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Mindfulness training supported by a restorative natural setting

*Integrating individual and environmental approaches
to the management of adaptive resources*

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Abstract

Lymeus, F. 2019. Mindfulness training supported by a restorative natural setting. *Integrating individual and environmental approaches to the management of adaptive resources. Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Social Sciences* 171. 159 pp. Uppsala: Acta Universitatis Upsaliensis. ISBN 978-91-513-0735-0.

This thesis integrates restorative environments research and mindfulness research: two disparate but related approaches to managing the demands of modern living. Both offer ways to improve attention regulation by detaching from routine mental contents and engaging with present experience. However, restoration works bottom-up, from supportive environmental features, while mindfulness meditation works top-down, through effortful training. Complementarities between the two are the foundations of restoration skills training (ReST), a five-week mindfulness-based course that uses mindful sensory exploration in a natural setting to build a meditative state effortlessly. As in conventional mindfulness training (CMT), ReST involves a learning structure to teach versatile adaptive skills.

Data were collected in four rounds, with successively refined versions of ReST given in a botanic garden and formally matched CMT given indoors. Data were collected to test short-term outcomes of practice sessions and long-term course outcomes. Four papers aim to determine whether ReST confers similar health benefits as CMT and has specific advantages related to lower effort and enhanced restoration. **Paper I** shows that on repeated measurement occasions across the course weeks, attention tests obtained before and after ReST practice sessions showed restorative effects (improved performance) consistently for general attention and increasingly for executive attention. In contrast, CMT practice indoors incurred increasing effort (deteriorated performance) seen in general attention. Despite these different short-term outcomes, ReST and CMT conferred similar generalized improvements over the course weeks. **Paper II** shows that ReST compared with CMT had higher course completion and better establishment of a regular practice. Compliance was mediated through perceived restorative qualities in the meditation setting and state mindfulness during the classes. **Paper III** shows that ReST was attended by at least similar benefits for general psychological functioning as CMT. Ratings of dispositional mindfulness and attention problems remained improved six months after ReST. After CMT, only attention problem ratings remained improved. However, chronic stress ratings were not lastingly improved with either course. **Paper IV** shows that with ReST, participants with higher initial ratings of attention problems subsequently completed more homework practice during the course. Homework practice in turn explained part of the improvement in dispositional mindfulness and attention problems. With CMT, homework practice was unrelated to initial attention problems and improvement. In conclusion, ReST is a promising alternative for people who struggle under heavy attention demands; effortful training is not necessary to improve attention regulation in early stages of mindfulness training. The theoretical and practical integration can guide further exchange between these related research fields.

Keywords: Mindfulness, Restorative, Environment, Meditation, Setting, Training, Attention, Adaptation, Attention, Resource, Integration, Individual, Environmental

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*Till min vän Hannes Mau Jaensson (1982 – 2010),
obesegrad mästare i den vilsamma levnadskonsten*

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I 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
- II Lymeus, F., Lindberg, P., & Hartig, T. (2019) A natural meditation setting improves compliance with mindfulness training. *Journal of Environmental Psychology*, 64: 98–106
- III Lymeus, F., Ahrling, M., Apelman, J., Florin, C., Nilsson, C., Vincenti, J., Zetterberg, A. Lindberg, P., & Hartig, T. (submitted) Mindfulness-based restoration skills training (ReST) in a natural setting compared to conventional mindfulness training: A randomized trial with six-month follow-up (preliminary title).
- IV Lymeus, F. (submitted) Mindfulness meditation training in a natural setting particularly helps people with attention problems (preliminary title).

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The contribution of Freddie Lymeus to the papers included in this thesis was as follows:

Paper I: Main responsibility for study conception, design, data analyses, and manuscript preparation in collaboration with co-authors. Main responsibility for data collection. **Paper II:** Main responsibility for study conception, design, data analyses, and manuscript preparation in collaboration with co-authors. Main responsibility for data collection. **Paper III:** Main responsibility for study conception, design, and data analyses in collaboration with co-authors T.H. and P.L. Main responsibility for data collection and manuscript preparation in collaboration with co-authors. **Paper IV:** Main responsibility for study conception, design, data collection, data analyses, and manuscript preparation.

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Abbreviations

ART	Attention restoration theory
CFQ	Cognitive-failures questionnaire
CI	Confidence interval
CMT	Conventional mindfulness training
FFMQ	Five-facet mindfulness questionnaire
LDST	Letter-digit substitution test
MBCT	Mindfulness-based cognitive therapy
MBSR	Mindfulness-based stress reduction
PET	Psychoevolutionary theory
PRS	Perceived restorativeness scale
PSS	Perceived stress scale
RE	Restorative environment
ReST	Restoration skills training
SCAS	Swedish core affect scale
TMS	Toronto mindfulness scale
TMT	Trail-making test

Preface

The Linnaean Collaboration for Studies in Nature, Health, and Sustainability

The work described in this thesis was completed within the Linnaean Collaboration for Studies in Nature, Health, and Sustainability (from here on, *the Linnaean Collaboration*), which is a research collaboration centered around the historic Linnaean Gardens of Uppsala University. The Linnaean Collaboration was initiated by professor of environmental psychology Terry Hartig and garden director Mats Block in 2010, when the Department of Psychology and the Department of Education relocated to the newly built Blåsenhus campus. Blåsenhus overlooks the New Botanic Garden to the west and the Baroque Garden to the north. The relocation meant that thousands of students and employees of these large institutions gained a day-to-day connection with the gardens, as viewed through classroom and office windows, as passed through in transportation to and from the workplace, and as settings for rest, conversation, studies, and contemplation.

The Linnaean Gardens have a proud history as a research institution, pre-dating even the installation of the botanist and physician Carl von Linné as professor of medicine at Uppsala University in 1741. As the scientific approach in botany and medicine transitioned to the confines of laboratories, use of the gardens' collections of native, exotic, and medicinal plants in research and teaching declined. Like many gardens around the world, the Linnaean Gardens have found a new role as a site where locals and visitors seek respite from the often hectic life in a modern city, connection with the past, information and knowledge, and cultural and aesthetic experiences.

The Linnaean Collaboration is a step to reinvent and reinvigorate research activities in the Linnaean Gardens. The Linnaean Collaboration therefore aims to address current issues of great importance for human health and ecological sustainability. It does so by considering the roles that the gardens can play for the many people who struggle to achieve sustainable balance between the many needs and demands incurred with a modern, urban lifestyle, as well as for the larger scale struggles of humanity to balance our needs and desires against the needs of other living entities and future generations.

The Studies in Context

I initiated discussions with Terry Hartig about research ideas and opportunities in 2006, as a student in the psychology program where he taught a course in environmental psychology. Those initial discussions led to the final thesis project for the professional degree in psychology and MSc that I worked with under his supervision and completed in 2008. That work integrated my interest in mindfulness-based approaches to health promotion with an environmental intervention founded in restorative environments theory. We kept our discussions alive while I worked as a clinical psychologist in outpatient psychiatry during the subsequent years. In 2012, the Department of Psychology, through its prefect Örjan Frans and PhD program director Ulf Dimberg, made funds available to employ a PhD student who would initiate and coordinate research activities within the emerging Linnaean Collaboration. I came into that role under the supervision of Terry Hartig and professor of clinical psychology Per Lindberg, who had joined the Linnaean Collaboration to contribute with expertise in health psychology and psychological treatment.

The research in the Linnaean Collaboration has been conducted within a resilient research model centered on the learning and teaching activities that proceed in the Blåsenhus campus and the surrounding gardens. The study of students has long been common in psychology, although many researchers have studied students out of practical necessity, often as a mere proxy for more relevant or representative groups. In contrast, the work within the Linnaean Collaboration has been shaped from the start by interest in the day-to-day activities and associated experiences of the people that inhabit the study settings. We have thus studied students in their own right and in close connection to their usual settings and activity patterns. Furthermore, this work has included students not only as subjects or study participants, but also as contributors to the phenomena of interest and to the creation of knowledge about them.

Thousands of students spend much of their lives in the geographical, architectural, organizational, and social context of Blåsenhus and the surrounding gardens. That means that they must balance their academic pursuits with the various activities that sustain the needed energies, motivation, focus, and meaning. They study, eat and rest; socialize, organize and create; discuss, learn, develop, and progress through courses, semesters, and grades. Within this multitude of activities, some can conflict with others, as when the same common areas in the campus building are used by some students who struggle to focus on their work and by others who engage in lively social activities. The dynamic between the campus building and the surrounding gardens can help mitigate such conflicts by providing a variety of spaces that support different activities or that help mitigate the psychological consequences of working in a mixed-use setting.

In our research model, students have taken part as study participants and receivers of relevant interventions thought to improve their capabilities and

conditions for healthy and efficient functioning under these circumstances. Students have also learned about the underlying theories and our research findings in relevant classes in the Psychology Program. During the last semester in their program of studies, 13 MSc students have (to date) chosen to complete their final thesis projects within the Linnaean Collaboration, contributing not only with their time and effort but also with unique input founded in their specific interests and expertise. After completing their theses, these former members of the Linnaean Collaboration carry with them their knowledge, experiences, and connections as they continue to shape their lives and the world, both as psychologists engaged in different sectors of society and as educated and committed individuals.

Building on input from our student collaborators as well as on overarching concerns for coherence and methodological rigor, the research activities in the Linnaean Collaboration have progressed along three lines of research within which similar designs and methods have been employed. One line of research concerns occupational health and has focused on how students can use the surrounding garden environments to recover during study breaks. Another line of research is concerned with the integration of mindfulness-based training and restorative nature experience. This thesis builds on research conducted within the latter line. A third line of research is under way to address remaining questions regarding the processes and applicability of the integrated approach.

Introduction

Going Back To Get By

It is a long-standing assumption in many spiritual and scientific traditions that mismatch between our ancient physical and psychological architecture and the conditions of modern living is at the core of much human suffering. When Siddhārtha Gautama had witnessed the struggles of the people in the agricultural society of north-eastern India some 2500 years ago, he went into the wilderness (Fisher, 2007, 2014). He left civilization to seek respite from the contrived and the conceptual, to meditate and discover the path to ending suffering. He then returned to the people to teach that path. In ancient Greece, stoic hermits followed very similar ideas and practices (Fabjański & Brymer, 2017). Later, philosophers of the European Enlightenment spread the understanding that humans are part of nature, that we inherit a “human nature”, and possess natural rights that must not be overridden by society (Bertram, 2018; Morris & Brown, 2019). They were followed by romantics and American transcendentalists who sought a truer state of being and knowing in nature (Goodman, 2018; Wayne, 2014). They were also followed by philanthropists and reformists who worked to counter the physical and moral ills of the working class in the expanding cities of the industrial era by providing them with access to fresh air and nature through the provision of urban parks (e.g., Olmsted, 1865; see Cranz, 1982). Over vast stretches of history, many have thus acted on the hope that a return to the natural world, although it can only be temporary and partial, can return humans to a healthier state of being (see Hartig et al., 2011; Kahn & Hasbach, 2013; Kellert & Wilson, 1995).

Today, around 70% of the European population lives in urban areas (Dye, 2008). By 2050, projections indicate that the same figure will apply to the total global population. That means that access to nature, for most people, is a limited resource (Bratman et al., 2019). Furthermore, access to nature is often unequally distributed within urban populations, so those who are vulnerable in other ways also have more limited access to qualitative nature experience (Cox, Hudson, Shanahan, Fuller, & Gaston, 2017; Schwarz et al., 2015).

Since the 1970's, restorative environments research has evolved as a branch of environmental psychology with the aim to understand and evaluate how nature experience can mitigate some of the central challenges of modern living, including heavy demands on people's limited attention regulation ca-

pabilities and chronic psychophysiological stress (Hartig & Kahn, 2016; Hartig, Mitchell, De Vries, & Frumkin, 2014; von Lindern, Lymeus, & Hartig, 2017). Situated as they are in the contrast between urban and increasingly rare and tamed nature, restorative environments researchers generally use the term “natural setting” pragmatically for those places that are available to people, are perceived as rich in natural content, and that thus provide opportunities for “nature experience” (cf. e.g., Hartig et al., 2014).

Over roughly the same time that restorative environments research emerged, other developments in psychology, behavioral medicine, occupational health, and related fields have considered ways of mitigating concentration problems, stress, and other ills of modern living through individual therapy and training (DeLeon, Kenkel, & Garcia-Shelton, 2011; Dewe, O’Driscoll, & Cooper, 2010; Felgoise, 2005; Folkman et al., 1991; Maslach, Schaufeli, & Leiter, 2001; Rabipour & Raz, 2012; Woolfolk, Lehrer, & Allen, 2007). Notably, perspectives rooted in Buddhist philosophy and meditation traditions have increasingly over this period informed and reshaped the understanding of health and adaptation, most prominently represented by the concept and practice of mindfulness (Harrington & Dunne, 2015; Kabat-Zinn, 2011; Nathoo, 2016; also see Hayes, 2004; Van Dam et al., 2018). The momentum behind the secularized mindfulness-based stress reduction (Kabat-Zinn, 1990) course and later adaptations of it have drawn criticism for lacking an ethical foundation for action against the larger-scale problems that presumably proliferate suffering in modern societies (see Grossman & Van Dam, 2011; Hyland, 2015; Møllgaard, 2008; Purser, 2015; Walsh, 2016). At the same time, mindfulness has proved immensely useful for scientific development as well as for the promotion of health and well-being for many people who are immersed in the modern context (Davidson & Kaszniak, 2015; Lutz, Dunne, & Davidson, 2007; Sedlmeier et al., 2012). It even shows some promise as a transitional pathway towards a more ecologically and socially sustainable way of living (Donald et al., 2019; Fischer, Stanszus, Geiger, Grossman, & Schrader, 2017; Schutte & Malouff, 2018; Wamsler et al., 2018).

This comprehensive summary is grounded in my work to integrate these two rather disparate approaches to helping people manage with the challenges of modern living: the restorative environments approach and the secularized mindfulness training approach. The integration has a theoretical component and a practical application that I call restoration skills training (ReST). ReST is intended to draw on the respective advantages of the environmental and the training-based approaches to overcome some of their respective weaknesses. Four empirical studies contrasts ReST against conventional mindfulness training to determine some of the ways in which the integrated approach could provide unique advantages. Next, I lay out a map of the text so readers will know what to expect and how the different sections lead up to the integration and the empirical studies.

Overview of the Text

The following three sections (Adapting To Challenges, What People Tend to Do When There's Nothing Else to Do, and Transcending the Automatic and Habitual) of this comprehensive summary overview several research fields that share a basic concern for understanding how people adapt to and interact with changing external conditions. These sections form a conceptual background for the subsequent sections and the empirical papers.

The fourth section (Mitigating the Challenges of Modern Living) then discusses how some specific conditions that prevail in modern societies contribute to widespread problems, and introduces two enduring general approaches to mitigating those challenges: efforts to bring nature to urban populations and efforts to strengthen suffering individuals. These two approaches are represented in contemporary science and practice in the form of restorative environments research and mindfulness research. The fifth section (The Restorative Environment) and the sixth section (Mindfulness Training) then extend on relevant theory in the respective fields, summarize the research evidence, and elaborate on some central issues in research and implementation.

The seventh section (Integrating Mindfulness with a Restorative Natural Setting) describes the theoretical integration of the two approaches and its practical application in ReST. The empirical part of the comprehensive summary then describes the research comparing ReST against conventional mindfulness training and discusses the findings that relate to the theoretical background and have practical implications.

Adapting To Challenges

Section summary and relevance

This section covers theoretical background from diverse research fields that all address aspects of how humans adapt to challenging environmental conditions. It takes a quick look back at human evolution in nature, then provides a really brief history of stress research, and moves on to more contemporary views of adaptation as an ongoing process. Finally, it considers pathways between environmental challenges and pathogenic processes.

The relevance of the contents of this section for the integration of restorative environments research and mindfulness research is that it connects them through their shared ambition to intervene in pathogenic processes by promoting efficient recovery from stressor exposure and by reinstating adaptive capabilities. The contents also serve as a necessary backdrop for the subsequent sections that consider what people do when challenges are low and there is nothing else to do, and how a person can sometimes transcend the automatic and habitual patterns of responding to the environment and instead act with some degree of apparent independence.

A quick look back at human evolution in nature

Embedded as our ancestors were in nature but also in social structures, their bodies and brains evolved in tandem with human culture (Confer et al., 2010; Cosmides & Tooby, 2013; Heyes, 2012; MacLean, 2016). Being a social and relatively peaceful species, human ancestors were uniquely able to solve complex problems and discover new ways to thrive (Heatherston, 2010; MacLean, 2016). Able to secure the energy and nutrition they needed, they could sustain larger, more energy-consuming brains with greater processing capabilities. The size of the brain is, in turn, closely linked to the ability to self-regulate cognitions and actions (MacLean et al., 2014). Even with this ability, however, modern humans remain dependent on cognitive and psychophysiological systems that evolved in much different times and environments (MacDonald, 2008; Öhman & Mineka, 2001). This observation is fundamental to theories regarding restorative environments (Kaplan, 1995; Ulrich, 1983).

Through evolution, humans have presumably developed automatic response systems that allow us to quickly and spontaneously orient attention towards, process, and react to objects and scenes that held particular value for survival and procreation during our species' history (Lovallo, 2005; MacDonald, 2008; Öhman, Flykt, & Esteves, 2001). These tend to capture attention in a bottom-up fashion, independent of any conscious decision (Arnsten, 2009; Pashler, Johnston, & Ruthruff, 2001). Such stimuli include dangerous animals (Öhman et al., 2001), food with high energy content (Wang et al., 2004), emotional faces (Dimberg, Thunberg, & Grunedal, 2002), and potential mates

(Suschinsky, Elias, & Krupp, 2007). Stimuli that signal a risk of social exclusion may be among the most potent (Dickerson & Kemeny, 2004). Objects and scenes that were important to avoid thereby came to elicit vigilant attention, anxiety or fear, and behavioral freezing – a pattern that has been described as the behavioral inhibition system – typically followed by behavior to stop contact with the aversive stimulus (Lovallo, 2005; Thayer & Lane, 2009). Appetitive stimuli, which signaled positive opportunities during evolution, instead engage less compulsory and more flexible attention, positive emotions, together with curiosity and exploring behavior (cf. Fredrickson, 2004; Fredrickson & Branigan, 2005; Ulrich, 1983; Ulrich et al., 1991). Flexible attention and a positive approach orientation is characteristic of restorative experience and of mindfulness.

The automatic response systems thus help regulate the body's resource consumption and allocation patterns and motivate particular behaviors (cf. Cosmides & Tooby, 2013). When the conditions demand frequent or prolonged activation of some psychophysiological system, however, it can lead to disease. The pathways from external demands to pathogenesis has been studied under the name stress. The mitigation of stress has been formulated as a central aim in both restorative environments research and mindfulness research.

A really brief history of stress

Questions about how encounters with stimuli in the environment come to influence internal bodily processes have engaged researchers from diverse fields (Cohen, Gianaros, & Manuck, 2016; Cooper & Dewe, 2008; Lovallo, 2005; McEwen, 2019; Taylor, Repetti, & Seeman, 1997). At the dawn of modern medicine, Bernard (1878/1974) explained that to compensate for the influence of events in the external environment, the body must have an internal feedback system that regulates the internal environment at a steady equilibrium where the organs can function efficiently. With that realization, Bernard set the stage for modern neuroscience (Thayer & Lane, 2009). He also laid the foundation for Cannon's (1929; also see Cooper, 2008; Lovallo, 2005) concept of homeostasis, which refers to the process of keeping certain vital bodily functions from varying beyond a narrow acceptable range. Cannon, and later Selye, also studied how organisms respond with compensatory processes when homeostasis is threatened by external challenges. Selye (1936; also see Cooper & Dewe, 2008; Lovallo, 2005) described how prolonged activation of the autonomic nervous system can lead to disruptions of metabolism, immune functioning, organ failure, and death. He introduced the concept of the general adaptation syndrome to describe that process, with stages of alarm, reaction and exhaustion. He also popularized the concept of stress when he extrapolated his laboratory research findings to the daily life experiences of humans (Selye, 1956; also see Cooper & Dewe, 2008). However, the view of stress as

a general and automatic response to diverse challenges was eventually abandoned.

Rather than a general response, Mason (1975) argued that stress is a complex of self-regulatory processes in response to psychological challenges. With the rise of cognitive psychology, Lazarus (1966; Lazarus & Folkman, 1984) further challenged the automaticity of the stress response when he introduced the cognitive-transactional model. In that model, appraisal of the nature of the challenge precedes a stress response. Lazarus also introduced the concept of coping, recognizing that people ordinarily take action to prevent or mitigate stressful encounters. Presumably, people weigh the perceived importance and the demands of the challenge against the options and resources they see available to deal with it. With challenges that can be managed, a coping response ensues that serves to overcome the external threat and/or to regulate the emotional discomfort that it causes. Only when self-regulatory capabilities are insufficient does a stress response ensue.

The classic view of stress as a general and stereotypical response was also challenged in other ways. Sterling and Eyer (1988) introduced the term allostasis to describe the processes that allow for appropriate variability in the face of changing demands in some bodily systems, thus serving to ensure homeostatic stability in the relatively few bodily systems that must be kept within narrow bounds. Modern stress research thus acknowledges the complexity of stress responses and bridges physiological and psychological perspectives (Aldwin, 2009; Cohen et al., 2016; Joëls & Baram, 2009; Juster, McEwen, & Lupien, 2010; Lovallo, 2005; Taylor et al., 1997). With the concept of allostasis, the emphasis shifted from the processes that maintain equilibrium to those that allow adaptation; that is, how flexible variation in some systems is actually needed to maintain steady functioning.

Adaptation as an ongoing process

Allostasis is the process of maintaining stability through variation (Cohen, Kessler, & Gordon, 1997; Lovallo, 2005; McEwen, 2019; Sterling & Eyer, 1988). In introducing the concept, Sterling and Eyer (1988) argued that many physiological systems do not have a fixed set-point but rather are in continuous adaptation. The allostatic perspective, in contrast to the homeostatic perspective, sees a healthy state as involving high responsiveness and optimal predictive fluctuation in anticipation of changing demands (Juster et al., 2010). For instance, the cardiovascular system must regulate blood pressure predictively as a person decides to rise from a chair in order to ensure a steady supply to oxygen to the brain. The allostatic perspective thus further acknowledges that adaptation is a whole-body process and involves higher as well as lower functions of the brain (Juster et al., 2010).

In a state of relaxed preparedness, autonomically regulated processes such as the heart rate are responsive to a subtle range of inputs from the environment (Thayer & Lane, 2000). Such variability is the output of the undisturbed processes of the internal feedback system that was identified by Bernard and Cannon (see Thayer & Lane, 2009). This is achieved when the prefrontal cortex is able to engage conscious processing of emotional content and thereby modulate limbic system activity (Brosschot, Gerin, & Thayer, 2006; Dickerson & Kemeny, 2004; Heatherton, 2010; Thayer & Lane, 2009). Faced with a perceived threat, prefrontal inhibition of the amygdala is released, allowing threat signals to permeate the central autonomic network (Thayer, 2006; Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012; Thayer & Lane, 2000). The system becomes temporarily dysregulated and unresponsive to the normal range of inputs from the environment. This rigidity is reflected in the heart rate through a relative dominance of slower sympathetic over faster parasympathetic nerve signals at the sinoatrial node (Thayer & Lane, 2000, 2009).

Humans clearly adapt continuously also in a psychological sense: They stop at the red light, put in effort at work, ignore the radio while engaging in conversation, and so on. The cognitive-transactional model and the concept of coping provided a framework for a view of humans as active in processing and adapting to environmental demands (Lazarus, 1993). Coping denotes the explicit cognitive and behavioral efforts that a person employs to manage with challenges and the associated experience of distress (Aldwin, 2009; Lazarus, 1966; Lazarus & Folkman, 1984; Schwarzer, 2001). When the capacity to cope with a stressful situation does not suffice, the scope of attention will narrow and go towards the source of the treat, and cognitive flexibility and conscious control will diminish (Chun, Golomb, & Turk-Browne, 2010; Fredrickson, 2001; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007; Öhman & Mineka, 2001). The emotional state will shift towards negative valence and high activation and automatic response systems will be prepared for swift execution (Fredrickson & Branigan, 2005; Lovallo, 2005; MacDonald, 2008; Öhman & Mineka, 2001). For a long time, research on stress and health centered on these activational patterns. However, more recent perspectives acknowledge that what happens after a stressful encounter is key to understanding the link between stress and health outcomes.

Pathways to disease and health

Adaptation to transient challenges is normally unproblematic; in fact, it is normally necessary to maintain health (McEwen, 1998, 2019). With that realization, the focus in stress research has widened to more fully include the adaptation or failure of adaptation to non-threatening conditions (Brosschot, 2010; Dickerson & Kemeny, 2004; Linden, Earle, Gerin, & Christenfeld, 1997; Thayer & Lane, 2000). When circumstances allow, the allostatic processes should fall back within a range that reflects relaxed preparedness (Linden et

al., 1997; McEwen, 1998). When the allostatic processes fail to recover, the prolonged activation no longer serves adaptation (Linden et al., 1997; McEwen, 1998). Instead, it is attended by unnecessary wear and tear on the adaptive systems in the body and brain. It is also attended by continuing cognitive and behavioral dysregulation that can cause poor performance and inappropriate behavior (cf. Brosschot, 2010; Evans, Hygge, & Bullinger, 1995; Lupien et al., 2007).

McEwen (e.g., 1998, 2019) introduced the concept of allostatic load to describe the wear and tear on the adaptive systems that over time link stressor exposure with pathogenic processes and disease (Juster et al., 2010; McEwen, 1998, 2019). Allostatic overload occurs when load accumulates to a degree that threatens the continued adaptive capability of some physiological system. With reduced adaptive capability in one system, other systems must overcompensate, exacerbating the load on those systems and ultimately threatening the functional integrity of the whole organism. Four conditions are identified as pathways to allostatic overload: too frequent exposure to some given adaptive demand; failure to accommodate to recurring stressors; failure to recover after stressor exposure; and too little response in one adaptive function, which requires other systems to overcompensate.

Identification of these pathways, McEwen et al. argue, could indicate possible points of intervention to interrupt the progression towards stress-related disease (Juster et al., 2010; McEwen, 1998, 2019). This model thus points towards the following approaches to intervention: 1) changing the environment to reduce exposure to some specific stressor, 2) facilitating measures to accommodate to specific stressors, 3) promoting efficient recovery from stressor exposure, and 4) returning an already weakened adaptive capability to a more efficient level of functioning. Such measures are not necessarily mutually exclusive (Hartig, Bringslimark, & Grindal Patil, 2008). They can be seen as represented to different degrees and through different mechanisms in the restorative environments and mindfulness approaches. The restorative environments approach mainly targets environmental exposure, stress recovery, and restoration of depleted adaptive capabilities. The mindfulness approach mainly targets accommodation to stressors, stress recovery, and enhancement of adaptive capabilities through training. When conditions are unchallenging, a well-functioning allostatic system is marked by reinstatement of self-regulation capabilities and attunement to the more subtle range of variation in experience from moment to moment (Thayer & Lane, 2000, 2009).

What People Tend to Do When There's Nothing Else to Do

Section summary and relevance

As was established in the preceding section, humans continually adapt to their environment. Even when the conditions are not challenging, processes of adaptation continue. However, when demands are low, people tend to disconnect from the present reality as the mind wanders off and finds something else to do. This section draws on diverse sources to identify cognitive processes that can preclude or disturb a restful presence. It considers how conceptual and self-referential mind-wandering processes associated with the default mode brain network can serve preparedness for action but also disrupt connection with the immediate present, and under some conditions lead into stressful experiences of perseverative cognition or boredom.

The relevance of the contents of this section to the integration of restorative environments research and mindfulness research is that they share the understanding that a mere absence of direct demands is not necessarily beneficial. Rather, positive engagement with present moment experience is needed to dampen or balance cognitive processes and allow a person to detach from the normal flow of activities. The section contents also form a background for the following section that indicates how a person can deploy limited central self-regulation capabilities and in an effort of will to in some degree and extent transcend automatic and habitual processes.

The default mode network

Functional neuroimaging research has conventionally used subtraction of the activity pattern seen when participants are not engaged with any specific task from the activity pattern seen while performing a given task (Raichle & Snyder, 2007). The expectation was that the contrast would show task-specific activations that reveal what areas of the brain are recruited to solve specific problems. However, researchers realized in the 1990's that some brain areas showed deactivation rather than activation with the introduction of a task. The findings of task-induced deactivation went against the previously dominant view that the primary function of the brain is to respond to inputs from the environment (Binder, 2012; Raichle & Snyder, 2007). In fact, the majority of the brain's energy consumption is related to task-independent activity, although only part of that activity comprises consciously accessible thought (Gusnard & Raichle, 2001; Raichle & Mintun, 2006). Task-independent activity is thought to maintain suitable arousal and anticipate and modulate the response to events in the environment (Raichle & Snyder, 2007; Sadaghiani, Hesselmann, Friston, & Kleinschmidt, 2010; Snyder & Raichle, 2012). When research participants' attention becomes engaged with an experimental task,

the task independent activity is interrupted in favor of task-specific activations.

The brain areas that are normally active at rest have been termed the default mode network (Raichle & Snyder, 2007). It includes brain areas thought to be involved in monitoring the environment and orienting towards salient and animate stimuli, and in emotional processing of sensory inputs from the environment (Gusnard & Raichle, 2001). It also includes areas thought to be involved in self-referential thinking including processing of episodic memories, self-monitoring, and mental simulation of future events. Ingvar (1985) seminally proposed that iterative simulation of potential future behavior supports the formation of prospective memories that allow goal-directed behavior. The prefrontal cortex integrates past, present, and simulated or planned futures to organize cognition and action over time. Such resting state activity can therefore be seen as a core aspect of adaptation (also see Gusnard & Raichle, 2001; Schacter, Addis, & Buckner, 2007).

Functional neuroimaging studies involving a resting state comparison have typically had participants sitting or lying down with eyes closed or fixated on some simple stimulus. Participants have then been instructed to, for instance "clear your mind" or "avoid thinking of words" (Binder, 2012), or "to relax, to refrain from moving, and to avoid any structured mental activity" (Mazoyer et al., 2001). Snyder and Raichle (2012) define rest, in the context of functional neuroimaging studies, as a "constant condition without imposed stimuli or other behaviorally salient events" but also note that it is "not truly a resting state at all". Binder (2012) notes that what in these studies was called rest is actually "an active, cognitively complex state marked by internal dialogue, imagery, emotion, retrieval of episodic memories, problem solving, and planning". Elevated default mode network activity in laboratory and daily life settings has been linked both between-subjects and within-subjects to the experience of mind-wandering (Mason et al., 2007; McVay, Kane, & Kwapil, 2009).

Mind-wandering

James (1890) had described the stream of thoughts that characterize much of the human experience, and experimental psychologists eventually caught on with studies on mind-wandering. Mind-wandering can be described as self-generated thought; that is, mental processes that are unrelated to any direct perceptual stimulation (Smallwood & Schooler, 2015). It has been construed as the "psychological baseline" from which people only temporarily depart when something demands attention. Smallwood and Schooler (2015) underscore that mind-wandering is not necessarily task-unrelated in the sense of being unrelated to any task: much of mind-wandering concerns recollection, planning, and problem-solving as reflected in joint activity in default mode and executive control networks in the brain (Christoff, Gordon, Smallwood,

Smith, & Schooler, 2009; Mooneyham & Schooler, 2013). Some authors have proposed that mind-wandering serves important functions for reflection on the self and relationships with important others (Immordino-Yang, Christodoulou, & Singh, 2012). It can occur intentionally or unintentionally, and with high or low meta-awareness (i.e. explicit awareness of the mental contents). However, it does involve some degree of disconnection from environmental stimuli. When the mind wanders, and especially when meta-awareness is low, task performance tends to become variable and error prone (e.g., Cheyne, Carriere, & Smilek, 2006; Christoff et al., 2009). Mind-wandering thus allows humans to spend much of their time travelling in time and space when the conditions in the present moment do not call with sufficient strength for any specific processing.

Because mind-wandering involves some degree of disconnection from environmental stimuli, it is distinct from distraction (Smallwood & Schooler, 2015). In fact, people tend to be least prone to distraction during mind-wandering. Instead, they tend to be most prone to distraction when they are engaged with a task that consumes some of their capacity for executive control (Lavie, 2005, 2010). In agreement with that interpretation, mind-wandering is more common among people with poor executive control (McVay & Kane, 2009, 2010); however, some have argued that the relationship is due to the self-generated thought itself consuming executive resources and so limiting resource allocation to the task (Christoff et al., 2009; Smallwood & Schooler, 2006).

Most mind-wandering seems to be future-oriented (Berntsen, 2019; Mooneyham & Schooler, 2013; Schacter et al., 2007; Smallwood & Schooler, 2015) and it seems to often be mildly pleasant (Fox, Thompson, Andrews-Hanna, & Christoff, 2014; Franklin et al., 2013). However, when mind-wandering is associated with negative mood, it tends to focus on negative past events or feared future events (Berntsen, 2019; Killingsworth & Gilbert, 2010; Ottaviani, Shapiro, & Couyoumdjian, 2013; Poerio, Totterdell, & Miles, 2013; Ruby, Smallwood, Engen, & Singer, 2013; Smallwood, Fitzgerald, Miles, & Phillips, 2009). This could be because negative mood leads to reduced cognitive and physiological flexibility which is characteristic of perseverative cognition (Ottaviani et al., 2013, 2016).

Perseverative cognition

The human ability to mentally travel in time and space allows non-present objects and events to influence the emotional state and to evoke and prolong stress responses. Brosschot, Thayer and colleagues (e.g., Brosschot, Gerin, & Thayer, 2006; Brosschot, Pieper, & Thayer, 2005) formulated the perseverative cognition hypothesis to explain the role of such thoughts in the stress process. Ruminative thoughts can renew a response to a negative event in the past

or prolong a response after a negative event. Similarly, worry can cause a person to react to events in the absence of any actual exposure. Such stress may sometimes occur even in the absence of conscious awareness of thoughts (Brosschot, 2010; Brosschot, Verkuil, & Thayer, 2010) and can elevate and prolong physiological stress parameters (Gerin et al., 2012; Ottaviani et al., 2016).

Work building on the perseverative cognition hypothesis highlights the importance of repetitiveness, negativity, and inflexibility of the thought process. For instance with prospective thinking, it becomes important to distinguish between constructive preparation and inflexible worry (Ottaviani et al., 2013; cf. Davis & Nolen-Hoeksema, 2000; Ruscio & Borkovec, 2004; Watkins, 2004). Perseverative cognition is thus characterized by an inability to detach from negative thoughts. Another problem arises when a person is unable to focus on anything at all.

Boredom

Boredom has been defined as wanting, but being unable, to engage in satisfying activity, and attributing that inability to the environment (Eastwood, Frischen, Fenske, & Smilek, 2012). Sensitivity to boredom increases when a person has weak abilities to regulate attention and the environment is not engaging enough to overcome that insufficiency. Farmer and Sundberg (1986) similarly suggest that a proneness to experience boredom is associated with a general disconnection from the environment and poor ability to mobilize adaptive resources. It is an aversive experience attended by effort and restlessness which serves to maintain arousal (Csikszentmihalyi & LeFevre, 1989; Iso-Ahola & Weissinger, 1990; O'hanlon, 1981). It is also attended by perceived slowing of time (Yang & Hsee, 2019; Zakay, 2014). Its aversiveness is exemplified by Wilson et al. (2014) who report that a majority of people prefer to entertain themselves with some external activity during short periods (i.e. 6 – 15 minutes) and that many even chose to self-administer mild electric shocks, over spending time in a sparsely furnished room without a task.

Boredom has been proposed to serve the adaptive function to motivate a person to seek more rewarding use for their limited resources of attention and time (Elpidorou, 2018; Yang & Hsee, 2019). However, people who are prone to boredom frequently fail to find constructive alternative behaviors and instead act impulsively and/or destructively (Eastwood et al., 2012; Farmer & Sundberg, 1986; Iso-Ahola & Weissinger, 1987). In contrast, environmental and instructional interventions to promote cognitive and behavioral approach, mitigate boredom (Csikszentmihalyi & LeFevre, 1989; Iso-Ahola & Weissinger, 1987; Kanevsky & Keighley, 2003; Nett, Goetz, & Hall, 2011; Vogel-Walcutt, Fiorella, Carper, & Schatz, 2012).

Transcending the Automatic and Habitual

Section summary and relevance

The ongoing adaptation processes that preserve functioning under changing environmental conditions and the self-referential thought patterns that tend to occupy consciousness when the conditions are unengaging define large parts of human life. However, humans also seem to have developed a capacity to transcend the automatic and habitual and choose other options. This section describes how the central capacity for inhibition allows a person to direct attention and self-regulate action in the service of valued goals. However, that capacity is limited. Prolonged efforts to stay on task despite competing processes lead to deteriorated performance, fatigue, and compensatory arousal.

This section connects back to the two preceding sections that dealt with adaptation to challenges and the self-referential thought patterns or boredom that tends to arise when demands and environmental stimulation are low. It also connects forward to the following section that addresses some of the characteristic challenges of modern living, many of which exert their negative influence mainly by imposing high and unrelenting demands on vulnerable self-regulatory capacities. The section is also of high relevance to the integration of restorative environments research and mindfulness research because they both assume that interventions to promote adaptive functioning in the modern context should aim to enhance attention regulation capabilities.

Inhibition, directed attention, and self-regulation

Plato developed the idea that noble and low motivations exert conflicting forces on human behavior, describing them as two horses harnessed to the same chariot (MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003). He proposed that the role of the charioteer is to keep both horses going steadily in the same direction, towards enlightenment. James updated the idea building on the then-developing understanding of excitatory and inhibitory nerve signals (James, 1890; also see MacLeod et al., 2003). He formulated the view that humans often experience conflict between competing psychological processes, and he used the word inhibition to describe how people resolve such conflicts. In contrast to neural inhibition, however, cognitive and behavioral inhibition seems to rely on an effort of will (Hockey, 1997; MacLeod et al., 2003).

A person can take a deep breath and approach a snake despite feeling scared or look straight ahead and walk past a fast food restaurant despite feeling hungry. With a stress response, a person can focus and relax to lower the arousal level. When thoughts drift off, a person can catch that and return attention to a given task even if it is less compelling. These can be seen as examples of self-regulation; that is, behavior that appears to be volitional and controlled rather than instinctive and automatic (Baumeister, Muraven, & Tice, 2000;

Heatherston, 2010; Kaplan & Berman, 2010; MacDonald, 2008; Rueda, Posner, & Rothbart, 2013). Such apparently willful behavior is made possible by top-down activation of some higher or more distant goal, and by inhibition of competing responses (Diamond, 2013; Dijksterhuis & Aarts, 2010; Pashler et al., 2001; Ridderinkhof, Wildenberg, Segalowitz, & Carter, 2004). The ability to selectively process currently goal-relevant stimuli, and to accordingly inhibit responding to irrelevant stimuli which may often be more salient, is therefore the basis for self-regulated behavior, as famously stated by James (1892). Authors from diverse contemporary traditions seem to agree (e.g. Barkley, 1997; Brown, Ryan, & Creswell, 2007; Chun et al., 2010; Dijksterhuis & Aarts, 2010; Hockey, 1997; Kaplan & Berman, 2010; Muraven & Baumeister, 2000; Petersen & Posner, 2012; Seligman, Railton, Baumeister, & Sripada, 2013). Self-regulation, in turn, is central in coping with stressful conditions and their experiential and physiological correlates (Skinner & Zimmer-Gembeck, 2007). However, the capacity to withstand competing processes and willfully direct attention is limited.

Resource investment, effort, and fatigue

The capacity to direct attention is known to be functionally limited in its momentary span, so that high simultaneous demands limit the ability to handle additional demands (Choi, van Merriënboer, & Paas, 2014; Chun et al., 2010; Schneider & Shiffrin, 1977). Importantly, Lavie (2005, 2010) has shown that increased susceptibility to distraction is only a feature of tasks that involve high cognitive load. Tasks that instead involve high perceptual load rather reduce susceptibility to distraction.

The capacity to direct attention is also known to be functionally limited in its temporal scope, so that unrelenting demands are associated with gradually impaired performance and failures of the self-regulatory capability (Cohen, 1980; Kaplan & Berman, 2010; Kurzban, Duckworth, Kable, & Myers, 2013; Langner & Eickhoff, 2013; Sarter, Gehring, & Kozak, 2006). Still, real-life human performance in demanding tasks is often remarkably stable (Hockey, 1997). Models of performance regulation have accounted for that stability by a compensatory control function that can substitute a diminishing cognitive resource with increasing effort or arousal.

Kahneman's (1973) model of attention and effort proposes that limited processing resources must continuously be redistributed to sustain efficient cognitive performance under changing demands. The level of resources that are invested in performance of a given task corresponds to perceived effort. When demands increase above a base-level of available processing capacity, sympathetic nervous system activity increases to produce physiological arousal which makes more cognitive resources available up to a point of moderate arousal (as per the Yerkes-Dodson law; see Cohen, 2011). When demands approach the level where a person can no longer compensate by increasing

arousal and applying more attentional effort, the spare capacity available for dealing with distractions is minimal so performance becomes increasingly fragile and variable. When cognitive capacity still does not suffice, a stress response ensues where arousal increases beyond a moderate level, the scope of attention becomes narrow and inflexible, and performance in complex tasks suffers due to loss of sensitivity to peripheral inputs.

Hockey (1997) builds in part on Kahneman's work and earlier cognitive and energetic resource models in formulating an integrated cognitive-energetic framework for the regulation of performance under stress and load. However, Hockey's framework differs from Kahneman's by emphasizing goal-directed, self-regulated aspects of resource allocation. In regulating behavior in pursuit of some given goal, costs are incurred in terms of the occupation and depletion of cognitive and physiological resources. Effort, in Hockey's framework, is seen as a compensatory control function that is under the control of the individual through the executive attention network. It is thus the willful allocation of effort that allows continued strivings towards a given goal despite the presence of possible competing goals, high load, distractions, or competition from parallel processes.

Effort is the intensification of mental and/or physical activity in the service of meeting some goal (Eisenberger, 1992; Inzlicht, Shenhav, & Olivola, 2018). It is generally perceived as aversive, so striving to maintain performance and goal-direction can interfere with other salient needs such as the regulation of the momentary emotional state by switching to more pleasant activity (Hockey, 1997; Kahneman, 1973). As seen over time, multiple needs will presumably need to be met in order to sustain overall health and well-being. Effort can then be seen as a motivating force for switching activity when the balance of costs and benefits of continuing becomes unfavorable. Many biologically founded needs are associated with dedicated control functions, such as the need for food is associated with hunger, the need for sleep is associated with sleepiness, and the need for rest is associated with fatigue (Hockey, 1997). These needs generally require high effort to compete with even over relatively short time spans.

While effort has predominantly been studied as an aversive experience, some researchers have noted that people frequently pursue effortful activities and value the outcomes of effortful pursuits higher than similar but less costly outcomes (Eisenberger, 1992; Inzlicht et al., 2018). In fact, effortful pursuits that override automatic processes and push the boundaries of the cognitive system have allowed humans to solve complex problems, and to build and function in the modern societies of today (cf. Heatherton, 2010; Kaplan, 1995; MacDonald, 2008; MacLean, 2016; Thayer & Lane, 2009).

Mitigating the Challenges of Modern Living

Section summary and relevance

The preceding sections have covered different aspects of how humans respond and act in relation to different environmental conditions and how such adaptation can incur costs in terms of interconnected processes of allostatic load, resource depletion, and deteriorated performance. This section identifies some of the adaptive demands that characterize life in modern societies and that have received most attention from researchers trying to explain why, despite the increasing availability of various amenities in modern societies, stress-related problems continually seem to rise. Two enduring approaches to mitigating those ills are outlined and contextualized: efforts to bring the good of nature to urban populations through gardens and parks, and efforts to strengthen suffering individuals in meeting the challenges of modern living.

The relevance for the integration of restorative environments research and mindfulness research lies in their shared hope to alleviate suffering that is connected to the conditions of modern living. The delineation of two enduring approaches to alleviating such problems flows into the two subsequent sections, which specifically cover the restorative environments approach and the mindfulness meditation approach as scientifically grounded, contemporary incarnations within those trends.

A new way of life

The conditions of human life have changed dramatically with the transitions from agrarian, to industrial, to post-industrial and globalized societies augmented with modern technology (DeBell, 2006; Dupré, 1996; Hudson, 2007; Lambert, Nelson, Jovanovic, & Cerdá, 2015; Sassen, 2016). A majority of the world's population, and over two thirds of the European population, lives in urban areas (Dye, 2008; cf. United Nations, 2019). While urbanity has many important advantages (Hartig & Kahn, 2016; see Lofland, 1998; Milgram, 1970), such environments tend to be relatively noisy, crowded, and polluted (e.g., Campbell, 1983). Milgram (1970) coined the term urban overload to describe how urban inhabitants must disengage from most of what and who they encounter due to the limitations in cognitive processing capability. At the same time, cities tend to be abundant with salient but irrelevant stimuli that capture attention (e.g., advertisements) and potential dangers that demand attention to keep safe in mundane activities (e.g., traffic) (Kaplan, 1995).

The modern world is also increasingly technological. On the Internet, in contrast to for instance libraries, the many different sources of information compete for attention (Eppler & Mengis, 2004; Schmitt, Debbelt, & Schneider, 2018). That means that the challenge now is not to find but to evaluate and select information: a more cognitively demanding process. Information

overload is frequently attended by ineffective processing, confusion, and stress (Eppler & Mengis, 2004). Media and communication technologies also tend to hijack attention with salient stimuli that appeal to the primordial response systems but often lead to stress and fatigue (Lee, Son, & Kim, 2016; Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008).

In this new world, much of what used to be important is inessential or even detrimental to effective functioning and health (Hartig et al., 2011; Heather-ton, 2010; Kaplan & Berman, 2010), as with advertisements that appeal to the human attraction to high calorie foods or media content that appeals to the human fascination for social intrigues. This may be described as a shift from a historical situation where relatively more exogenously driven (bottom-up) processes were of great importance, to a current situation where people must rely primarily on their limited capacity for self-regulated, endogenously controlled (top-down) processes for adequate functioning. Since the automatic response system is a poor guide in the modern environment, its impulses must frequently be overridden, which places additional load on the limited self-regulatory system.

Characteristic stressors

Stress responses facilitate adaptation to challenges and so ensure survival (Aldwin, 2009; Juster et al., 2010; Lovallo, 2005). However, adaptation to stressors comes at a price and the challenges abound in modern societies. With unrelenting or recurring challenges, stress can become chronic and lead to illness (Cohen et al., 2016; Juster et al., 2010). Several specific sources of stress have been identified as particularly relevant to explaining the proliferation of illness and poor well-being in modern societies. The prominent models in these fields tend to converge on the position that the major causes of stress-related problems are situated in the conditions of modern living, although personal vulnerabilities are generally also considered as variables that moderate the relationship between an unhealthy context and health-related outcomes.

Environmental stressors

Research on environmental stress has centered on four categories of stressors (Evans & Cohen, 1987): Cataclysmic events, stressful life events, daily hassles, and ambient stressors.

Cataclysmic events. Cataclysmic events are extraordinary occurrences that demand major adaptations by all people in the affected community, including natural disasters, large-scale technological failures, and acts of war. For instance, after Hurricane Katrina that hit the Gulf Coast of the USA in 2005, some already vulnerable groups of survivors had elevated risk of various health problems including post-traumatic stress disorder and depression (Rhodes et al., 2010), poor health behaviors such as substance abuse (Moise

& Ruiz, 2016), and domestic violence (Schumacher et al., 2010). The occurrence of some cataclysmic events can be expected to increase with progressing climate change and the human displacement that it causes (e.g., Reuveny, 2007; Warner, Hamza, Oliver-Smith, Renaud, & Julca, 2010).

Stressful life events. Stressful life events are incidents in the lives of individuals that require major adaptations in the normal course of living, such as losing or gaining a family member or changing career. Events that threaten a persons' social standing or self-image seem to be particularly potent (Cohen, Murphy, & Prather, 2019). The occurrence of such events has been linked with the progression of cardiovascular disease and cancer (Cohen et al., 2019). Some types of stressful life events can be expected to increase with trends of growing social mobility and job insecurity (e.g., Das-Munshi, Leavey, Stansfeld, & Prince, 2012; Sverke, Hellgren, & Näswall, 2002); however, as with cataclysmic events, it may be that only already vulnerable individuals are meaningfully affected.

Daily hassles. Daily hassles are the types of ordinary, often recurring phenomena that cause annoyance in the flow of daily life. Examples include noisy neighbors, arguments, and traffic congestion. Many daily hassles are therefore common in dense urban areas. The gradual wear and tear of facing such mild but persistent challenges provides a more feasible link to undesirable health outcomes than single major events (DeLongis, Coyne, Dakof, Folkman, & Lazarus, 1982). As with the other stressor types, exposure interacts with individual-level factors such as personality to predict health-related outcomes (e.g., Gruen, Folkman, & Lazarus, 1988; Larsson, Berglund, & Ohlsson, 2016).

Ambient stressors. Ambient stressors are chronic environmental factors that are often characteristic of urban environments, such as background noise at work or home, crowding, and air pollution. Humans can often habituate to such conditions but they are still associated with low-level stress (Campbell, 1983). Noise, for instance, is associated with sleep disturbance and performance impairments (Pirrera, Valck, & Cluydts, 2010; Smith, 1989). Exposure to ambient stressors is therefore thought to consume self-regulatory capabilities, making a person more vulnerable to other stressors (Evans, Jacobs, Dooley, & Catalano, 1987).

Work and social stressors

In addition to the four general categories of environmental stressors, researchers have studied stress emanating from particular domains of life, including work and social life.

Demand-control-support. The demand-control-support model (Karasek & Theorell, 1990; Sargent & Terry, 2000) centers on conditions of imbalance between the demands imposed by a job and the control and supporting resources that a person has available to carry out the specific tasks required by the job. Specifically, highly demanding jobs that offer little control over how the work is completed and little support from work leaders and other colleagues have been associated with stress and risk of mental and cardiovascular illness (Doef & Maes, 1998).

Effort-reward imbalance. The effort-reward imbalance model (de Jonge, Bosma, Peter, & Siegrist, 2000; Siegrist, 2002) emphasizes the need for reciprocity between employees and employer. Employee dissatisfaction and stress presumably follow with a perceived imbalance between the investment of personal resources (e.g., time, effort) in a job and the received rewards for that investment (e.g., security, social standing). Work conditions involving high effort and low reward are thought to be increasing in prevalence with growing job insecurity and job market competition. These factors have mainly been associated with psychosomatic complaints and sick-leave outcomes (Tsutsumi & Kawakami, 2004).

Job burnout. Research on job burnout has considered the balance between interpersonal demands and personal resources to complement the dynamic between job demands and job resources (Maslach et al., 2001). Research building on that model has mainly focused on work conditions that require high levels of personal engagement together with high demands on self-regulation, as with health care professionals who tend to suffering patients under high-stress conditions. Without adequate opportunities for relief and support within the work context, the central cognitive resources needed to maintain high engagement and performance become depleted and stress ensues (Deligkaris, Panagopoulou, Montgomery, & Masoura, 2014).

Social evaluative threat. Finally, a model for how social stressors can be particularly conducive to poor health outcomes has been formulated in terms of social evaluative threat. Specifically, Dickerson and Kemeny (2004) showed that challenges that involve motivated performance under low control and threat of critique and humiliation are associated with high and prolonged stress responses. Social evaluative threat has been identified as a source of stress associated with urban living (Lederbogen et al., 2011; Peen, Schoevers, Beekman, & Dekker, 2010) and with social media use (Somerville, 2013).

Efforts to bring nature to urban populations

Many authors are concerned that large segments of people living in modern, urbanized societies are physically separated and psychologically disconnected

from nature (e.g., Fisher, 2013; Howell, Dopko, Passmore, & Buro, 2011; Kahn & Hasbach, 2013; Kaufman & McNay, 2017; Kesebir & Kesebir, 2017; Schultz, 2002; Soga & Gaston, 2016; Zelenski & Nisbet, 2014). At the same time, studies show that many urban people have strong attachments to natural places (e.g., Altman & Low, 2012; Korpela & Hartig, 1996; Korpela, 1989) and find ways to incorporate nature experience in their lives (e.g., Staats, Jahncke, Herzog, & Hartig, 2016; Tzoulas et al., 2007; Van den Berg, Hartig, & Staats, 2007). Many urban people also hold relatively high biospheric and ecocentric values and pro-environmental attitudes (e.g., De Groot & Steg, 2007; Milfont & Duckitt, 2010; Schultz & Zelezny, 1999; Whitburn, Linklater, & Abrahamse, 2019) and want to act pro-environmentally (e.g., Sörqvist & Langeborg, 2019; Steg & Vlek, 2009; Thøgersen, 2005). Products and experiences that are perceived as natural rather than artificial tend to be judged more positively (e.g., Haga, Halin, Holmgren, & Sörqvist, 2016; Sörqvist et al., 2015). In fact, appealing to peoples' affinity for nature has become an important business strategy (Bartlett, 2011; Joye, Willems, Brengman, & Wolf, 2010; Munshi & Kurian, 2005; Pearson & Henryks, 2008).

“Nature” (with a capital “N”) encompasses and sustains all human life and experience. For the many people who live and work in mostly built environments, however, experiences of “nature” as settings with prominent vegetative and other seemingly natural elements constitute a valued and salient contrast in their normal efforts to survive and thrive (Bratman et al., 2019; Cox, Hudson, Shanahan, Fuller, & Gaston, 2017; Hartig et al., 2011; von Lindern et al., 2017). Efforts to harness some of the perceived qualities of nature for the good of strained city dwellers have an ancient and rich history (Cranz & Boland, 2004; Monem, 2007; Rogers, 2001). More recently, access to nature has been construed as an important ecosystem service (Bratman et al., 2019). Two types of places for nature contact in cities are of particular relevance for the Linnaean Collaboration and this thesis: botanic gardens and public parks. In certain respects, these two categories have come to converge over recent decades.

Botanic gardens

The practice of planting and tending specially selected plants in gardens is known to have persisted at least 3000 years (Botanic Gardens Conservation International, 2017; Hill, 1915). The main purposes of early gardens seem to have been medicinal, gastronomical, and aesthetic. The tradition was carried forward through Roman times and, with the spread of Christianity, was adopted by monks. The Christian monks kept plants for their medicinal properties but also for their beauty that could facilitate contemplation on God's creation. Monastic gardens were established all around Europe from the 9th century and onward.

With the Renaissance and the budding of a modern approach to scientific inquiry, not least in botany and medicine, so-called physic gardens devoted to the study and cultivation of medicinal herbs appeared in the university cities

of Italy (in Pisa in 1543, Padua and Florence in 1545, and Bologna in 1547). They spread over the next 100 years to cities all around Europe. These, the first botanic gardens, were founded on scientific principles, were systematically managed, and were engaged in active collection of seeds, plants, and knowledge. Those physic gardens that were tied to academic institutions were used for research as well as for education. Some physic gardens were also kept privately by wealthy apothecaries and enthusiasts.

With the era of exploration, colonization, and international trade that followed, the European botanic gardens increasingly took on the role of displaying the ever growing collections of exotic plants that could show the reach and achievements of the empires (Thompson, 1972). By the late 17th century, heated orangeries and greenhouses were being built in the European botanic gardens in order to keep specimens of sensitive plants alive despite the often unfavorable climate (Botanic Gardens Conservation International, 2017; Hill, 1915). Meanwhile, botanic gardens were also set up in the colonized lands to serve as research stations and nurseries for large-scale cultivation of spices and other valuable products. As hubs of the effort of discovery, cultivation, and trade of “new” plant species, botanic gardens by this point had become essential to the economic success of important imperial powers like Holland and Great Britain (Thompson, 1972). Botanic gardens were also established in North America after the European model, with a great proliferation in the 19th century.

In the 19th and 20th centuries, botanic gardens faced dwindling significance for economic and scientific development (Thompson, 1972). The world and its plants had already been “discovered” and growing and trading operations firmly established, so botanic gardens lost their function as hubs in this endeavor. Meanwhile, the science of botany split into a field science more concerned with the natural ecology of plants in situ, and a laboratory science also removed from the garden setting. Parallel developments in the science of medicine led to its gradual separation from botany.

In a parallel development, the 19th century also saw the rise in Europe, North America, and the British Commonwealth of public gardens that rarely had a foundation in natural science. These were instead mainly aimed to serve the needs and pleasures of urban populations (Botanic Gardens Conservation International, 2017). With this development, many botanic gardens also turned towards emphasizing their role as places for recreation and aesthetic enjoyment, as well as travel destinations of historical and cultural importance.

Public parks

The growing industrial cities in Europe and the US were plagued not only by the spread of infectious diseases but also by mental health and social problems (Cranz & Boland, 2004; Dempsey, 2012; Tate, 2004; Worpole, 2000; Young, 1995). A belief arose that the people were short of sunlight, fresh air, and wholesome living nature that could strengthen their bodies and minds. One

distinguished proponent of the need for accessible nature to civilize urban life in America was the landscape architect Frederick Law Olmsted who in 1865 wrote in his report on Yosemite and the Mariposa grove:

“It is a scientific fact that the occasional contemplation of natural scenes of an impressive character, particularly if this contemplation occurs in connection with relief from ordinary cares, change of air and change of habits, is favorable to the health and vigor of men and especially to the health and vigor of their intellect beyond any other conditions which can be offered them, that it not only gives pleasure for the time being but increases the subsequent capacity for happiness and the means of securing happiness. The want of such occasional recreation where men and women are habitually pressed by their business or household cares often results in a class of disorders the characteristic quality of which is mental disability, sometimes taking the severe forms of softening of the brain, paralysis, palsey, monomania, or insanity, but more frequently of mental and nervous excitability, moroseness, melancholy, or irascibility, incapacitating the subject for the proper exercise of the intellectual and moral forces.”

Pleasure grounds. The 19th century park proponents were largely romantic environmentalists (Cranz & Boland, 2004; Young, 1995). These saw the problems that plagued the urban working class and understood these as environmental rather than individual problems. Building on Christian views, nature was seen as balanced and good and therefore capable of instilling balance and goodness in people. Olmsted (1865) continued to argue that parks must be public rather than private, or “[t]he great mass of society, including those to whom it would be of the greatest benefit, is excluded from it”. The parks should be large and pastoral, with coherent and unobtrusive vegetation, and set in the outskirts of cities to contrast against the normal settings and activities of urban living (Cranz & Boland, 2004). Olmsted’s social and aesthetic ideals are reflected in Central Park in New York City and many other urban parks in North America. However, the placement of pleasure grounds at distance from the residential areas of working people led to these parks primarily being used by the middle class (Cranz & Boland, 2004; Young, 1995).

Reform parks and recreation facilities. With the 20th century, rational and modernist ideals reformed park design (Cranz & Boland, 2004; Young, 1995). Darwinian notions of imbalance and struggle as inherent in nature had replaced the romantic view. With this shift came more controlled and managed use of natural elements, where curvilinear shapes and coherent nature content were replaced with straight lines and colorful flowers. Parks were considered as tools of social reform, such as in the physical education of working class children and assimilation of immigrants, and so were equipped with sports facilities, play areas, and field houses for community activities. In contrast to the pleasure grounds, they were subsumed in the urban form and connected to the neighborhoods and populations they were meant to serve.

The open space system. In a counter movement to both the separation from the city seen with earlier pleasure grounds and the segmentation and standardization seen in reform parks and recreation facilities, the open space system saw its rise in the mid-20th century (Cranz & Boland, 2004). Parks were now seen as integrated networks of open spaces and corridors within the urban structure, which could help to relieve social unrest and vitalize city life. Under this ideology, any underdeveloped space in the city could be reconceived as a park; abandoned industrial sites, waterfront passages, disused rail- or road-ways, rooftops, and pockets in between existing buildings and traffic arrangements (Cranz & Boland, 2004; Dempsey, 2012; Tate, 2004; Worpole, 2000; Young, 1995). Thus, parks were no longer considered as contrasts or add-ons to the city, but as natural parts of it. Their contents and characters also became more diverse and dynamic, influenced by the surrounding geography and architecture, the historical use of the place, and by the local needs and opportunities through democratic and participatory processes. An important new function was cultural, such as in art installations, concerts, and farmers' markets. The open space system also saw a reinstatement of the notion that parks should play a role in providing psychological relief, though now within (rather than outside of) the context of the urban environment and lifestyle.

Botanic gardens and urban parks in the sustainable city

By the 1970's, people around the world increasingly recognized the negative consequences of long-running over-exploitation of many natural resources and the attendant destruction of the habitats of many species. In response to this realization, many botanic gardens turned toward an emphasis on the conservation of threatened plants coupled with public outreach on issues of environmental protection and sustainable development (Dodd & Jones, 2010; Donaldson, 2009; Maunder, 1994; Pennisi, 2010; Williams, Jones, Gibbons, & Clubbe, 2015). During this same time, botanic gardens also saw that the sheer novelty and multitude of species on display was no longer enough to draw visitors or to justify high maintenance costs. Hence, many botanic gardens began to specialize their collections and tailor the design and contextualization of the displays to the local conditions and needs.

Concerns for sustainability simultaneously reshaped urban planning efforts more generally as represented for instance in the new urbanism movement (Hebbert, 2003), urban greening projects (Bowler, Buyung-Ali, Knight, & Pullin, 2010a), and urban agriculture (Horst, McClintock, & Hoey, 2017). As part of this larger movement, the ideology and design of urban parks also transformed. Cranz and Boland (2004) outline a new movement in public park design: the sustainable park. It builds on the open space network of the cities but also embraces the more heavily built areas. Throughout the urban structure, it aims to restore natural systems and habitats and develop the city in an ecological process. The sustainable parks are not only sustainably managed and self-sustaining but can also provide a variety of services to the ecosystem

of the city, such as support for water regulation and waste management, and reduced pollution (Elmqvist et al., 2015).

The movement towards sustainably green cities encompasses purposes of serving human health as well as ecological sustainability. Restored natural ecosystems within the urban context do not only ensure that ecological processes recover health and balance; they also provide essential ecosystem services for human inhabitants of the city. Central ecosystem services that a sustainable city can provide include the possibilities that natural areas and elements afford for the regulation of adaptive capabilities and stress for urban inhabitants (Bratman et al., 2019; Carrus et al., 2017; Hartig & Kahn, 2016).

Efforts to strengthen suffering individuals

The historically dominant views of ill health have emphasized environmental factors as causes and solutions, as represented for instance in the various formulations of miasma theory in different times and cultures (e.g., Sterner, 1948). The last circa 100 years have, however, seen a transition with tremendous development in individual-level treatment approaches for specific illnesses. Many of these approaches are firmly grounded in rigorous science and have documented effects (see Barlow, 2007; Davidson et al., 2003; Levant & Hasan, 2008). With regard to the modern ailments that are commonly attributed to stress, however, the individual level approaches to prevention and treatment have had limited success (Åsberg et al., 2010; Leventhal, Weinman, Leventhal, & Phillips, 2008; Maslach et al., 2001; Ong, Linden, & Young, 2004; Taylor et al., 1997).

Over several decades, the prevalence of stress-related health problems has grown at a disturbing rate (Bratman et al., 2019; Lambert et al., 2015; Steel et al., 2014; Vigo, Thornicroft, & Atun, 2016). In parallel, the availability of treatments has grown, and so have the costs of treatment. For instance Maslach (2001) has questioned why the majority of programs to prevent job burnout have targeted individuals when the available research shows that contextual factors in organizations are the major causes of the phenomenon. Awa, Plauermann, and Walter (2010) also show that only programs that involve organizational changes have lasting impact on burnout rates. Referring to Swedish conditions, Åsberg et al. (2010) attribute growing problems with stress-related illness and sick-leave to changes in the labor market and welfare systems, pointing to the futility of meeting these problems with individual-level treatments. Taylor et al. (1997) also lay out how the individual-level approach to mitigating structural problems transfers the responsibility for change from advantaged to disadvantaged population segments. With a view to the implementation of individual-level approaches in health care practice, several authors have showed that evidence-based programs rarely translate into evidence-based treatments (Leventhal et al., 2008; Ong et al., 2004). These issues

are general and principal problems for individual-level approaches to prevention and treatment of stress-related problems. However, the focus in this thesis is on mindfulness-based training as applied within that context of health psychology, behavioral medicine, and psychological treatment.

In its inception, mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) drew on philosophy and practices rooted in several different Buddhist traditions in Asia and North America (Crane et al., 2017; Harrington & Dunne, 2015; Husgafvel, 2018; Kabat-Zinn, 2011). However, the approach was carefully adapted to Western audiences and health professionals and drew heavily on science-based precursors in the West (Crane et al., 2017; Kabat-Zinn, 2011). Nathoo (2016) describes how the Western precursors of MBSR prominently included the progressive relaxation program founded by Jacobson in the early 20th century (see Jacobson, 1929). Progressive relaxation was a seminal step in the development of health psychology, and particularly of training approaches to promoting psychological health. The Western precursors also include the work by Benson (see Benson & Klipper, 1975) with relaxation response training based on transcendental meditation. Relaxation response training broadened the mind-body integration with its emphasis on bodily health outcomes of mental training and thus advanced the field of behavioral medicine. In exchange with parallel developments in clinical psychology, Kabat-Zinn's work also contributed greatly to the several theories and practices that make up the third wave of cognitive-behavioral therapies (Hayes, 2004).

In the 21st century, popular awareness and scientific evaluations of mindfulness-based health interventions have surged, and so has criticism of the approach (Van Dam et al., 2018; Walsh, 2016). Some critics have pointed towards conceptual confusion and misrepresentation of Buddhist philosophy (Grabovac, Lau, & Willett, 2011; Purser, 2015). Others have pointed to various problems that could result from the separation of mindfulness training from its ethical foundations (Grossman & Van Dam, 2011; Walsh, 2016) including its appropriation by actors who could be seen as representing incongruent values (Hyland, 2015; Møllgaard, 2008). Yet others have focused on issues in mindfulness research and implementation (Baer, Crane, Miller, & Kuyken, 2019; Davidson & Kaszniak, 2015). Despite these issues, the evidence base regarding the benefits of mindfulness training has continued to grow, as will be detailed in the section Mindfulness Training. First, however, the next section details the restorative environments approach.

The Restorative Environment: An Environmental Approach to Mitigating the Challenges of Modern Living

Section summary and relevance

While efforts to bring nature to urban populations have long provenance, contemporary theory regarding the links between nature contacts and functional and health benefits developed since the 1970's. This section identifies some basic premises in restorative environments research before describing two prominent theories in the field: attention restoration theory and psychoevolutionary theory. It then specifies what environmental qualities make a setting restorative, and reviews research evidence for restorative effects of nature contacts. Finally, it discusses issues in research and implementation including questions of how restoration unfolds over time within a restorative experience and with repeated contacts.

The contents of this section serve as building blocks for the integration of restorative environments research and mindfulness research, and they have direct relevance for how ReST took shape. The section is followed by one that similarly covers fundamentals in mindfulness research.

Basic premises in restorative environments research

Restoration involves the replenishment of adaptive resources that have become depleted in efforts to meet demands, so that the associated functional capabilities are reinstated (Hartig, 2017). Restorative environments research thus takes a dynamic resource perspective on adaptive functioning, assuming that adaptive proficiency varies not only between individuals but within individuals as they go through mundane activity patterns (von Lindern et al., 2017). Having expended an adaptive resource in meeting one challenge, a person will thus be less able to handle a subsequent challenge that places demands on the same resource, unless the resource is first reinstated (see the section *Transcending the Automatic and Habitual* for background and parallel formulations of this assumption). Restoration can unfold in the absence of direct adaptive demands. However, a restorative environment not merely permits but promotes restoration of a given adaptive resource (Hartig, 2007, 2017). A restorative environment thus facilitates, speeds, or deepens restoration.

Theory about restorative environments grew out of the observation that people who live and work in mostly built settings tend to seek out nature for respite and rest (Hartig et al., 2011; Kaplan & Kaplan, 1989; Ulrich, 1983). When they are given a choice, they tend to prefer natural over built settings (Ibarra et al., 2017; Joye & Van den Berg, 2011; Van den Berg et al., 2007), a bias that seems to increase when they are fatigued or stressed (Hartig & Staats, 2006; Staats, Kieviet, & Hartig, 2003).

Being fundamentally situated in the urban – nature contrast, much restorative environments research has studied experiences with relatively managed and confined nature such as botanic gardens and urban parks, which are commonly available to urban residents in the course of day-to-day life. Measures of theoretically relevant mediating constructs (e.g., with the Perceived Restorativeness Scale [PRS]; Hartig, Kaiser, & Bowler, 1997; Hartig, Korpela, Evans, & Gärling, 1997) have frequently been used to indicate how well different environments support restorative processes, as is done in Paper II. In capturing relevant outcomes, much of the research has targeted central attention regulation capabilities as assessed with different performance tests, as is done in Paper I. Much research has also targeted affective states, such as the experienced arousal and valence as is done in Paper I. Other research has targeted central psychophysiological indicators of stress and restoration. These three domains of outcome measures correspond to the adaptive capabilities that are in focus, with different emphasis and perspective, in prominent restorative environments theories. The field has long referred to two theories: attention restoration theory and psychoevolutionary theory.

Attention restoration theory

Attention restoration theory (ART; Kaplan & Kaplan, 1989; Kaplan, 1995) refers back to James' (1890) distinction between voluntary and involuntary attention. ART construes effective functioning as fundamentally reliant on the cognitive ability to direct attention; that is, to willfully regulate attention as relevant for fulfilling a specific task (e.g., writing a report) and so to inhibit processing of irrelevant stimuli (e.g., a conversation in the hallway) and inappropriate behaviors (e.g., angry outbursts). Given that the capacity to direct attention is limited, sustained efforts to direct attention can presumably deplete the resource. Depletion is attended by gradually impaired performance and, eventually, fatigue of the self-regulatory capability. ART assumes that many commonplace tasks and other everyday demands tax the directed attention resource to some extent.

It follows that having sufficient opportunities to restore the capability to direct attention is important to sustain functioning, health, and well-being. In contrast to environments that require individuals to direct their attention to function effectively, restorative environments support a cognitively effortless mode of operation (Kaplan & Kaplan, 1989; Kaplan, 1995). This means that individuals can attend and act in accordance with their momentary inclinations by simply letting their attention go to what they find interesting. According to ART, an environment is restorative if it is rich in softly fascinating features that can softly hold attention in a bottom-up fashion, is perceived as coherently ordered and of substantial scope, and is compatible with what the individual wants to do. Additionally, a restorative environment permits a person to have

a sense of psychologically being away, not having to engage with routine mental contents, including those associated with everyday tasks and demands. Taken together, these characteristics allow people to become positively engaged with pleasantly interesting experiences in the moment, with few constraints and interruptions.

ART assumes that when attention is softly held and shielded from demands and distractions, the neurocognitive foundations of directed attention can rest and the resource become replenished. Regular restoration can thus protect against fatigue and self-regulatory failures and it can mitigate stress by bolstering the resources needed to deal with demanding or threatening situations. Kaplan and Kaplan (1989) assert that natural environments, more than most environments, provide such restorative opportunities (see also Kaplan, Kaplan, & Ryan, 1998; Kaplan, 1995).

Psychoevolutionary theory

The psychoevolutionary theory (PET; also known as psychophysiological stress recovery theory or stress reduction theory; Ulrich, 1983; Ulrich et al., 1991) is concerned primarily with affective responses to particular contents in the visual stimulus array. The theory assumes that some visual characteristics support stress reduction and that this has an innate basis. Stress is one manifestation of the operation of the evolved automatic response system that directs approach and avoidance behavior. For example, an acute stress response may be triggered by visual stimuli that are perceived as threatening, such as a looming dark shape. That affective response involves the physiological activation necessary to execute appropriate behavior, such as fighting or fleeing. Pleasant emotions are considered as another part of the same evolved system; natural selection would have favored an affective response to visual stimuli that signaled safety and opportunities to restore depleted adaptive resources.

The process of stress recovery is thought to be initiated by positive affective responses that derive from perceiving a scene as mildly to moderately interesting, pleasant, and calm (Ulrich, 1983; Ulrich et al., 1991). Restoration will be facilitated if the visual stimulus array has moderate depth, moderate complexity, provides a focal point, and contains particular environmental contents. It is believed that the characteristics typical of savannah landscapes (e.g., with regard to the shape and distribution of trees and grassy uniform ground) as well as the presence of water are particularly likely to evoke restorative responses, because these landscapes resemble the primary environments of human evolution, when the given characteristics signaled possibilities relevant for survival.

Following a stressful experience, a person viewing such a pleasant scene will feel positive affects replacing the negative ones, affirming that well-being is being fostered instead of threatened (Ulrich, 1983; Ulrich et al., 1991). The person will concomitantly experience decline in physiological activation. An

innate tendency to respond this way in appropriate situations would hold survival value by enabling faster recovery from acute stress and so providing protection against chronic stress and ensuring the ability to adapt to changing circumstances in the long term (Ulrich, 1983; cf. Cosmides & Tooby, 2013; Fredrickson, 1998).

Restorative qualities in natural settings

A restorative environment not merely permits but promotes restoration of a given adaptive resource (Hartig, 2007, 2017). In general, permission of restoration requires conditions that allow psychological distance from those factors that have contributed to the depletion of the resource. Many environmental properties could contribute to restorative quality by permitting restoration. These are the various properties that ensure an absence of stressors, as identified in the section *Mitigating the Challenges of Modern Living*. Environments can for instance provide a sense of safety by allowing good overview and possibilities to retreat in case of unexpected events. They can also shield against stressful ambient conditions by providing shade that mitigates heat and buffering barriers that reduce noise emanating from surrounding areas. Natural areas frequently accomplish these conditions rather well (Bratman et al., 2019; Hartig et al., 2014). Through nature visits, people can often also escape job demands and social stressors and so be able to act more freely in accordance with their spontaneous inclinations (cf. Korpela et al., 2018; Staats & Hartig, 2004; Staats et al., 2016, 2003; von Lindern, 2017). (Hartig, 2007, 2017). However, psychological distance is not merely a matter of physical separation from demands but also of the degree to which a person can experience that separation (see von Lindern, 2017).

In addition to environmental properties that permit restoration, other properties might promote restoration. These include those stimuli and processes that stimulate effortless, bottom-up driven attention as in aesthetic pleasures, curiosity, and exploration (Kaplan & Kaplan, 1989; Ulrich, 1983). The original writings within ART and PET described the conditions that favor positive engagement rather vaguely as “soft” (Kaplan & Kaplan, 1989) or “mild” (Ulrich, 1983). Several authors have lately attempted to define the level of complexity in a scene or setting that can promote engagement without imposing undue cognitive processing demands (e.g., Basu et al., 2018; Hagerhall et al., 2015; Joye, Steg, Ünal, & Pals, 2016). In terms of the physical properties of natural environments that could promote restoration through positive engagement, one of particular relevance here is the degree of biodiversity (Marselle, Stadler, Korn, Irvine, & Bonn, 2018). Botanic gardens are by definition settings that contain a high level of biodiversity, introducing complexity of stimulation for vision and other sensory modalities (see Carrus et al., 2017). At the same time, they impose a high degree of structural order on that complexity, making it more cognitively manageable.

While there could well be some range of complexity within which most people would respond favorably (see Hagerhall et al., 2015), variations in processing capability between and within people are likely to determine the preferred level of complexity in a given moment (Basu et al., 2018). Measures developed for use in testing ART have over the past 10 years been used to represent the restoration permitting and promoting factors in terms of perceived rather than objective qualities. The PRS includes subscales for Being Away and Fascination that have been tested as mediators of various outcomes in a variety of cross-sectional and experimental studies (e.g., Basu et al., 2018; Gonzalez, Hartig, Patil, Martinsen, & Kirkevold, 2010; Lindal & Hartig, 2013; Masoudinejad & Hartig, 2018). These subscales have also been used in Paper II in the present research.

Summary of the evidence for health benefits of nature

Access to nature in urban contexts enables benefits for health through multiple pathways (Hartig et al., 2014). In addition to restorative effects, health benefits can accrue from the facilitation of physical activity and social connections, and improved air quality and regulation of temperature. However, these pathways are interdependent and frequently work together. For instance, physical exercise in nature can promote both bodily fitness and psychological restoration (Bodin & Hartig, 2003), and visiting nature with a friend can sometimes promote a sense of safety that permits restoration (Staats & Hartig, 2004).

Having access to nature in daily life has been described as an important ecosystem service that protects and promotes health in a population (Bratman et al., 2019). A review of epidemiological studies (van den Berg et al., 2015) concluded that the association is strong for mental health outcomes (19 studies) and all-cause mortality (7 studies), and moderate for general health (14 studies). In a recent meta-analysis of 103 observational and 40 interventional studies, Twohig-Bennett, and Jones (2018) were able to analyze different stress-related processes and health outcomes separately. With regard to different precursors to illness, they saw that greater nature exposure was associated with lower salivary cortisol, diastolic blood pressure, and high-density lipoprotein cholesterol, and with higher heart rate variability. With regard to physical health outcomes, Twohig et al. saw that greater nature exposure was associated with lower risk of preterm birth and low birth weight, type-II diabetes, and cardiovascular and all-cause mortality. Several of the included studies showed larger benefits of nature exposure for people with low socioeconomic status or who lived in more deprived areas. A census-based study of the British population showed a similar general pattern (Wheeler et al., 2015).

While the relationship between access to nature and health is well established, causation and the mechanisms involved are difficult to determine in such large-scale studies. Support for ART and PET has more commonly been drawn from laboratory and field studies.

Attention outcomes

Empirical support for attention restoration theory has been discerned in the results of true and quasi-experiments in laboratory and field settings. Some of these have concerned single, brief occasions spent in natural versus urban environments (e.g., Berman, Jonides, & Kaplan, 2008; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mang, & Evans, 1991) or different kinds of natural environments (e.g., Gatersleben & Andrews, 2013; Ratcliffe, Gatersleben, & Sowden, 2013). Others have studied repeated contacts with nature in a residential or therapeutic context (e.g., Cimprich, 1993; Kuo & Sullivan, 2001). In one such study, Lymeus, Lundgren, & Hartig (2017) found that performance on the Letter-Digit Substitution Test (LDST; van der Elst, van Boxtel, van Breukelen, & Jolles, 2006) was differently affected by mindfulness practice sessions with nature images than with conventional mindfulness practice, with effects emerging gradually over an MBSR course. LDST is also used here in Paper I.

However, a relatively early meta-analytic review of the evidence (Bowler, Buyung-Ali, Knight, & Pullin, 2010b) could only include five, methodologically heterogeneous, controlled studies that compared some attention outcome of nature exposure against some non-natural condition. While the meta-analysis did show an advantage for nature, the small sample of studies and diversity in outcome measures largely disallowed firm conclusions regarding the attentional benefits of nature experience. Another meta-analytic review by Ohly et al. (2016) covered the 26 controlled studies that had been published up to 2013 and included 31 contrasts. With the larger sample of studies, separate meta-analyses could be performed for the different outcome measures. The analyses confirmed reliable benefits with regard to performance on some working-memory tasks and one executive attention task (i.e. Trail-Making Test, which is used in Paper I, Study 2). Several other tests did not show reliable improvements. However, many tests had at this time only been used in one study and so could not be included in meta-analyses. The review also had a number of methodological problems (see Hartig & Jahncke, 2017). Since then, the field has developed further.

A recent meta-analytic review by Stevenson et al. (2018) included the 46 controlled studies that had been published since 2013. It showed that the evidence base and its methodological quality have increased substantially in later years. When the studies were separated by the attentional capability that was measured as an outcome, the authors could conclude that performance on different tasks meant to measure working memory (7 studies), cognitive flexibility (e.g., the Trail-Making Test) (6 studies), and attentional control (10 studies) showed the strongest evidence for improvements with nature experience, with small to moderate effects.

Emotional and psychophysiological outcomes reflecting stress reduction

Empirical support for psychoevolutionary theory has been discerned in the results of experiments in laboratory and field settings by Ulrich (1979; 1984; Ulrich et al., 1991), and others (e.g., Hartig et al., 2003; Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998). Importantly, very similar theoretical notions that seem to have been developed without awareness of Ulrich's work have also received experimental affirmation. Specifically, Fredrickson (1998, 2004; Fredrickson & Levenson, 1998) tested an "undoing hypothesis" that invokes essentially the same affective mechanism for stress recovery described in 1983 by Ulrich; positive affect evoked by some environmental stimuli blocks negative affect and thoughts and enables more rapid, complete psychophysiological stress recovery. Such independent studies speak to the plausibility of the theory. Looking across multiple experiments, the meta-analytic review by Bowler et al. (2010) affirmed the beneficial effects of contact with nature in terms of reduced feelings of anger (eight studies), fatigue (four studies), and sadness/depression (five studies); however, they found too few suitable experiments to affirm any physiological benefits. A later meta-analytic review by McMahan and Estes (2015) targeted emotional valence outcomes from 32 studies. That analysis led to the conclusion that nature experience is attended by improved positive affect with a moderate effect size and with decreased negative affect with a small effect size.

Issues in research and implementation

Issues in tests of restorative environments theory

ART specifies a condition of directed attention fatigue as an antecedent, and restoration of that resource as the process for study. However, those assumptions have generally not been tested empirically (Joye & Dewitte, 2018): Most studies have merely measured improvement in attention and taken that as supportive of ART. Few studies have employed experimental control of fatigue, though there are exceptions (e.g., Hartig, Bök, Garvill, Olsson, & Gärling, 1996; Hartig, Evans, Jamner, Davis, & Gärling, 2003; also see Hartig & Jahncke, 2017; Stevenson, Schilhab, & Bentsen, 2018). If improvement should be common to both fatigued and non-fatigued persons, then other processes than restoration, such as invigoration or motivation, could explain the positive outcomes. There also remains ambiguity regarding the procedures and measures that will best capture restoration of the directed attention resource (Hartig, 2011; Joye & Dewitte, 2018; Stevenson et al., 2018). Furthermore, the central construct of soft fascination requires further development in terms of its specific properties and mechanisms of action as well as in terms of what (natural and other) stimuli can elicit it (cf. Basu, Duvall, & Kaplan, 2018; Joye & Dewitte, 2018).

Criticisms have also been raised regarding low specificity of the claims in PET regarding what specific natural stimuli could have held consistently and sufficiently strong survival value for the evolution of a dedicated response system for psychophysiological stress reduction (see Hartig et al., 2011; Joye & Van den Berg, 2011). Given that human ancestors were immersed in nature, it is implausible that general categories of nature scenes such as savannah-like landscapes would have been linked with restoration responses. Those environments would have encompassed opportunities to recover lost resources as well as threats and numerous inconsequential experiences.

How much is enough?

Research has fairly recently begun to address the question of what dose of nature is enough to produce important effects. Dose can be construed in terms of how much accessible nature must be present in a person's living environment to produce meaningful improvements in health status. Dose can also be construed in terms of how long or how often a person has to visit natural settings to achieve meaningful improvements in current levels of attention regulation capability or in psychophysiological or emotional symptoms of stress.

Kardan et al. (2015) mapped the density of street trees to predict the health of city residents. They conclude that having 10 more street trees in a city block improves the average inhabitant's perceived health by only 1%. However, that effect is comparable to being seven years younger. Having 11 more trees in a city block improves the average inhabitant's cardiac and metabolic health by 0.5%, which is comparable to being 1.4 years younger. Along similar lines, Astell-Burt, Feng, and Kolt (2014) saw that people living in neighborhoods with 0 – 40% green space had 9% risk of type II diabetes while those with 41 – 60% green space had 8% risk. With benefits for multiple wide-spread and costly health problems, small improvements can be well worth the investment in enhanced urban greenspace (Bratman et al., 2019; Elmquist et al., 2015).

Yet, in another study, Astell-Burt, Mitchell, and Hartig (2014) showed that the amount of nearby nature which supports general mental health can differ with demographic factors. For men, they saw that moderate and high access to nature was more beneficial than low access, across adulthood. For women, however, they saw that access to nature only became important in midlife and that moderate access was more beneficial than high or low access. They propose that living too far removed from the amenities and social contacts afforded by a city is more detrimental to women than to men. Such evidence of effect modification warns against simplistic notions of dose.

How long is enough?

Having better access to nature is related to how much time people spend in contact with nature (Flowers, Freeman, & Gladwell, 2016; White et al., 2019); however, nearby nature is blunt as a measure of exposure. Presumably, actual time spent in nature should be a stronger predictor of health benefits.

Interventions in studies on restorative effects of nature experience range from very brief contacts (e.g., a 40 second period looking out a window; Lee, Williams, Sargent, Williams, & Johnson, 2015) to wilderness stays over several days (e.g., Mang, 1984). Many laboratory experiments with photographic stimuli have used durations of 10-20 min (e.g., Hartig et al., 1996; Ulrich et al., 1991). However, only a few studies have empirically addressed how long it might take for any meaningful benefits to occur, and whether benefits continue to accrue with longer stays.

Barton and Pretty (2010) reanalyzed ten studies on the effects of exercise activities in nature on mood and self-esteem. They saw that the largest effects lie in the contrast between doing nothing and doing just five minutes of activity in nature. For both outcomes, the marginal benefits of continuing longer declined up to a half day of activity but then rose slightly again for full-day activities. Shanahan et al. (2016) targeted several health outcomes and could determine that people who stay for at least 30 minutes on average when they visit nature had lower risk of depression and high blood pressure. The degree of benefit for depression risk increased slightly with longer average duration of nature visits up to 75 minutes before leveling off; however, the effects on blood pressure did not increase consistently. Hunter, Gillespie, and Chen (2019) looked at cortisol levels in saliva collected before and after nature visits in the context of a nature-prescription intervention. The prescriptions recommended participants to spend 10 minutes or more in nature at least three times per week. On average, the nature experiences reduced cortisol levels 21% below the diurnal curve of that hormone. The greatest cortisol reduction per time unit spent was seen with 20 – 30 minute visits but benefits continued to increase at a reduced rate with longer visits.

Considering how benefits might accumulate over repeated visits, some studies have assessed the relationship between a weekly dose of nature contact and health outcomes. Cox et al. (2017) looked at the use of private gardens and saw that an effect on the risk of depression appeared at a threshold of 5 – 7 hours per week and that no additional gain was evident for those who spent more time in the garden. White et al. (2019) extrapolated an average weekly dose of nature from information on people's last nature visit and visit frequency. The likelihoods of being in good health and of having high well-being were improved for those who spent 2 – 3 hours in nature per week and did not improve further with more exposure. The degree of benefit from spending 2 – 3 hours per week in nature versus spending no time in nature was similar to the benefit of meeting recommended levels of physical activity.

It thus seems that brief contacts of under 30 minutes are often sufficient to reap much of the restorative benefits of nature on a single occasion, but that a total weekly time of at least a couple of hours is needed for generalized benefits to occur. Yet, very little is known about how restoration unfolds over time and about the mechanisms by which it accumulates with repeated contacts.

What changes with time?

The progression in a restorative experience over time is a central issue in the development of ReST, where participants are guided and paced through a progression in practices and foci (see Paper I). ART stipulates a process of restoration that unfolds over time in supportive contexts. Yet time is not necessarily a stable quantity. A few experimental studies have shown that the perception of time slows in contacts with natural settings (Berry et al., 2015; Davydenko & Peetz, 2017) which accords with enhanced attention to sensory impressions and reduced arousal (cf. Glicksohn, 2001). However, little is yet known about how psychological processes might develop across extended nature contacts.

Within single visits, Kaplan and Kaplan (1989) theorize that a person will first tend to experience a clearing of the head from residual cognitive fragments of what they just left behind. Then the person will start to regain the capacity to regulate attention and action. Then the person will gain cognitive quiet as their normal concerns settle. Finally, the person may find room for deep reflection that tends to draw towards a sense of oneness with the natural world. However, these aspects of the theory has barely been examined in empirical research.

Williams et al. (2018) recently highlighted the neglect of temporal progression in restorative environments research. In conceptualizing how nature experience may facilitate creativity, they theorize that pleasant and undemanding nature settings provide opportunities for mind-wandering in combination with gentle exogenous support for the attentional orienting network (see Petersen & Posner, 2012). They propose that people tend to cycle through periods of mind-wandering and effortless, bottom-up driven attention to fascinating aspects of the environment. With a pleasantly interesting setting that supports positive emotions and shifting of attention, negative aspects of mind-wandering such as perseverative cognition can be averted.

How do effects accumulate?

Another long-standing assumption in restorative environments research is that the effects of nature contacts can accumulate in individuals over time when they access nature regularly (see Hartig et al., 2014; White et al., 2019). Accumulation is an important concern in ReST where repetition corresponds to weekly classes and regular homework practice in a training course (see Papers I and III). However, research grounded in restorative environments theory has largely neglected to develop an understanding of the mechanisms and processes involved in such accumulation (see Hartig, 2007). Rather, it has predominantly assumed that mere repetition of restoration patterns sustains health over time (cf. e.g., Hunter et al., 2019). With that assumption, the progress has been limited in understanding the learning processes that may be involved and how restorative experiences might shift in quality and meaning with repeated exposures. There are a few exceptions.

One exception is the work initiated by Korpela (Korpela & Hartig, 1996; Korpela, Hartig, Kaiser, & Fuhrer, 2001; Korpela et al., 2018) on how people form attachments to favorite places that become central resources for self-regulation in their lives. Another exception is Kaplan (2001), who draws in part on meditation literature to indicate how people might learn from experience to notice needs for restoration as well as where and how they can draw restorative benefits efficiently in order to enhance adaptation over time. The meditation literature could further inform restorative environments research regarding how cognitive-behavioral practices and learning processes can enhance restorative transactions and so support restorative processes.

Mindfulness Training: A Skill-Based Approach to Mitigating the Challenges of Modern Living

Section summary and relevance

Current theoretical developments are beginning to disentangle the multifaceted mindfulness construct. This section delineates focused-attention practice from open-monitoring and describes different experiential qualities that are associated with focused-attention and open monitoring practice at different levels of meditation experience. It also describes theory regarding how mindfulness practices and states through a process of training can come to permeate a person's life as a disposition. Two different training mechanisms – attention network training and attention state training – form largely distinct pathways to generalized enhancements. The section also summarizes the evidence for mindfulness training as an approach to mitigating the challenges of modern living and some important issues to consider in research and implementation of mindfulness interventions.

The contents of this section serve as building blocks for the integration of restorative environments research and mindfulness research, and they have direct relevance for how ReST took shape as an integrated practical approach. The next section introduces the theoretical integration.

Basic premises in mindfulness research

Mindfulness is a construct derived from Buddhist meditation traditions (Grabovac et al., 2011; Lutz et al., 2007; Sedlmeier et al., 2012). One commonly cited contemporary definition describes mindfulness as a quality of awareness that arises when someone intentionally attends to present experience and withholds judgements and reactions to it (Kabat-Zinn, 1990, 1994). In this work, however, I have foremost built on the operational definition that was proposed by Bishop et al. (2004), which describes mindfulness as entailing attentiveness to present experience with qualities of curiosity (i.e. experiential openness and acceptance) and decentering (i.e. viewing one's thoughts and feelings about experience as subjective and transient).

Mindfulness can be construed and observed in several ways (see e.g., Berkovich-Ohana & Glicksohn, 2014; Davidson & Kaszniak, 2015; Lutz, Jha, Dunne, & Saron, 2015). It can be seen as a cognitive-behavioral practice that people can willfully engage in to alter their relationship with experiences, as in meditation or in the application of mindfulness techniques in daily life situations. Mindfulness can also be seen as an experiential state that varies in prominence as people go through different environments and activities, including but not necessarily exclusive to mindfulness practice. Mindfulness can additionally be seen as a personal disposition, or a general tendency to

experience mindfulness in many situations. Seen as a general tendency, dispositional mindfulness is presumably related to other fundamental aspects of a persons' functioning such as attentional functioning and chronic stress. Finally, mindfulness can be seen as a form of training or a path of personal development in which people can invest through regular practice over time. Approached in each of these ways, as described in the following subsections, mindfulness can be related to the processes and outcomes of concern in the development of ReST.

Mindfulness practices

In studying mindfulness as a practice, researchers have often used single meditation sessions with assessments before and after of performance on attention and other self-regulation tests (e.g., Friese, Messner, & Schaffner, 2012; Johnson, Gur, David, & Currier, 2015) or with brain imaging techniques (e.g., Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012). The practices that have passed under the rubric mindfulness in research and practice have, however, been highly variable (Davidson & Kaszniak, 2015; Grossman & Van Dam, 2011; Sedlmeier et al., 2012; Van Dam et al., 2018). To bring some order to the diversity, Lutz et al. (2008) proposed a fruitful delineation between focused-attention practices and open-monitoring practices. Recent studies, including a large meta-analytic review of functional neuroimaging studies (Fox et al., 2016) have built on and largely affirmed the relevance of that delineation.

In the early stages of mindfulness training, the emphasis is typically on focused-attention practices which are intended to improve attention regulation capabilities (Lutz et al., 2008; Malinowski, 2013; Tang, Holzel, & Posner, 2015). The view that the first step in meditation training should improve attention regulation capabilities is rooted in tradition and has been absorbed into contemporary theory (Grabovac et al., 2011; Lutz et al., 2008; Sedlmeier et al., 2012). As a person gains in attention regulation capabilities and meditation experience, the typical progression is towards an emphasis on open-monitoring practices which more closely resemble what traditional accounts describe as mindfulness training (Lutz et al., 2008). However, even at advanced levels of meditation skill, meditation sessions are often initiated with a brief period of focused-attention practice to reduce cognitive noise stemming from preceding activities.

Focused-attention practice

Focused-attention practice involves directing attention with a narrow focus to a given object such as the sensations that arise with the breath (Lutz et al., 2008). Focused-attention practice reduces activity in several default mode network areas on average across a meditation session, as reflective of reduced mind-wandering and elaborative processing (Fox et al., 2016). In early stages

of meditation training, however, the narrow focus is dependent on effortful attention regulation processes (Fox et al., 2016; Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012; Malinowski, 2013; Tang et al., 2015). Those processes are indicated by activations in executive control and motor inhibition networks in the brain. Given the limitations of that capability (as outlined in the section *Transcending the Automatic and Habitual*), beginning meditators are often distracted and lose attention to the object of focus (Frewen, Hargraves, DePierro, D'Andrea, & Flodrowski, 2016; Hasenkamp et al., 2012), a phenomenon that is considered part of the training process. The loss of the attentional focus is taken as an opportunity to train skills that support sustained attentiveness, including skills in monitoring the stream of consciousness, releasing distractions without further cognitive elaboration, and redirecting attention to the object (Lutz et al., 2008). Lutz et al. propose that with substantial experience, the supporting skills can be developed to a point where they can be deployed effortlessly.

Open-monitoring practice

In transitioning from focused-attention practice to open-monitoring, the skill in monitoring the stream of consciousness becomes central (Lutz et al., 2008). Open-monitoring practice is done without a particular object of focus and instead allows for any aspect of experience to rise in prominence and to dissipate in its own time. Monitoring skills allow a person to simply observe the shifting contents of consciousness without further processing, and so to maintain the meditative task-set without relying on effortful attention regulation. Activations in brain areas involved in coordinating and monitoring attention to both internal and external inputs probably reflect that process (Fox et al., 2016). Furthermore, open-monitoring is associated with reduced sensory gating activity, which apparently reflects enhanced processing of sensory information. Fujino et al. (2018) experimentally compared focused-attention and open-monitoring practice in experienced meditators, and showed that compared with the resting state, both practice types were attended by similar general deactivations in the default mode network reflecting reduced mind-wandering. However, open-monitoring reduced activity in attention control networks and processing of autobiographical memories while focused-attention practice increased such activity.

Open-monitoring also supports so-called reflexive awareness (Lutz et al., 2008). As mindfulness is maintained while experiences come and go, a person can gain familiarity with the stereotypicalities and variations in their relationship with different objects and events, and thereby become increasingly aware of how experience is shaped by subjective mental processes (Lutz et al., 2008; Raffone & Srinivasan, 2009). Eventually, the specific sensations, thoughts, and emotions that enter the field of consciousness can all be experienced together, without any single aspect of experience rising to become even a temporary focus in the meditation. They can simply pass through conscious

awareness without any attachment, aversion, or elaboration. Berkovich-Ohana and Glicksohn (2014) similarly indicate that with open-monitoring, default-mode processes can be allowed to enter the field of consciousness, though simply observed and allowed to pass, akin to the ongoing background monitoring of environmental events.

Mindfulness as a state

Studies on the experience of mindfulness have relied on two different research approaches. One has used rating scale assessments with theoretically derived items to assess the depth or intensity of mindfulness as a mediator of outcomes. Such a measure is used in analyses presented in Paper II: the Toronto Mindfulness Scale (Lau et al., 2006) which building on the operational definition by Bishop et al. (2004) contains subscales for curiosity and decentering. The other has employed the methodological approach of neurophenomenology (see Thompson & Varela, 2001; Varela, 1996), Lutz and colleagues (Abdoun, Zorn, Poletti, Fucci, & Lutz, 2019; Lutz et al., 2007; Lutz, Jha, Dunne, & Saron, 2015) and Berkovich-Ohana and Glicksohn (2014) have taken that approach to developing theory regarding how experiences that are commonly associated with mindfulness relate to brain functions and cognitive-behavioral processes. The phenomenological aspects are relevant for the development of ReST because they can indicate points of overlap and disparity between mindfulness and restorative nature experience with a high degree of nuance. However, approaches to measuring them quantitatively are only now beginning to emerge (see Abdoun et al., 2019).

The phenomenological matrix of mindfulness practices

According to Lutz et al. (2015), the phenomenology of mindfulness varies along several dimensions with different types of meditation practice and different levels of experience. Together, these dimensions also contribute to a higher-order phenomenological component of mindfulness meditation, which is maintenance over time of the task-set or the determination to approach experience mindfully. Lutz et al. describe three primary functional dimensions: object orientation, dereification, and meta-awareness. They also discuss four qualitative dimensions that characterize the meditative experience: aperture, clarity, stability, and effort.

Object orientation. As a functional dimension, object orientation is akin to endogenous orienting of attention (cf. Petersen & Posner, 2012). The dimension describes the degree to which a person is oriented towards any specific object, where high and low object orientation are not necessarily associated with high and low mindfulness. High object orientation can be experienced with focused-attention meditation, with search for a particular object, and

other activity patterns. Low object orientation can be experienced with open-monitoring meditation, with mind-wandering, et cetera.

Dereification. Dereification, as described by Lutz et al. (2015), encompasses the construct decentering as used by Bishop et al. (2004) as well as similar terms (e.g., defusion [Hayes, 2004]; metacognitive insight [Chambers, Gullone, & Allen, 2009]). It describes the degree to which psychological content is experienced as transient mental phenomena rather than as accurate reflections of objective reality. Different meditation practices approach this process in different ways and to different degrees; however, higher dereification is generally associated with higher levels of mindfulness. Low dereification is seen for instance in perseverative cognition, where negative self-referential thoughts are mistaken for truths and therefore associated with psychophysiological stress responses (cf. Brosschot, 2010). High dereification is presumably related to high cognitive flexibility, where a person can engage with and switch between several different ways of relating to a situation or a problem without forming particular attachments to any given interpretation. With very high dereification, thoughts could completely lose their representational integrity and be experienced as insubstantive and passing perturbations in the experiential field.

Meta-awareness. Meta-awareness can be understood as the background monitoring process by which a person may maintain awareness of ongoing mental activities (Lutz et al., 2015). Meta-awareness is sometimes experienced as a sudden awakening, as when a person realizes that s/he was just mind-wandering and disconnected from the present moment (cf. Smallwood & Schooler, 2015). This experience occurs frequently in early stages of mindfulness training and particularly in focused-attention practice (e.g., Frewen, Hargraves, DePierro, D'Andrea, & Flodrowski, 2016; Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012). However, Lutz et al. (2015) argue that mindful meta-awareness is the ability to continually maintain a background monitoring process while one may also engage with a given task or train of thought; that is, to simultaneously encompass both the subjective context and any specific object that is in focus for the moment. This ability is particularly trained in open-monitoring practice. Meta-awareness therefore does not typically involve a shift of focus back to a task but rather the ability to engage with objects without becoming fully immersed and losing connection with the context of that engagement. For instance, watching a sunset while also retaining awareness of ambient environmental conditions, evoked emotional tones, and associative cognitive processes. Meta-awareness can therefore facilitate detection of specific perturbations in the experiential field, including mind-wandering processes and external events.

Four qualitative dimensions. In addition to the foregoing three functional dimensions of mindfulness, Lutz et al. (2015) also discuss four qualitative dimensions that characterize the meditative experience: aperture, clarity, stability, and effort:

- Aperture, or broadness of the attentional spotlight, typically progresses from a narrow focus in early stages of focused-attention practice to a wide scope in open-monitoring practice.
- Clarity of experience refers to its felt vividness, and can in focused-attention practice be described in terms of the perceived contrast between attended and non-attended stimuli. In open-monitoring, also relatively peripheral aspects of experience can have high clarity as a wide focus and high meta-awareness extend the field of consciousness.
- Stability involves the perceived degree of persistence in a particular relationship with experience, as with attention to a given object in focused-attention practice. In open monitoring, high stability can be achieved in the absence of a given focus, as with steadily high dereification and meta-awareness of the shifting contents of conscious awareness.
- Effort refers to the perception that a given experiential state is difficult to sustain over time (cf. Hockey, 1997). When a mindful state is maintained with high effort, the perception of conscious control is present, and the stability of the state will tend to deteriorate over time. Focused-attention practice typically involves high effort and a transition to open-monitoring is characterized by a release of the maintenance of meditation from effortful control. That leaves more conscious room for development of other aspects of the experience. With low effort, perceptions of conscious control can be absent and high stability can still be maintained as in the background monitoring process of meta-awareness. Mindfulness can then begin to permeate a person's life.

The consciousness state-space in mindfulness

Berkovich-Ohana and Glicksohn (2014) discuss how the experience of time will tend to develop with increasing meditation experience. They propose that mindfulness involves a predominance in awareness of the core consciousness. Core consciousness relies on immediate sensory input from the body and environment. Building on Varela (1996; Thompson & Varela, 2001), they assume that one psychological moment can normally span < 3 seconds. Self-referential thought processes, such as those associated with default mode network processes and mind-wandering, extend consciousness to comprise time and space beyond that short present moment (cf. Schacter et al., 2007). Self-referential thoughts attach the self with past or future events and with abstract notions that characterize extended (rather than core) consciousness (cf. Immordino-Yang et al., 2012). Berkovich-Ohana and Glicksohn (2014) also describe how mindfulness training can, in early stages mainly characterized by focused-attention practice, dampen default mode processes through inhibitory

effort. This allows a person to stay within the short psychological moment and core consciousness. Without effortful inhibition of narrative processes, however, increased attention to sensory inputs characteristic of open-monitoring practice (cf. Fox et al., 2016; Lutz et al., 2008), together with reductions in arousal, tend to alter time perception towards a longer moment and slower perceived passage of time (also see Berkovich-Ohana, Glicksohn, & Goldstein, 2011; Kramer, Weger, & Sharma, 2013). By practicing open-monitoring, a person will learn to monitor default mode processes in a manner akin to normal background monitoring of sensory impressions: effortlessly and without higher-order processing unless it is called for. That allows the person to remain grounded core consciousness in an embodied, extended moment.

Dispositional mindfulness

Much work in mindfulness research has built on the understanding of mindfulness as a disposition or trait (Brown, Weinstein, & Creswell, 2012; Creswell, Way, Eisenberger, & Lieberman, 2007; Fogarty et al., 2015; Paul, Stanton, Greeson, Smoski, & Wang, 2013). Numerous different self-report scales have been used to define and assess the construct. To address the confusion resulting from the proliferation of different definitions and measures of dispositional mindfulness, Baer et al. pooled items from the five different self-report scales that were most used at the time and used factor analyses to construct a single, multifaceted measure (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer et al., 2008). The resulting measure, the Five-Facet Mindfulness Questionnaire (FFMQ), has since been the most researched, and has informed understanding of the component parts of mindfulness. The FFMQ is also used in the research on ReST (Papers II, III, and IV) as a predictor and outcome of mindfulness practice. Baer et al. identified five subscales in the item pool: observing (as in awareness of different aspects of experience), describing (as reflecting abilities to reflect on experience), acting with awareness (as in withstanding mind-wandering in the course of activity), non-judging (as in accepting experience as it is), and non-reactivity (as in responding deliberately rather than reactively to experience). The five facets of mindfulness have frequently been construed in terms of cognitive-behavioral skills (Baer, Carmody, & Hunsinger, 2012; Bishop et al., 2004; Linehan, 1993). Seen as such, they presumably influence a persons' functioning on multiple levels.

As a marker of individual differences, dispositional mindfulness as measured with FFMQ is related to a number of relevant health-related variables including aspects of personality, the propensity for cognitive failures (assessed with the Cognitive Failures Questionnaire [Broadbent, Cooper, Fitzgerald, & Parkes, 1982], which has also been used in the research on ReST), psychological flexibility, self-compassion, psychological health (e.g., Baer et al., 2006; Bluth & Blanton, 2014; Bohlmeijer, Ten Klooster, Fledderus, Veehof, & Baer, 2011; Bowlin & Baer, 2012; de Bruin, Topper, Muskens,

Bögels, & Kamphuis, 2012; Giluk, 2009). Other studies have established group-level differences in dispositional mindfulness between experienced meditators and non-meditators (e.g., Baer et al., 2008; Christopher, Neuser, Michael, & Baitmangalkar, 2012; Lykins, 2009).

Of greater relevance for the present purposes, however, are the studies that have considered the role of dispositional mindfulness in the ability to manage different types of challenges. For instance, Bullis et al. (2014) showed that people with higher dispositional mindfulness reacted with less anxiety to an experimental stress induction and recovered faster afterwards in terms of HR return to baseline. In another example, Evans, Baer, and Segerstrom (2009) showed that people with higher dispositional mindfulness were more persistent in attempting to solve difficult anagrams. A study by Brown et al. (2012) found that higher dispositional mindfulness was related to lower cortisol responses in a social stress induction. These results speak of the practical utility of high dispositional mindfulness or mindfulness skills. However, that knowledge is of limited use unless the involved capabilities can be improved. A study by Baer et al. (2012) considered dispositional mindfulness measured with FFMQ as a mediator of other health outcomes of mindfulness training. They showed that improvement in dispositional mindfulness preceded and mediated improvements in chronic stress (assessed with the Perceived Stress Scale [Cohen, Kamarck, & Mermelstein, 1983] which has also been used in the research on ReST). The next subsection covers the processes of improvement in mindfulness training.

Mindfulness training

Mindfulness training courses aim to relieve suffering and promote health through class meetings and regular mindfulness practice between classes over a number of weeks, all with guidance from a skilled instructor (Crane et al., 2017). The dominant framework for mindfulness-based training in the secular context has been MBSR (Kabat-Zinn, 1990). MBSR typically spans eight weeks across which participants complete homework assignments to meditate on most days with recorded instructions, and go to weekly class meetings characterized by a participatory learning process that includes theoretical discussions and homework consultation. Most mindfulness-based health interventions have more or less closely built on MBSR and included different adaptations in length, intensity, delivery format, and specific contents to suit specific populations or purposes (Crane et al., 2017). One such adaptation is mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002; Teasdale et al., 2000) which is tailored to people with recurring depression. The following subsections highlight some of the mechanisms that are thought to be involved in producing benefits with mindfulness training, focusing on those mechanisms that are particularly relevant for the work with ReST.

Mechanisms of development with regular practice

Conceived as a form of training, regular mindfulness practice over time can presumably accumulate in individuals to produce generalized benefits. Several potentially complementary and overlapping mechanisms of accumulation have been proposed (see Baer, 2003; Brown et al., 2007; Holzel et al., 2011). Among the proposed mechanisms are that mindfulness practice intervenes with avoidance behaviors in relation to negative experiences, thereby causing gradual exposure and desensitization (e.g., Arch & Craske, 2006) and that it teaches techniques for mitigating the influence of negative thoughts on behavior and mood (e.g., Teasdale et al., 2000). It has also been proposed that mindfulness practices promote skillful means of dealing with challenges (e.g., Baer, Carmody, & Hunsinger, 2012) and of regulating psychophysiological responses to stress (e.g., Shearer, Hunt, Chowdhury, & Nicol, 2016). Some authors have connected mindfulness more generally with behavioral regulation, enhanced efficiency of which could provide secondary benefits, for instance by facilitating a healthy life-style (e.g., Levesque & Brown, 2007). However, the mechanism that seems to have gained most traction in the past decade or so assumes neurocognitive enhancements in response to regular mindfulness practice (Chiesa, Calati, & Serretti, 2011; Holzel et al., 2011; Lutz et al., 2008; Malinowski, 2013; Tang et al., 2015). Presumably, these enhancements in central networks involved in attention regulation then transfer to generalized enhancements in self-regulation that improve health processes also outside of meditation sessions.

The proposed attention training mechanism is congruent with traditional views of meditation training (Grabovac et al., 2011; Lutz et al., 2007) as well as with contemporary notions of cognitive training and neuroplasticity (Lutz et al., 2008; Tang et al., 2015). In a further development, Posner, Tang et al. (Posner, Rothbart, Rueda, & Tang, 2010; Posner, Rothbart, & Tang, 2015; Tang & Posner, 2009, 2014) have formulated theory that delineates two different forms of attention training: attention network training and attention state training.

In attention network training, a person engages in repetitive effortful practice with the aim to stimulate enhancements of the specific neural networks that are involved in the practice. This has typically been the assumption invoked by authors concerned with other forms of “brain training” than meditation, such as working memory training (see Melby-Lervåg & Hulme, 2013; Rabipour & Raz, 2012; Tang & Posner, 2014). However, it also corresponds with conceptions of the practices employed in early stages of focused-attention meditation (Lutz et al., 2008; Malinowski, 2013; Posner et al., 2015; Tang & Posner, 2014) and with the assumption that such practice is attended by effort and frequent failures of control among beginning participants (Abdoun et al., 2019; Fox et al., 2016; Hasenkamp et al., 2012).

In contrast to attention network training, attention state training occurs when a person learns to draw on ongoing experience to balance their bodily and mental state to gain better access to existing attentional functions (Posner et al., 2010, 2015; Tang & Posner, 2009, 2014). As with attention network training, attention state training is not unique to meditation. Tang and Posner (2009) assume that the same mechanism is involved in restorative nature experience and draw parallels to attention restoration theory, which has not yet elicited much, if any, response from restorative environments researchers. In the context of meditation training, however, attention state training is most closely connected with open-monitoring practices (Posner et al., 2010; Tang et al., 2015; Tang & Posner, 2014). Tang and Posner (2009) plot idle mind-wandering and effortful control as opposing poles on a continuum where they consider that an optimal meditative state lies at the balancing point between these poles. They also sketch the time course of a process in attention state training, in which attention restoration constitutes an initial step that is shared between nature experience and open-monitoring practice. Open-monitoring further includes practices intended to deepen the state by adjusting the inflow of sensory impressions (e.g., by opening or closing eyes) and bodily processes such as the breath. Over repeated practice sessions, Tang and Posner (2009) assume that a person learns to balance the mental and bodily state more efficiently. The balanced state neither drifts off into mind-wandering, nor requires effort that leads to deterioration in the meditative state. The balanced state neither drifts off into mind-wandering that disrupts contact with the present moment and can prevent stress recovery (e.g., by allowing perseverative cognition; cf. Brosschot et al., 2006), nor requires effort that is associated with arousal and destabilizes the meditative state. With that balance comes efficient regulation of the autonomic nervous system that over time can lead to more generalized parasympathetic dominance characterized by enhanced attention regulation and relaxed preparedness (cf. Thayer & Lane, 2009).

Although open-monitoring may be less effortful than focused-attention practice, open-monitoring is commonly thought to be difficult for beginners who lack in ability to balance effortlessness with attentional stability (Lutz et al., 2008). According to dominant views in the mindfulness literature, beginners should first train their attention regulation capabilities through focused-attention exercises. Congruent with an attention network training rationale, most mindfulness courses for beginners emphasize focused-attention practices. At the same time, Tang and Posner's theorizing (Posner et al., 2010; Tang & Posner, 2009) suggests that attention network training may not be a necessary initial step in mindfulness training. Instead, the needed stabilization and enhancement of attention could be facilitated through attentionally restorative nature experience.

Brain changes with mindfulness training

Many studies have shown structural differences in brain networks associated with mindfulness training, as comprehensively reviewed by Fox et al. (2014), Holzel et al. (2011), and Tang et al. (2015). Fox et al. (2014) concluded that studies comparing experienced meditators against non-meditators consistently showed differences in several brain regions, including areas thought to be involved in meta-awareness (frontopolar cortex), processing sensory inputs from the body and environment (sensory cortices and insula), and self-regulation of behavior and emotions (anterior cingulate, mid-cingulate, and orbitofrontal cortices). A few longitudinal studies have indicated that some structural changes can emerge over just a few weeks (e.g., Holzel et al., 2011; Tang, Lu, Fan, Yang, & Posner, 2012; Tang et al., 2010). Tang et al. (2015) suggest that attentional enhancements with mindfulness training are mainly driven by activations in the anterior cingulate cortex during meditation practice. Tang et al. (2010) saw increase in anterior cingulate axonal density after two weeks' training and improved myelination after four weeks' training (also see Tang et al., 2012; Tang, Tang, Rothbart, & Posner, 2019).

In addition to the structural changes described above, long-term meditation training is related to changes in resting state brain activity. Creswell et al. (2016) and Taren et al. (2017) studied the functional connectivity of areas involved in cognitive control before and several days after a three-day mindfulness meditation retreat or a matched relaxation training retreat, among stressed adults. They found that the meditation retreat relative to relaxation training increased resting-state connectivity within the control network and between central control areas and the default mode network. Willful control over mind-wandering thus seemed to persist after the meditation retreat. However, the meaning of such changes is yet poorly understood (Berkovich-Ohana, Glicksohn, Ben-Soussan, & Goldstein, 2017; Irmischer et al., 2018).

Summary of the evidence for health benefits of mindfulness

Attention outcomes

Other approaches to cognitive training (e.g., working-memory training; Klingberg, 2010) have lost some momentum in the last decade after being subjected to rather forceful criticism for conceptual shortcomings and overextended promises (e.g., Melby-Lervåg & Hulme, 2013; Rabipour & Raz, 2012; Rapport, Orban, Kofler, & Friedman, 2013). Despite lively discussions regarding conceptual and methodological issues (see Davidson & Kaszniak, 2015; Vago, Gupta, & Lazar, 2018; Van Dam et al., 2018), few critical opinions have been raised regarding the feasibility of mindfulness training as a means to improve cognitive functioning (though see Lao, Kissane, & Meadows, 2016).

While many single studies have reported longer-term improvements in attentional functions and related cognitive domains, the existing reviews have generally found mixed or inconclusive results. A systematic review by Chiesa et al. (2011) included 23 studies that used objective outcome measures, some of which compared brief mindfulness inductions or full mindfulness courses against an active or passive control condition, and some of which compared experienced meditators against matched control participants. One important contribution of this review was that it related the findings to the different types of mindfulness practice delineated by Lutz et al. (2008). Chiesa et al. concluded that the early stages of mindfulness training that commonly emphasize focused-attention practices seems to improve selective and executive attention while open-monitoring seems to improve sustained attention. However, open-monitoring was confounded with meditation experience in the analyses.

A meta-analytic review by Eberth and Sedlmeier (2012) included a host of different outcomes, among them a generic category of attention measures obtained from eight studies. They also focused on mindfulness training interventions compared against passive control conditions for adults in the general population (i.e. excluding studies with clinical populations). The results showed medium sized average improvements across the various measures.

Gallant (2016) also focused on mindfulness training interventions compared to passive control conditions for adults in the general population in a systematic review targeting performance on tests of executive attention. The analyses were separate for tests of inhibition (6 studies), updating (3 studies), and shifting (5 studies), and showed consistent improvements only for inhibition while the effects on updating and shifting were more variable.

A recent meta-analytic review by Cásedas, Vadillo, and Lupiáñez (2019) included only randomized controlled trials that compared mindfulness training interventions (i.e. excluding studies using single practice sessions) to an active or passive control condition and that employed a performance test of executive attention. The sample of 13 studies passed checks for heterogeneity and publication bias. The results showed a reliable small-to-medium sized improvement for overall executive functioning, and in sub-analyses also for working memory and inhibitory control tasks. However, sub-analysis of cognitive flexibility tasks did not show reliable improvement.

Emotional and psychophysiological outcomes reflecting stress reduction

Several research reviews have concluded that mindfulness training has benefits for stress and different aspects of emotional functioning. An early meta-analytic review by Grossman et al. (2004) included 20 studies and showed medium sized improvements with mindfulness training on a pooled set of different mental health outcomes as well as for physical health outcomes. However, the degree of benefit was homogenous across healthy and patient populations and across controlled and uncontrolled studies.

The meta-analytic review by Eberth and Sedlmeier (2012) showed small-to-medium sized improvements with mindfulness training on stress (6 studies), anxiety (9 studies), general negative affect (13 studies) and positive affect (5 studies), emotion regulation (6 studies), and well-being (13 studies). The average improvement across studies was largest for self-reported stress.

A later meta-analytic review by Khoury et al. (2015) included 29 controlled studies of MBSR for healthy populations. The analyses showed large benefits for stress (9 studies), moderate benefits for anxiety (6 studies), depression (4 studies), distress (3 studies), and quality of life (4 studies), and small benefits for burnout (5 studies). However, the effects were heterogeneous across the studies: the benefit increased with the course length.

Sanada et al. (2016) performed a meta-analytic review of controlled studies of mindfulness training that assessed salivary cortisol as an index of stress. The analyses showed average small-to-moderate benefits in contrasts with active and passive control conditions. The effects showed some heterogeneity across the studies: the benefit increased with the course length and with the total time of mindfulness practice.

Despite these generally positive conclusions, several authors have pointed towards issues in the research and in the implementation of mindfulness as a health intervention. The next subsection summarizes some of those issues.

Issues in research and implementation

Training approach specificity and comparison conditions

Davidson and Kaszniak (2015), Van Dam et al. (2018), and Vago et al. (2018) have underscored that the strength of the evidence for mindfulness training suffers from heterogeneity and vague descriptions of the training methods. Many studies refer to mindfulness training generically without further description of the course contents or specific practices used. MBSR and MBCT – the most well-described approaches to mindfulness training – constitute exceptions. However, they both involve a mix of focused-attention, open-monitoring, and other practices so evaluations of their longer-term effects cannot inform conclusions about the working components (cf. Britton et al., 2018).

Furthermore, Davidson and Kaszniak (2015), Van Dam et al. (2018), and Vago et al. (2018) have pointed towards the lack of studies that use appropriate active control conditions. Among the exceptions, Schmidt et al. (2011) compared MBSR against a progressive relaxation course and MacCoon et al. (2012) compared MBSR against a health enhancement course that was matched in terms of the course structure. Davidson and Kaszniak (2015) stress the importance of matching length and homework requirements in comparison conditions, in addition to the usual concerns for fidelity and blinding.

In research on attention outcomes of mindfulness training, Johnson et al. (2015) note that several studies that employed several practice sessions over

a number of weeks obtained outcome measures directly after the last of those sessions (e.g., Tang et al., 2007; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), thus confounding training effects with practice effects. Given that focused-attention practice presumably incurs effort but trains attention over time, such designs are fatally flawed (as noted by Lymeus, 2008). Prominent authors in the field have underscored the need to differentiate between mindfulness as a practice and mindfulness as training (e.g., Davidson & Kaszniak, 2015); however, few if any researchers seem to have picked up on the implications of such differentiation for the interpretation of some highly cited studies of brief and short-term attention outcomes. Furthermore, it is difficult to know whether other studies have mistakenly drawn conclusions about generalized benefits based on attentional performance measures obtained shortly after practice because information about the exact timing of procedures has rarely been reported in mindfulness training studies.

Although the field has long since accepted the delineation between focused-attention and open-monitoring practice, it is only in the last year or so that studies have appeared that experimentally contrast the two approaches (Abdoun et al., 2019; Britton et al., 2018; Fujino et al., 2018). The study by Britton et al. (2018) describes the development and validation of two distinct versions of MBCT: one that emphasizes focused-attention practice and one that emphasizes open-monitoring. In this initial validation study, they showed that after the course, participants' had different beliefs about the purposes and health-promoting mechanisms of mindfulness training.

Acceptability and compliance

One issue that could potentially be of great importance for mindfulness research and practice but that has not been widely acknowledged is the uptake of mindfulness training in the population. Carlson (2018) notes that disproportionate numbers of those who seek mindfulness training are wealthy white western women. These characteristics tend to correlate with access to various resources that could support initial engagement as well as maintenance of mindfulness practice over time. Such resources were identified by Birtwell, Williams, van Marwijk, Armitage and Sheffield (2019), who report that meditators most frequently endorsed the supporting role of having practical resources, time and routine, support from others, as well as expectations congruent with the training rationale. Common difficulties included sleepiness and a lack of time. Extending on these observations, people who volunteer for mindfulness studies could differ on average from the population segments to which mindfulness researchers seek to generalize and apply their conclusions. For instance, the effort incurred with focused-attention practice might come through as a smaller issue in studies than it is for many of those to whom mindfulness training is recommended to remedy self-regulation problems.

A related problem that has drawn only slightly more research attention is that a substantial proportion of participants drop out or comply poorly with

the intended training program in common mindfulness courses. While Khoury et al. (2013) report an average drop-out rate of 16% from mindfulness-based therapies, Nam and Toneatto (2016) found an average drop-out rate as high as 29% in patient populations (also cf. e.g., Abbott et al., 2014; Abdoun et al., 2019; Lamothe, Rondeau, Malboeuf-Hurtubise, Duval, & Sultan, 2016). The theoretical framework put forth by Sekhon, Cartwright, and Francis (2017) describes compliance as a reflection of the acceptability of health interventions. A participant's compliance is thought to depend on the balance between perceptions of the effort and other costs of participation in relation to the resources available to meet those demands, and to the anticipated or experienced benefits of participation (as well as other aspects of less concern here). Poor acceptability in some subgroups of the target population can be a major problem in treatment evaluations and in practice (Hollon, Miller, & Robinson, 2002; Nam & Toneatto, 2016; Sekhon et al., 2017).

To date, only a few studies have addressed the causes of poor compliance with mindfulness training (Nam & Toneatto, 2016). Studying formerly depressed people participating in MBCT, Crane and Williams (2010) found that drop-outs initially had more problems with perseverative cognition (i.e. rumination), and greater decline in problem solving performance with a negative mood induction, than course completers with comparable emotional symptoms. In another study, Banerjee, Cavanagh, and Strauss (2018) showed that participants with more initial perseverative cognition (i.e. rumination and worry) had poorer compliance with an online mindfulness course. In a precursor to the present project, Lymeus, Lundgren, and Hartig (2017) saw that students with poorer initial performance on a test of general attention participated in fewer classes and completed fewer homework exercises in an MBSR course than participants with already stronger attention. Abdoun et al. (2019) saw that volunteers in their mindfulness training study practiced more with open-monitoring exercises than with focused-attention exercises despite instructions to practice equally with both. They also saw that the average rate of homework practice decreased markedly over the study weeks.

Deterioration and adverse events

Few studies have reported the occurrence of deteriorated health and adverse events in connection with mindfulness training. Baer et al. (2019) recently reviewed the existing literature and concluded that it is not rare to experience transient discomfort and exacerbation of intrusive thoughts or anxiety. Participants with certain psychiatric disorders may be particularly sensitive and have difficulty managing such transient discomfort and exacerbation (Baer et al., 2019; Dobkin, Irving, & Amar, 2012). However, many consider such experiences as natural parts of a therapeutic process, as in exposure to otherwise avoided experiences. A similar transiency could be the case with the effort that presumably is incurred with focused-attention practices but may lead to longer-term improvements. With regard to serious adverse events, Baer et al.

(2019) refer to several such reports but remark that none could determine whether mindfulness training was a cause. Concerning deterioration in general functioning and health, Baer et al show that it is not uncommon, but nor is it more common in mindfulness training conditions than in control conditions; in both types of study conditions, the occurrence of deterioration is around 10% on average across studies. Baer et al. conclude that the occurrence of deterioration can probably in most cases be explained by factors external to the training. The authors do, however, encourage researchers to report on deterioration. That requires outcome evaluations on an individual level rather than simply with regard to the group average.

Integrating Mindfulness with a Restorative Natural Setting

Section summary

This section summarizes previous work connecting mindfulness and nature before going on to conceptualizing the meditation setting, defining principles and purposes of integrating the two approaches, and identifying complementarities between the two with regard to practices and processes. The section then describes considerations in imposing a learning structure on restorative processes and how ReST is intended to work in practice. Readers are presumed to be familiar with the background provided in preceding sections so citations are only used sporadically here to make specific points. The next section then presents the aims of the empirical works.

Parallel research connecting mindfulness and nature

Connections can readily be identified between restorative experience in nature and meditative experience. Olmsted wrote in his report on Yosemite and the Mariposa grove (1865) that:

“[T]he interest which natural scenery inspires . . . is for itself and at the moment it is enjoyed. The attention is aroused and the mind occupied without purpose, without a continuation of the common process of relating the present action, thought or perception to some future end. There is little else that has this quality so purely. There are few enjoyments with which regard for something outside and beyond the enjoyment of the moment can ordinarily be so little mixed. The pleasures of the table are irresistibly associated with the care of hunger and the repair of the bodily waste. In all social pleasures and all pleasures which are usually enjoyed in association with the social pleasure, the care for the opinion of others, or the good of others largely mingles. In the pleasures of literature, the laying up of ideas and self-improvement are purposes which cannot be kept out of view. This, however, is in very slight degree, if at all, the case with the enjoyment of the emotions caused by natural scenery. It therefore results that the enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system.”

As noted at the outset, meditation in nature also has deep historical roots (e.g., Fabjański & Brymer, 2017; Fisher, 2007, 2014). A Google search on August 29th 2019 using the search term “meditation in nature” revealed that it also has contemporary appeal as reflected in some 540 000 hits. It has, however, received limited attention in the scientific literature. In fact, surprisingly few studies have considered meditation as an environmentally situated practice at all. There are some exceptions, most of which have appeared in the years since

the work with ReST was initiated (see Djernis et al., 2019). The current literature can be roughly organized into six categories that I summarize in the subsections below. For each category, I also indicate what differentiates ReST from the other work.

Shinrin-yoku

One category of studies refer to shinrin-yoku, a Japanese practice of taking in nature with all senses that lately has gained popular attention in North America and Europe under the name forest bathing (Hansen, Jones, & Tocchini, 2017; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010). Shinrin-yoku has been advanced as a complementary or alternative method for managing the physiological symptoms of stress. However, the shinrin-yoku literature has mostly developed independently from restorative environments research and other branches of nature and health research as well as from the mainstream of meditation science. In contrast to ReST, shinrin-yoku studies have thus not been connected with established theory. They have also concerned single visits with a basic meditation practice that is not apparently organized within a structured course of training intended to provide lasting adaptive benefits.

Mindfulness-enhanced nature contacts

Another category includes studies that are more firmly grounded in current theory, which has been applied to enhance restorative experiences through prompts or instructions that guide attention, curiosity, relaxation, and other processes that could heighten mindfulness in nature visits (e.g., Duvall, 2011, 2013; Korpela, Savonen, Anttila, Pasanen, & Ratcliffe, 2017; Lin, Tsai, Sullivan, Chang, & Chang, 2014; Pasanen, Johnson, Lee, & Korpela, 2018). In contrast to ReST, these studies have not typically referred to their interventions as mindfulness although some have referred to meditation literature. Also, the brief prompts and instructions differ from the full meditation instructions that are used in ReST to guide and pace a person through a progression of practices in the environment. These studies further lack a structured progression of training over repeated visits.

Nature-enhanced mindfulness practice

A third category is concerned with how nature-inspired scenes and stimuli presented in different technological modalities such as virtual reality and mobile phone applications can support meditative states and practices (e.g., Chandrasiri, Collett, Fassbender, & De Foe, 2019; Costa et al., 2019, 2018; Gromala, Tong, Choo, Karamnejad, & Shaw, 2015; Kosunen et al., 2016; Salehzadeh Niksirat, Silpasuwanchai, Mohamed Hussien Ahmed, Cheng, & Ren, 2017). Several of these studies have referred to restorative environments theory for guiding principles in designing the technologies. In contrast to ReST, however, such technologies do not allow for full sensory connection and exploration of a dynamic and living environment. The studies have also

not included a progression in practices organized within a structured course of training over time.

Mindfulness as part of nature-based therapy

A fourth category has emerged within the broader field of nature-based therapy. In this context, some studies have included mindfulness training as part of garden-based treatment or rehabilitation programs for people with stress-related illness (e.g., Corazon, Nyed, Sidenius, Poulsen, & Stigsdotter, 2018; Willert, Wieclaw, & Thulstrup, 2014). Other studies have evaluated extended wilderness programs for people with behavioral or substance abuse problems (e.g., Combs, Hoag, Javorski, & Roberts, 2016; Russell, Gillis, & Heppner, 2016). In contrast to ReST, these studies have used mindfulness concepts and practices together with multiple other activities and therapeutic techniques. Although some studies have built on elaborated theory (see e.g., Corazon, Stigsdotter, Moeller, & Rasmussen, 2012) they have not exclusively nor extensively integrated mindfulness and restorative environments theory.

Mindfulness and connectedness to nature

A fifth category deals with the relationship between mindfulness and people's sense of connectedness with nature (Barbaro & Pickett, 2015; Schutte & Malouff, 2018; Wolsko & Lindberg, 2013). The construct "nature connectedness" (or "nature relatedness") refers to a general attitude toward nature (Brügger, Kaiser, & Roczen, 2011) rather than to the specific experiences of connection in specific nature contacts that are of central concern in ReST. However, some of this research has developed theory regarding how mindfulness and related experiential qualities supported in nature contacts may mediate the outcomes (see Barbaro & Pickett, 2015; Howell et al., 2011; Van Gordon, Shonin, & Richardson, 2018). Several recent studies have also used mindfulness-based instructions to enhance the proposed processes (Aspy & Proeve, 2017; Nisbet, Zelenski, & Grandpierre, 2019; Unsworth, Palicki, & Lustig, 2016; Wang, Geng, Schultz, & Zhou, 2019). In contrast to ReST, these studies have not included a progression in practices organized within a structured course of training over time. They also have not been directly concerned with restoration or with the attentional processes involved.

Mindfulness and sustainable development

A sixth category that to some extent overlaps with the preceding one is concerned with the relationships between mindfulness and pro-environmental attitudes and behaviors (e.g., Barbaro & Pickett, 2015; Fischer et al., 2017; Geiger, Grossman, & Schrader, 2019; Panno et al., 2018; Wamsler et al., 2018). In contrast to ReST, most research in this area has involved cross-sectional surveys aiming to determine the statistical relationships between measures of dispositional mindfulness and other constructs. One study employed contrasts between experienced meditators and non-meditators (e.g., Panno et al., 2018),

though without considering the meditation setting. The proposed processes and outcomes also differed from those of concern in ReST.

Conceptualizing the meditation setting

The work with ReST assumes that the setting matters in meditation. It has considered how physical setting characteristics could interact with meditation practice and phenomenology and how verbal instructions can modulate that relationship. It has also considered how growing meditation experience or skill could reshape the person-environment transaction in meditation. Building on the idea that restorative environments both permit and promote restoration, this subsection outlines some of the ways that different setting characteristics can be understood to permit and promote mindfulness and meditation.

Many meditators, meditation instructors, and meditation institutions create a time and place for meditation that is at least conceptually, but often also physically, separate from other mundane settings and activities. The meditation setting can thus be defined by its spatiotemporal boundaries as well as by a psychological shift away from other possible activity patterns within the environment (akin to the task-set discussed by Lutz et al. [2015]). Considered as a behavior setting (see von Lindern et al., 2017), the physical characteristics of meditation settings necessarily support a given set of activities and concomitant experiences and at the same time prohibit other activities, or facilitate the inhibition of them. The various structural elements, ambient qualities, objects, processes, and activities that make up a meditation setting can be presumed to exert influence on a meditator through their evolved stimulus functions as well as through their culturally and personally defined significance.

The meditation setting includes the physical place characteristics that provide a meditator with a particular array of perceptual inputs through the senses (i.e. interoceptive and tactile sensations, sounds, visual patterns, smells and tastes). Meditation settings are sometimes selected and adapted to provide a relatively low level of stimulation by for instance slightly dim lighting conditions and shielding provisions that limit outside sounds. Many also include specially arranged seating provisions. Together, these and other conditions can be seen as environmental properties that permit meditation. Many meditation settings also provide the sounds of meditation bells or music, patterned or figurative artwork, burning incense, as well as plants, stones, water, and other specially selected features. Through their cultural and learned significance, these can serve to define the setting specifically as a setting for the activity of meditation and therefore potentially support a sense of psychological distance (i.e. being away and decentering) from demands and routines. Many of them also provide potentially fascinating stimulation that can softly draw and hold attention to present moment experiences and support curiosity. Such characteristics would promote mindfulness and meditation.

Meditation can also be seen as occurring in a verbal setting. Meditation settings frequently include the voice of an instructor that carefully guides and paces the activity and that introduces potentially fascinating and cognitively undemanding verbal content to the experience (e.g., through the use of metaphors and insightful turns of phrase; see Hayes [2004] and Hayes & Wilson [1994] for elaboration on the use and function of metaphors). With a fascinating and undemanding physical environment that permits and promotes patterns of sensory exploration that progress over time, a meditation setting could similarly guide and pace meditative activity. Various features and processes could also serve metaphorical functions and promote insights with relevance for the practice and for relating to causes of suffering in life (e.g. as pertaining to impermanence, growth, et cetera).

Given the small and large signs of care that many meditators put into selecting arranging meditation settings – from a quiet spot in the home or workplace to a special place by a lake or a centuries-old Zen garden – the setting is apparently important for their practice. The setting characteristics might sometimes be more important than the specific practice approach, especially so in the very early stages of meditation training. After all, only after some basic level of meditation skill has been established can a person be expected to regulate the meditative state top-down with some degree of efficiency and thus begin to build an independence from contextual aspects of the situation. In conventional mindfulness training, increasing meditation experience is usually marked by a transition to open-monitoring practices in which sensory connections with environmental stimuli are allowed and enhanced as part of the meditation. In ReST, the setting is selected with the aim to support meditation and therefore allowed and enhanced as part of the practice from the start.

Principles and purposes of integration

ReST goes beyond other studies that have connected mindfulness and nature. ReST is firmly grounded in established theory restorative environments research and mindfulness research, and builds on an elaborated integration. It also employs a structured course of training over time intended to teach a variety of relevant practices and skills rather than simply induce a mindful state, and it uses a fully immersive field setting rather than technologically mediated or laboratory-based nature proxies. The research approach also differs from previous work in that it relates the theoretically relevant practices and processes to short- and long-term outcomes and so can give unique insight into the involved mechanisms. The following subsections describe the principles and purposes of the integration and its practical application in ReST.

Similarity and complementarity

Restorative environments theory and mindfulness theory share a concern for bolstering attention regulation capabilities to promote general functioning and

health. The proposed processes involved in such enhancements seem closely related, as most notably seen in the conceptual overlap between constructs put forth by Kaplan and Kaplan (1989; Kaplan, 1995) in ART (i.e. being away and soft fascination) and those put forth by Bishop et al. (2004) in their often cited operational definition of mindfulness (i.e. decentering and curiosity). These similarities give an initial indication that the two approaches could mutually support each other. However, the two approaches also differ in important ways. Restorative environments theory sees the experience of being away and soft fascination as regulated in a bottom-up fashion by environmental features while mindfulness theory sees decentering and curiosity as regulated in a top-down fashion by the individual. The two approaches also differ in how they see the driving mechanisms and temporal progression of attentional changes. Restorative environments theory sees effortless attentiveness to environmental features as promoting restoration of depleted attention regulation capabilities over the course of a single nature visit. Mindfulness theory sees attentional enhancements over several weeks as driven by neural activation patterns in repeated sessions of effortful attention network training.

Given these differences, it becomes clear that simply adding the two approaches together might not activate mutually supportive processes. Rather, there is potential for conflict between the two approaches. An integrated approach gains from drawing not only on similarities but also on differences that can serve complementary functions. ReST builds on the assumption that any benefit that could not be achieved with either approach alone relies on identification and effective use of points of complementarity between the two.

Overcoming major disadvantages of each approach

As shown in the section *Mitigating the Challenges of Modern Living*, a major issue for modern societies has been to secure sufficient access and use of natural areas with high restorative quality for urban populations (see Bratman et al., 2019; Schwarz et al., 2015). When access can be gained, however, restoration is thought to proceed effortlessly and spontaneously and provide greatest benefit for those who need it most; that is, for those who struggle most to meet the demands in their lives. In contrast, as shown in the section *Mindfulness Training*, a major issue for effective implementation of mindfulness training has been that the demands incurred with the training are relatively high for people who already struggle to meet the demands in their lives (see Banerjee et al., 2018; Crane & Williams, 2010). Hence, many of those who would have most to gain from beginning mindfulness training will not complete the training and achieve benefits. Indeed, it makes sense from the dynamic resource perspective of restorative environments research that individuals who already struggle to meet the demands in their lives might be unwilling or unable to spend much of their limited free time in further efforts to maintain focus and composure during focused attention meditation exercises, even with expectations of longer-term benefits. They may experience a more primary need for

relief from regulatory demands and restoration of depleted regulation resources. On the other hand, their longer-term development could be improved if they gained adaptation capabilities that can make them better able to handle future demands. For those who do complete mindfulness training, enhancements in adaptive capabilities are thought to be widely useful so functioning is improved in a generalized and sustained way.

The overarching practical function that ReST is intended to serve is to draw on the low personal investment required by the restorative environments approach and on the possibility for generalized enhancements in adaptation skills that the mindfulness training approach affords, to overcome the weaknesses of the respective approaches. Against the background of wide-spread stress-related problems in modern societies and the enduring difficulty in finding effective and practicable means to address them, ReST could thereby serve important functions in facilitating the introduction to mindfulness training for many of those who would not be willing or able to invest in more demanding training. Through training in relevant skills, ReST could also enhance restorative benefits of nature contacts even when they are limited in spatiotemporal scope or quality so urban people will in effect be better served by the natural amenities that are available to them. By preserving a progressive learning structure in the ReST course, training in relevant mindfulness and restoration skills could improve functioning in a generalized and sustained way. Table 1 summarizes these points.

Table 1. *Conceptual summary of how disparities in short-term investment demands and long-term versatility between restorative environments (RE) and conventional mindfulness training (CMT) are integrated in restoration skills training (ReST).*

	RE	CMT	ReST
Short-term investment	Low: Restoration with environmental support	High: Practice requires effort	Low: Practice with environmental support
Long-term versatility	Low: Regular visits sustain adaptation	High: Enhancements generalize to many situations	High: Enhancements generalize to many situations

Resource dynamics in practice and training

ReST aims to mitigate the demand on attention regulation resources incurred in beginning conventional mindfulness training. It also aims to build generalized and versatile skills that could improve adaptation in many situations, to overcome the spatiotemporal limitations of relying on nature experience. Hence, instead of returning a short-term resource investment in effortful prac-

tice with longer-term gains achieved with regular practice over time (as focused-attention practice in early stages of mindfulness training does; cf. Lutz et al., 2008), an investment in ReST practice should be mitigated with environmental support for the practice and compensated with short-term restoration. However, relative ease and restoration in ReST must also be complemented with longer-term gains. ReST therefore preserves the structured learning process from conventional mindfulness training that ensures generalized enhancements in regulation capabilities. Table 2 summarizes these points.

Extending on the theory put forth by Tang, Posner et al. (Posner et al., 2010; Tang & Posner, 2009), restorative nature experience can initiate and facilitate attention state training. With regained access to attention regulation capabilities and low stress, a person can presumably train in skills that support low-effort monitoring processes and facilitate efficient regulation of the mental and bodily state. By building on restorative qualities in the setting, ReST could therefore teach versatile self-management skills that will allow participants more complete access to their attention regulation capabilities in many situations. ReST participants should thereby be able to connect with enhanced efficiency and attunement to restorative qualities in the setting. They should also achieve longer-term improvements in general adaptive functioning that could approximate the gains achieved through attention network training.

Figure 1 shows conceptually how ReST seeks to alternate between and ultimately join attention restoration supported bottom-up by the meditation setting with skillful monitoring supported by training in open-monitoring practices. In contrast, conventional mindfulness training in early stages relies mainly on attentionally depleting focused-attention practices. Over time, conventional mindfulness training increasingly transitions to low-effort open-monitoring practices.

Table 2. *Conceptual summary of how disparities in resource dynamics between restorative environments (RE) and conventional mindfulness training (CMT) are integrated in restoration skills training (ReST).*

	RE	CMT	ReST
Short-term outcome	Improvement determined by need	Deterioration determined by investment	Improvement determined by need and skill
Mechanism of progression	Management through regular restoration	Attention network training	Attention state training and enhanced regular restoration
Long-term outcome	Sustained adaptive functioning	Enhanced adaptive functioning	Enhanced adaptive functioning

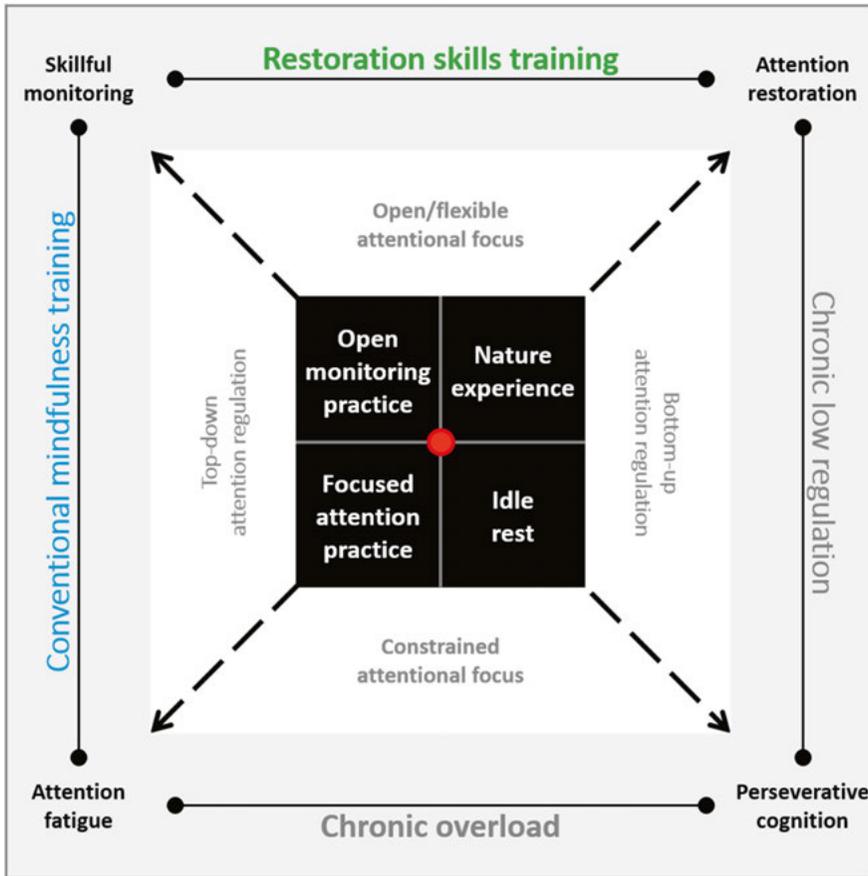


Figure 1. A person with concentration problems (red central dot) can engage with focused-attention practices that require top-down attention regulation with a constrained focus. Over time in practice, that leads to depletion of attention regulation capabilities. By supporting opposite attentional patterns characterized by bottom-up attention regulation and flexible focus, engaging with nature experience can mitigate depletion through a process of attention restoration. With idle rest without any specific task or external support, the person will become distracted by salient thought contents when attention is regulated bottom-up and constrained. By engaging in open-monitoring practices, the person can train in monitoring skills that sustain a state characterized by top-down attention regulation and high flexibility. Restoration skills training alternates between training in monitoring skills and restorative attention regulation processes supported by a natural meditation setting. Conventional mindfulness training, in contrast, moves along the dimension between fatiguing focused-attention practice and less effortful skillful monitoring. Without engaging with any practice or supportive environment, the person will instead tend to loose connection with the immediate present and be prone to perseverative cognition.

Complementarities in practices and processes

Considering the disparities rather than merely the similarities between restorative nature experience and mindfulness allows integration with regard to the practices and processes involved. Building on that integration, ReST is intended to mutually support and enhance aspects of each approach. Table 3 summarizes the main points from this subsection.

Table 3. *Conceptual summary of how disparities in practices and processes between restorative environments (RE) and conventional mindfulness training (CMT) are integrated in restoration skills training (ReST).*

	RE	CMT	ReST
Attention networks	Exogenous orienting	Endogenous orienting and switching	Orient to stimuli that hold attention exogenously
Attentional effort	Low	Moderate	Low to moderate but offset with restoration
Regulation	Bottom-up	Top-down	Skillful alternation supported by monitoring processes
Approach orientation	Soft fascination	Curiosity	Draw on mutual support
Distraction management	Psychological distance	Decentering	Draw on mutual support

Attention networks and effort

Mindfulness meditation conventionally relies on endogenous orienting and sustaining of attention to a given object and the executive capabilities involved in switching attention away from distractions and back to the object (cf. Lutz et al., 2008; Tang et al., 2015). These attentional functions rely on inhibition of competing processes and are often attended by experiences of effort. The effort incurred depends in principle on how low a persons' available attention regulation capabilities are, how weak the stimulus properties of the object are, and how abundant and strong the potential distractors are (cf. Hockey, 1997; Lavie, 2010). In contrast, restorative nature experience regulates attention exogenously (bottom-up, through softly fascinating properties) and without imposing any specific object of focus. Attention can thus be sustained with rela-

tive stability without effort. Because natural settings typically involve a relatively high perceptual load and low cognitive load, they shield the field of consciousness from distractions.

In order to draw on the advantages of both approaches, ReST relies mainly on the setting to release attention from mental contents related to preceding activities. It then employs endogenous regulation of attention to initiate focused processing of given objects. The objects are selected for their high potential to evoke soft fascination. ReST then relies on softly fascinating stimulus properties to sustain attention exogenously and effortlessly. With the transition to exogenous regulation of attention, attention restoration processes will compensate for effort expended in the earlier, endogenously regulated stages of the practice. ReST thus compensates a relatively low initial attentional resource investment with restoration that over the short-term reinstates and in most cases probably further enhances attention regulation capabilities. With the loss of attentional focus in the practice, a person will therefore be well equipped to reengage attention.

Synergy and alternation between bottom-up and top-down regulation

ReST also uses the potential for complementarity between the spontaneous bottom-up and the volitional top-down directionality of the processes that underlie the otherwise similar experiential qualities in restorative nature experience and mindfulness. In any moment, a meeting of bottom-up (i.e. soft fascination) and top-down forces (i.e. attentional focus characterized by curiosity) that both serve the regulation of attention towards the same object will likely strengthen and bolster that connection above and beyond what either force could accomplish alone. ReST therefore uses softly fascinating objects and processes in the environment that can draw and hold attention effortlessly while also using practices intended to enhance curiosity through exploration of sensory impressions.

Within a practice session, alternation between a relative emphasis on bottom-up and top-down regulation of the meditative state is exemplified and initiated through instructions. In free exploration, a participant can then practice independently in alternating the relative influence of bottom-up and top-down processes to maintain a strong and steady sensory connection with environmental features. Such alternation can proceed as needed given the participants' current regulation capacity and the degree of soft fascination that a given object can elicit. Beginning meditators with low attention regulation capabilities will likely benefit from a high degree of bottom-up support when they must first gain focus and composure as they enter the meditation setting and establish a meditation task-set. Then in initial stages of the meditation, they will presumably benefit from more of top-down regulation to dampen mind-wandering processes and overcome possible boredom by enhancing connection with environmental stimuli. Once a strong connection with sufficiently fascinating environmental features has been established, they can rely

more on bottom-up regulation again. Over the course of meditation practice, background monitoring of the field of consciousness will allow them to proceed as needed by applying more top-down regulated focus and curiosity whenever the attentional stability weakens. In ReST, focused-attention practice should thus constitute a brief, intermediate stage between initial soft fascination and later, prolonged open-monitoring that relies on low-effort monitoring processes and only occasional and mild reactivation of top-down regulation across an extended experience.

Mindfulness processes that support restoration

Experiences in commonly available natural environments are often suboptimal in some way. The experience can fail to provide sufficient psychological distance from the normal routines and demands, or be perceived as relatively mundane and uninteresting (cf. Kaplan, 1995). It can also be constrained by interference from ambient conditions (e.g., traffic noise) or lack in spatial or temporal extent (e.g., in a small park, on a short work break). Even with ample access to qualitative restorative environments, residual individual-level connections with demands (e.g., through perceived setting interdependencies, mobile technology, or perseverative cognition) can hinder and constrain restoration (cf. von Lindern, 2017). Hence, although restorative environments theory does not specify any particular individual characteristics or special skills that are necessary to drive restorative processes, it does indicate several processes that could be enhanced with meditation training.

Looking to the process components of mindfulness, training in engaging with experience with curiosity could likely enhance the sense of fascination with otherwise relatively mundane stimuli and mitigate boredom. Training in decentering could likely support the sense of being away from demands and routines as well as reduce negative influences of encounters with constraining features. Furthermore, training in decentering could likely ensure flexibility in highly fascinating settings, by facilitating switching when stimuli grab attention in a more than soft fashion.

In keeping with the aims to permit and promote restoration, the training in these practices in ReST is adapted to require minimal investment in terms of effort. ReST therefore draws on restorative processes to support the training.

Restorative processes that could support mindfulness

Many beginning meditators, especially those with low attention regulation capabilities, struggle with thoughts, boredom, discomfort, or distractions during practice (cf. Frewen et al., 2016; Hasenkamp et al., 2012). ReST therefore seeks ways that a restorative environment can facilitate the learning of skills in curiosity and detachment. In contrast to focused-attention practices that target a given object, and in contrast to inwardly directed open-monitoring practices that target routine mental contents including mind-wandering processes,

ReST emphasizes practice with undemanding and softly fascinating environmental features that can help a person to relate with curiosity to the present reality. An environment that also supports psychological distance from demands and routine mental contents can help to shield the field of consciousness from mind-wandering processes and facilitate regulation of autonomic nervous system activity. A restorative environment can thus provide a supportive setting for training in curiosity and detachment. However, ReST also aims to facilitate regulation in difficult experiences in order to enhance general functioning. Once a person engages with environmental features with curiosity and decentering, these person-environment transactions are therefore used as learning opportunities, where the relationship with external objects serves as an example or metaphor for how a person can relate to thoughts, emotions, and bodily sensations as the exercise progresses. This is akin to the proposition by Berkovich-Ohana and Glicksohn (2014) that in advanced stages of mindfulness training, meditators can monitor default mode network activities in a similar manner as they normally monitor the environment.

Considerations in imposing a learning structure on restorative processes

ReST is intended not only to support mindfulness experiences and practices during classes and sessions but also to promote learning of versatile skills. This subsection discusses some issues that require consideration in imposing a learning structure on restorative experience and in reconciling restoration with training. Table 4 summarizes the main points from this subsection.

Table 4. *Conceptual summary of how a restorative environment (RE) learning structure between and conventional mindfulness training (CMT) are integrated in restoration skills training (ReST).*

	RE	CMT	ReST
Temporal structure	Spontaneous repetition determined by need and access	Scheduled regularity with learning progression	Scheduled regularity with learning progression
Constraints	Access and quality	Available resources to invest	Restorative opportunities within course structure
Verbal instructions	Unguided, spontaneous	Verbal guidance and pacing	Initiate with guidance, maintain in free exploration
Progression within sessions	Unguided, spontaneous	Verbal guidance and pacing, enhanced with skill	Guidance and spontaneous progress facilitate skill

Classes and homework practice

The temporal structure of restorative nature experience is determined spontaneously by a person based on perceived needs and on access. Variations in need and access are, in turn, determined by regular activity patterns within the persons living environment. In contrast, mindfulness training is often initiated within the fixed structure of a course with scheduled class meetings and recommended regularity in homework practice. That structure is intended to promote a certain learning progression (cf. Crane et al., 2017). Given the aim in ReST to teach versatile skills, it retains the structure and learning progression of conventional mindfulness courses grounded in MBSR.

By imposing a course structure and setting the class meetings in a restorative environment, ReST works to overcome limitations on access and quality of nature experience that may constrain restoration in daily life. At the same time, an imposed structure might in some cases dampen restoration when a perceived need for restoration is not a determinant of the specific visit. This should be a minor problem because nature settings and mindfulness can provide benefits beyond restoration. By ensuring regular access to a qualitative restorative environment, ReST can also help to secure the availability of resources to invest in the practice. For the homework practice, however, ReST does not require or specifically endorse practice in natural settings because that could impose constraints related to access and quality of nature experience in a person's daily life on the learning progression. Instead, ReST homework instructions encourage participants to connect with sensory aspects of their usual environments. While this cannot ensure that participants will find support for their practice in mundane settings, it could have the advantage to potentiate restorative opportunities in daily life by promoting connection with otherwise perhaps overlooked environmental qualities.

The use and form of verbal instructions

Conventional mindfulness practice is typically directed by an instructor and frequently entails relatively strict constraints on movement and attentional focus. One important purpose of that is to promote connection with experiences, not least with the many and varied discomforts that tend to arise with prolonged sitting and focusing but also with subtle and pleasant experiences that can go unnoticed in the normal flow of activity. However, another purpose is to train beginning meditators in regulating the meditative state top-down.

In contrast, restorative environments theory does not specify given practices that are conducive of restoration because it is concerned with spontaneous activities and effortless experiences that tend to arise more easily with the support of a natural environment. In fact, restorative environments theory assumes that a relative absence of demands and constraints on activity is characteristic of natural environments compared to most built environments. The

resulting allowance for a broad spectrum of activities and experiences presumably relieves needs to direct attention and self-regulate action. With the integrated approach in ReST, however, meditation instructions are used to guide and pace the particular practices that presumably will help a person to engage more mindfully with experience in the environment. These instructions must be carefully used and worded because direction and constraints can limit the restorative potential in the transaction with the environment by imposing self-regulatory demands. Instructions are therefore used to help meditators become grounded and connected with the environment and initiate sensory exploration, whereafter ReST practice transitions to minimally guided or unguided exploration in the environment.

The ReST approach aims to use practice instructions to enhance attentiveness and curiosity in connection with environmental features with only minimal demand on attention regulation capabilities. More specifically, the instructions are formulated to help beginning meditators to become grounded in the activity and environment, and to stay with and explore experiences with curiosity so that they are able to connect with fascinating features that could otherwise go unnoticed. The instructions therefore guide participants in exploring ways to engage with environmental features. The ReST approach also aims to use practice instructions that promote decentering and help meditators manage potential distractions with minimal effort. The instructions therefore guide participants in embracing all aspects of present experience and in maintaining engagement with environmental features even when thoughts and emotions bring additional facets to the experience. The instructions therefore avoid any reference to redirecting attention to a given object, and instead guide participants in extending the scope of focus to include environmental features as well as any thoughts and emotions that arise.

The specific wording of meditation instructions matters for how beginning meditators understand and apply the practices (cf. Britton et al., 2018). Hence, ReST relies on a terminology intended to avert any associations to effortful control of attention or mental contents. The ReST exercise instructions instead aim to achieve similar purposes by guiding meditators to let themselves be oriented towards pleasantly interesting experiences, let their attention be regulated by the sense of fascination and being away that the environment affords, and embrace and open up to any and all experiences that arise in the practice. Figure 2 shows conceptually how the instructional language in ReST supports the engagement of attentional and attitudinal mindfulness processes in a bottom-up fashion in transactions with the natural meditation setting. The figure also contrasts this with the top-down processes engaged with focused-attention practice instructions in CMT.

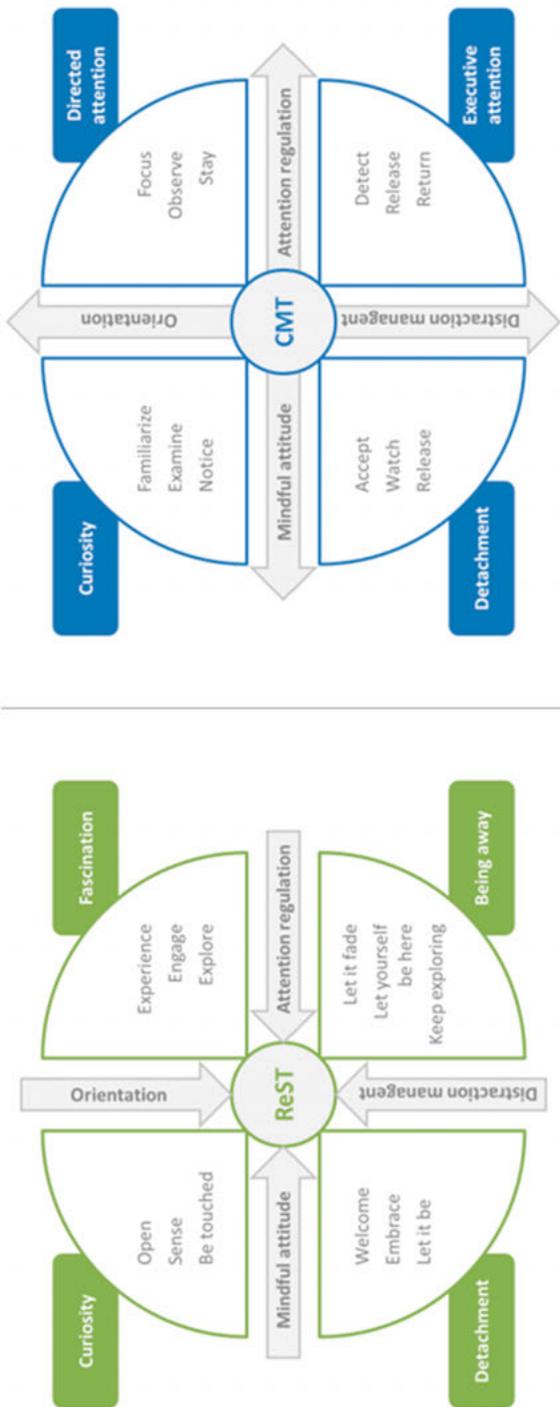


Figure 2. Concept image showing how the instructional language supports the engagement of attentional and attitudinal mindfulness processes in a top-down fashion in transactions with restorative qualities in the natural meditation setting in restoration skills training (ReST), as opposed to in a bottom-up fashion in conventional mindfulness training (CMT) that emphasizes focused-attention practice in indoor settings. In ReST, the attentional orientation is determined by the interplay of curiosity and fascination, attention is regulated by environmental supports of fascination and a sense of being away, distractions are managed through mutually supportive aspects of being away and decentering, and a mindful attitude is supported by environmental features that promote decentering and curiosity. In CMT, attention is endogenously oriented to a given object by the application of directed attention and a curious attitude, attention is regulated in an interplay between directed attention and executive abilities that support attentional switching, distractions are managed by executive switching capabilities together with decentering processes, and a mindful attitude is achieved through wilful engagement of curiosity and decentering.

Progression within sessions

Restoration can proceed spontaneously given the needed permitting and promoting environmental properties. However, it does frequently require an initial decision to temporarily leave other activities and go to a restorative environment. Once there, gentle exogenous support for the orienting network maintains attentional stability over time. Although understanding of the temporal progression of restorative processes is underdeveloped, Kaplan and Kaplan (1989) proposed an initial stage of clearing the head from residual thoughts related to preceding activities, followed by restoration of attention regulation capability, advancement to a stage of cognitive quiet, and finally a stage of deep reflection that may lead toward a deepened sense of oneness with nature.

Meditation also requires an active decision, which has been described in terms of a task-set. The proposed progression resembles that described for restorative experience. Mindfulness meditation instructions normally begin with focused-attention practice to clear the head and reduce stress (cf. Lutz et al., 2015, 2008). This initial practice presumably enhances attentional focus, dampens default-mode processes, and facilitates attention-regulation. More experienced meditators can then proceed to open-monitoring practice in which they allow different internal and external stimuli to enter and leave awareness while they maintain a steady state of monitoring the field of consciousness. With that comes the development of reflexive awareness where a person can gain insight into how automatic mental processes shape their experience and begin to transcend the sense of separation between the self and the world. Although it is attended by lower effort because it relies on monitoring processes rather than attention regulation, open-monitoring is still presumed to be achieved through top-down processes.

Presumably, then, both approaches can engender an initial clearing of thoughts followed by enhanced attention to present experience and a dampening of automatic processes that reflect default mode network activity. Ultimately, mental room for reflection supports transcendence of the boundaries between the self and the surrounding environment. Given that ReST can draw on environmental support for attention regulation and thereby allow beginning meditators to engage with prolonged open-monitoring practice, it could make progression through more advanced stages characterized by reflexive awareness and possibilities to experience transcendence and oneness available with less time in training.

How ReST ties it all up in practice

Meditation sessions

The ReST approach to mindfulness training in a natural setting builds on an assumption that underlies restorative environments theory (Kaplan & Kaplan, 1989; Ulrich, 1983) which is also reflected in the traditional roots of contemporary mindfulness training (Fisher, 2007): Humans can more easily adapt to natural conditions that correspond with our evolved cognitive and psychophysiological system than we can to conditions that commonly prevail in urban built settings. When adaptation is seen as an ongoing process, it does not begin nor end with an acute stress response. Rather, adaptation continues throughout daily life. When external conditions are unchallenging, high flexibility around a low average level marks healthy preparedness (Thayer & Lane, 2009). The cognitive system will be attuned to the subtle variations in ongoing experience: attention will smoothly shift or steadily rest when softly driven by positively motivated pursuits such as curiosity. A person with good access to attention regulation capabilities and a low stress level will fairly easily find peace in the low-level stimulation and have room left over for reflection. However, for people who come in to the situation with depleted attention regulation resources and/or high chronic stress, simple idleness tends to be aversive rather than restful. With weakened attention control, emotional processes with negative valence will dominate the psychophysiological system and default mode network processes will dominate conscious experience (Raichle & Snyder, 2007; Smallwood & Schooler, 2015). The mind will tend to wander and get stuck with negative past events or feared future events. With this, physiological arousal will tend to linger at an elevated level and experiences of restlessness will intensify.

In engaging with focused-attention practice, a person can temporarily break this undesirable pattern by an effort of will (cf. Lutz et al., 2008). Focusing narrowly on the breath will clear the mind from thoughts about past and future events and dampen psychophysiological arousal as seen at the level of brain activity in restored inhibition of default mode and amygdala activations. However, an effort of will cannot be sustained indefinitely. Mind-wandering episodes will occur repeatedly and upon noticing mind-wandering the person will have to re-engage the attentional focus (cf. Hasenkamp et al., 2012). Over time, maintenance of the attentional focus will tend to deteriorate. With a gradual depletion of attention regulation resources, only an increase in effort and concomitant arousal can reinstate focus (cf. Hockey, 1997). With increasing difficulty in maintaining focus, restlessness will increase and motivation to continue will drop (cf. Csikszentmihalyi & LeFevre, 1989).

The ReST approach instead engages a person with sensory experience in the present environment. Entering a setting that differs starkly from the usual settings of demanding pursuits in daily life engenders low setting-interdependency and fosters a sense of being away that will make thoughts relating to

other times and contexts less likely and intensive (cf. von Lindern, 2017). Suitable settings for ReST practice contain arrangements that signal safety, that provide a spacious but immersive contrast to the usual settings of daily activities, and a diversity of pleasantly interesting natural features.

After settling in to the environment, ReST practices begin with brief grounding practice and breath meditation to obtain initial regulatory control over cognitive and psychophysiological processes. With initial control achieved, the focus of attention is guided to impressions from the environment as perceived through one or more sensory modalities. Instructions guide and pace exploration of those impressions while encouraging curiosity/fascination rather than willful control to regulate the process. The instructional language guides participants to open up to or allow themselves to become engaged by different aspects of experience, rather than to focus or stay with experience. That is, to act effortlessly in relation to the present stimuli.

Effortless engagement with sensory impressions promotes high levels of perceptual load while imposing low levels of load on cognitive control capacities. These processes shield from distraction (cf. Lavie, 2005) and allow attention to become regulated bottom-up by providing gentle exogenous support for the orienting network (Petersen & Posner, 2012). With thoughts about non-present objects and events, the instructions serve to promote detached inclusion in a scope of attention rather than noticing and refocusing. Detached inclusion of mind-wandering events along with support for orienting attention allows for flexible alteration of attention to internal and external stimuli that rise in salience (cf. Williams et al., 2018). ReST instructions further transition to guide participants in reflecting on their patterns of reactions to different objects and events in the environment, and in embracing the space between experiences in awareness through metaphorical connection with the air and light that separates objects in the surrounding space. That transition is intended to promote a state of deep open-monitoring where reflexive awareness can develop (cf. Lutz et al., 2008).

Course progression

Building mainly on the attention state training account (Tang & Posner, 2009), ReST can engage and facilitate learning processes seem with open-monitoring. However, these learning processes are not only relevant for the acquisition of mindfulness skills and proficiency in applying them in challenging situations. The learning processes are, presumably, also applicable to the ability to engage in a beneficial way with restorative environments. Kaplan (2001) indicates in broad terms how training in meditation skills could bolster health by making a person better able to draw restorative benefits in specific instances of nature contact, more perceptive to processes of depletion, and more effective in responding to restoration needs that arise. Furthermore, meditation skills can presumably reduce resource expenditure in dealing with demands

As with the exercise instructions, the theoretical discussions and homework consultation in the ReST classes employ an adapted vocabulary that omits reference to training and control and instead elevates the benefits of connecting with sensory aspects of experience in daily life to remain anchored and to enjoy a richer and more acute presence in the world. The theoretical discussions during ReST classes also use metaphors that draw on natural phenomena in general and on specific natural phenomena in the class setting. This is to promote learning while also ensuring that the theoretical content can be acquired with minimal conceptual elaboration and with minimal loss of the grounded presence in concrete aspects of the environment.

ReST participants progress through course weeks where the classes and homework exercises center on different themes derived from MBSR (see Supplement A). Further details on the structure and contents of the ReST course are given along with other methodological details in the General Methods section. Before going on the methods, however, I will in the following section introduce the aims of the four empirical studies.

Purposes and Research Aims

The overarching purposes of the research project are represented in the comprehensive summary as well as the included studies. Those purposes are:

- To develop an integrative framework at the intersection of the individual training approach and the restorative environments approach to the management of personal adaptive resources.
- To develop an application of that integration – an application that has come to be called restoration skills training (ReST) – which is useful for the promotion of relevant functional capabilities and health.
- To provide initial empirical evidence bearing on the underlying integrative framework and the usefulness of ReST compared with a feasible alternative intervention.

The purpose to provide initial empirical evidence bearing on the integrative framework and its application can be divided into several research aims that are addressed in specific hypothesis tests in the included studies. These research aims are:

1. To determine whether the ReST approach to meditation succeeds in drawing on and enhancing restorative processes supported by the environment.
2. To determine whether ReST confers generalized and sustained improvements in psychological functioning and health for the average participant.
3. To determine whether the (anticipated) improvements in psychological functioning and health attained with ReST are at least similar, on average, to those of CMT.
4. To determine whether the (anticipated) greater ease of ReST compared with CMT is associated with improved acceptability for people who would struggle with more effortful CMT.
5. To assess the practical utility of ReST as a health intervention by evaluating the proportion of ReST participants who enjoy reliable benefits and the proportion who deteriorate.
6. To assess the degree to which theoretically relevant processes contribute to explaining the (anticipated) advantages of ReST over CMT.

General Methods

This thesis builds on data collected over four rounds of mindfulness-training courses. We conducted the first data collection round in the spring of 2013. The second data collection round followed in the fall of 2013. The third and fourth data collection rounds were conducted in the spring of 2015 and 2017, respectively. The timing of the data collection rounds was determined in part by the process of developing our ideas about the practice approach and in part by external factors such as the availability of the needed staffing resources.

The work with the courses was in each data collection round led by the author under the supervision of Terry Hartig and Per Lindberg. The work was completed with assistance and input from different psychology students, who are included as co-authors on Paper III. These students worked with different aspects of the project in the course of completing their MSc theses for the clinical psychology program at Uppsala University. The author served as assistant supervisor for these MSc theses while Terry Hartig served as main supervisor.

We report methods as they are relevant to this thesis and to the included papers. Additional design features and measurements were included, some of which were of specific interest to student collaborators and outside the scope of the present work.

Design

Between-subjects design

In each data collection round, participants were randomly assigned to either a ReST course or a conventional mindfulness training (CMT) course. The ReST classes were held in a botanic garden and used an approach to mindfulness training that was adapted to draw on restorative processes stimulated by the natural features and processes in the environment. The CMT classes were held indoors in a campus building and used a conventional approach to mindfulness training that was suited to the sparsely furnished indoor setting.

The ReST approach to mindfulness training was successively developed and refined across the data collection rounds. The CMT approach remained principally consistent across the data collection rounds, but we updated the course to match any changes we made to the format in ReST. Random alloca-

tion across the rounds was not possible. The general design thus had two between-subjects factors: Round (1 – 4) and Course type (ReST, CMT). The fourth data collection round, which compared the fully developed ReST course against CMT, also included a separately recruited control group that received no intervention but participated in the assessments of general psychological functioning and health. Round 4 thus had three levels of the factor Course type for some analyses.

Within-subjects design

In each data collection round, the ReST and CMT courses had one 90-minute class per week over five weeks, and homework assignments to be completed on most days between the classes. Some outcomes were assessed with repeated measures over the course weeks and classes. Other measures were obtained before and after the course and with a subsequent long-term follow-up.

Restoration outcomes

Directly before the start of the classes on weeks 1, 3, and 5 of the courses, the ReST and CMT participants completed attention tests and rated their momentary affective state. In Round 1 – 3, they completed the same measures again directly after the class. In Round 4, they instead completed the same measures after a standardized, 20-minute “basic mindfulness exercise” that reflected the two approaches to meditation. This design thus included time on two levels: Course week (1, 3, and 5), and Class or Session (before and after meditation).

Experiences during meditation

Directly after the classes on weeks 1, 3, and 5 of the courses, the ReST and CMT participants completed ratings of experiences of state mindfulness and perceived restorative qualities in the meditation setting during the class.

Homework completion

For course weeks 1 – 4, the ReST and CMT participants kept records of completed homework exercises (no new homework was assigned in the last class). The homework completion records were summed per course week for each participant: The data were thus entered with four levels of the factor Week (1 – 4).

Generalized attention performance

As data for analyses of change in generalized attention performance capability, we used the attention test data obtained before the classes on weeks 1, 3, and 5. We thus have data with three levels of the factor Week for participants in all data collection rounds. Round 4 additionally included an assessment at the time of enrollment in the study, so Round 4 data could be analyzed with four levels of the factor Week.

General psychological functioning and health

We obtained measures of general psychological functioning and health before the course started and directly after the course for participants in all data collection rounds, yielding a time factor with two levels. The ReST and CMT participants in Rounds 2 – 4 completed these measures again six months after the course ended, so that data was distributed over time in three levels.

Course completion

After the course ended, each participant was classified as either non-starter, course completer, or drop-out. Drop-out was operationalized as having come to at least one class and then either giving notice of discontinuing the course or missing at least two sequential classes and not returning for subsequent classes.

Other design features

We recruited participants who experienced stress or concentration problems in their daily lives as students, and with no or little meditation experience. We consider this a design feature because it served to ensure that the participants, on average, would have some potential for improvement in adaptation skills with repeated training over the course weeks.

We also held all the classes in the late afternoon. We consider this a design feature because it served to ensure that the participants, on average, would have expended some adaptive capability in efforts to meet the day's demands and so would have some need and potential to respond to a restorative intervention.

Participants

In each data collection round, we followed the same procedures for enrollment and assignment. Supplement B gives the number of participants who completed assessments in connection with the classes on each occasion (Paper I), and Supplement C gives details of participant flow through the recruitment, training, and evaluation phases of the study as relevant for course completion (Paper II) and long-term outcomes (Papers III and IV).

Recruitment

We posted flyers in several areas of our university campus, asking for volunteers for a study about mindfulness training. We particularly stated that we

sought participants who studied $\geq 75\%$ of full time, experienced stress or concentration problems, but had no other major health issues and little or no meditation experience. Screening included the MINI International Neuropsychiatric Interview (Lecrubier et al., 1997) and excluded those who indicated a history of neuropsychiatric disorder, psychoses, hypomanic or manic episodes or recurring depression, moderate to severe post-traumatic stress symptoms, serious self-harm, or suicide attempts. The screening also excluded those with any current moderate to severe disorders, suicidal ideation, or ongoing psychological or psychiatric treatment. The exclusion criteria built on Dobkin, Irving, and Amar (2012) and judgment regarding groups that might be better served in a health care setting.

In recruitment for the passive control group in Round 4, we approached students in the campus environment asking for volunteers for a study. To be eligible, they had to certify that they had no major health issues and little or no meditation experience.

Power considerations

We enrolled participants in the four data collection rounds planning to eventually pool data from different rounds as appropriate to test different hypotheses. For each Round, however, we conducted separate power analyses with a particular view to the tests of attention administered before and after the classes or practice sessions (as subsequently reported in Paper I). These analyses anticipated 25% drop-out, fairly high correlation among measurements ($r \approx .7$), and small- to medium-sized Course type x Time (2 x 2) interactions. We concluded that 40 initial participants in a Round should suffice for medium effects ($f \approx .25$) while 60 initial participants would allow detection of a more satisfactory range of effects ($f \approx .15 - .20$). However, we also had practical constraints. In Round 1, we could only accommodate 20 course participants. In Round 2, we aimed for 40 but only recruited 31 within the allocated time-window. In Round 3, we aimed for at least 40 and recruited 49. In Round 4, we aimed for 60 course participants and recruited 59, plus 29 control group participants.

Assignment

Within each data collection round, eligible mindfulness training volunteers who provided informed consent to participate in the courses were stratified by gender and randomly assigned to either ReST or CMT using a random number generator. Altogether, 159 course participants were assigned. Seven withdrew before they had completed the initial measures and ten withdrew before the first class. Three at some point revoked consent to handle their data. The available data therefore come from 139 course participants: 68 who started ReST (44 women; median age = 24) and 71 who started CMT (49 women; median

age = 23). For the control group in Round 4, participants who failed to complete either of the assessments were excluded: The control group consisted of 21 participants (13 women; median age = 22).

In Round 1, the course participants could be accommodated in one ReST and one CMT course group. In the later rounds, which recruited larger numbers, participants were accommodated in multiple course groups of up to 12 participants. These met on different weekdays. Participants self-selected a course group that fit their schedule and could not switch groups during the course.

Participation in the courses was free of charge. Participants could drop out at any time without facing any further requests or consequences. They were, however, promised three cinema tickets if they completed the course and all measurements in connection with the course. The control group participants were also promised three cinema tickets for their trouble. In Rounds 2 – 4, course participants were promised a fourth cinema ticket if they completed the six-month follow-up.

Ethical review

The research was approved by the regional ethical review board (registration number: 2013/033) and adhered to the Declaration of Helsinki.

Measures

Measures of attention performance

The course participants provided measures of attentional performance before and after the classes or meditation sessions on course weeks 1, 3, and 5. In all Rounds, they completed a substitution test (the Letter–Digit Substitution Test [LDST]; van der Elst, van Boxtel, van Breukelen, & Jolles, 2006). In Round 4 they also completed a Trail-Making Test (TMT; (Reitan, 1958).

Letter-Digit Substitution test

We chose the LDST because of its robust psychometric properties, high change sensitivity, and suitability for brief group administration. Substitution tests are generally considered as measures of information processing speed, a capability that is sensitive to variations in the selective and executive components of attention (Davis & Pierson, 2012; Lezak, 2004; Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991). Similar substitution tests have previously shown sensitivity to brief mindfulness inductions (Zeidan et al., 2010) and LDST has previously shown reliably different effects of mindfulness practice or rest sessions with nature stimuli versus mindfulness practice sessions without nature stimuli (Lymeus et al., 2017). The participants were instructed to

quickly and accurately fill in digits (1–9) in blank spaces corresponding to randomly assigned letters, guided by a code-key. The score is the number of correct responses completed in 60 s, where higher scores indicate better attention performance. The participants completed multiple trials in the assessments before the classes and sessions (and, in Round 4, at the extra assessment at enrollment). Multiple trials were used to establish familiarity and reduce training effects. The score after the classes was obtained with a single trial to minimize disruption and time demand. All trials used new versions, counterbalanced across participants.

Trail-Making Test

We chose the TMT because of its robust psychometric properties and high change sensitivity, and because it allows separation of executive performance capability from the more general information processing capability and thus could complement the LDST (Lezak, 2004; Reitan, 1958; Tombaugh, 2004). In part A of the TMT, participants were instructed to draw a line between consecutive numbers in circles spread out pseudo-randomly on a sheet of paper (i.e. place and order in a grid determined by random number generator and then minimally rearranged to ensure straight lines could be drawn in correct sequence). In part B, they saw numbered and lettered circles and were instructed to draw a line switching between the numerical and alphabetical sequence (i.e. 1-A-2-B, etc.). They received instructions to work as quickly as they could without making mistakes. TMT-A assesses information processing speed while TMT-B adds a set-switching component that relies on executive capabilities. The intra-individual difference between TMT-A and TMT-B performance on a given trial shows the performance decrement incurred by the set-switching task. That switching cost index thus isolates the executive component from the information processing component.

In its original form, TMT is scored by the time it takes to complete the tasks, which is procedurally difficult in a group format. To accommodate brief group administration and repeated measurements, we created several TMT-A and TMT-B versions, matched for length. All participants worked for 20 s on TMT-A and then 20 s on TMT-B. Three scores were obtained: the number of correct connections completed on TMT-A and TMT-B (possible range 0–25), respectively, and the switching cost conceived as TMT-A minus TMT-B. Higher scores on TMT-A and TMT-B indicate better information processing and executive performance. Lower switching cost indicates better executive functioning relative to the given level of information processing capability within a trial. All trials used new versions, counterbalanced across participants.

Measures of states and experiences in connection with meditation classes

In addition to the measures of attention performance, we used three self-report measures to assess states and experiences in relation to the meditation classes of course weeks 1, 3, and 5. Directly before and after the classes, we measured participants' affective state with the Swedish Core Affect Scale (Västfjäll, Fri-man, Gärling, & Kleiner, 2002). Directly after the classes we measured their experiences of state mindfulness with the Toronto Mindfulness Scale (TMS; Lau et al., 2006). We also measured the degree to which they perceived restorative qualities in the meditation setting with the Perceived Restorativeness Scale (PRS; Hartig, Kaiser, & Bowler, 1997; Hartig, Korpela, Evans, & Gärling, 1997).

Swedish Core Affect Scale

We chose the SCAS because it provides a brief and reliable way of tapping the degree of activation as well as the valence of a person's momentary affective state (Västfjäll et al., 2002; Västfjäll & Gärling, 2007). The original form of the SCAS includes twelve self-reported items that reflect four affective dimensions. To keep administration brief in this research, we chose to measure two of the four affective dimensions: unpleasant activation/pleasant deactivation and unpleasant deactivation/pleasant activation. These two dimensions reflect aspects of affect that map onto the theoretically relevant constructs stress (unpleasant activation) and the counter process of stress reduction (pleasant deactivation), and fatigue (unpleasant deactivation) and the counter process of regaining positive energy (pleasant activation). Each of the two dimensions are assessed by using three pairs of negative and positive adjectives that mark opposite poles on a nine-point scale. Participants indicated how they felt with regard to each adjective pair, with 1 meaning complete agreement with the negative adjective, 5 meaning neutral, and 9 meaning complete agreement with the positive adjective. Lower scores thus indicate stress and fatigue, respectively. Increase in scores indicate stress reduction and regained positive energy, respectively.

Toronto Mindfulness Scale

We chose the TMS because it measures central aspects of mindfulness that correspond to the operational definition by Bishop et al. (2004) that we build on in the theoretical integration. Importantly, the TMS was also more or less unique in targeting state aspects of mindfulness. The self-report measure includes 13 statements about the degree to which a person experienced state mindfulness in meditation (0 = not at all, 4 = very much). Higher scores indicate higher state mindfulness. The item scores can be broken down into two subscales: curiosity and decentering. In its original English, TMS has good

psychometric properties including change sensitivity with mindfulness training and predictive power with regard to health outcomes of the training (Lau et al., 2006). In lieu of a Swedish version, we translated the measure for this research using an iterative translation-back translation procedure (Behling & Law, 2000) involving native English and native Swedish speaking individuals. We therefore cannot refer to any independent data on the psychometric properties of the Swedish TMS.

Perceived Restorativeness Scale

We chose the PRS because it measures central aspects of restorative experience that correspond with ART as formulated by Kaplan and Kaplan (1989; Kaplan, 1995). Since it was introduced (see Hartig, Kaiser, et al., 1997; Hartig, Korpela, et al., 1997), the PRS and various adaptations of it have been widely used in studies on restoration (e.g., Gonzalez, Hartig, Patil, Martinsen, & Kirkevold, 2010; Tyrväinen et al., 2014; White et al., 2010) and frequently shown good psychometric properties and validity. In this study, we used 10 statements that concern the degree to which a person perceives the environment as supporting fascination and being away, respectively (0 = not at all, 10 = completely). Higher scores indicate higher restorative quality.

Measures of course compliance

For each course week, participants received homework instructions in verbal as well as written form. The instructions were for two exercises – one formal and one informal meditation exercise – per course week, and included a rationale for why they should practice and a recommendation to complete both exercises on most days leading up to the next class. The paper with written instructions also contained a table where participants could register for each weekday whether they completed any formal or informal homework exercise. They handed in the registrations in the following class. We summed these registrations for each course week.

After the course ended, each assigned course participant was classified as either non-starter, course completer, or drop-out. Non-starters were those who failed to show up for any class. Drop-outs were those who came to at least one class and then either gave notice of discontinuing the course or missed at least two sequential classes without returning for subsequent classes.

Measures of general psychological functioning and health

Before and after the course, and with Round 2 – 4 participants also six months after the course ended, we measured general psychological health and functioning in three theoretically relevant domains. We measured dispositional mindfulness with the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006), cognitive functioning with the

Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982), and chronic stress with the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983).

Five Facet Mindfulness Questionnaire

We chose the FFMQ because it is a widely used measure of dispositional mindfulness with many studies affirming its usefulness in identifying individual differences (e.g., Baer et al., 2008; Bohlmeijer, Ten Klooster, Fledderus, Veehof, & Baer, 2011) as well as in detecting and predicting improvements with mindfulness training (e.g., Baer, Carmody, & Hunsinger, 2012; Kiken, Garland, Bluth, Palsson, & Gaylord, 2015). The FFMQ was created from factor analyses of several older mindfulness measures, which identified five facets of mindfulness that tend to form separate subscales in the measure: non-judgment, non-reactivity, acting with awareness, observing, and describing. In this study, we used a shortened, Swedish version (Lilja et al., 2011). It has 29 items about how often in the last month a person had the various mindfulness experiences. The occurrence of each experience is indicated with a five-point scale (1 = never, 5 = always). After reversal of negatively formulated items, higher scores indicate higher dispositional mindfulness.

Cognitive Failures Questionnaire

We chose the CFQ because it is the most well-established and most general measure of real-life cognitive functioning in terms of the propensity for lapses in cognitive control (Carrigan & Barkus, 2016). The CFQ is aimed at capturing mistakes in the areas of perception, action, and memory which are indicative of cognitive vulnerability to stress (Broadbent et al., 1982; S. Kaplan, 1995). It taps aspects of cognitive functioning and change that are difficult to capture with performance-based tests (Carrigan & Barkus, 2016). The CFQ has 25 questions about how often in the last month a person made different mistakes. The occurrence of the mistakes is indicated with a five-point scale (0 = never, 4 = very often). Higher scores indicate poorer cognitive functioning.

Perceived Stress Scale

We chose the PSS because it is a well-established measure of the occurrence of stressful experiences as defined by the cognitive-transactional model (Lazarus, 1966; Lazarus & Folkman, 1984) rather than by some objectively defined stressor exposure (S. Cohen et al., 1983). Objectively defined stressor exposures such as stressful life events can affect people quite differently depending on their appraisal of the situation and their capabilities for dealing with it, so such measures can be blunt. The PSS instead measures stress in terms of experiences of overload, loss of control, and inability to cope. The psychometric properties of the PSS are generally good (E.-H. Lee, 2012). It

has 14 questions about experiences of stress. The occurrence of the experiences is indicated with a five-point scale (0 = never, 4 = very often). After reversal of positively formulated items, higher scores indicate higher perceived stress.

Study Procedures and Settings

The procedures and settings were generally similar across the data collection rounds with some relatively minor exceptions as noted in the following text.

Pre-test measurements

Measurements before the course

Before the course started, participants completed the FFMQ, CFQ, and PSS either on paper in connection with the interview for enrollment (Rounds 1 – 3) or via an online survey (SurveyMonkey.com) within one week before the course start (Round 4). These measurements also included questions about some basic participant characteristics (age, gender, study subject). In Round 4, the passive control group participants also completed these measures in the same manner.

Measurements before the mindfulness classes

In Rounds 2 – 4 where course participants were accommodated in multiple course groups, they were offered to choose the course groups that best fit their schedule and preference with regard to the weekday and starting time. They could not switch groups once the course started. Some course groups started relatively earlier in the late afternoon and others started relatively later. The starting times were counterbalanced for ReST and CMT groups across the offered weekdays so that both course types were given both earlier and later. This way, ReST and CMT participants always started at different times so that they would not meet in the course of the study procedures.

The ReST and CMT classes and the measurements that were obtained in connection with the classes were completed in The Botanic Garden and indoor areas of the Blåsenhus campus building at Uppsala University. At their starting time, the participants met the instructor(s) inside the western entry to Blåsenhus and were guided in group to the relevant study setting. On course weeks 1, 3, and 5, all participants first walked to a classroom in the campus building to complete measures. There, they sat down at desks and were led by verbal instructions through the completion of LDST, SCAS, and, in Round 4 also TMT.

The ReST participants were then led in group to the relevant site in the Botanic Garden where they participated in the class. CMT participants stayed

in Blåsenhus to participate in their class. In Round 1 – 3, they stayed in the same room where they had completed the measurements. In Round 4, they walked in group to another classroom in Blåsenhus. These other classrooms were selected so that the walked distance would approximate that completed by the ReST participants. The Botanic Garden and the campus building are directly adjacent to each other, so the walks were not long. On most occasions, the ReST participants walked ca. 50 – 100 m to get to the Tropical Greenhouse. On some occasions they walked up to ca. 150 m to other areas of the Botanic Garden.

Mindfulness class settings

Restoration skills training

The ReST classes were held in the Botanic Garden, mostly in the Tropical Greenhouse. The greenhouse had in pilot studies shown high perceived restorative quality compared to different indoor campus settings (i.e., higher fascination and being away; Kihlberg, 2012; Nordfeldt, 2012). They were therefore expected to support ReST practices. Outdoor areas of the Botanic Garden and an orangery were also used for some classes. These settings, too, were expected to be high in restorative quality. For unguided exercise, participants were free to move around in all rooms in the greenhouse and to go to outside areas of the garden. They could walk around or find a place to sit as they preferred. For most parts of the classes, however, they sat in one of the rooms of the greenhouse. Extra, foldable chairs were brought in to facilitate the seating arrangements.

The Tropical Greenhouse has several rooms with different size and shape, climate, and vegetation. Three larger rooms that each had necessary amenities were typically used for sitting and standing guided exercise and for theoretical discussions.

- The winter garden room is a mildly temperate, stone-paved hall with café style chairs and tables dispersed among canopy trees and flowering plants. Its climate is regulated to ca. 16 – 23 C° and 60 – 80% relative humidity (RH).
- The rainforest room is an oblong room with winding gravel paths through dense rainforest vegetation with overhanging foliage. One of its trees is a *Ficus Religiosa* that was cloned from a tree thought to be a sapling of the tree under which the Buddha reached enlightenment. The room also has a small terrace with chairs. Its climate is regulated to ca. 20 – 25 C° and 70 – 90% RH.
- The Victoria hall is a spacious, rounded room dominated by a large circular water lily pond that is surrounded by an aisle and tropical trees and plants lining the walls. The room has a small terrace for

seating overlooking the pond. Its climate is regulated to ca. 23 – 27 C° and 70 – 90% RH.

The greenhouse also has two smaller rooms that participants could enter during unguided exercises: The orchid room with raised flower beds and hanging arrangements of orchids and the succulent room with raised sand and gravel beds with cacti and other succulents.

Throughout the greenhouse, tropical frogs roam free and the several water bodies are home to small fish. The occasional chirping calls of the frogs and the sounds of water drops hitting water surfaces, leaves, and stone contribute to the auditory environment of the greenhouse. The climate system introduces mechanical and background sounds of relays, vents and fans. Some outside sounds emanating from the weather, traffic and passers-by can also be heard.

Conventional mindfulness training

Several different but essentially similar class-rooms were used for the CMT classes. The rooms had closed curtains to prevent outside views and no artwork or decorations. They also had acoustic tile ceilings with soft fluorescent lighting, and off-white wall color. The auditory environment included some outside sound emanating from traffic, passers-by in the hallway, and other activities in the building. Building on pilot studies (Kihlberg, 2012; Nordfeldt, 2012), the rooms were expected to be low in both restorative qualities and distractions, and therefore expected to support conventional mindfulness practices.

During the mindfulness classes, the desks were cleared from the center of the room. Participants sat in a circle, on chairs or on the floor as they preferred, for most exercises and discussions. Some exercises also involved standing and walking meditation practices, which were completed in the same room.

Mindfulness training courses

A common starting point in Mindfulness-Based Stress Reduction

In preparations for the project, we took a starting point in MBSR as described by Kabat-Zinn (1990, 1994). We made some adaptations of the course format to make it more suited to the needs of people with stress and concentration problems. These adaptations were inspired by previous adaptations of mindfulness training for people with self-regulation problems (Ghaderi & Parling, 2007, 2009; Hesslinger, Philipsen, & Richter, 2010; Hesslinger et al., 2002; Linehan, 1993; Zylowska et al., 2008) as well as by experiences we had made in precursors to this research (Lymeus, 2008; Lymeus et al., 2017).

One adaptation is that we made the course briefer in terms of the course length (five 90-min classes over five weeks; no “day of mindfulness”) and in terms of the length of exercise durations (ca. 15 – 30 min in-class and 15 – 20

min homework). Another adaptation is that we used a preliminary script for the instructors to ensure the intended content was conveyed in a clear and consistent manner. For the homework, we gave verbal instructions on how to practice as well as written handouts with the same instructions. These adaptations were retained through all Rounds for both courses. In the earlier Rounds, we handed out written theoretical materials so participants could remind themselves of central concepts between the classes; however, we abandoned those because few participants seemed to use them. Across the Rounds, both courses retained a progressive structure grounded in MBSR, in which each subsequent course week introduces new concepts and practices that build on the preceding weeks' content.

The development of ReST

Building on the course format described above, we iteratively introduced different adaptations in the ReST course. These were driven by theoretical assumptions outlined in the Introduction as well as by experience that we gained as the project progressed. In the following, we summarize the most significant steps taken in each Round in the process of developing ReST. An overview of the course contents in the different rounds is given in Supplement A.

Round 1. In the first data collection round, we used mostly the same materials and exercises in ReST as in CMT. However, we replaced some of the conventional exercises with exercises that targeted experiences in the environment, such as sounds and smells. We also included more walking meditations, since these allowed for exploration of the environment. The theoretical discussions in ReST also drew more on experiences in the environment and emphasized contact with the environment.

Round 2. In the second data collection round, we connected the first four course weeks' theoretical themes to a sensory modality rather than to more conventional foci on experiential contents emanating from within. We also centered the in-class and homework exercises around these modalities and themes. Furthermore, we abandoned the use of recorded practice instructions for the homework exercises in favor of a more intuitive and flexible approach to meditation. The participants instead practiced with a given exercise in-class that they then also had as homework for the coming week. We retained written instructions that summarized the basics of the practice.

Round 3. In the third round, we made some changes to the progression of theoretical themes across the course weeks. We also made substantive progress in developing an instructional language that would serve to promote effortless, open, and direct engagement with concrete aspects of the present moment in meditation as well as in daily life. That instructional language included terminology that would avert associations to effortful training, metaphors that drew

on natural and environmental phenomena, and exercise instructions that centered around experiences rather than around practices.

Round 4. In the fourth round, we made additional refinements to the instructional language. We also introduced a “basic ReST exercise” that we used as the only formal homework assignment every week of the course in order to promote overlearning of the most central aspects of the practice approach. With the basic ReST exercise, we also reintroduced the possibility to use recorded practice instructions in homework exercise; however, we explained that participants were free to choose a way of completing the homework exercises that suited them. With the introduction of the basic ReST exercise, the sensory modality specific homework exercises were converted to informal exercises.

The conventional mindfulness training course

The CMT course built on the same brief format for mindfulness training as ReST. For each step of development of ReST, we also made adjustments in CMT. Most of the adjustments were purely structural and served to retain the experimental contrast between the two practice approaches when we made changes to ReST. They were thus made so that the difference in practice approach would not be confounded with structural differences between the courses. In some cases, however, we considered that aspects of the CMT course had to remain unchanged in order to keep a resemblance to other common conventional mindfulness courses.

Although it could have enhanced the experimental contrast in some respects, we concluded that we could not shape CMT completely around the attention network training rationale and the associated focused-attention practices: That would not likely have worked as a feasible and helpful introduction to mindfulness training for beginners with stress and concentration problems. The research builds on the comparison of ReST against the standard of conventional mindfulness training, which we could presume to be both acceptable and effective for many participants. We did make some adjustments to the instructional language and the selection of exercises in CMT; however, the exercises and other course contents remained connected to their roots in MBSR and feasible from the participants’ perspective.

In all Rounds of CMT, we handed out recorded practice instructions for the formal homework exercises. Recorded meditation instructions are commonly used in MBSR and other conventional mindfulness courses. In Rounds 1 – 3, we used suitable brief exercises from the original MBSR materials and other sources (Ghaderi & Parling, 2007, 2009). In Round 4, we recorded a basic CMT exercise that built on the original MBSR material but that was closely matched with the basic ReST exercise in terms of length and progression through the content. We describe these exercises below.

The basic ReST and CMT exercises

The basic ReST exercise builds on the developed ReST approach to mindfulness. It was also used as the first exercise in the ReST classes on course week 1, 3, and 5, before and after which we obtained attention and affect measures to study restoration outcomes (see Paper I, Study 2). We therefore describe the principles behind the exercise in some detail here. The basic ReST exercise was done while seated. However, this was mainly to retain the experimental contrast of the practice approach (rather than body posture and physical exertion) with the basic CMT exercise that, as is conventional for mindfulness of breath practice, was completed as a sitting meditation.

The instructor first advised participants to take an upright but relaxed position and to allow their eyes to be open and let the gaze more freely if they were comfortable with that. The meditation then commenced with 6.5 min of grounding practice: The instructions guided participants in opening up to the experience of being in the room and in the seated position; awakening themselves to experiences in different parts of the body by gently moving them or touching them with the hands; cupping the nose and mouth with the hands to explore the flow of air that connects the body with the environment. The exercise then proceeded with three minutes of mindfulness of breath practice in which instructions guided participants in connecting with the breath as experienced in the whole body. Next, the exercise transitioned to a seven-minute sequence of instructions that guided participants in embracing the soundscape as part of the experience, and then engage with visual impressions as experienced with focused as well as with unfocused gaze. Finally, the exercise entailed instructions for open mindfulness of all aspects of experience that rose and fell in awareness.

The basic CMT exercise instructions had a similar introduction but advised participants to keep their eyes closed if they were comfortable with that. They then commenced with 6.5 min of grounding practice that entailed a similar scan of the body but without any movement. It then proceeded with mindfulness of breath practice that built on the instructions used for one of the brief sitting mindfulness exercises in the commercially available recorded material for the MBSR course.

Post-test measurements

Measurements after mindfulness classes and sessions

In Rounds 1 – 3, the participants stayed in the mindfulness class environment after the class on course weeks 1, 3, and 5. In the garden settings, they moved to tables and chairs that had been prepared in the nearest suitable area. In the Tropical Greenhouse, the measures were completed either in the Winter Garden or in the reception area. The assessment settings were arranged so that the participants could assume a normal seated position and work unhindered with

the materials. In the campus building, they moved to tables and chairs that had been placed along the walls of the class-rooms. There, they were again led by verbal instructions through the completion of LDST and SCAS. They then completed the TMS and PRS.

In Round 4, the assessments after mindfulness practice were obtained directly after completion of the 20-minute basic ReST and CMT exercises. That allowed a relatively high level of control over the intervention and more closely timed assessment of the outcomes. As in the earlier Rounds, they moved to tables that had been prepared in the class environment. There they completed LDST, TMT, and SCAS. Then the mindfulness class continued. After the whole 90-minute class ended, the participants again sat down at the prepared tables and completed the TMS and PRS. The TMS and PRS were completed at the end of the class rather than directly after the 20-minute sessions for two reasons: 1) to minimize the time demand and disruption in the mindfulness class, and 2) to keep the TMS and PRS data comparable with that obtained in the earlier rounds so they could be pooled for some analyses.

In all Rounds, the participants were asked to hand in their registrations of completed homework assignments at the end of the class.

Measurements directly after the course

In Rounds 1 – 3, they first completed the LDST, SCAS, TMS, and PRS as described above, and then they completed the FFMQ, CFQ and PSS again. In Round 4, they instead completed the FFMQ, CFQ, and PSS via the online survey tool (SurveyMonkey.com) within one week after the course ended. In Round 4, the passive control group participants also completed the FFMQ, CFQ, and PSS in the same manner. They were also asked if they had initiated any form of meditation training or other relevant treatment since they last completed the measures.

Measurements six months after the course

Round 2 – 4 participants were contacted by email approximately six months after the course ended and asked to complete the FFMQ, CFQ and PSS again via the same online survey tool. Repeated reminders were sent to those who failed to respond. A few completed the follow-up assessments as late as ten months after the course ended.

Statistical Analyses

All data preparation and statistical analyses were done with SPSS. Preparation of the data was done building on guidelines provided by Tabachnick and Fidell (2007). Several analyses employed the PROCESS macro for SPSS (A. F. Hayes, 2017). In testing for statistically significant differences, we used the conventional $p < .05$ criterion or 95% confidence intervals (CI).

None of our hypothesis tests concerned effects of Round, although some effects of Round could be anticipated given the development of ReST. To check and control for effects of Round, we included Round and Round x Course type in the statistical models where appropriate.

Change from pre-tests to post-tests was evaluated using change scores as the outcome variable in ANCOVA that included the pre-test score as a covariate (see Vickers & Altman, 2001).

In some of the analyses in Papers II and IV, we used PROCESS to test hypotheses regarding moderation (PROCESS model 1) and serial mediation (PROCESS model 6). These analyses produced bias-corrected and heteroscedasticity-consistent (HC3; see Hayes & Cai, 2007) inferences based on 10 000 bootstrap samples.

One of the serial mediation models in Paper II built on a transformation of repeated-measures data (Homework registrations, TMS, and PRS) to ordinary least squares regression coefficients (i.e. intercepts and slopes; see Lorch & Myers, 1990; Twisk, 2004). This procedure accommodates inclusion of the relevant parameters of observed trends over time as single variables in the model.

Summary of the Papers

Paper I – Building Mindfulness Bottom-Up: Meditation in Natural Settings Supports Open Monitoring and Attention Restoration

Background and aims

Theory suggests that conventional mindfulness training for beginners incurs attentional effort (e.g., Chiesa et al., 2013; Lutz et al., 2015; 2008; Malinowski, 2013; Tang et al., 2015). Presumably, it takes regular effortful practice over weeks or months to achieve desired enhancements in attentional performance. In contrast, restorative nature experience supports a mindfulness-like state without incurring effort (Lymeus et al., 2017; Tang & Posner, 2009) and restores attentional performance capabilities quickly (Bowler et al., 2010b; Hartig et al., 2014; Ohly et al., 2016).

We reasoned that if mindfulness practices can be adapted to draw support from a natural meditation setting, then the practice will be less effortful for beginning meditators. We further reasoned that when the beginning meditators gradually become more skillful in meditation, they will be able to engage more fully with the restorative nature experience and therefore restore attentional performance capabilities to a greater degree. The training will thus improve their resting skills.

We built on this reasoning in the development of the restoration skills training (ReST) course – an approach to mindfulness that is adapted to draw on and enhance restorative processes in a natural setting. For a comparison, we used a conventional mindfulness training (CMT) course held indoors.

We posed two hypotheses: Both mindfulness training courses will be attended by generalized improvement in attentional performance as seen over five weeks of training (hypothesis 1, referring to the research aim to determine whether ReST confers generalized and sustained improvements in psychological functioning and health for the average participant); however, the mindfulness meditation exercises that the participants complete over those five course weeks will affect them differently, so that conventional mindfulness exercise is attended by signs of effort (performance decrement) while ReST exercise is increasingly attended by signs of restoration (performance improvement) (hy-

pothesis 2, referring to the research aim to determine whether the ReST approach to meditation succeeds in drawing on and enhancing restorative processes supported by the environment).

Methods

Student volunteers with perceived stress or concentration problems were randomly assigned to ReST or CMT in four rounds of courses. We pooled data from Round 1 – 3, that used comparable methods, as Study 1. Round 4 had improved methods so we analyzed that data separately as Study 2.

On weeks 1, 3, and 5 of the courses, the participants completed attention tests and ratings of their momentary affective state. They did so before and after participation in the 90-min mindfulness classes (Study 1, comprising data collection rounds 1 - 3) or before and after 20-min, standardized meditation exercises at the beginning of the classes (Study 2, comprising data collection round 4). Study 2 also included an extra pre-test assessment at the time of enrollment so we could tell whether any improvement in attentional performance coincided with the course start, and thus could rule out that apparent improvement was an artifact of repeated testing.

Study 1 used the Letter-Digit Substitution Test (LDST; van der Elst et al., 2006) and the Swedish Core Affect Scale (SCAS; Västfjäll et al., 2002). Study 2 used LDST; SCAS, and a Trail-Making Test (TMT; Reitan, 1958). The LDST is sensitive to variation in general attention performance while the TMT allows separation of a score for executive attention capability from the general performance score. The SCAS has one scale for the dimension stress – relaxation and one scale for the dimension fatigue – positive energy.

Rather many participants missed one or more assessments so the number of cases available for analysis differed across analyses. We analyzed the data with repeated-measures ANOVA (Study 1 $N = 51$; Study 2 $N = 29$) to draw conclusions about whether ReST and CMT were attended by different trends of change over time. We then used ANCOVA with change scores as the outcome and pre-test values as a covariate to determine whether the ReST and CMT participants differed from each other at any point in time (Study 1: week 1 $N = 85$, week 3 $N = 64$, week 5 $N = 60$); Study 2: week 1 $N = 42$, week 3 $N = 37$, week 5 $N = 33$).

Results

For both ReST and CMT participants, the general attention performance scores obtained before the classes improved substantially from the course start to week 3 and then levelled off to week 5. This was true in both studies (i.e. LDST score in Study 1; LDST and TMT part B score in Study 2). This affirms hypothesis 1.

The ReST and CMT participants also showed different trends over the course weeks in how their attention test scores changed with the mindfulness classes (Study 1; LDST) and exercises (Study 2; LDST and TMT executive attention score). For the LDST scores, the ReST participants improved on all course weeks while the CMT participants improved in the first weeks and deteriorated on the last week. For the TMT executive attention scores, the ReST participants improved substantially on the last course week while the CMT participants showed no clear change on any of the weeks.

Tests for whether the ReST and CMT participants differed from each other at any point in time showed that on the last course week, they differed in change with the mindfulness classes (Study 1; LDST change score) and exercises (Study 2; LDST change score and TMT executive attention change score). This affirms hypothesis 2.

Analyses of the affective state measures showed that both ReST and CMT participants were more relaxed (and less stressed) after the mindfulness classes (Study 1) and exercises (Study 2). In study 2, the ReST participants achieved more relaxation than the CMT participants did. However, the degree of relaxation that they achieved did not increase over the course weeks.

Discussion

ReST seems to help people with stress and concentration problems to meditate effortlessly and learn important restoration skills. ReST was also attended by generalized attentional performance improvements similar to those achieved with CMT.

CMT seems to be restorative in the first few weeks and then become effortful. There seems to be an initial honeymoon phase in the very early stages of mindfulness training. Then, when beginning mindfulness practitioners begin to learn to regulate the meditative state top-down, the meditation incurs effort.

Effort with CMT was only evident on the last week of the course, but the generalized performance improvements happened in the first weeks. Therefore, effortful training cannot have caused the generalized improvements. This is at odds with accepted theory in mindfulness research (e.g., Chiesa et al., 2013; Lutz et al., 2015; 2008; Malinowski, 2013; Tang et al., 2015). We propose that restoration is an alternative pathway for such improvements.

In practice, ReST holds promise as an undemanding introduction to mindfulness training and as a way to enhance restoration in limited contacts with nature.

Paper II – A Natural Meditation Setting Improves Compliance with Mindfulness Training

Background and aims

Restoration skills training (ReST) was developed with two overarching aims. First, the ReST practices should build a meditative state effortlessly on restorative experiences supported by the environment. Second, ReST should over time confer benefits at least comparable to the effects of conventional mindfulness training (CMT) completed indoors. Paper I addressed the first aim. This paper addressed the second aim.

The benefits of CMT are well-established (Chiesa et al., 2011; Eberth & Sedlmeier, 2012; Tang et al., 2015). However, relatively many participants comply poorly with the courses or drop out (see e.g., Abbott et al., 2014; Lamothe et al., 2016; Nam & Toneatto, 2016). Studies have indicated that participants who have more attention problems to begin with are least likely to complete the training (Banerjee et al., 2018; Crane & Williams, 2010; Lymeus et al., 2017), although they presumably have most to gain from it. If many in the target population find a health intervention to be more demanding than they are willing to accept in their already poor state, that is a serious problem for both research and for practice (Davidson & Kaszniak, 2015; Sekhon et al., 2017).

If ReST can build a meditative state effortlessly on restorative experiences supported by the environment, it should be more acceptable than CMT. Higher acceptability means more people can complete the training and enjoy the benefits. This article addressed that assumption by analyzing records of course completion and homework completion from ReST and CMT courses.

We posed two hypotheses referring to the research aim to determine whether the (anticipated) greater ease of ReST compared with CMT is associated with improved acceptability for people who would struggle with more effortful CMT: Compared with CMT, ReST will have higher compliance (hypothesis 1). Also, initial attention problems will have less influence with ReST than with CMT on compliance (hypothesis 2). Furthermore, we tested one hypothesis referring to the research aim to assess the degree to which theoretically relevant processes contribute to explaining the (anticipated) advantages of ReST over CMT: the compliance advantages will be mediated through higher experiences of restorative quality and mindfulness in the classes (hypothesis 3).

Methods

159 student volunteers with perceived stress or concentration problems were randomly assigned to ReST or CMT in four rounds of courses. We pooled data from the four rounds.

Before the course, the participants completed an attention performance test: the Letter-Digit Substitution Test (LDST; van der Elst et al., 2006). During the five-week course, they kept records of completed homework assignments. In connection with the classes on weeks 1, 3, and 5 of the course, they also reported on how they perceived the restorative quality of the course setting with the Perceived Restorativeness Scale (PRS; Hartig, Korpela, et al., 1997) and on their experiences of state mindfulness with the Toronto Mindfulness Scale (TMS; Lau et al., 2006). When the course ended, we classified each participant as completer or drop-out.

To test hypothesis 1, we compared ReST and CMT participants' rate of course completion with Chi-square analysis and homework completion with repeated-measures ANOVA. Then we transformed the repeated measures data (homework, PRS, and TMS) to average scores to represent general levels and to ordinary least squares regression coefficients to represent the linear change over time (see Lorch & Myers, 1990). These could be used in PROCESS (Hayes, 2017) analyses testing for moderation (hypothesis 2) and serial mediation (hypothesis 3) of compliance differences.

Results

With ReST, 90% of those who started the course completed it. Significantly fewer completed CMT: 73%, which is comparable to figures reported elsewhere in mindfulness studies. This was in line with hypothesis 1. On average across the course, the completers practiced with homework exercises to a similar degree, completing around seven exercises per week. However, the more decimated sample of CMT completers started out slightly higher and then dropped in homework compliance over the course weeks while the ReST participants kept a steady exercise rate. Although the average across the weeks was similar, we took the result as partial support for hypothesis 1 and used the regression coefficients representing linear change over the course weeks in the remaining analyses of homework.

The tests for hypothesis 2 did not show any signs for either course type that initial attention problems were related to drop-out or change in homework completion.

The first test for hypothesis 3 concerned mediation of course completion. It showed that the ReST participants perceived the class setting as more restorative, which led them to experience higher mindfulness during the classes, which in turn explained part of their higher tendency to complete the course. This was in line with the hypothesis.

The second test for hypothesis 3 concerned mediation of change in homework completion over the course weeks. It showed that the ReST participants perceived the class setting as increasingly restorative over the course weeks,

which explained some of their tendency to keep up the exercise rate. The increase in perceived restorativeness was in part driven by increase in state mindfulness, which was fueled by a high initial exercise rate.

Discussion

More ReST participants completed the course and established a regular meditation practice. The mediation analyses support the theory behind ReST: Restorative experiences during meditation in a natural setting support beginning meditators in their practice and help them complete the course. For those who complete the course, the gradual acquisition of mindfulness skills helps them engage more fully with the restorative setting which helps them maintain a regular practice habit. These results fit well with the findings reported in Paper I.

We could not confirm that initial attention problems predicted drop-out or change over the course weeks in homework completion to a lesser degree with ReST than with CMT. Still, we conclude that ReST can be a more acceptable introduction to mindfulness training for people with stress or concentration problems than the conventional approach. If more people can complete the course, then more people can potentially enjoy the health benefits of mindfulness training.

Paper III – Mindfulness-Based Restoration Skills Training (Rest) In a Natural Setting Compared To Conventional Mindfulness Training: A Randomized Trial with Six-Month Follow-Up

Background and aims

Conventional approaches to mindfulness training are attended by improvements in several aspects of day-to-day functioning and health (Chiesa et al., 2011; Eberth & Sedlmeier, 2012; Tang et al., 2015). However, they rely on effortful meditation practices and many participants comply poorly with the recommendations (Banerjee et al., 2018; Crane & Williams, 2010; Lymeus et al., 2017).

ReST has important advantages compared with CMT. The meditation practices incur less effort and promote restoration (Paper I). Restorative experiences in the ReST classes also support beginners in meditation and facilitate compliance (Paper II). These advantages allow larger numbers to stay with the training. However, theory in mindfulness research suggests that effort is an important driver of improvements in the early stages of mindfulness training (e.g., Chiesa et al., 2013; Lutz et al., 2015; 2008; Malinowski, 2013; Tang et

al., 2015). This raises the question of whether the more effortless ReST approach can match the more demanding CMT with regard to its effectiveness in conferring improvements in the theoretically and practically relevant domains of dispositional mindfulness, cognitive functioning, and chronic stress. We expected that it would. We tested the benefits of ReST in several steps.

The first step refers to the research aim to determine whether ReST confers generalized and sustained improvements in psychological functioning and health for the average participant. We tested the hypotheses that directly after the course, ReST participants would show improvements compared to values before the course (hypothesis 1) and compared to any change among participants in a passive control condition (hypothesis 2; analyses for Round 4 only), and that improvements compared to values before the course would still be evident six months after the course (hypothesis 3).

The second step referred to the research aim to determine whether the (anticipated) improvements in psychological functioning and health attained with ReST are at least similar, on average, to those of CMT. For these tests, we used the criterion that any disadvantage of ReST compared with CMT could be no more than small (i.e. $f = .1$) in order to retain some of the small-to-medium sized advantage in acceptability (cf. Paper II) and in order to be practically negligible for the participants (see Revicki, Hays, Cella, & Sloan, 2008). We tested the hypotheses that any disadvantage for ReST compared with CMT would be $f < .1$ as seen directly after the course (hypothesis 4) and six months after the course (hypothesis 5).

The third step referred to the research aim to assess the practical utility of ReST as a health intervention by evaluating the proportion of ReST participants who enjoy reliable benefits and the proportion who deteriorate. These analyses thus looked at change on the individual level rather than the average, building on a reliable change index (RCI; Jacobson & Truax, 1991). Again, we adopted the criterion that any disadvantage for ReST compared with CMT could be no more than small. We tested the hypotheses that directly after the course, the effect size of the course type difference in the likelihood of reliable change would be no more than small to the disadvantage of ReST compared with CMT with regard to improvement (hypothesis 6a) and deterioration (hypothesis 6b), that directly after the 5-week ReST course, the likelihood of reliable change would be greater with ReST than among participants in the passive control group with regard to improvement (7a) and no greater than among passive control participants with regard to deterioration (7b) (analyses for Round 4 only), and that six months after the courses, the effect size of the course type difference in the likelihood of reliable change would be no more than small to the disadvantage of ReST compared with CMT with regard to improvement (8a) and deterioration (8b).

Methods

159 student volunteers with perceived stress or concentration problems were randomly assigned to ReST or CMT in four rounds of courses. In round 4, we also recruited participants for a passive control group; however, these were recruited separately from the course participants and were not randomly assigned.

Where possible, we pooled data from the four rounds. All hypothesis tests were done both with the intention-to-treat sample (ITT) where drop-outs had their last value carried forward, and with the per-protocol sample (PP) which only included those who provided usable data on the relevant measurement occasions.

Before and directly after the course, the participants completed the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) which measures dispositional mindfulness; the Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982) which measures cognitive functioning; and the Perceived Stress Scale (PSS; Cohen et al., 1983), which measures chronic stress. Course participants in Rounds 2 – 4 were also contacted again six months after the course ended, and asked to complete these measures again.

We tested hypotheses 1 – 5 for all three outcome measures with ANCOVA with the change scores as the outcome and the values obtained before the course as a covariate. We also assigned each participant an overall classification as improved, unchanged, or deteriorated according to the RCI and analyzed these categorical data with Chi-square analyses.

Results

The step 1 analyses showed that the confidence intervals (CI) for the ReST participants' change from before to directly after the course did not overlap zero for any of the measures, affirming hypothesis 1. However, we saw that the chronic stress measure only showed reliable improvement in Round 4, for both ReST and CMT. In pairwise contrasts using Round 4 data, the CI also did not overlap with the change scores in the passive control group, affirming hypothesis 2. Six months after the course, the CI for dispositional mindfulness and cognitive functioning still did not overlap zero, in line with hypothesis 3; however, the improvement in chronic stress was no longer significant. ReST was thus attended by benefits on average, which were largely but not fully sustained over six months.

The step 2 analyses showed that the average improvements with ReST were similar to those of CMT according to the $f < .1$ criterion for all measures directly after the course, affirming hypothesis 5. The analyses also showed that six months after the course, the benefits with ReST were still at least similar to those of CMT, affirming hypothesis 6.

The step 3 analyses on reliable change classifications showed that 38% of those who completed the courses were improved and 7% deteriorated directly after the course. The distribution of improved, unchanged, and deteriorated participants was similar for ReST and CMT according to the $f < .1$ criterion, affirming hypothesis 6. Comparisons against the passive control group in Round 4 showed that ReST participants were significantly more likely to improve and no more likely to deteriorate, affirming hypothesis 7. Six months after the course ended, 37% of the course participants who responded to the follow-up were improved and 13% deteriorated. The analyses could not confirm any difference between ReST and CMT participants in the likelihood of improvement or deterioration, affirming hypothesis 8.

Discussion

Taking a ReST course confers sustained psychological health benefits for the average participant, with regard to dispositional mindfulness and self-perceived cognitive functioning. Regarding chronic stress, the benefits were less consistent and less sustained. Looking at change on the individual level, a little over one third of those who completed ReST enjoyed reliable improvement in their psychological health both directly after the course and six months later. We could not identify any meaningful disadvantage for ReST compared with CMT, and no added risk for deterioration with ReST compared with the passive control condition.

We conclude that ReST is no less efficacious or safe as CMT. Importantly, ReST does not rely on participants' willingness and ability to practice with effortful focused-attention exercises, as conventional mindfulness courses for beginners typically do, so larger numbers of ReST participants can access those benefits. ReST is therefore a viable alternative to conventional mindfulness training for people who struggle under heavy demands in their daily lives.

Paper IV – Mindfulness meditation training in a natural setting particularly helps people with attention problems

Background and aims

Restorative nature experience tends to particularly benefit those who need it most; that is, those who have greatest potential for restoration (e.g., Twohig-Bennett & Jones, 2018; Wheeler et al., 2015; see Hartig, 2007). In contrast, the effort incurred in early stages of mindfulness training seems to discourage participants with low attention regulation capabilities from completing the training (Banerjee et al., 2018; Crane & Williams, 2010; Lymeus et al., 2017). The preceding papers show that ReST is less effortful and more acceptable

than CMT, yet still confers similar long-term benefits for the average participant. To fully address the reasoning behind how ReST might have specific advantages for people with attention problems, it remains to be seen whether the distribution within the sample in initial attention problems is differentially related to engagement with the training and with achievement of eventual benefits.

Building on this reasoning, Paper IV tests a theoretically derived moderated serial mediation model in which course type moderates the relationship between initial attention problems and mindfulness practice, which in turn predicts improvement in dispositional mindfulness, which in turn predicts improvement in attention problems. Hypotheses state that initial attention problems should be positively related to homework practice and improvement for ReST participants. In contrast, initial attention problems should be negatively related to homework practice and improvement for CMT participants.

Methods

Of 159 randomized participants, 105 completed the course and the relevant assessments and could be included in the analyses. Before and after the course, they completed measures of dispositional mindfulness (FFMQ; Baer et al., 2006) and attention problems (CFQ; Broadbent et al., 1982). During the course, they kept records of completed homework practice. The PROCESS macro for SPSS was used to test a moderated serial mediation model where the initial values on FFMQ and CFQ served as predictors of homework practice and of improvement over the course in FFMQ and CFQ values.

Results

Across both course types, higher initial CFQ values predicted more homework practice and greater improvement in CFQ scores. Higher homework practice was in turn related to improvement in FFMQ and CFQ scores. Importantly, initial FFMQ values were not related to homework practice. The theoretically derived moderated serial mediation model could explain part of the relationship between initial CFQ values and improvement in CFQ values. That relationship differed between ReST and CMT participants as expected. Specifically, ReST participants with higher initial CFQ values completed more homework practice. In contrast, homework practice was unrelated to initial CFQ values for CMT participants. The model thus showed that among ReST participants, those with greater initial attention problems practiced more, and that additional practice explained part of the improvement in dispositional mindfulness, which in turn explained part of the improvement in attention problems. For CMT participants, initial attention problems did not explain homework completion.

Discussion

ReST is able to preserve one important feature of restorative nature experience even when it is integrated with a mindfulness-based training approach, namely the feature of differentially benefitting those who need it most. The findings are congruent with the previous results showing that ReST is less effortful and more acceptable than CMT, and they affirm that this particularly benefits participants with more attention problems to begin with. The results support the hypothesis regarding ReST; however, they did not show the anticipated inverse pattern of relationships with CMT. Rather than being negatively related to homework practice and improvement in CMT, initial attention problems were unrelated to practice and improvement. That could be because the CMT in this study used a brief course and exercise format compared with other conventional mindfulness courses.

General Discussion

Main Findings

Looking across the four empirical papers, the main finding is that the ReST approach to mindfulness practice and mindfulness training appears to support beginning meditators with concentration problems and stress better than conventional mindfulness training. This overarching finding builds on four categories of more specific findings regarding the attentional resource dynamics in mindfulness practice and training; acceptability and compliance; longer-term improvements; and the relationship between initial attention problems, compliance, and improvement.

Findings regarding attentional resource dynamics in mindfulness practice and training

Paper I showed that across the five course weeks, the ReST participants consistently restored general attention performance capabilities with the classes and sessions. Towards the end of the course, they also restored executive performance capability. The ReST approach to meditation thus not only permits but promotes restoration, which is consistent with the intentions behind the development of ReST and with the integrative framework elaborated in this thesis. To the best of my knowledge, this is the first research that has demonstrated training in skills that can enhance the restoration achieved in nature contacts. In contrast, CMT participants improved in the first course weeks but then increasingly depleted general attention performance capabilities across the course weeks. This is approximately in line with established mindfulness theory (Lutz et al., 2008). However, to the best of my knowledge, no previous empirical work has addressed the dynamics of effort in the early stages of mindfulness training. The results in Paper I suggest a previously unrecognized initial honeymoon phase in which conventional mindfulness training is restorative. That would be consistent with several reports of effects of very brief mindfulness training courses (e.g., Tang et al., 2007; Zeidan et al., 2010) and single-session mindfulness inductions (e.g., Friese et al., 2012; Mrazek et al., 2012). Over five weeks' training, however, the practice shifts towards incurring effort that reflects in depleted general attention performance capability with meditation sessions. Furthermore, to the best of my knowledge, no research has previously considered that the effort incurred with conventional

mindfulness training can be problematic for many who could have much to gain from mindfulness training. The difference in the degree of effort incurred with ReST and CMT sets the background for the second main finding.

Findings regarding acceptability and compliance

Paper II showed that ReST had relatively high acceptability. This was reflected in substantially higher course completion compared with CMT and compared with numbers reported elsewhere for mindfulness training more generally (Khouri et al., 2013; Nam & Toneatto, 2016). It was also reflected in better maintenance of a regular meditation practice during the course. The acceptability advantage for ReST was in part attributable to the theorized supporting dynamics in the relationships between perceived restorativeness of the course setting and state mindfulness processes. Although the study reported in Paper II did not allow retrospective confirmation of the reasons for drop-out, the compliance patterns for those who completed CMT fit with the suggestion that beginning conventional mindfulness training might be attended by a short initial honeymoon phase before participants begin to learn to regulate the focused-attention state independently. Increasing effort is a feasible explanation for the pattern of gradually decreasing maintenance of the practice habit (cf. Sekhon et al., 2017).

Findings regarding longer-term improvements

The courses engendered longer-term improvements which were similar for ReST and CMT. Paper I showed longer-term improvement in attentional performance capabilities over the course weeks. Paper I, Study 2 affirmed that no clear improvement occurred between the enrollment and course start. Rather, the bulk of the improvement occurred between course week 1 and 3 and it could therefore be attributed to the course start rather than to repeated testing. However, the temporal patterns did not fit with an attention network training mechanism because signs of effort with the CMT classes and sessions were not seen until the later weeks, after the longer-term improvement had already levelled off.

Paper III showed similar improvements in dispositional mindfulness and attentional functioning that were sustained over six-months after both ReST and CMT. However, improvements in stress were less consistent with both courses and they were not sustained at a statistically reliable level after six months. Both ReST and CMT helped around a third of the completer participants (or with drop-outs included, around a quarter of the course starters) improve aspects of their general functioning according to a conservative criterion (reliable change index), with the course and six months later. Neither of the courses were attended by elevated risk of deterioration.

Findings regarding the relationship between initial attention problems, compliance, and improvement

Paper IV showed that the ReST approach is capable of conferring particular benefits for attentional functioning for those participants who need it most; that is, those who experienced more problems to begin with. For ReST participants, the relationship between initial ratings of attention problems and improvement with the course could in part be explained by how participants with different levels of initial attention problems engaged with the homework exercises. In ReST, those with more initial attention problems practiced more, on average, which accords with the findings reported in Paper I that ReST practice permits and promotes restoration and with the findings in Paper II that perceived restorativeness interacts with state mindfulness to facilitate homework completion. Higher total homework practice in turn engendered greater improvement in dispositional mindfulness and attention problems. The effect thus went via higher homework compliance, which further supports assumptions that ReST, like CMT, works as a mindfulness training course.

The results do not affirm expectations that conventional mindfulness training disproportionately benefits participants with already strong attention capabilities. Paper II could not show that the initial score on any of the measures (LDST, CFQ, FFMQ, PSS) obtained before the course predicted the likelihood of completing the course or of maintaining a steady homework practice over the course weeks. Paper IV could not show that the positive relationship between initial attention problems and total mindfulness practice seen for ReST was inverted for CMT participants, only that the relationship seen for ReST participants was absent with CMT. The failure to detect a disproportionate disadvantage for CMT participants with more initial attention problems could be because CMT, like ReST, used a brief format that was already to some degree adapted for people with self-regulation problems: Longer courses that use longer exercises, such as MBSR and MBCT, do seem to disadvantage people with concentration problems (Banerjee et al., 2018; Crane & Williams, 2010; Lymeus et al., 2017).

Implications

Implications regarding ReST as a health intervention

ReST works as a mindfulness training course: It is attended by attention performance improvements and longer-term benefits for psychological functioning that are similar on average to the effects of conventional mindfulness training. ReST also has important advantages over CMT for people with concentration problems: It is a more acceptable introduction to mindfulness training, in part because restorative qualities in the setting support beginning meditators

in deepening and maintaining their practice. This seems to specifically benefit those participants who have most attention problems to begin with. The results support the conclusion that ReST could be a good alternative to conventional mindfulness training for people with concentration problems.

Implications for restorative environments research

Mindfulness practices and processes can interact with restorative processes to promote health. Importantly, the findings in Paper I demonstrate empirically for the first time the possibility to promote restoration through training in mindfulness skills that help people gain distance from depleting demands and routine mental contents, and open up to what can be positively engaging in the setting. Improvement in such skills can enhance restoration outcomes in supportive settings, as shown here, and might further widen the scope of restorative opportunities to include settings of lesser restorative quality. However, of note for restorative environments research, the restorative natural setting supported not only restoration (Paper I) but also state mindfulness in meditation classes and, ultimately, completion of the course and maintenance of a meditation practice (Paper II). This shows how in integration of a compatible individual-level approach to health promotion with a restorative environment, the setting can convey important supporting functions with relevance for the success of the individual-level intervention.

The theoretical work presented in this thesis updates and extends the reasoning laid out by Kaplan (2001). Meditation and mindfulness research has developed immensely since that time, with a level of conceptual elaboration that allows for greater precision in integration of the two approaches. Specifically the delineation of focused-attention and open-monitoring practice (Lutz et al., 2008) and the mapping of how experiential aspects of such practices develop over time within and between practice sessions (Lutz et al., 2015) are of direct relevance to understanding how the two approaches can relate to each other. The delineation of attention network training and attention state training (Tang & Posner, 2009) is, however, perhaps of greater general relevance for restorative environments research. Few authors have taken notice of that attempt to connect meditation science with ART. However, it could further an understanding of how restorative experiences in nature can accumulate to produce generalized health benefits over repeated visits through a process of training in self-regulatory skills. Such training can unfold with deliberate practice as in ReST, but may also unfold with little conscious awareness in spontaneous contacts.

The empirical work largely supports the integrative framework, which can serve further development in restorative environments research. The findings also have implications for mindfulness research.

Implications for mindfulness research

ReST can help people achieve longer-term attention performance enhancements as well as sustained improvements in attention problems and dispositional mindfulness with a minimal investment of effort. Paper I shows that even with CMT, the longer-term attention performance enhancements occurred in the first course weeks, before the practice was attended by any clear signs of effort. These results go against established theory in mindfulness research (Chiesa et al., 2011; Lutz et al., 2008; Malinowski, 2013; Tang et al., 2015) by showing that effortful practice is not necessary to achieve meaningful enhancements in attentional functioning in the early stages of mindfulness training. In fact, even the focused-attention practices employed in CMT were apparently effortless and attended by signs of restoration in the first weeks of training. Beginning meditators might thus go through an initial honeymoon phase. Only towards the end of the five-week CMT course did signs of effort emerge.

The shift from effortless to effortful practice over the first five weeks of mindfulness training could be due to the processes of learning to self-regulate the meditative state, as proposed in Paper I. Only with top-down regulation of the meditation would signs of effort appear. When unskilled participants with concentration problems and stress sit down to meditate, the change of setting and activity breaks the normal routine and simply hearing and following meditation instructions might be fascinating and relaxing. Over the course weeks, however, they will gain in skills that allow them to begin to self-regulate the meditative state independently; that is, with some degree of independence from the instructor and other external conditions in the situation. Perhaps in a parallel process, the novelty of meditation might wear off leading to boredom. Boredom, in turn, would be attended by increased effort to maintain the activity.

The results suggest that the bulk of improvement in attention test performance occurs in the first few weeks of mindfulness training, in both ReST and CMT, whereafter improvement levels off. The improvements coincided with the restorative practice effects seen in the first weeks. The levelling off coincided with increasing effort in CMT practice. The relative benefit of conventional mindfulness practice for attention regulation capabilities thus seems to diminish quickly, which could explain why rather many people comply poorly with mindfulness courses and have trouble maintaining a regular practice habit over time.

Earlier mindfulness studies have not generally taken care to obtain measures meant to tap longer-term training outcomes at a temporal distance from practice sessions (Johnson et al., 2015; Lymeus, 2008). This research is therefore first to relate performance-based practice and training effects and thus begin to uncover the resource dynamics in mindfulness practice and training (cf. Kiken et al., 2015).

Strengths and Limitations

Comparison conditions

The overall design contrasts two formally comparable, feasible approaches to mindfulness training that both are congruent with the respective meditation settings. Very few studies have contrasted different bona-fide approaches to meditation (Abdoun et al., 2019; Britton et al., 2018; Fujino et al., 2018). In fact, the evidence in the field really suffers from the fact that not many studies have used active control conditions at all (Davidson & Kaszniak, 2015; Vago et al., 2018; Van Dam et al., 2018). The present research applied experimental methods in the field, where the training and practice was implemented in naturalistic conditions. Furthermore, the participants were people who volunteered out of an interest in participating in mindfulness training and who could have much to gain from such training. Together, these strengths give the research pragmatic value and allow the conclusions to extend beyond the confines of a research setting: They give a good foundation for predicting what a person with concentration problems could expect to experience and achieve by choosing to engage with ReST or with conventional mindfulness training.

The contrast between ReST and CMT sought to test whether ReST could promote similar longer-term outcomes on attention performance and general psychological functioning as a conventional course aimed towards the proposed dominant mechanism behind improvements in early stages of meditation training: attention network training through focused-attention practice. The contrast between ReST and CMT also sought to test whether ReST had some advantages for people with concentration problems and stress. Viewed as treatment evaluation as well as mechanistic (e.g., dismantling) research, active control studies offer superior evidence compared to passive control studies. However, a study with randomization over three conditions (i.e. ReST, CMT, waiting list) would have been even stronger. The choice to not include a randomized passive control condition that ran through all of the rounds was determined mainly by the relatively limited marginal benefit of the added burden of processing and retaining larger numbers of participants throughout the many stages of evaluation at different levels in this research. The separately recruited passive control group that participated only in the fourth data collection round and only in some, procedurally rather light, aspects of the research (see Paper III) is clearly inferior to a fully integrated control arm. However, for its low cost it did provide some control over shared extraneous factors in the student population (e.g., seasonality, history) and thereby added some strength to the conclusions that could be drawn regarding the benefits and utility of the fully developed ReST course, as described in Paper III.

One issue that the contrasts between ReST and CMT cannot address directly is the relative contribution of the setting and the practice to the outcomes

of ReST (or, for that matter, of CMT). The research approach aimed to compare ReST with a feasible conventional alternative in order to draw practically relevant conclusions. Given that aim and the limited resources available for the research, including additional conditions that would allow factorization of practice and setting effects (i.e. by including ReST and CMT practice conditions set in an incongruent environment) was deemed a lower priority. The ReST approach, which was built in and on restorative nature contacts, would likely fail in attaining meaning and support in an indoor setting that offers little in fascinating objects and processes. Conversely, conventional mindfulness training emphasizing focused-attention practice targeting internal aspects of experience would likely conflict with a rich and fascinating setting, making the practice more difficult for beginners with concentration problems. However, with the conflating of practice and setting, any conclusions about the differences between ReST and CMT must refer to the whole package. That is certainly not uncommon in treatment studies where multicomponent interventions are frequently compared as packages rather than with regard to each component part (e.g., Leventhal et al., 2008; Ong et al., 2004).

Another point to consider is that the CMT used in this research, while it was based on MBSR, does not precisely mimic MBSR or any other established mindfulness training course. For both ReST and CMT, the course format and exercises were made brief to particularly suit participants with concentration problems. For CMT, the practice approach emphasized focused-attention practice to preserve the experimental contrast against ReST. The papers as well as this comprehensive summary take care to describe the courses in some detail with regard to the course format as well as to the practice approach to avert problems with vague intervention descriptions that otherwise abound in mindfulness research (Davidson & Kaszniak, 2015; Van Dam et al., 2018). The descriptions allow researchers to judge the similarities and disparities between ReST, CMT, and other conventional mindfulness training courses. However, the findings reported concerning CMT cannot be directly generalized to other conventional mindfulness training courses that differ to some extent in format and contents.

The research cannot determine retrospectively how those who dropped out experienced the courses or what values the drop-outs would have had on the post-course assessments. It was mainly a matter of neglect in the planning stages that the ethical review application did not include an opportunity to pursue drop-outs to obtain post-course measures. Having such data would have further improved the strength of the conclusions in Paper II and Paper III.

Tests for restoration logically require that some degree of depletion has occurred beforehand (e.g., Hartig, 2007). The participants were enrolled on a premise of self-perceived concentration or stress problems. The study procedures were also completed in the late afternoon when participants were expected, on average, to have expended some adaptive capability in meeting the

day's demands. The attentional performance improvements seen with ReST sessions in Paper I concurred with pleasant deactivation (i.e. relaxation) but not with pleasant activation (i.e. engagement) which suggests that important alternative explanations (i.e. invigoration or motivation) were not responsible for the attention outcomes. However, an experimental fatigue induction before the mindfulness classes and sessions would have further ensured a need for restoration and would probably have exacerbated the differences in the short-term outcomes of ReST and CMT practice. Other studies completed within the Linnaean Collaboration have explored different experimental and naturalistic methods for fatigue induction (e.g., Bernhardsson, 2017; Billing & Lloyd Sjöblom, 2019; Samuelsson, 2016; Shamsae, 2016).

Lastly, the small research team working under tight resource constraints could not employ unaffiliated and blinded instructors and data collectors as is frequently recommended for treatment evaluations (e.g., Davidson & Kaszniak, 2015). The author (Lymeus) led the work with the courses and data collection with competent assistance from different psychologists-in-training working directly under his supervision in the different data collection rounds. The risk of biases such as implicit allegiance or expectancy effects influencing the results should be minor because the comparisons between ReST and CMT presuppose improvements with CMT, which represents the proposed dominant pathway to improvements in early stages of mindfulness training. All meditation instructions and other course contents were based on a preliminary script that was developed in parallel for ReST and CMT to ensure comparability, quality, and consistency. Participants in both course types also received a bona-fide rationale for engaging with the training to achieve attention and health benefits based on the supposed mechanisms involved in ReST and CMT, respectively. Also note that the hypotheses regarding the longer-term outcomes are formulated in terms of similarity of ReST and CMT. With the intention to test for similarity, any implicit biases should not translate to reduce the overall feasibility or the quality of instruction in CMT: The potential for implicit bias might have been greater in a superiority trial. Hypotheses regarding differences between ReST and CMT concerned processes (i.e. perceived restorativeness and state mindfulness), performance-based outcomes (i.e. attention tests), and compliance records that were obtained at a relative distance from the course procedures. These outcomes should be relatively less susceptible to biases.

Development across the rounds

As also noted above, working in naturalistic field conditions with tight resource limitations imposed some constraints and demands for adaptation. Rather than conducting one large randomized controlled trial, the research was completed in four separate data collection rounds with randomization within but not across the rounds. The ReST course was allowed to develop over the

data collection rounds, so preliminary results and accumulated experience as well as the parallel work with theoretical integration could feed back to inform an iterative process of refinement of ReST. Although this introduced variability across the rounds, it was an efficient approach to development.

For all effects, the statistical analyses involved checks and controls for main and interaction effects involving the factor Round and so were able to isolate the effects of interest (e.g., effects of course type). However, several of these checks revealed variation associated with Round that presumably reflects extraneous factors such as seasonality, history, and social processes in the course groups as well as effects of the development of ReST. The extraneous factors therefore limit the possibility to draw conclusions about how the development of the ReST course translated into change in its outcomes.

Some methodological aspects also differed over the data collection rounds because of realizations and opportunities that arose over the years with this project. In retrospect, collecting data from a six-month follow-up from all four rounds would have improved analyses and facilitated reporting of the results. The improvements in the measurement design and tests employed for measuring attention performance in round four were less problematic: The round 4 results (presented in Paper I, Study 2) could be used to affirm and elaborate on the round 1 – 3 results (presented in Paper I, Study 1).

The measurement design for the attention outcomes (first developed for the study by Lymeus [2008] which was later published as Lymeus et al. [2017]) has the important advantage of tapping both the short-term outcomes of practice and the longer-term outcomes of training. As such, it combines the experimental approach more typical in laboratory studies with an evaluation approach more typical in treatment studies. Bridging the divide between the short-term and longer-term outcomes, or between process oriented and outcome oriented research, within the same study, the design could uniquely address mechanisms of action.

Measurement issues

The field conditions also required compromise with regard to the number and selection of measurement instruments. In capturing attention restoration effects in the mindfulness classes and sessions reported in Paper I, measurements had to be obtained immediately after completion of the intervention so the tests had to be brief and practicable to administer in group and within the respective practice settings. The LDST and the adapted TMT were selected for their robust psychometric properties and known sensitivity to minor variations in different attentional constructs. Despite these advantages, however, LDST performance varies with change in multiple attentional functions: substitution test performance varies with general information processing capability, which in turn is dependent on selective and executive components of attention as well as other abilities (i.e. psychomotor speed; see Mirsky et al.,

1991). The TMT allows separation of the executive capability of set switching from the general attention or information processing capability and so provides more nuance (see Tombaugh, 2004). Still more nuanced conclusions regarding how specific attentional functions were affected with the different approaches to mindfulness could have been achieved with more sophisticated, computerized testing such as with the attention network test (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Other studies completed within the Linnaean Collaboration have developed procedures for computerized testing for restoration outcomes (Bernhardsson, 2017; Hildonen, 2014; Svanberg, 2015). However, such testing requires individual measurement sessions over a comparatively long test duration, which could not be accommodated in this research.

For the assessment of longer-term outcomes on dispositional mindfulness, attention problems, and chronic stress, we relied on retrospective self-reports. Each of the measures we chose (FFMQ, CFQ, PSS) are established and valid measures of foundational aspects of real-life functioning (Carrigan & Barkus, 2016; S. Cohen, 1988; Sauer et al., 2013). Each of them has also been criticized for conceptual and/or psychometric shortcomings (see Grossman, 2008; Könen & Karbach, 2018; Nielsen et al., 2016). The more general reliance on retrospective self-report assessments in much of psychological research has also been debated (e.g., Shiffman, Stone, & Hufford, 2008). For the constructs in question, alternative methods are being developed such as for the assessment of mindfulness through contextualized real-time reports (Mrazek, Franklin, Phillips, Baird, & Schooler, 2013) and self-monitoring tools (Levinson, Stoll, Kindy, Merry, & Davidson, 2014). For stress, psychophysiological assays have been developed that have high construct validity and temporal precision, such as heart-rate variability (Thayer et al., 2012; van der Zwan, de Vente, Huizink, Bögels, & de Bruin, 2015). As has been noted for attentional functioning, however, momentary performance capability does not necessarily reflect real-life functioning in which multiple demands must be coordinated over prolonged periods (Carrigan & Barkus, 2016): There is unique value in measures that tap experienced functioning.

The selected measures capture foundational aspects of real-life functioning that are relevant for restorative nature experience as well as for mindfulness training. However, they do not capture every aspect of functioning that could be affected and that could potentially be affected differently with ReST and CMT. For instance, psychological flexibility (Bond et al., 2011) and self-compassion (Neff, 2003) have been proposed as important pathways between mindfulness training and health outcomes. Questions about how ReST and CMT compare with regard to these and other relevant outcomes could be addressed in future research. For many psychological aspects of interest for mindfulness studies, suitable assessment methods are not yet available (see Abdoun et al., 2019; Grossman, 2008).

Future Directions

Ongoing research within the Linnaean Collaboration

This research forms part of ongoing, interconnected research efforts within the Linnaean Collaboration. Studies are under way to address some of the limitations and outstanding questions in the studies comprised by this thesis. These research efforts are not yet completed in terms of data collection and analysis, but the following paragraphs describe the research designs and aims and in some cases preliminary findings.

One line of ongoing research at this point comprises 116 student participants who have completed attention tests before and after participating in regular learning activities within their study programs, and then again after spending a short break in the tropical greenhouse or in the common areas of the campus building. Several measures of background functioning and relevant mediating constructs have also been obtained, including perceived restorativeness and state mindfulness. That line of research could show how attentional demands over a regular work day in the life of a student interact with shifts in emotional states, how the surrounding botanic gardens can function to support continued well-being and performance over a work day by facilitating restoration during study breaks, and how restorative environmental qualities might interact spontaneously with state mindfulness to produce restoration outcomes even without any mindfulness practice. Preliminary analyses of various subsets of the data have been presented MSc theses by Hildonen (2014), Samuelsson (2016), and Svanberg (2015). One question with direct relevance for ReST that will be addressed within this line of research is the degree to which experiences in the garden settings as considered alone, without any mindfulness practice, support state mindfulness.

Another line of ongoing research evaluated more controlled methods for studying fatigue and restoration, as described in MSc theses by Bernhardsson (2017) and Shamsaee (2016). These studies employed extended performance on computerized attention tests to induce fatigue and stress, and to subsequently study restoration under different environmental conditions. These studies constitute important preliminary steps in the development of a tightly controlled paradigm for studying fatigue and restoration as determined by different environmental and task-related factors. The development of such a paradigm will eventually allow further tests of how the processes engaged with ReST and CMT interact with environmental conditions. Bernhardsson compared visits to the tropical greenhouse against the common areas of the campus building. Shamsaee used ReST practice instructions in relation to window views of the botanic garden, CMT instructions with no window view, or resting instructions that did not involve mindfulness practice in the view and no view conditions, and hence sought to disentangle simple resting effects from

the meditation effects to determine the added benefit of the two approaches to mindfulness practice.

Bergsten (2019) continues the work to disentangle setting and practice effects in ReST by reporting contrasts between ReST practice completed in the tropical greenhouse vs indoors. Billing and Lloyd Sjöblom (2019) continued the work to determine the practical usefulness of ReST by comparing ReST practice in the tropical greenhouse compared with CMT practice indoors as a means for psychology students to restore from the demands incurred by working with patients in psychotherapy contacts as part of their clinical training.

With the completion of these ongoing research efforts, several of the outstanding questions regarding ReST will be addressed. The ongoing work will simultaneously serve to reinforce the research model in the Linnaean Collaboration and extend the range of different methodological platforms on which future studies can be built. In addition to the plans to continue research on ReST within the Linnaean Collaboration, the work comprised in this thesis can guide further developments in restorative environments and mindfulness research more generally.

Guide for further developments at the intersection of restorative environments research and mindfulness research

The present studies show that a restorative natural setting can support beginning meditators in an adapted form of mindfulness practice and training, and that an adapted form of mindfulness training can enhance restorative processes and restoration outcomes. However, there are several caveats to consider in further developments and applications of that knowledge.

1 + 1 < 2

One caveat relates to the necessity of integration. Mindfulness training and restorative nature experience have intriguing similarities; however, those similarities do not alone warrant integration. Considering only the similarities, the two approaches would be more useful as separate pathways towards similar goals. Arguments for integration should instead draw on their differences. In doing so, researchers should consider that both approaches have specific properties that in relation to some given aim could provide specific advantages or disadvantages. Simply adding one to the other is not likely to increase the benefit in an additive manner. To the contrary, the two could conflict in several ways and reduce the achieved benefit below levels expected with either approach alone. The integrative framework outlined in this thesis indicates how some of the specific properties of restorative nature experience and mindfulness training can provide advantages and disadvantages for the management of adaptive resources.

For instance, effort incurred in early stages of conventional mindfulness training will inevitably prohibit restoration and further tax limited attention resources. Engagement with mindfulness training will also inevitably incur indirect costs to other resources, such as time that could be used for restorative or other beneficial activities. Other points of potential conflict can be identified from the perspective of mindfulness. As discussed in Paper I, a restorative environment that is rich in salient stimuli and processes will likely distract beginning meditators trying to engage with practices that target internal aspects of experience. That could, in turn, prevent central pathways of development including effective attention network training as well as exposure. Careful integration is therefore necessary to connect the two approaches by drawing on their respective advantages to overcome their respective disadvantages with regard to the pursuit of some given aim.

Considering what mindfulness training cannot do

Another caveat is that the feasibility is limited for broad-range use of any form of mindfulness training as a means of mitigating a lack of qualitative nature amenities for urban populations. Natural settings in urban areas can bring opportunities for restorative experience to many and particularly benefit those with the greatest needs (e.g., Twohig-Bennett & Jones, 2018; Wheeler et al., 2015). In contrast, mindfulness training typically appeals to limited segments of the population that disproportionately comprise relatively advantaged individuals (Carlson, 2018). Findings in related research fields can further inform considerations. For instance, researchers concerned with mindfulness training in service of sustainable behavior change must consider that selective uptake in mindfulness training probably prevents such programs from reaching those population segments that are already least likely to favor pro-environmental transitions (cf. Geiger et al., 2019; Panno et al., 2018). In efforts to mitigate stress-related problems in work contexts, individual-level approaches tend to be costly and ineffective compared to interventions targeting the contextual determinants of health and illness (Åsberg et al., 2010; Awa et al., 2010; Maslach et al., 2001). Furthermore, as noted by Taylor et al. (1997), applying individual-level solutions to contextual-level problems is not only unpractical but also ethically troublesome.

McNature and the need for further research

The enthusiastic dissemination of mindfulness in the last decades in many cases went ahead of the evidence and beyond its ethical and philosophical foundations (Grossman & Van Dam, 2011; Hyland, 2015; Møllgaard, 2008; Purser, 2015; Van Dam et al., 2018; Walsh, 2016). “McMindfulness” came to describe the appropriation and commodification of mindfulness, or as Safran (2014) put it: “the marketing of a constructed dream; an idealized lifestyle; an

identity makeover“ (also see Hyland, 2015; Walsh, 2016). Rather similar debate has surfaced regarding the appropriation and commodification of nature in the service of interests that sometimes conflict with sustainable transitions and ecologically founded ideals (Bartlett, 2011; Munshi & Kurian, 2005; Pearson & Henryks, 2008). These examples show a need for restraint in the interpretation and communication of findings in both of these areas.

ReST is promising but these findings warrant further research rather than packaging and marketing. Only students have participated, only in the Uppsala University botanic garden, and only with the creators of the course as instructors and evaluators. And only those outcomes that were tapped with the current measures and measurement design have been evaluated. Replication of the findings would bolster confidence that ReST could have practical use in health promotion efforts. In terms of future developments, however, more of process-oriented research on ReST could potentially stimulate further developments at the intersection of restorative environments research and meditation science.

Wrapping it up

The setting matters in meditation. From a mountaintop monastery, to full immersion in wild forests, to a cool yoga studio, to a cushion in the bedroom corner, to a crowded commuter train on the way home from work, the setting inevitably is a part of the meditation experience. Experienced meditators can choose a setting and adapt the practice according to their current skills, needs, and aims. The work with ReST has elaborated and tested one combination of setting and practice that seems to be particularly relevant for people who struggle with concentration problems and stress in managing the demands in their lives. ReST apparently succeeded in meeting their low initial skill-level, their need to restore and enhance adaptive capabilities, and their aim to establish a meditation practice that could continue to benefit them over time. Conventional mindfulness training indoors is probably well suited to people who have some resources to invest in attention network training, as the tests of time and multiple scientific studies have shown. Yet other combinations of settings and practices could serve other groups and purposes. One could speculate on how more dramatic nature scenes or more harsh and demanding nature contacts might relate to different practices, processes, and aims relevant for meditation. One could also elaborate further on how different specific natural elements such as water and growing vegetation might be suited to different functions in meditation practice. Restorative environments research provides fruitful ground for such considerations.

My curiosity and efforts in bridging the gap between restorative environments research and mindfulness research have led me deep into the human origin in the heart of nature, through enduring historical lines of thinking and acting that show how humans have since early days of agricultural civilization

found themselves torn between desires for progress and desires to turn back to nature and the perceived natural. Although the cities, the offices and classrooms, the paved roads and the smartphones are all purpose built by humans for humans, it seems that they cannot allow us to feel fully connected with ourselves and with the world that we shape and live in. Perhaps the problem lies in the purposefulness of built things, which allows them to be tools for a purpose in performing, developing, moving, or communicating. Nature is not purposeful but meaningful nonetheless. Still, Siddhārtha Gautama returned to civilization to teach the people how to live well and develop there. Within efforts to bring nature to urban populations as well as in the traditional roots of mindfulness meditation, a pursuit of sustainability has long been present in some sense. These concerns have increasingly come to embrace ecological sustainability in addition to sustainable functioning and health for humans. As people from all levels and regions of society begin to commit to a more sustainable way of living in modern societies, there seems to be some hope that the future could hold both progress and a return, not to but of nature in our lives. Although it takes more than science, a scientific approach to the human relationship with nature as represented here by restorative environments research and mindfulness research could help in progressing that development wisely.

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Supplement A

Overview of the restoration skills training (ReST) and conventional mindfulness training (CMT) courses as they were given in the four data collection rounds.

	Course	Theme	In-class exercises	Homework
Round 1, week 1	ReST	Introduction Setting: Orangery	1. Raisin exercise 2. Sitting meditation 3. Body scan	Formal: Inward and outward attention Informal: Mindful washing
	CMT	Introduction	1. Raisin exercise 2. Sitting meditation 3. Body scan	Formal: Inward and outward attention Informal: Mindful washing
Round 1, week 2	ReST	Attention Setting: Greenhouse	1. Walking meditation 2. Mindfulness of sound 3. Body scan	Formal: Internal and external attention Informal: Mindfulness in routine activity
	CMT	Attention	1. Counting breaths 2. Mindfulness of sound 3. Body scan	Formal: Internal and external attention Informal: Mindfulness in routine activity
Round 1, week 3	ReST	Acceptance Setting: Greenhouse	1. Mindful movement 2. Loving kindness	Formal: Internal and external attention Informal: Mindfulness in routine activity
	CMT	Acceptance	1. Mindful movement 2. Loving kindness	Formal: Internal and external attention Informal: Mindfulness in routine activity
Round 1, week 4	ReST	The thinking brain Setting: Coniferous grove	1. Loving kindness 2. Thoughts as clouds 3. Mindful movement	Formal: Body scan Informal: Mindfulness wherever you are
	CMT	The thinking brain	1. Loving kindness 2. Thoughts as clouds 3. Mindful movement	Formal: Body scan Informal: Mindfulness wherever you are
Round 1, week 5	ReST	Mindfulness of feelings Setting: Kitchen garden, greenhouse	1. Walking meditation 2. Mindfulness of feelings 3. Mindful movement	
	CMT	Mindfulness of feelings	1. Mindful movement 2. Mindfulness of feelings 3. Loving kindness	
Round 2, week 1	ReST	Introduction / The body Setting: Greenhouse	1. Raisin exercise and sitting meditation 2. Mindfulness of the body, sitting and walking	Formal: Body scan Informal: Mindful walking
	CMT	Introduction / The body	1. Raisin exercise and sitting meditation	Formal: Body scan

			2. Body scan	Informal: Mindful washing
Round 2, week 2	ReST	Curiosity / Touch Setting: Greenhouse	1. Guided tactile meditation 2. Guided anchoring and independent tactile exploration	Formal: Tactile meditation Informal: Mindful touching
	CMT	Attention / The breath	1. Mountain meditation 2. Mindfulness of breath	Formal: Body scan Informal: Mindfulness in routine activity
Round 2, week 3	ReST	Acceptance / Hearing Setting: Greenhouse	1. Guided sound meditation 2. Guided anchoring and independent sensory exploration	Formal: Sound meditation Informal: Mindful hearing
	CMT	Acceptance / Compassion	1. Mindful movement 2. Loving kindness	Formal: One thing at a time Informal: Mindfulness in coming and leaving
Round 2, week 4	ReST	The thinking brain / Seeing Setting: Greenhouse	1. Guided visual meditation 2. Guided anchoring and independent sensory exploration	Formal: Visual meditation Informal: Mindful seeing
	CMT	The thinking brain / Thoughts	1. Walking meditation 2. Thoughts as clouds	Formal: Passing thoughts Informal: Mindfulness in unpleasant situations
Round 2, week 5	ReST	The moment / All experience together Setting: Greenhouse	1. Guided meditation on smell and taste 2. Guided anchoring and independent sensory exploration	
	CMT	The moment / Mindfulness of feelings	1. Mindfulness of thoughts and feelings 2. Mindfulness of the moment	
Round 3, week 1	ReST	Introduction / The body Setting: Greenhouse	1. Raisin exercise and sitting meditation 2. Guided body scan and independent walking meditation	Formal: Body scan Informal: Mindful walking
	CMT	Introduction / The body	1. Raisin exercise and sitting meditation 2. Body scan	Formal: Body scan Informal: Mindful washing
Round 3, week 2	ReST	Curiosity / Touch Setting: Greenhouse	1. Guided tactile exploration 2. Guided anchoring and independent tactile exploration	Formal: Tactile exploration Informal: Mindfulness of touch
	CMT	Attention / The breath	1. Mountain meditation 2. Mindfulness of breath	Formal: Mindfulness of breath Informal: Mindfulness in routine activity
Round 3, week 3	ReST	Thinking and judging / Hearing Setting: Greenhouse	1. Guided sound meditation 2. Guided anchoring and independent auditory exploration	Formal: Auditive exploration Informal: Mindfulness of sound
	CMT	Acceptance / Feelings	1. Self-compassion 2. Walking meditation	Formal: One thing at a time Informal: Mindfulness in unpleasant situations
Round 3, week 4	ReST	Thinking and judging / Seeing Setting: Greenhouse	1. Guided visual meditation	Formal: Visual meditation Informal: Mindfulness of sight

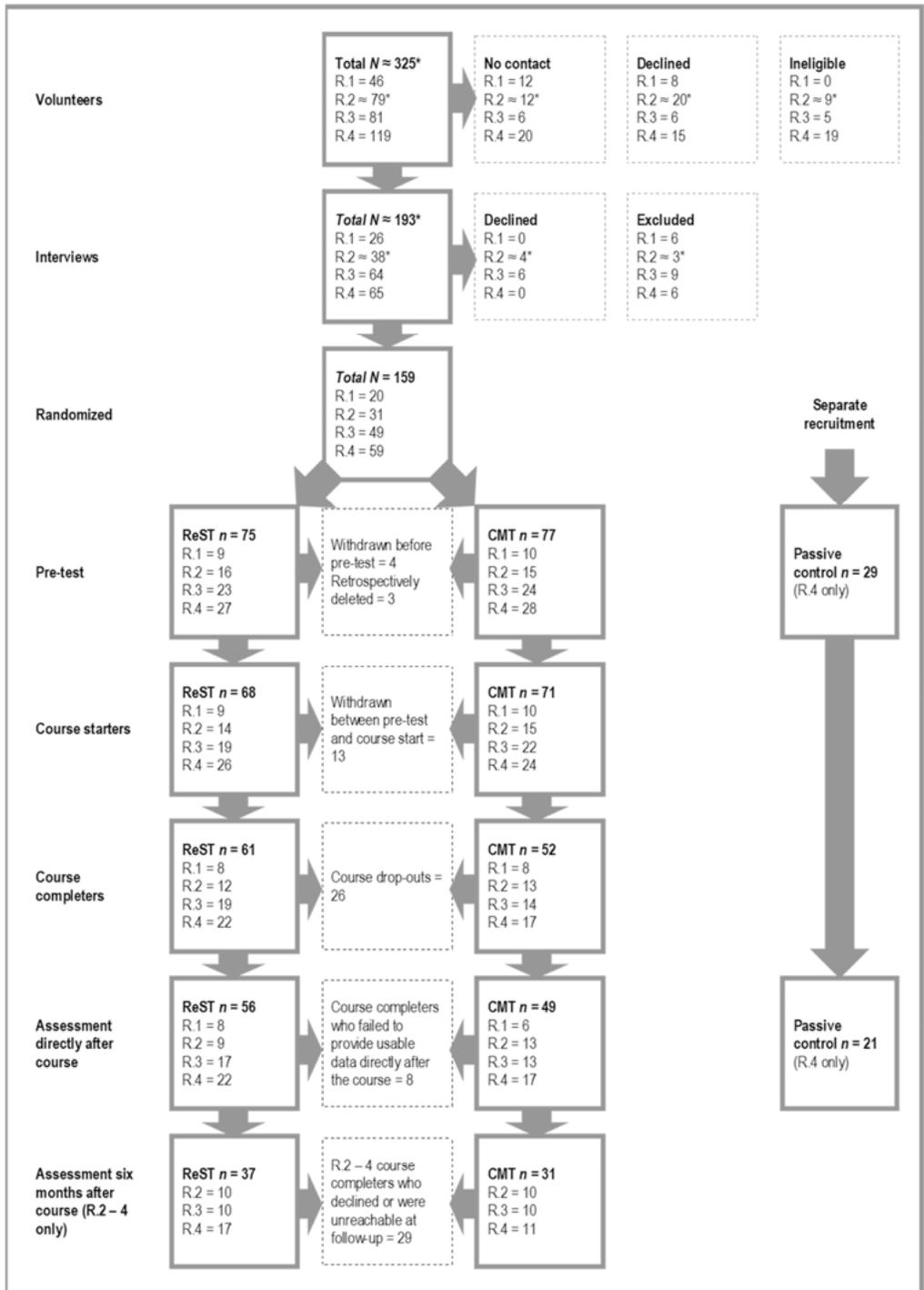
			2. Guided anchoring and independent visual exploration		Formal: Passing thoughts Informal: Mindfulness in transition between activities
CMT	Detachment / Thoughts		1. Thoughts as clouds 2. Mindfulness of thoughts and feelings		
ReST	The moment / All experience together Setting: Greenhouse		1. Meditation on smell and taste 2. Guided anchoring and independent sensory exploration		
CMT	The moment / All inner experience together		1. This moment 2. Sitting meditation with all internal experience		
ReST	Introduction / The body Setting: Greenhouse		1. Basic ReST exercise 2. Standing and walking meditation		Formal: Basic ReST exercise Informal: Walking meditation
CMT	Introduction / The body		1. Basic CMT exercise 2. Body scan		Formal: Basic CMT exercise Informal: Mindfulness of the body
ReST	Exploring experience / Touch Setting: Greenhouse		1. Guided tactile meditation 2. Guided anchoring and independent tactile exploration		Formal: Basic ReST exercise Informal: Mindfulness of touch
CMT	Attention and distraction / The breath		1. Mountain meditation 2. Mindfulness of breath		Formal: Basic CMT exercise Informal: Mindfulness of breathing
ReST	Embracing experience / Hearing Setting: Greenhouse		1. Basic ReST exercise 2. Guided anchoring and independent auditory exploration		Formal: Basic ReST exercise Informal: Mindfulness of sound
CMT	Acceptance and decentering, part 1 / Thoughts		1. Basic CMT exercise 2. Thoughts as clouds		Formal: Basic CMT exercise Informal: Mindfulness of thinking
ReST	Letting go / Vision Setting: Greenhouse		1. Guided visual meditation 2. Guided anchoring and independent visual exploration		Formal: Basic ReST exercise Informal: Mindfulness of sight
CMT	Acceptance and decentering, part 2 / Feelings		1. Thoughts and feelings 2. Walking meditation		Formal: Basic CMT exercise Informal: Stop and accept
ReST	The moment / All experience together Setting: Greenhouse		1. Basic ReST exercise 2. Guided anchoring and independent sensory exploration		
CMT	The moment / All inner experience together		1. Basic CMT exercise 2. The moment		

Supplement B

The number of participants in Paper I who completed the attention tests and affect ratings in connection with the meditation classes (Study 1) and sessions (Study 2), in the restoration skills training (ReST) and conventional mindfulness training (CMT) conditions.

Paper I	Course	Enrollment	Week 1	Week 3	Week 5	Complete data
Study 1	ReST		40	33	29	25
	CMT		45	31	31	26
Study 2	ReST	26	21	21	17	15
	CMT	24	21	16	16	14

Supplement C



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