a trait across diverse daily life activities. We will use a version (Lilja et al., 2011) with 29 items that can be summed into sub scores for the mindfulness facets of observing, describing, non-judgment, non-reactivity, and acting with awareness, as well as a total trait mindfulness score. We will analyze change in the sub scores as well as the total score with the interventions.

The Engaged Living Scale (ELS; Trompetter et al., 2013) measures how much a person aligns their behavior with their own values despite any constraints and challenges. Such alignment is considered a key target mechanism in mindfulness- and acceptance-based psychotherapies (Hayes et al., 2011). It has 10 items measuring valued living and 6 items measuring life fulfillment, and a total score that reflects general aspects of an engaged lifestyle. We will analyze change in the total score with the interventions.

The De Jong Gierveld Loneliness Scale (Gierveld & Tilburg., 2006) measures experiences of loneliness conceived as emotional isolation and lack of social participation. It has subscales for intimate and social aspects and yields a total score for overall of social well-being. Its short form has 6 questions that yield a total sum. We will analyze change in this total sum with the interventions.

The following measures reflect aspects of participant's relationship with nature and constitute a secondary outcome domain:

The Intentional Nature Exposure Scales (INES; Wood et al., 2019) measures the frequency of nature contacts and awareness of natural environmental elements in the settings of a person's daily life as well as in intentional nature visits. It has 5 items that yield a total score of nature exposure. We will analyze change in this total score with the interventions.

The Nature Connection Index, trait version (NCI-T, Richardson et al., 2019) measures a person's affective and experiential relationship to nature as related to five pathways to nature connectedness: emotion, beauty, contact, meaning and compassion. The trait version includes 6 questions about general patterns in a person's relationship with nature. The responses are scored based on a weighted point index. We will analyze change in this point index with the interventions.

The pro-environmental behavior scale from the People & Nature Survey (2023) measures pro-environmental behavior in three domains – household behaviors, shopping behaviors and public behaviors – thus spanning private as well as economic and societal aspects of a person's engagement for the environment. It has 4 items for each domain that can be summed for a domain-specific scores as well as a total score that reflects overall pro-

environmental behavior. We will analyze change in the domain scores as well as the total score with the interventions.

The Environmental Concerns Scale (ECS; Schultz et al., 2001) measures a person's level of concern for environmental threats in three domains: concern for their possible consequences for oneself (egoistic), for other people (altruistic) and for all living beings (biospheric). It has 4 questions about each domain. We will analyze change in the domain scores with the interventions.

Finally, the following set of questions collect information needed for health economic assessments:

Health care service use will be assessed with a bespoke set of 6 questions covering frequency of different health care visits, dose and frequency of any antidepressant or anxiolytic medication, number of sick days, and resources needed to access health care (e.g., for travel). We will analyze these responses as part of a health economic impact assessment for NbT:s more broadly, separately from the reporting of this study.

Measure set B: Intervention experiences and acceptability

Measure set B includes both online and paper-based measures to be used at various time points to monitor how participants experience and engage with the interventions.

The Intervention Group Environment Scale (I-GES; Wilson et al., 2008) measures social processes in group-based clinical and community health interventions. It builds on the often replicated observation that social processes constitute one key set of mechanisms behind the health-related outcomes of such interventions, and draws in part on a theoretical background that considers the group environment as a behavior setting (Barker, 1968). Its questions are formulated to be non-specific to the type of intervention, hence fitting psychotherapeutic, educational, supportive, skills-building, and other groups-based programs. The I-GES has 8 questions that form a subscale for group cohesiveness, 11 questions that form a subscale for implementation and planning, and 6 questions that form a subscale of counterproductive activity. The I-GES will be used directly after each of the weekly group meetings.

The Perceived Restorativeness Scale (PRS; Hartig, Kaiser, et al., 1997; Hartig, Korpela, et al., 1997) measures restorative qualities in the transactions between a person and their environment, as identified in the attention restoration theory (Kaplan & Kaplan, 1989; Kaplan, 1995). It has 5 items that measure the sense of being away from normal routines and demands, 5 that measure the presence of softly fascinating features and processes, and 6 that measure compatibility with own preferences and motivations. The total score and subscale scores are widely used to distinguish psychological qualities in indoor and urban outdoor vs natural outdoor environments and to predict how well they support restoration from stress and fatigue. The PRS will be used directly after each of the weekly group meetings. We will analyze the total and subscale scores for average levels in the interventions. Lymeus et al. (2019) also noted that PRS is sensitive to change over several

weeks with nature- and mindfulness-based interventions: We will analyze the total and subscale scores for change over the intervention weeks.

The State Mindfulness Scale (SMS; Tanay & Bernstein, 2013; also see Ruimi et al., 2022) measures momentary experiences of mindfulness in a specified situation, building on a conception of mindfulness as varying with changes in context and behavior. Its questions use relatively mundane wording which does not require an understanding of mindfulness concepts and which is not limited specifically to meditation-based experiences. The SMS has 15 questions that form a subscale for mindfulness of mental processes and 6 questions that form a subscale for body awareness, and their total sum reflects the general concept of state mindfulness. The SMS will be used directly after each of the weekly group meetings. We will analyze the total and subscale scores for average levels in the intervention settings. Studies have also affirmed that SMS is sensitive to change over several weeks with mindfulness-based interventions: We will analyze the total and subscale scores for change over the intervention weeks.

The Nature Connection Index, state version (NCI-S, Richardson et al., 2019) measures a person's affective and experiential relationship to nature as related to five pathways to nature connectedness: emotion, beauty, contact, meaning and compassion. The state version includes 6 questions about general patterns in a person's relationship with nature. The responses are scored based on a weighted point index. The NCI-S will be used directly after each of the weekly group meetings. We will analyze the total scores for average levels in the intervention settings. Studies have also affirmed that nature connectedness may change with increased nature contact as well as with mindfulness-based training that does not involve nature contact (Lengieza & Swim, 2021): We will analyze the total scores for change over the intervention weeks.

The Theoretical Framework of Acceptability and its associated questionnaire (TFA; Sekhon et al., 2017) measures the acceptability of health interventions. It construes acceptability as comprised of seven domains: affective attitude, burden, perceived effectiveness, ethicality, intervention coherence, opportunity costs, and self-efficacy. Intervention participant's perceptions in these domains presumably determine how interesting, suitable and manageable an intervention is to them, and therefore also the likelihood and level at which they engage with the intervention. It has 1 item per domain and their sum represents the overall acceptability. The TFA questionnaire will be used prospectively before the start of the interventions to assess participant's initial attitudes and expectations, two weeks into the interventions to assess their concurrent perceptions of acceptability, and after the interventions to assess their retrospective experience of attending.

Homework registration forms similar as those used by Lymeus et al. (2019) and Tóth (2022) will be used to measure the frequency and duration of intervention-specific activities in the days between the group meetings. Participants will indicate on a paper form each time that they completed activities in line with the instructions provided as part of each intervention – that is, nature visits and/or meditation practice sessions – and for how long they were active. These data will be used together with group meeting attendance (recorded by the researchers) to estimate participant's compliance with and received dose of the

interventions. The homework registrations will also include three visual analogue scales where participants will indicate aspects of their experience during the homework activity, specifically the degree to which they found the activity to be relaxing (vs effortful), interesting (vs boring) and pleasant (vs unpleasant).

Transportation to group meetings will be assessed with two questions about which mode(s) of transportation participants used and how far they travelled from their previous location/activity to the location of the group meeting. These data will be used as part of health economic evaluations of the interventions.

Measure Set C: Fatigue induction and restoration

Measure Set C includes measures related to the fatigue induction and restoration procedures that only a subset of 100 volunteer participants will complete. We describe the Time Load Dual Back task among these measures because it is not only a fatigue induction procedure but also a source of data.

The Time Load Dual Back task (TloadDback; Borragán et al., 2016; 2017) will be used as a fatigue induction task. It builds on the time-based resource-sharing model of mental effort (Barrouillet et al., 2004) which suggests effort is a function of the amount of work required divided by the time allowed to do it. Under that assumption, task demands can be increased by reducing the processing time allowed, even when the task complexity remains stable. TloadDback is a variation on the N-back paradigm that also imposes an interfering task to maximize the recruitment and depletion of working memory resources. The task is administered on a computer where participants are to quickly press the spacebar whenever two or more of the same letters are presented in direct sequence on the screen. However, in between every stimulus in the letter sequence, a digit is presented, which constitutes the interfering task. Participants are to quickly press either of two keys to indicate whether the digit is odd or even. A response accuracy score of 0-100 is calculated per block with weighting of .65 for letter and .35 for digit accuracy. The task demands are tailored to a participant's individual performance capacity in an initial training and calibration where the stimulus presentation duration is gradually decreased in 100ms increments. The last stimulus duration at which the participant could initially perform with a response accuracy score of at least 85 is then used for the fatigue induction. The individually set high intensity of the task has been observed to produce psychophysiological stress symptoms including reduced heart rate variability, as well as subjective fatigue within the relatively short time span of the 16 minute standard administration time, and also serves to avert possible confounds such as boredom or sleepiness (O'Keeffe et al., 2020). Change over time in the response accuracy score can also be analyzed as an indication of the progression of cognitive fatigue (Borragán et al., 2017). We will analyze change in response accuracy scores over time-on-task as well as the following subjective and psychophysiological measures.

The Stress Appraisal Measure (SAM; Peacock & Wong, 1990) measures threat and coping appraisals in relation to a specific challenge, building on the cognitive transactional model of stress (Lazarus & Folkman, 1984). Feldman et al. (2004) created a brief version where 3 items assess the degree to which a given task is perceived as threatening and 4 items assess

the degree to which a participant appraises the task as manageable. In this case, the SAM will be used after the training and calibration phase of the TloadDback, specifying the upcoming 16 minute performance phase as the challenge in question. The score used for analysis will be the mean of all item responses.

Heart rate will be will be monitored with the Bittium FarosTM 180 (Bittium, n.d.) which is a medical and research grade electro-cardiogram (ECG) product suited for field studies (Jarczok et al., 2021; Lumikari et al., 2019; Malagù et al., 2021; Roddick & Chen, 2021). It has been described as a "gold standard" and a benchmark in mobile heart rate monitoring (Bent et al., 2020; Hinde et al., 2021). The small device (weight: 18 grams, size: 48×29×12 mm) can be mounted with a glued patch on the chest that participants can apply themselves. Hence, it does not require participants to be physically examined or handled by a researcher. In this study, participants will receive instructions for how to apply the glued patch and monitor themselves, behind a screen wall or in a separate room, before a researcher checks the output of the device to confirm correct application. [PENDING APPROVAL OF ETHICAL REVIEW AMENDMENT 2024-04984-02, ABOVE TEXT MARKED IN YELLOW WILL BE REPLACED WITH: "…the Polar Verity Sense (Polar Global, n.d.) which is a photoplethysmographic armband suited for field studies (Laborde et al., 2017; Merrigan et al., 2023; Navalta et al., 2023). It offers several advantages to electro-cardiogram products that require mounting directly on the chest, including superior ease of application when participants can put the sensor on their arm with a simple elastic strap without any major integrity threats, while providing sufficiently valid and reliable data. The current state of the technology and data processing software is able to accommodate ambulatory assessment."] In this case, the monitor will be worn through an initial 5 minute baseline, the TloadDback fatigue induction, and the subsequent restoration phase. We will analyze differences in change over time across the fatigue induction and restoration phases between the pre-intervention and post-intervention procedures, specifically for high frequency heart rate variability (HF-HRV: 0.15–0.4 Hz) which reflects momentary self-regulatory effort as an inverse index of parasympathetic (vs sympathetic) dominance (Holzman & Bridgett, 2017; Laborde et al., 2017; Thayer et al., 2012). We will also analyze differences between the pre- and post-intervention restoration phases in low-frequency heart rate variability (LF-HRV: 0.04–0.15 Hz) which reflects chronic allostatic load and long-term risk of stress-related disease (Laborde et al., 2017; McCrory et al., 2023).

Task-induced subjective fatigue will be measured with the Swedish Occupational Fatigue Inventory (SOFI; Åhsberg, 2000; also see Johansson et al., 2008) together with the Need for Attention Restoration Scale (NARS; Hartig & Staats, 2006; Staats et al., 2003). SOFI measures lack of energy, physical exertion, physical discomfort, lack of motivation and sleepiness with 4 items per subscale. Lack of energy is considered to be a more general representation of fatigue while the other dimensions are thought to more specifically reflect the effects of specific types of challenges. NARS includes 4 items, with the same format as SOFI, that measure attentional fatigue. Hence, using SOFI and NARS together allows for separation of the relevant aspects of fatigue. In this case, ratings will be obtained directly after the fatigue induction and again directly after the restoration phase. We will analyze change in the

subscale scores for lack of energy and attentional fatigue. The remaining subscales will be used for descriptive purposes.

Together with the last assessment with SOFI and NARS, the PRS, SMS and NCI-S (described under Measure Set B) will be used directly after the restoration phase. We will analyze their subscale and total scores.

Miscellaneous measures

Weekly health updates will be obtained with a single item on the homework registration form, where participants will be asked how they have been feeling during the week compared to the preceding week, response options including ”much worse”, ”a bit worse”, ”about the same”, ”a bit better” and ”much better”. This question serves to monitor for sudden deterioration during the intervention, in which case a participant may require a follow-up phone call from the researchers and possibly referral to healthcare services. Participants who do not show up for a group meeting will be contacted by their instructor who in case of any concerns will notify the researchers.

Retrospective reports on continued practice after the intervention will be obtained with the one-month and six-month follow-up surveys. These will use a similar format as previously used by Lymeus et al. (2022) and ask about how often participants have done different intervention specific activities (i.e., nature visits and/or meditation practice) in the time since the intervention ended.

Change in other treatments will be assessed with the assessments directly after the interventions as well as with the one-month and six-month follow-ups. These questions will ask if participants initiated any form of psychological or medical treatment or changed the dose or form of any ongoing such treatment.

A voluntary donation task will be used when participants receive their reimbursement. This is a common procedure aimed to observe pro-environmental behavior, as an alternative or supplement to the more indirect self-report approach (Lange, 2023), through how participants prioritize between different uses of the monetary value that they have earned. Upon completing the last part of the required study procedures, participants will see a confirmation that they are eligible to receive the €50 reimbursement and be asked if they want to donate some of that value to charity before taking out the remaining sum for their own use. The charities they can choose include those working for pro-environmental causes (e.g., the World Wildlife Fund, Greenpeace), where a donation choice reflects biospheric concerns, and those working for humanitarian causes (e.g., Red Cross/Crescent, Amnesty International), where a donation choice reflects altruistic concerns. The remaining sum will be put on the gift certificate for their own use at a wide range of stores and service providers; that is, in satisfaction of their egoistic concerns. These categories of concern correspond to the categories underlying the Environmental Concerns Scale (Schultz et al., 2001). We will analyze the donated sums of biospheric and altruistic donations as well as the binary occurrence of donations regardless of the sum, the latter of which may be less sensitive to floor effects due to relative financial strain in the student population.

Semi-structured interviews with a subset of ca 34 volunteer participants – 12 from each active treatment arm – will build on questions proposed by RESONATE work packages and developed in collaboration between the work package representatives and the CS7 research group. The questions focus on eliciting the participant's thoughts about their motivations to participate in an intervention, their experiences of participation, and their perceptions of how the interventions impact them.

ATTRITION

Attrition will be considered in several categories depending on the timing of participant's termination in relation to the recruitment, intervention, and follow-up procedures. Missing data will be handled with imputation methods in order to include all participants who were assigned to an intervention condition in intention-to-treat analyses. For assessments that were conducted with a planned missing data approach (i.e., some questionnaires in Measure set B), we will use Expectation Maximization methods that are suited to data missing completely at random and do not complicate subsequent inferential analyses. Non-random missing data will be handled with Multiple Imputation methods that provide a range of estimates based on all relevant parameters, including baseline characteristics and drop-out status.

Participants who make an initial expression of interest will be directed to the screening survey. Those who fail to complete the screening survey, who complete the screening survey but do not proceed to complete the enrollment interview, and who decline further participation in connection with the enrollment interview, will be asked to volunteer the main reasons for why they were initially interested in the study and for why their interest ceased.

Those who provide informed consent in connection with the enrollment interview, and therefore were assigned to an intervention condition, but then fail to attend any intervention activities will be considered non-starters. These participants will be asked to volunteer the main reasons for why they did not follow-through with their intention to participate. Because they were assigned to an intervention condition, they will also be asked to complete all the relevant assessments (Measure set A) before and directly after the intervention period and in the 1-month and 6-month follow-ups, in order to include their data in the intention-to-treat analyses. However, only those who complete the assessments before the intervention period will be pursued to collect data also in the subsequent assessment time points. The monetary value compensation connected to completion of all planned assessments will help motivate collection of data from, and inclusion in analyses of, this group.

Participants who attend some of the intervention activities and then fail to attend subsequent intervention activities will be considered drop-outs from the interventions. Those who spontaneously state an intention to withdraw from the intervention will be marked as drop-outs at that time point. Those who fail to show up for a group meeting without spontaneously providing any explanation will be contacted by the researchers and asked if they intend to continue with the intervention. If not, they will be marked as drop-outs at that time point. These participants will be asked to volunteer their main reasons for dropping out of the interventions, and asked to complete all the relevant assessments (Measure set A) directly after the intervention period and in the 1-month and 6-month follow-ups. Again, the monetary value compensation will help motivate this in order to include them in intention-to-treat analyses. Participants who fail to attend group meetings but cannot be reached to verify their possible intention to drop out will be marked as drop-

outs when have missed two sequential group meetings and not attended any subsequent group meetings. Hence, a participant who fails to attend the final two group meetings will be retrospectively marked as a drop-out at the time point of the last contact with the researchers or instructors, while one who fails to attend two sequential group meetings in the middle of the intervention period (i.e., group meeting 2 and 3, or group meeting 3 and 4) but then attend again towards the end of the intervention period will not be considered a drop-out.

ANALYSES

Main study design

Our main analyses will be performed with an intention-to-treat approach, thus all the participants who were assigned to an intervention condition will be included in order to estimate intervention effects that are weighted for intervention condition differences in drop-out patterns. The main between-subjects factors in these analyses will be the respective intervention components (Nature and Mindfulness, respectively), which together constitute the factorial study design; this is a more efficient analytic approach than the alternative to contrast the four interventions (ReST, Green prescription, conventional mindfulness training, waitlist control) and allows conclusion not only about intervention differences but about interaction between intervention components (Collins et al., 2014; Whelan et al., 2012). To protect against biased testing and reporting, the analyses will be conducted with blinded dummy codes for the respective factors so that the person responsible for analyses is unaware of how the results relate to the respective interventions. To protect against chance findings due to multiple statistical tests on the several measures included in Measure set A, we will initiate each round of analyses with a multivariate ANOVA on the difference scores (deltas) from the assessment before the intervention to the respective target time point (i.e., directly after intervention, 1-month follow-up, 6-month follow-up). Separate multivariate ANOVA:s will be performed for each of the targeted outcome domains: health status (primary outcome), resilience, and relationship with nature. Where the multivariate ANOVA indicates the presence of an effect, we will proceed with specific hypothesis tests as follows.

The main hypothesis tests will use mixed design ANCOVA's with dependent variables being the delta scores and including the pre-intervention score as covariate (per recommendations by Vickers & Altman, 2001; also see Clifton & Clifton, 2019). Differences between the interventions in average levels of change over time will be confirmed through a statistically significant ($p < .05$) and non-negligible (partial eta squared $\geq .01$) effect of the respective intervention components (Nature and Mindfulness, respectively) or their interaction term. If the pre-intervention score (covariate) in these analyses shows signs of interaction with the Nature or Mindfulness factors, we will follow up with secondary analyses that omit the pre-intervention score continuous variable but include a third between-subjects factor: the symptom severity classification variable that was used to stratify the sample across the interventions. This is in order to identify any interactions between symptom severity and the intervention components on the outcomes; for instance whether the nature-based interventions are more effective for participants with more marked initial symptoms.

Proportions of participants who improved and deteriorated with the interventions, in terms of their health, will be examined and compared between the four intervention conditions. Significant change cutoffs will be based on existing guidelines for the respective outcome measures, DASS (Ronk et al., 2013) and SF-12 (Fan et al., 2004). The proportions of improved (vs unchanged and deteriorated) and deteriorated (vs unchanged and improved) participants as assessed on the respective occasions: directly, 1 month and 6 months after the intervention period. Chi-Square tests (4 [trial arms] x 2 [yes/no significant change]) will be

used, with 2 x 2 follow-ups when needed to confirm suggested group differences. In the case of proportions deteriorated (vs unchanged or improved), however, statistical significance is not a suitable decision criterion because a lack of statistical significance could hypothetically be due to low power or measurement issues in the study. Hence, an additional test of the safety of the active interventions is that they should have a negligible disadvantage, in terms of the deteriorated proportion, compared to the waitlist control group, where a negligible disadvantage is defined as less than a small effect by the most used standard (i.e., phi < .10).

Processes of change will first be analyzed with mixed (repeated measures) ANOVA:s to describe and compare the average levels as well as the trends of development over the intervention weeks in the respective process measures. These analyses will include Nature and Mindfulness as between-subjects factors. Perceived restorativeness, state mindfulness and state nature connectedness will be measured every intervention week so will be included in the analyses with five levels of the within-subjects factor Week. Homework completion will be measured on four weeks (2, 3, 4 and 5; each reflecting the preceding week) and have four levels of that factor. Intervention group cohesion will only be measured on the second and fifth intervention weeks and so will have two levels of the Week factor. These analyses will also contribute to decisions that need to be made in preparation for the subsequent conditional process analyses; specifically which measures should be represented in the conditional process analyses as an average across the weeks, or as a linear trend of development with or without control for the intercept (see Lymeus et al., 2019).

We will examine how the proposed process variables contribute to the mental health outcomes of the interventions through conditional process analysis using the PROCESS macro for SPSS (Hayes, 2017). These analyses will test how participant's experiences and engagement in the interventions contribute to explain health improvements (see Figure 1a and 1b). For these analyses, average scores or regression coefficients reflecting a trend – to be determined based on emerging understanding of the data patterns – will be used for each process measure. We will use the delta of mental health ratings from before to after the intervention for the outcome. To complement these novel conceptual tests, we will also seek to replicate the conditional process results that were previously reported by Lymeus et al. (2019) and Lymeus (2022).

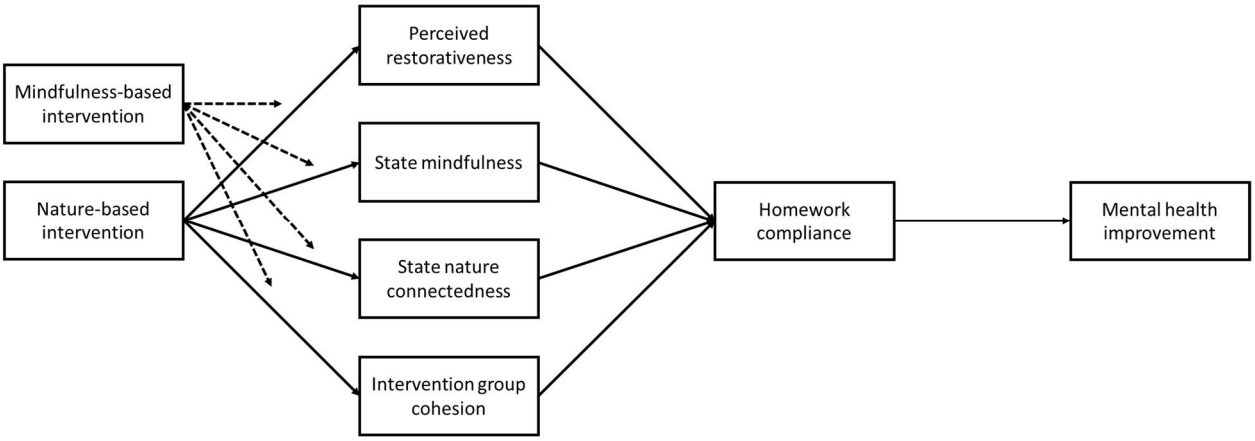

Figure 1a. Conceptual sketch showing a moderated parallel and serial mediation model to be tested, aiming to compare the unique influence of several proposed processes in nature- and mindfulness-based health interventions.

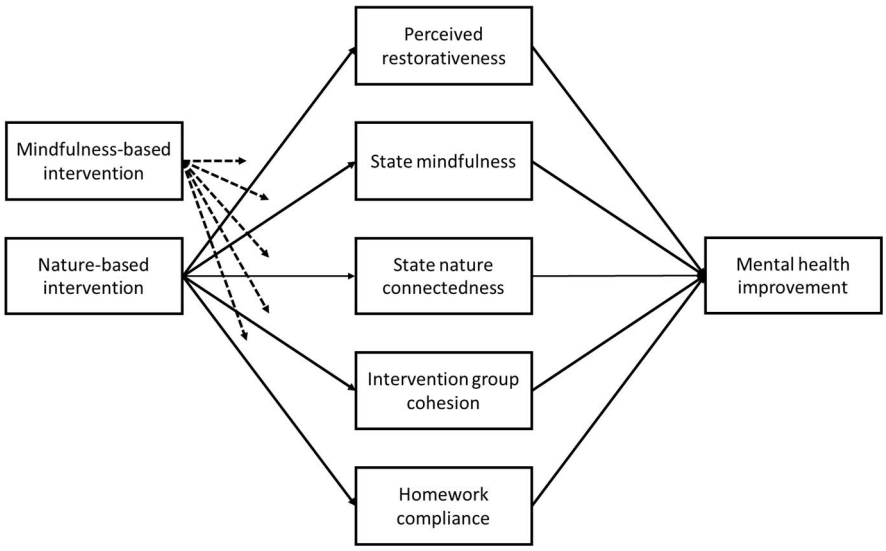

Figure 1b. Alternate conceptual sketch showing a moderated parallel mediation model to be tested, aiming to compare the unique influence of several proposed processes in nature- and mindfulness-based health interventions.

Fatigue induction and restoration

Analyses of the data from the fatigue induction and restoration procedures before and after the interventions include continuous heart-rate data. The high frequency heart rate variability (HF-HRV) in the inter-beat intervals will be isolated through well-validated semi-automated pre-processing techniques facilitated by the Kubios software (Kubios, n.d.; Tarvainen et al., 2014). The HF-HRV time series will be averaged over equal 1 – 5-minute epochs, depending on what temporal resolution the researchers deem most appropriate to describe the emerging data trends, to accommodate analysis with a mixed (repeated-measures) ANOVA. The analysis will include the two intervention components (i.e., Nature and Mindfulness) as a between-subjects factor and the series of epochs as one within-subjects factor nested within the within-subjects factor Occasion (before vs after intervention). Emerging effects will be further explored and confirmed with post-hoc univariate ANOVA:s as needed.

The HRV trends during the restoration phase will be converted to a single variable (e.g., either a linear regression coefficient or the area under the curve, depending on the complexity of the data) in order to be used as an outcome variable in a linear regression where participant's ratings of experiences of perceived restorativeness, state mindfulness and state nature connectedness will be used as predictors. This will allow conclusions about how strongly the different proposed processes contribute to explaining the efficiency of physiological recovery.

We will then use mixed (repeated measures) ANOVA:s to analyze change in participant's ratings in relation to the fatigue induction and restoration phases. These analyses will again include the two intervention components (i.e., Nature and Mindfulness) as between-subjects factors. Stress appraisals in relation to the fatigue induction; and experiences of perceived restorativeness, state mindfulness and nature connectedness during the restoration phase will be analyzed with two levels of the within-subjects factor Occasion (before and after intervention). Because ratings of subjective fatigue will be obtained twice on each occasion – in relation to the fatigue induction and restoration phases – the two-level within-subjects factor Time will be nested within the two-level within-subjects factor Occasion for those analyses. Emerging effects will be further explored and confirmed with post-hoc univariate ANOVA:s as needed.

Semi-structured interviews

Qualitative data will be collected via the semi-structured interviews. The recorded interviews will be pseudonymized with the participant's unique ID code, transcribed, and then translated into English. Deductive and inductive qualitative content analysis will be performed by other members of the RESONATE consortium according to principles described in the respective protocols. In short, the analyses will investigate themes based on hypotheses founded in the nature-based biopsychosocial resilience theory (NBRT, White et al., 2023) with the aim to understand the intervention feasibility and acceptability. Triangulation will be used where quantitative and qualitative results are analyzed separately and brought together to identify convergent, complementary, and divergent results.

DATA MANAGEMENT

Sensitive and non-sensitive personal information that participants provide about themselves will be entered into a data file managed by the responsible researchers and stored on Uppsala University servers according to applicable regulations and institutional guidelines. Only the information that participants provide voluntarily will be used in the study, and it will be handled in accordance with the General Data Protection Regulation (GDPR). No unauthorized person will have access to data.

Identifying information (name, contact information) will be collected and stored together with a personal code in a document that is only accessible to the responsible researchers at Uppsala University. The completed questionnaires and interview transcripts will be marked only with participant's personal code, not with any directly identifiable information. The responses are then stored in a separate location for analysis together with other participants' information. The personal information in these data materials can only be linked to any identifying information via the personal code that is only available to the responsible researchers at Uppsala University.

To ensure the fulfillment of the RESONATE's overarching purposes, Uppsala University and RESONATE's partners are joint controllers of the data in accordance with the Joint Control Agreement and applicable international and national laws and standards. Selected pseudonymized data, which are needed to perform specific analyses aligned with the tasks of the respective RESONATE work packages, will be shared with RESONATE's project partners through the RedCap platform. This is governed by the Data Sharing Agreement that ensures that the information will be handled in accordance with GDPR and under the terms of approval from all relevant ethical review bodies. When participant's personal information is shared with RESONATE's partners, it will only be marked with their personal code, not with any directly identifying information.

Following the completion of the RESONATE project and subsequent complete anonymization of the CS7 data through destruction of the code list, the data will be made available to the wider research community in a findable, accessible, interoperable, and reusable (FAIR) way through the Open Science Framework data repository (https://osf.io/). The EU also hosts a specific data repository for nature-based solutions, OPPLA (https://oppla.eu/), where we will share links to our datasets and publications to ensure their availability also to relevant stakeholders and practitioners in the field.

DISSEMINATION

CS7 involves dissemination efforts on multiple levels:

The relatively many research participants will gain familiarity with the respective nature-based and mindfulness-based interventions and the practices that they promote. The active interventions all involve techniques to promote establishment of continued habits based on the intervention activities and the 6-month follow-up assessments partly serve to assess the intervention's levels of success in this regard. Targeting young academics, many of whom we expect to go on to gain some professional and cultural influence in the future, the interventions may not only affect them individually but also play a small part in a larger trend towards more resilient future communities and societies as set out in the NBRT.

The health professionals and future health professionals who join the study as intervention instructors and assistant instructors will gain experiences and skills that may contribute to shaping their continued work-related interests and activities after the project. The at least 15 people who we expect to employ to lead intervention groups at some time point and location of the completion of the study will bring specific skills to the project but also share knowledge and gain new insights – not least the at least 5 ReST instructors who will be trained in delivering the intervention as part of their employment will be able to work independently with ReST after the project and therefore begin to spread the ReST approach in health promoting and therapeutic practice. Furthermore, advanced students in the psychology and medicine programs – i.e., soon to be clinical psychologists and medical doctors – will be involved as assistant instructors in the delivery of interventions. At their level of study, they will already have some experience in clinical work under supervision, but their participation in the interventions and collaboration with the main instructors will likely constitute a major step in their professional development and potentially help shape their interests and future career choices towards working with nature-based and mindfulness-based methods.

Toward the end of the project, CS7 will involve efforts to inform the wider communities of relevant professionals about the interventions and results of the study as well as NbT:s more generally. Targeted seminars and lectures will be hosted by the research group and opportunities to be invited to speak and conduct workshops in interested clinics and professional associations will be pursued. Contacts established in the course of conducting the study will be drawn upon in these pursuits, along with targeted outreach activities. Our experience in similar previous efforts suggest that quite many psychological, medical and other relevant professionals are aware of and interested in NbT:s but that very few have any specific understanding of the principles by which such interventions work and of the outcomes that they can achieve; we therefore believe that these dissemination activities that focus on specific interventions and provide robust results regarding their processes and effects will have the potential to be popular and influential.

Collaboration between the RESONATE consortium members is expected to promote mutual learning experiences as we engage in exchange around the several nature-based health solutions, nature-based, and integrated nature- and mindfulness-based interventions. This

consortium includes prominent professionals and researchers in the NbT and nature-and-health fields, many of whom we have not had any previous direct exchange with, so the extensive collaboration in co-creative, analytic and communication activities that are underway or planned can be expected to build a significantly stronger global platform of knowledge and interaction around NbT:s. Additional planned exchange with the other consortia funded under the same call as RESONATE may further broaden a global platform.

The wider research community will be targeted with peer reviewed publications, conference presentations, etc. Pending several detail decisions, we plan for CS7 to yield at least three articles published in moderate to high impact journals in addition to our contributions of data and expertise to other parts of the RESONATE consortium:

- One paper will cover the main study design with a focus on the health, resilience and nature-oriented outcomes of participation in the respective interventions. Given that we have quite a large material to cover here, it may be feasible and necessary to publish a separate paper targeting the six-month follow-up.
- A second paper will cover the conditional process analyses investigating moderating and mediating mechanisms behind the intervention outcomes. This paper could potentially include analyses of drop-out and homework compliance patterns in the interventions; alternatively, those results could be included in a separate paper.
- A third paper will cover the fatigue induction and restoration procedures before and after the interventions.
- Selected data from CS7, including the semi-structured interviews, health economic aspects, environmental impacts, etc, will be included in papers led by the respective work packages and contributed to by CS7 research group members.
- CS7 research group members will collaborate with the other RESONATE case studies and work packages as desired and needed, which is expected to result in contributions to several additional papers.

ETHICAL CONSIDERATIONS

The study follows the Declaration of Helsinki and its addendums, and received ethical approval from the Swedish Ethical Review Authority in 2021 (dnr 2021-06675-01). That original ethical application was formulated based on a preliminary study protocol that involved the same major elements as the current version, in addition to some elements that either were completed as pilot studies in preparation for CS7 or that that await completion independent of CS7. The initial plan for what later became RESONATE CS7 was included in that ethical application as "Study 4". One later amendment reflecting developments of the plan was approved in March 2024 (2024-01087-02) before the relevant study components were initiated. The developments concerned the planned number of research participants; the value and form of the reimbursement to research participants including aspects of the design of the voluntary donation task; data sharing within the RESONATE consortium; revisions of the measurement sets; and resulting revisions of the written information to research participants that is part of obtaining their informed consent. A second amendment (2024-04984-02) was submitted in July 2024 in preparation for initiation of the relevant study components in the fall of 2024. The developments concern switching to a less invasive heart rate monitor and a more streamlined self-report battery for the fatigue induction and restoration procedures; specification of a new question set for the semi-structured interviews; resulting revisions of the information to research participants; and new recruitment materials. All of the proposed developments are aligned with common research standards and practices and none are expected to introduce any added burden or risk that could shift the balance of advantages and disadvantages of the study; hence, we expect no difficulty in securing the approval by the Ethical Review Authority within ca 1 month from the submission.

The interventions and the research procedures of CS7 were developed with the good of the research participants first in mind. All three active interventions are bona fide health interventions thought capable of benefiting the target group, and participation builds on the intrinsic motivation of the eligible volunteers to take part in such interventions. A large majority of the process and outcome measures reflect positive constructs, such as resilience and nature habits, with the anticipation that the interventions can promote such aspects of health and sustainability. Where measures target negative constructs, such as mental health symptoms, they do so from a viewpoint of care for the participant's wellbeing which is shared by the researchers and intervention instructors. The instructors are professionally trained individuals with appropriate qualifications, again with the safety and benefit of the participants in mind. Where research procedures can be demanding, specifically in the fatigue induction, we follow with a restoration phase that is expected to support participant's recovery from the task. For the time demand of the several assessment procedures – though notably not for the time spent completing intervention activities during group meetings or homework, which we explicitly expect participants to engage with out of intrinsic motivation – we offer the participants fair reimbursement in the form of gift certificates that they can choose to use for their own benefit or to donate to a humanitarian or environmental non-profit organization depending on their personal needs and values.

The study will collect sensitive personal data, notably about aspects of participant's health including their mental health symptoms and heart rate. Some of the questions about nature-related values and attitudes could also be viewed as sensitive as the responses may to some extent reflect participant's spiritual or political viewpoints. Using these measures in psychological studies is, however, not uncommon or controversial. The data will be handled in line with the applicable laws and standards, with the study's ethical approvals, with Uppsala University's guidelines and routines, with RESONATE:s Data Sharing Agreement and Joint Control Agreement, and with the informed consent of the individual participants. No unauthorized persons will have access to the personal data. When data is shared with RESONATE partners through a well-recognized and suitable technical platform (RedCap), it will be shared following complete anonymization and necessary curation. When data is shared in well-recognized open repositories, it will be shared following complete anonymization and necessary curation. Any possible needs for selection and curation of data before sharing will be discussed within the research group and with the RESONATE steering committee.

REFERENCES

Åhsberg, E. (2000). Dimensions of fatigue in different working populations. Scandinavian Journal of Psychology, 41(3), 231–241.

Alfonsson, S., Wallin, E., & Maathz, P. (2017). Factor structure and validity of the Depression, Anxiety and Stress Scale-21 in Swedish translation. *Journal of Psychiatric and Mental Health Nursing, 24*(2–3), 154–162.

American Psychiatric Association. (2013). DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure, Adult. https://www.psychiatry.org/psychiatrists/practice/dsm/educational-resources/assessment-measures

Aspy, D. J., & Proeve, M. (2017). Mindfulness and loving-kindness meditation: Effects on connectedness to humanity and to the natural world. *Psychological Reports, 120*(1), 102–117.

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27–45.

Baer, R., Crane, C., Miller, E., & Kuyken, W. (2019). Doing no harm in mindfulness-based programs: Conceptual issues and empirical findings. *Clinical Psychology Review, 71*, 101–114.

Banerjee, M., Cavanagh, K., & Strauss, C. (2018). Barriers to mindfulness: A path analytic model exploring the role of rumination and worry in predicting psychological and physical engagement in an online mindfulness-based intervention. *Mindfulness, 9*(3), 980–992.

Barash, D. P. (1986). *The Hare and the Tortoise: Culture, Biology and Human Nature*. Penguin Press.

Barbaro, N., & Pickett, S. M. (2016). Mindfully green: Examining the effect of connectedness to nature on the relationship between mindfulness and engagement in pro-environmental behavior. *Personality and Individual Differences, 93*, 137–142.

Barker, R. G. (1968). *Ecological psychology*. Stanford University Press.

Barrouillet, P., Bernardin, S., & Camos, V. (2004). Time constraints and resource sharing in adults' working memory spans. *Journal of Experimental Psychology: General, 133*(1), 83.

Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental science & technology, 44*(10), 3947-3955.

Baumeister, R. F., Muraven, M., & Tice, D. M. (2000). Ego depletion: A resource model of volition, self-regulation, and controlled processing. *Social Cognition, 18*(2), 130–150.

Bent, B., Goldstein, B. A., Kibbe, W. A., & Dunn, J. P. (2020). Investigating sources of inaccuracy in wearable optical heart rate sensors. *Npj Digital Medicine, 3*(1), 18.

Berkovich-Ohana, A., Glicksohn, J., Ben-Soussan, T. D., & Goldstein, A. (2017). Creativity is enhanced by long-term mindfulness training and is negatively correlated with trait default-mode-related low-gamma inter-hemispheric connectivity. *Mindfulness, 8*(3), 717–727.

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V [Z. V.], Abbey, S., Michale, A., & Velting, D. and Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice, 11*(3), 230–241.

Bittium. (n.d.). Retrieved December 3, 2021, from https://www.bittium.com/medical/https:/www.bittium.com/medical/bittium-faros

Borragán, G., Slama, H., Destrebecqz, A., & Peigneux, P. (2016). Cognitive fatigue facilitates procedural sequence learning. *Frontiers in Human Neuroscience, 10*, 86.

Borragán, G., Slama, H., Bartolomei, M., & Peigneux, P. (2017). Cognitive fatigue: A time-based resource-sharing account. *Cortex, 89*, 71-84.

Brakemeier, E. L., & Herpertz, S. C. (2019). Innovative psychotherapieforschung: auf dem weg zu einer evidenz-und prozessbasierten individualisierten und modularen psychotherapie. *Der Nervenarzt, 90*(11).

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., Vries, S. de, Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Kuo, M., Lawler, J. J., Levin, P. S., Lindahl, T., Meyer- Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., … Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances, 5*(7), eaax0903.

Bravo, A. J., Villarosa-Hurlocker, M. C., & Pearson, M. R. (2018). College student mental health: An evaluation of the DSM–5 self-rated Level 1 cross-cutting symptom measure. *Psychological Assessment, 30*(10), 1382.

Brazier, J., Roberts, J., & Deverill, M. (2002). The estimation of a preference-based measure of health from the SF-36. *Journal of Health Economics, 21*(2), 271–292.

Britton, W. B., Davis, J. H., Loucks, E. B., Peterson, B., Cullen, B. H., Reuter, L., Rando, A., Rahrig, H., Lipsky, J., & Lindahl, J. R. (2018). Dismantling Mindfulness-Based Cognitive Therapy: Creation and validation of 8-week focused attention and open monitoring interventions within a 3-armed randomized controlled trial. *Behaviour Research and Therapy, 101*, 92–107.

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology, 21*(1), 1–16.

Brügger, A., Kaiser, F. G., & Roczen, N. (2011). One for all? Connectedness to nature, inclusion of nature, environmental identity, and implicit association with nature. *European Psychologist, 16*(4), 324–333.

Burger, T., Potgieter, J. C., & Nell, W. (2024). Methods and environmental conditions typical of nature-based mindfulness practice: A scoping review. *Mindfulness*, details forthcoming.

Carmody, J., & Baer, R. A. (2009). How long does a mindfulness-based stress reduction program need to be? A review of class contact hours and effect sizes for psychological distress. *Journal of Clinical Psychology, 65*(6), 627–638.

Carver, C. S., & Scheier, M. (2012). *Perspectives on personality (7th ed.)*. Pearson.

Chiesa, A., Calati, R., & Serretti, A. (2011). Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings. *Clinical Psychology Review, 31*(3), 449–464.

Clifton, L., & Clifton, D. A. (2019). The correlation between baseline score and post-intervention score, and its implications for statistical analysis. *Trials, 20*(1), 43.

Cohen, S. (1980). Aftereffects of stress on human performance and social behavior: A review of research and theory. *Psychological Bulletin, 88*(1), 82.

Cohen, S., & Herbert, T. B. (1996). Health psychology: Psychological factors and physical disease from the perspective of human psychoneuroimmunology. *Annual review of psychology*, *47*(1), 113-142.

Collins, L. M., Dziak, J. J., Kugler, K. C., & Trail, J. B. (2014). Factorial experiments: efficient tools for evaluation of intervention components. *American journal of preventive medicine, 47*(4), 498-504.

Corazon, S. S., Stigsdotter, U. K., Jensen, A. G. C., & Nilsson, K. (2010). Development of the nature-based therapy concept for patients with stress-related illness at the Danish healing forest garden Nacadia. *Journal of Therapeutic Horticulture, 20*, 33-51.

Coventry, P. A., Brown, J. E., Pervin, J., Brabyn, S., Pateman, R., Breedvelt, J., ... & White, P. L. (2021). Nature-based outdoor activities for mental and physical health: Systematic review and meta-analysis. *SSM-population health, 16*, 100934.

Cox, D. T. C., Shanahan, D. F., Hudson, H. L., Fuller, R. A., Anderson, K., Hancock, S., & Gaston, K. J. (2017). Doses of nearby nature simultaneously associated with multiple health benefits. *International Journal of Environmental Research and Public Health, 14*(2), 172.
Crane, R. S., Brewer, J., Feldman, C., Kabat-Zinn, J., Santorelli, S., Williams, J. M. G., & Kuyken, W. (2017). What defines mindfulness-based programs? The warp and the weft. *Psychological Medicine, 47*(6), 990–999.
Crane, C., & Williams, J. M. G [J. Mark G.] (2010). Factors associated with attrition from mindfulness-based cognitive therapy in patients with a history of suicidal depression. *Mindfulness, 1*(1), 10–20.
Creswell, J. D. (2017). Mindfulness Interventions. *Annual Review of Psychology, 68*, 491–516.
Dunn, R., Callahan, J. L., Swift, J. K., & Ivanovic, M. (2013). Effects of pre-session centering for therapists on session presence and effectiveness. Psychotherapy Research, 23(1), 78–85.
Dye, C. (2008). Health and urban living. *Science, 319*(5864), 766–769.
Fan, V. S., Au, D. H., McDonell, M. B., & Fihn, S. D. (2004). Intraindividual change in SF-36 in ambulatory clinic primary care patients predicted mortality and hospitalizations. *Journal of Clinical Epidemiology, 57*(3), 277–283.
Feldman, P. J., Cohen, S., Hamrick, N., & Lepore, S. J. (2004). Psychological stress, appraisal, emotion and cardiovascular response in a public speaking task. *Psychology & Health, 19*(3), 353–368.
Fox, K. C. R., Dixon, M. L., Nijeboer, S., Girn, M., Floman, J. L., Lifshitz, M., Ellamil, M., Sedlmeier, P., & Christoff, K. (2016). Functional neuroanatomy of meditation: A review and meta-analysis of 78 functional neuroimaging investigations. *Neuroscience & Biobehavioral Reviews, 65*, 208–228.
Fox, K. C. R., Nijeboer, S., Dixon, M. L., Floman, J. L., Ellamil, M., Rumak, S. P., Sedlmeier, P., & Christoff, K. (2014). Is meditation associated with altered brain structure? A systematic review and meta-analysis of morphometric neuroimaging in meditation practitioners. *Neuroscience & Biobehavioral Reviews, 43*, 48–73.
Frewen, P., Hargraves, H., DePierro, J., D'Andrea, W., & Flodrowski, L. (2016). Meditation Breath Attention Scores (MBAS): Development and investigation of an internet-based assessment of focused attention during meditation practice. *Psychological Assessment, 28*(7), 830–840.
Friese, M., Messner, C., & Schaffner, Y. (2012). Mindfulness meditation counteracts self-control depletion. Consciousness and cognition, 21(2), 1016-1022.
Fujino, M., Ueda, Y., Mizuhara, H., Saiki, J., & Nomura, M. (2018). Open monitoring meditation reduces the involvement of brain regions related to memory function. *Scientific Reports, 8*(1), 9968.
Fukuyama, F. (1999). *The great disruption*. Profile Books.
Gierveld, J. D. J., & Tilburg, T. V. (2006). A 6-item scale for overall, emotional, and social loneliness: Confirmatory tests on survey data. *Research on aging, 28*(5), 582-598.
Goldberg, S. B., Riordan, K. M., Sun, S., & Davidson, R. J. (2021). The empirical status of mindfulness-based interventions: A Systematic review of 44 meta-analyses of randomized controlled trials. *Perspectives on Psychological Science*, 1745691620968771.
Goldberg, S. B., Tucker, R. P., Greene, P. A., Davidson, R. J., Wampold, B. E., Kearney, D. J., & Simpson, T. L. (2018). Mindfulness-based interventions for psychiatric disorders: A systematic review and meta-analysis. *Clinical Psychology Review, 59*, 52–60.
Gu, X., Zheng, H., & Tse, C. S. (2023). Contact with nature for emotion regulation: the roles of nature connectedness and beauty engagement in urban young adults. *Scientific Reports, 13*(1), 21377.
Hartig, T. (2007). Three steps to understanding restorative environments as health resources. In *Open space: People space* (pp. 183–200). Taylor & Francis.
Hartig, T. (2021). Restoration in Nature: Beyond the Conventional Narrative. In A. R. Schutte, J. C. Torquati, & J. R. Stevens (Eds.), *Nature and Psychology: Biological, Cognitive, Developmental, and Social Pathways to Well-being* (pp. 89–151). Springer International Publishing.
Hartig, T., & Staats, H. (2006). The need for psychological restoration as a determinant of environmental preferences. *Journal of Environmental Psychology, 26*(3), 215–226.
Hartig, T., & Kahn Jr, P. H. (2016). Living in cities, naturally. *Science, 352*(6288), 938-940.
Hartig, T., Kaiser, F. G., & Bowler, P. A. (1997). Further development of a measure of perceived environmental restorativeness (working paper #5). Institute for Housing and Urban Research, Uppsala University.
Hartig, T., Korpela, K. M., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing and Planning Research, 14*(4), 175–194.
Hartig, T., Mitchell, R., Vries, S. de, & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health, 35*(1), 207–228.
Hasenkamp, W., Wilson-Mendenhall, C. D., Duncan, E., & Barsalou, L. W. (2012). Mind wandering and attention during focused meditation: a fine-grained temporal analysis of fluctuating cognitive states. *Neuroimage, 59*(1), 750-760.
Hayes, A. F. (2017). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. Guilford Publications.
Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (1999). *Acceptance and Commitment Therapy: An Experiential Approach to Behaviour Change*. Guilford press.
Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2011). *Acceptance and Commitment Therapy: The Process and Practice of Mindful Change*. Guilford press.
Hinde, K., White, G., & Armstrong, N. (2021). Wearable devices suitable for monitoring twenty four hour heart rate variability in military populations. *Sensors, 21*(4), 1061.
Hockey, G. R. J. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. *Biological Psychology, 45*(1), 73–93. https://doi.org/10.1016/S0301-0511(96)05223-4
Holzman, J. B., & Bridgett, D. J. (2017). Heart rate variability indices as bio-markers of top-down self-regulatory mechanisms: A meta-analytic review. *Neuroscience & Biobehavioral Reviews, 74*, 233–255.
Hunter, M. R., Gillespie, B. W., & Chen, S. Y. P. (2019). Urban nature experiences reduce stress in the context of daily life based on salivary biomarkers. *Frontiers in psychology, 722*.
Jarczok, M. N., Buckley, T., Guendel, H. O., Boeckelmann, I., Mauss, D., Thayer, J. F., & Balint, E. M. (2021). 24 h-heart rate variability as a communication tool for a personalized psychosomatic consultation in occupational health. *Frontiers in Neuroscience, 15*, 31.
Jenkinson, C., Layte, R., Jenkinson, D., Lawrence, K., Petersen, S., Paice, C., & Stradling, J. (1997). A shorter form health survey: Can the SF-12 replicate results from the SF-36 in longitudinal studies? *Journal of Public Health, 19*(2), 179–186.
Johansson, S., Ytterberg, C., Back, B., Holmqvist, L. W., & von Koch, L. (2008). The Swedish occupational fatigue inventory in people with multiple sclerosis. *Journal of Rehabilitation Medicine, 40*(9), 737–743.

Johnson, S., Gur, R. M., David, Z., & Currier, E. (2015). One-Session Mindfulness Meditation: A Randomized Controlled Study of Effects on Cognition and Mood. *Mindfulness, 6*(1), 88–98.
Kabat-Zinn, J. (1994) *Wherever You Go There You Are: Mindfulness Meditation In Everyday Life*. Hyperion.
Kabat-Zinn, J. (1990). Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness. Delacorte.
Kabat-Zinn, J. (2011). Some reflections on the origins of MBSR, skillful means, and the trouble with maps. *Contemporary Buddhism, 12*(01), 281–306.
Kahneman, D. (1973). Attention and Effort. Prentice-Hall.
Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*(3), 169–182.
Kaplan, S. (2001). Meditation, restoration, and the management of mental fatigue. *Environment and Behavior, 33*(4), 480–506.
Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. *Perspectives on Psychological Science, 5*(1), 43–57.
Kaplan, R., & Kaplan, S. (1989). *The Experience of Nature: A Psychological Perspective*. Cambridge University Press.
Kaplan, S., & Talbot, J. F. (1983). Psychological Benefits of a Wilderness Experience. In I. Altman & J. F. Wohlwill (Eds.), Behavior and the Natural Environment (pp. 163–203). Springer.
Kazdin, A. E. (2017). Addressing the treatment gap: A key challenge for extending evidence-based psychosocial interventions. *Behaviour research and therapy, 88*, 7-18.
Kohn, R., Saxena, S., Levav, I., & Saraceno, B. (2004). The treatment gap in mental health care. *Bulletin of the World health Organization, 82*(11), 858-866.
Kubios HRV. (n.d.). Kubios. Retrieved July 23, 2024, from https://www.kubios.com/scientific-research/
Laborde, S., Mosley, E., & Thayer, J. F. (2017). Heart rate variability and cardiac vagal tone in psychophysiological research–recommendations for experiment planning, data analysis, and data reporting. Frontiers in Psychology, 8, 213.
Lange, F. Behavioral paradigms for studying pro-environmental behavior: A systematic review. *Behav Res 55*, 600–622 (2023).
Lavie, N. (2010). Attention, distraction, and cognitive control under load. *Current Directions in Psychological Science, 19*(3), 143–148. https://doi.org/10.1177/0963721410370295
Lazarus, R. S., & Folkman, S. (1984). *Stress, Appraisal, and Coping*. Springer.
Lebuda, I., Zabelina, D. L., & Karwowski, M. (2016). Mind full of ideas: A meta-analysis of the mindfulness–creativity link. *Personality and Individual Differences, 93*, 22–26.
Lecrubier, Y., Sheehan, D., Weiller, E., Amorim, P., Bonora, I., Harnett Sheehan, K., Janavs, J., & Dunbar, G. (1997). The Mini International Neuropsychiatric Interview (MINI). A short diagnostic structured interview: Reliability and validity according to the CIDI. *European Psychiatry, 12*(5), 224–231.
Lengieza, M. L., & Swim, J. K. (2021). The paths to connectedness: A review of the antecedents of connectedness to nature. *Frontiers in psychology, 12*, 763231.
Lilja, J. L., Frodi-Lundgren, A., Hanse, J. J., Josefsson, T., Lundh, L.-G., Sköld, C., Hansen, E., & Broberg, A. G. (2011). Five Facets Mindfulness Questionnaire—Reliability and factor structure: A Swedish version. *Cognitive Behaviour Therapy, 40*(4), 291–303.
Lock, S., Rees, C. S., & Heritage, B. (2020). Development and validation of a brief measure of psychological resilience: The state–trait assessment of resilience scale. *Australian Psychologist, 55*(1), 10-25.
Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy, 33*(3), 335–343.
Lumikari, T. J., Putaala, J., Kerola, A., Sibolt, G., Pirinen, J., Pakarinen, S., Lehto, M., & Nieminen, T. (2019). Continuous 4-week ECG monitoring with adhesive electrodes reveals AF in patients with recent embolic stroke of undetermined source. *Annals of Noninvasive Electrocardiology, 24*(5), e12649.
Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences, 12*(4), 163–169.
Lymeus, F. (2019). Mindfulness training supported by a restorative natural setting: Integrating individual and environmental approaches to the management of adaptive resources [Doctoral Thesis, Uppsala University]. https://www.diva-portal.org/smash/record.jsf?pid=diva2:1345479
Lymeus, F. (2022). Individual differences in cognitive functioning predict compliance with restoration skills training but not with a brief conventional mindfulness course. *Frontiers in Psychology, 13,* 715411.
Lymeus, F., Ahrling, M., Apelman, J., Florin, C. d. M., Nilsson, C., Vincenti, J., Zetterberg, A., Lindberg, P., & Hartig, T. (2020). Mindfulness-based restoration skills training (rest) in a natural setting compared to conventional mindfulness training: Psychological functioning after a five-week course. *Frontiers in Psychology, 11*, 1560.
Lymeus, F., Lindberg, P., & Hartig, T. (2018). Building mindfulness bottom-up: Meditation in natural settings supports open monitoring and attention restoration. *Consciousness and Cognition, 59*, 40–56.
Lymeus, F., Lindberg, P., & Hartig, T. (2019). A natural meditation setting improves compliance with mindfulness training. *Journal of Environmental Psychology, 64*, 98–106.
Lymeus, F., Lundgren, T., & Hartig, T. (2017). Attentional effort of beginning mindfulness training is offset with practice directed toward images of natural scenery. *Environment and Behavior, 49*(5), 536–559.
Macaulay, R., Lee, K., Johnson, K., & Williams, K. (2022). Mindful engagement, psychological restoration, and connection with nature in constrained nature experiences. *Landscape and Urban Planning*, *217*, 104263.
Mahoney, M. R., Farmer, C., Sinclair, S., Sung, S., Dehaut, K., & Chung, J. Y. (2020). Utilization of the DSM-5 Self-Rated Level 1 Cross-Cutting Symptom Measure-Adult to screen healthy volunteers for research studies. *Psychiatry Research, 286*, 112822.
Malagù, M., Vitali, F., Rizzo, U., Brieda, A., Zucchetti, O., Verardi, F. M., Guardigli, G., & Bertini, M. (2021). Heart rate variability relates with competition performance in professional soccer players. *Hearts, 2*(1), 36–44.
Malinowski, P. (2013). Neural mechanisms of attentional control in mindfulness meditation. *Frontiers in Neuroscience, 7*.
Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A. M., ... & Fuertes, E. (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental research*, *158*, 301-317.
Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*(4), 503–515.
Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial? The role of connectedness to nature. *Environment and behavior, 41*(5), 607-643.

McCracken, L. M., Badinlou, F., Buhrman, M., & Brocki, K. C. (2020). Psychological impact of COVID-19 in the Swedish population: Depression, anxiety, and insomnia and their associations to risk and vulnerability factors. *European Psychiatry, 63*(1), e81.
McCrory, C., McLoughlin, S., Layte, R., NiCheallaigh, C., O'Halloran, A. M., Barros, H., ... & Kenny, R. A. (2023). Towards a consensus definition of allostatic load: a multi-cohort, multi-system, multi-biomarker individual participant data (IPD) meta-analysis. *Psychoneuroendocrinology*, 106117.
Merrigan, J. J., Stovall, J. H., Stone, J. D., Stephenson, M., Finomore, V. S., & Hagen, J. A. (2023). Validation of Garmin and Polar devices for continuous heart rate monitoring during common training movements in tactical populations. Measurement in Physical Education and Exercise Science, 27(3), 234-247.
Milgram, S. (1970). The Experience of Living in Cities. *Science, 167*(3924), 1461–1468.
Nathoo, A. (2016). From Therapeutic Relaxation to Mindfulness in the Twentieth Century. In F. Callard, K. Staines, & J. Wilkes (Eds.), *The Restless Compendium: Interdisciplinary Investigations of Rest and Its Opposites* (pp. 71–80). Springer International Publishing.
Navalta, J. W., Davis, D. W., Malek, E. M., Carrier, B., Bodell, N. G., Manning, J. W., ... & DeBeliso, M. (2023). Heart rate processing algorithms and exercise duration on reliability and validity decisions in biceps-worn Polar Verity Sense and OH1 wearables. *Scientific Reports, 13*(1), 11736.
NIMH, National Institute of Mental Health (n.d.). Mental Illness. Author. https://www.nimh.nih.gov/health/statistics/mental-illness
Nisbet, E. K., & Zelenski, J. M. (2011). Underestimating nearby nature: Affective forecasting errors obscure the happy path to sustainability. *Psychological Science, 22*(9), 1101–1106.
Nisbet, E. K., Zelenski, J. M., & Grandpierre, Z. (2019). Mindfulness in nature enhances connectedness and mood. *Ecopsychology, 11*(2), 81–91.
OECD/EU (2018), Health at a Glance: Europe 2018: State of Health in the EU Cycle, OECD Publishing, Paris. https://doi.org/10.1787/health_glance_eur-2018-en.
O'Keeffe, K., Hodder, S., & Lloyd, A. (2020). A comparison of methods used for inducing mental fatigue in performance research: Individualised, dual-task and short duration cognitive tests are most effective. *Ergonomics, 63*(1), 1-12.
Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change, 47*, 88-94.
Palm, J., & Stjernberg, B. (2022). Restoration Skills Training in a natural setting compared to Nature on Prescription [Master's thesis]. Uppsala University.
Patwary, M. M., Bardhan, M., Browning, M. H., Astell-Burt, T., van den Bosch, M., Dong, J., ... & Van Den Eeden, S. K. (2023). The economics of nature's healing touch: A systematic review and conceptual framework of green space, pharmaceutical prescriptions, and healthcare expenditure associations. *Science of The Total Environment*, 169635.
Peacock, E. J., & Wong, P. T. (1990). The stress appraisal measure (SAM): A multidimensional approach to cognitive appraisal. *Stress Medicine, 6*(3), 227–236.
People and Nature Surveys for England. (2024, February 14). GOV.UK. https://www.gov.uk/government/collections/people-and-nature-survey-for-england
Polar Global. (n.d.). Retrieved July 23, 2024, from https://www.polar.com/en/products/accessories/polar-verity-sense
Posner, K., Brent, D., Lucas, C., Gould, M., Stanley, B., Brown, G., Fisher, P., Zelazny, J., Burke, A., & Oquendo, M. (2008). Columbia-suicide severity rating scale (C-SSRS). Columbia University Medical Center.
Posner, M. I., Rothbart, M. K., Rueda, M. R., & Tang, Y. (2010). Training effortless attention. In B. Bruya (Ed.), *Effortless Attention: A New Perspective in the Cognitive Science of Attention and Action.* (pp. 409–424). MIT Press.
Richardson, M., Hunt, A., Hinds, J., Bragg, R., Fido, D., Petronzi, D., ... & White, M. (2019). A measure of nature connectedness for children and adults: Validation, performance, and insights. *Sustainability, 11*(12), 3250.
Ronk, F. R., Korman, J. R., Hooke, G. R., & Page, A. C. (2013). Assessing clinical significance of treatment outcomes using the DASS-21. Psychological Assessment, 25(4), 1103–1110.
Rosa, H. (2013). *Social Acceleration: A New Theory of Modernity*. Columbia University Press.
Ruimi, L., Hadash, Y., Tanay, G., & Bernstein, A. (2022). State mindfulness scale (SMS). In *Handbook of Assessment in Mindfulness Research* (pp. 1-16). Springer International Publishing.
Schultz, P. W. (2001). The structure of environmental concern: Concern for self, other people, and the biosphere. *Journal of environmental psychology, 21*(4), 327-339.
Schutte, N. S., & Malouff, J. M. (2018). Mindfulness and connectedness to nature: A meta-analytic investigation. *Personality and Individual Differences, 127*, 10-14.
Segerstrom, S. C., & Miller, G. E. (2004). Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. *Psychological bulletin, 130*(4), 601.
Sekhon, M., Cartwright, M., & Francis, J. J. (2017). Acceptability of healthcare interventions: an overview of reviews and development of a theoretical framework. *BMC health services research, 17*(1), 1-13.
Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports, 6*, 28551.
Slagter, H. A., Lutz, A., Greischar, L. L., Francis, A. D., Nieuwenhuis, S., Davis, J. M., & Davidson, R. J. (2007). Mental training affects distribution of limited brain resources. *PLoS Biology, 5*(6), e138.
Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. *Frontiers in Ecology and the Environment, 14*(2), 94–101.
Staats, H., Kieviet, A., & Hartig, T. (2003). Where to recover from attentional fatigue: An expectancy-value analysis of environmental preference. *Journal of Environmental Psychology, 23*(2), 147–157.
Steel, Z., Marnane, C., Iranpour, C., Chey, T., Jackson, J. W., Patel, V., & Silove, D. (2014). The global prevalence of common mental disorders: A systematic review and meta-analysis 1980–2013. International *Journal of Epidemiology, 43*(2), 476–493.
Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*(3), 309–317.
Tanay, G., & Bernstein, A. (2013). State Mindfulness Scale (SMS): Development and initial validation. *Psychological Assessment, 25*(4), 1286.
Tang, Y.-Y., Holzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nat Rev Neurosci, 16*(4), 213–225.
Tang, Y.-Y., & Posner, M. I. (2009). Attention training and attention state training. *Trends in Cognitive Sciences, 13*(5), 222–227.
Tang, Y.-Y., & Posner, M. I. (2014). Training brain networks and states. *Trends in Cognitive Sciences, 18*(7), 345–350.

Tarvainen, M. P., Niskanen, J.-P., Lipponen, J. A., Ranta-aho, P. O., & Karjalainen, P. A. (2014). Kubios HRV – Heart rate variability analysis software. *Computer Methods and Programs in Biomedicine, 113*(1), 210–220.
Thayer, J. F., Åhs, F., Fredrikson, M., Sollers III, J. J., & Wager, T. D. (2012). A meta-analysis of heart rate variability and neuroimaging studies: implications for heart rate variability as a marker of stress and health. *Neuroscience & Biobehavioral Reviews, 36*(2), 747-756.
Tóth, A. L. (2022). Nature exposure with and without mindfulness training improves psychological distress and wellbeing [Master's thesis]. Universität Heidelberg.
Trompetter, H. R., Ten Klooster, P. M., Schreurs, K. M., Fledderus, M., Westerhof, G. J., & Bohlmeijer, E. T. (2013). Measuring values and committed action with the Engaged Living Scale (ELS): psychometric evaluation in a nonclinical sample and a chronic pain sample. *Psychological assessment, 25*(4), 1235.
Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201–230.
United Nations (2018). World Urbanization Prospects The 2018 Revision.
Van den Berg, A. E., Hartig, T., & Staats, H. (2007). Preference for nature in urbanized societies: Stress, restoration, and the pursuit of sustainability. *Journal of Social Issues, 63*(1), 79–96.
Vickers, A. J., & Altman, D. G. (2001). Analysing controlled trials with baseline and follow up measurements. *BMJ, 323*(7321), 1123.
Walters, S. J., & Brazier, J. E. (2005). Comparison of the minimally important difference for two health state utility measures: EQ-5D and SF-6D. *Quality of Life Research, 14*, 1523–1532.
Whelan, D. B., Dainty, K., & Chahal, J. (2012). Efficient designs: factorial randomized trials. *JBJS, 94*, 34-38.
White, M. P., Alcock, I., Grellier, J., Wheeler, B. W., Hartig, T., Warber, S. L., Bone, A., Depledge, M. H., & Fleming, L. E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports, 9*(1), 7730.
White, M. P., Hartig, T., Martin, L., Pahl, S., van den Berg, A. E., Wells, N. M., ... & van den Bosch, M. (2023). Nature-based biopsychosocial resilience: An integrative theoretical framework for research on nature and health. *Environment International*, 108234.
WHO. (2021). Nature, biodiversity and health: An overview of interconnections (2021). https://www.euro.who.int/en/health-topics/environment-and-health/urbanhealth/publications/2021/nature,-biodiversity-and-health-an-overview-of-interconnections-2021
Wielgosz, J., Goldberg, S. B., Kral, T. R. A., Dunne, J. D., & Davidson, R. J. (2019). Mindfulness meditation and psychopathology. *Annual Review of Clinical Psychology, 15*, 285–316.
Wielgosz, J., Schuyler, B. S., Lutz, A., & Davidson, R. J. (2016). Long-term mindfulness training is associated with reliable differences in resting respiration rate. *Scientific Reports, 6*.
Wilson, P. A., Hansen, N. B., Tarakeshwar, N., Neufeld, S., Kochman, A., & Sikkema, K. J. (2008). Scale development of a measure to assess community-based and clinical intervention group environments. *Journal of Community Psychology, 36*(3), 271-288.
Wood, C., Barron, D., & Smyth, N. (2019). The current and retrospective intentional nature exposure scales: Development and factorial validity. *International Journal of Environmental Research and Public Health, 16*(22), 4443.
Zhang, J., Yu, Z., Zhao, B., Sun, R., & Vejre, H. (2020). Links between green space and public health: A bibliometric review of global research trends and future prospects from 1901 to 2019. *Environmental research letters, 15*(6), 063001.