Nebraska Symposium on Motivation 67

Anne R. Schutte
Julia C. Torquati
Jeffrey R. Stevens *Editors*

Nature and Psychology

Biological, Cognitive, Developmental, and Social Pathways to Well-being

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Nebraska Symposium on Motivation

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Series editor

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Series Preface

We are pleased to offer this volume from the 67th Nebraska Symposium on Motivation.

This year the volume editors are Anne Schutte, Julia Torquati, and Jeffrey Stevens. In addition to overseeing the development of this book, the volume editors coordinated the 67th Symposium, including selecting and inviting the contributors. I would like to express my appreciation to Professors Schutte, Torquati, and Stevens for a stimulating meeting and an excellent series of papers on nature and its impact on human cognition, behavior, and well-being.

Historically, the symposium series has been supported by funds from the Office of the Chancellor of the University of Nebraska-Lincoln and by funds given in memory of Professor Harry K. Wolfe to the University of Nebraska Foundation by the late Professor Cora L. Friedline. This year's symposium was supported by funding from Chancellor Ronnie Green, the Department of Child, Youth, and Family Studies, and the College of Architecture.

This symposium volume, like those in the recent past, is dedicated in memory of Professor Wolfe, who brought psychology to the University of Nebraska. After studying with Professor Wilhelm Wundt in Germany, Professor Wolfe returned to his native state, to establish the first undergraduate laboratory in psychology in the nation. As a student at the University of Nebraska, Professor Friedline studied psychology under Professor Wolfe.

Lincoln, NE, USA — Lisa J. Crockett

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Chapter 1
Introduction

Anne R. Schutte, Julia C. Torquati, and Jeffrey R. Stevens

For the first time in history, the majority of the world's population lives in urban areas (55%, UN Department of Economic and Social Affairs, 2018). In North America that percentage is significantly higher at 82% (UN Department of Economic and Social Affairs, 2018). In addition, children spend less time engaged in activities in nature than in past generations (Larson, Green, & Cordell, 2011). This decrease in time outdoors is happening despite mounting evidence that time outdoors in natural environments or "green space" benefits health and well-being (Bowler, Buyung-Ali, Knight, & Pullin, 2010).

We have known since at least the 1980s that exposure to nature can lower stress and promote recovery after illness (Ulrich, 1981, 1984). More recent research has found that time in nature also promotes many other aspects of well-being, such as improving mental health (Berman et al., 2012; Triguero-Mas et al., 2015), physical health (Dadvand et al., 2016; Mitchell & Popham, 2008), body image (Swami, Barron, Todd, Horne, & Furnham, 2020), immune system function (Li, 2010; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010), physical activity (Dzhambov, Hartig, Markevych, Tilov, & Dimitrova, 2018), and cognition (Berman, Jonides, & Kaplan, 2008). Pertinent for this volume, time in nature has been shown to improve aspects of cognition, in particular attention and executive function, in children and adults (e.g., Berto, 2005; Faber Taylor & Kuo, 2011; Schutte, Torquati, & Beattie, 2017).

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The goal of the 67th Nebraska Symposium and this resulting volume was to bring together researchers from different disciplines and theoretical viewpoints who examine the relationship between spending time in natural environments and cognition. The symposium presentations and the chapters, however, morphed into something broader than that, as the authors grappled with the influence of natural environments on multiple aspects of health and well-being, all of which affect cognition either directly or indirectly. Thus, some chapters focus specifically on the influence of natural environments on cognition while others take a broader perspective and discuss the influence of natural environments on well-being.

The chapters also reflect the interdisciplinary nature of the area, as they are written by researchers from various disciplines and draw on research and theories in psychology, neuroscience, child development, and architecture, among other areas. Although the authors may come from different disciplines, several chapters have roots in *attention restoration theory* (ART), one of the primary explanations of the influence of nature on cognition, specifically the influence of nature on attention (Kaplan & Kaplan, 1989). This theory was proposed by Kaplan and Kaplan (1989) and builds on William James' (1892) discussion of "effortful attention." According to attention restoration theory, directing attention to something that does not automatically "catch" attention requires effort, and, therefore, directed attention can be fatigued by prolonged mental effort. But allowing directed attention to "rest" can restore it to prior levels. Directed attention can rest when effortless attention, or "fascination," can be engaged instead of directed attention. Fascination is engaged when the environment allows attention to be engaged by bottom-up processes instead of top-down, effortful processes.

A second influential theory is the *stress reduction theory*, also called stress recovery theory, proposed by Ulrich (Ulrich et al., 1991). Stress reduction theory is a psycho-evolutionary theory. According to this theory, because humans evolved in natural environments, the features found in those environments are aesthetically preferred, resulting in a reduction in both physiological and psychological (i.e., emotional) arousal. Much of the work presented in these chapters has roots in either attention restoration theory (e.g., Sullivan & Li) or stress reduction theory, but several of the authors have incorporated other theories, e.g., prospect-refuge theory, and/or expanded substantially on restoration theory.

In Chap. 2, Sullivan and Li begin with a discussion of the definitions of natural environments, and then describe how our attention is influenced by daily challenges to attention, especially for those living in modern, urban environments. They present an overview of attention restoration theory and summarize research that has tested this theory. In a systematic review, Sullivan and Li find that the number of studies that test attention restoration theory has increased substantially in recent years. Their chapter summarizes the methods used across 48 studies that tested the influence of natural environments on attention. This methods summary is a useful resource for designing future studies by cataloging the different types of nature exposures, e.g., direct exposure to nature, photos, and so on, and the resultant effects of the exposure. Their summary reveals that a majority of the studies find at least some positive effects of nature for both exposure to actual natural environments and

images and videos of nature. The positive effects also hold across different measures of attention and cognition. Sullivan and Li end by providing practical recommendations for how to increase exposure to nature in ways that support attention.

In Chap. 3, van den Berg delves more deeply into the question of why spending time in nature has positive effects on well-being. Specifically, she discusses whether preferences for natural environments and the restorative effects of these environments are due to the stimuli in the environment, i.e., bottom-up effects, or due to culturally transmitted views of nature, i.e., top-down influences. Evolutionary accounts of these effects have focused on the automatic positive responses that exposure to natural environments elicit. van den Berg focuses on the top-down effects of cultural transmission of views of nature and learned associations with nature. She expands on the current theories and discusses a *conditioned restoration theory* that focuses on the influence of top-down, learned positive associations between nature and positive responses. She also explores research that examines possible visual, auditory, and olfactory pathways through which nature may influence preference and restoration.

In Chap. 4, Berman and colleagues summarize some of the theories that have been applied to influences of nature on cognition, including stress reduction theory, attention restoration theory, processing fluency account, prospect-refuge theory, evolutionary approaches, and affordances. They propose a new, interdisciplinary field of study, *environmental neuroscience*, and discuss how the methods and theoretical approaches in this field can be applied to examine mechanisms at different levels of analysis, ranging from microscale to macroscale. They end their chapter with a discussion of pro-environmental attitudes and behaviors and how interactions with nature that increase conservation activities may do so through improvements in attention that then lead to higher levels of self-control.

In Chap. 5, Hartig focuses on theoretical viewpoints. He discusses attention restoration theory and stress reduction theory along with theories that expand on these restoration theories by focusing more on interpersonal and community resources and relationships. Much of the research testing attention restoration theory and/or stress reduction theory has focused on individual responses to a natural environment exposure. Hartig's chapter expands restoration theories to higher levels of social interactions and focuses on how environments influence both close relationships and community relationships, and he discusses two new theoretical perspectives. His *relational restoration theory* brings attention restoration theory and stress reduction theory together with research that finds improved relationships following time together in nature. He argues that being in the company of another person in an environment influences both the relationship and how the environment affects the individual. Hartig then discusses *collective restoration theory*, which emphasizes the depletion and restoration of social resources at the community or population level, thus, going beyond the close relationships discussed in relational restorative theory.

In Chap. 6, Chawla focuses on the roles of nature in children's development. Chawla draws upon varied theoretical frameworks, including William James' theory, Gibson's ecological theory, and others, to explain children's interactions with

nature and how those interactions shape how they think and how they respond to nature. In this way, Chawla takes a different approach than most of the other chapters. Instead of focusing only on how the environment passively influences individuals, she describes how children learn from being in and attending to nature, focusing on their active agency in interacting with nature. Variability in how children interact with nature versus built areas may lead to understanding differences in how interaction with nature influences the children's developing cognition and social skills. Chawla points out, however, that nature can also allow for "quiet disengagement" and relief from stress. She also considers how children's interaction with nature influences how they think about the environment.

In Chap. 7, Wells links literature on resilience to literature on the benefits of exposure to nature. She explores the proposal that natural environments can act as a mediator or moderator in the link between adversity and health. Wells specifically examines links between greenness and mental health, physical health, birth weight, and academic achievement. She examines differences in findings across and within studies and finds that green space appears to have stronger positive effect for those in various at-risk groups, evidence of a "buffering" effect. For example, green space in low-socioeconomic status neighborhoods is more strongly associated with birth weight than in higher socioeconomic status neighborhoods (e.g., Dadvand et al., 2014). Wells then discusses the mechanisms through which nature may have its moderating effect and proposes a mediated moderation model with executive function and social connectedness as the mediators. Unfortunately, in many urban areas there are disparities in the amount of green space, with less green space accessible to those in the lower socioeconomic status. This disparity in access to green space may further exacerbate differences in mental and physical health.

In the final chapter, Heft offers a critical review of the chapters and the research area more generally. He takes a broad philosophical view founded on the work of Wohlwill (1970) that emphasizes the transactional quality of human interactions with nature. Heft uses this foundation to highlight assumptions about the definition of natural environments, as well as categorize the other chapters in this volume in a framework constructed around the transactional nature of their approaches. He ends with a reminder for future research on the influences of natural environments on cognition to consider its existing psychological and philosophical roots.

How the environment influences cognition, and well-being more generally, has implications for many areas, including education, urban planning, conservation, and architecture, just to name a few. The connection between time spent in natural environments and human health and well-being has gained popularity in recent years, and now, more than ever, it is important to be able to give evidence-based recommendations for when and how to increase exposure to natural environments. Thus, it is important to expand our knowledge beyond just what time in nature affects to a more detailed understanding of how time in nature influences well-being. The chapters in this volume push this area of research forward in terms of theory, methods, and research questions, serving as a catalyst for future theorizing and research in this important area of study.

We gratefully acknowledge the hard work and support of many people who contributed to the success of the 67th annual Nebraska Symposium on Motivation. We appreciate the financial support from the University of Nebraska-Lincoln Chancellor Ronnie Green and from the late Professor Cora L. Friedline's bequest to the University of Nebraska Foundation in memory of Professor Harry K Wolfe, whose generous gifts made the symposium possible. We would also like to thank the Department of Child, Youth, and Family Studies, and the College of Architecture for their financial support. We thank Professor Lisa Crockett, the Symposium series editor, for wise and patient guidance through the planning process. Pam Waldvogel, Elise Thayer, and Keting Chen provided superb logistical support, ensuring the safe transport of speakers and managing both the in-person events and the live-streaming. Michael Forsberg's screening and discussion of his documentary film, *Follow the Water*, greatly enriched the symposium, adding artistic and cultural dimensions to our examination of psychology and nature.

References

Berman, M. G., Jonides, J., & Kaplan, S. (2008). Cognitive benefits of nature interaction. *Psychological Science, 19*, 1207–1212. https://doi.org/10.1037/0022-3524.74.5.1252

Berman, M. G., Kross, E., Krpan, K. M., Askren, M. K., Burson, A., Deldin, P. J., et al. (2012). Interacting with nature improves cognition and affect for individuals with depression. *Journal of Affective Disorders, 140*, 300–305. https://doi.org/10.1016/j.jad.2012.03.012

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25*(3), 249–259. https://doi.org/10.1016/j.jenvp.2005.07.001

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BioMed Central Public Health, 10*, 456. https://doi.org/10.1186/1471-2458-10-456

Dadvand Payam, Villanueva Cristina M., Font-Ribera Laia, Martinez David, Basagaña Xavier, Belmonte Jordina, Vrijheid Martine, Gražulevičienė Regina, Kogevinas Manolis, & Nieuwenhuijsen Mark J. (2014). Risks and Benefits of Green Spaces for Children: A Cross-Sectional Study of Associations with Sedentary Behavior, Obesity, Asthma, and Allergy. Environmental Health Perspectives, 122(12), 1329–1335. https://doi.org/10.1289/ehp.1308038

Dadvand, P., Bartoll, X., Basagaña, X., Dalmau-Bueno, A., Martinez, D., Ambros, A., et al. (2016). Green spaces and general health: Roles of mental health status, social support, and physical activity. *Environment International, 91*, 161–167. https://doi.org/10.1016/j.envint.2016.02.029

Dzhambov, A., Hartig, T., Markevych, I., Tilov, B., & Dimitrova, D. (2018). Urban residential greenspace and mental health in youth: Different approaches to testing multiple pathways yield different conclusions. *Environmental Research, 160*, 47–59. https://doi.org/10.1016/j.envres.2017.09.015

Faber Taylor, A., & Kuo, F. E. (2011). Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Applied Psychology: Health and Well-Being, 3*(3), 281–303. https://doi.org/10.1111/j.1758-0854.2011.01052.x

James,W. (1892). *Psychology* (Briefer course). New York: Henry Holt

Kaplan, R., & Kaplan, S. (1989). *The experience of nature: A psychological perspective*. New York, NY: Cambridge University Press.

Larson, L. R., Green, G. T., & Cordell, H. K. (2011). Children's time outdoors: Results and implications of the National Kids Survey. *Journal of Park and Recreation Administration, 29*(2), 1–20.

Li, Q. (2010). Effect of forest bathing trips on human immune function. *Environmental Health and Preventive Medicine, 15*, 9–17. https://doi.org/10.1007/s12199-008-0068-3

Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *The Lancet, 372*, 1655–1660. https://doi.org/10.1016/S0140-6736(08)61689-X

Park, B. J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of *Shirin-yoku* (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventive Medicine, 15*, 18–26. https://doi.org/10.1007/s12199-009-0086-9

Schutte, A. R., Torquati, J. C., & Beattie, H. L. (2017). Impact of urban nature on executive functioning in early and middle childhood. *Environment and Behavior, 49*(1), 3–30. https://doi.org/10.1177/0013916515603095

Swami, V., Barron, D., Todd, J., Horne, G., & Furnham, A. (2020). Nature exposure and positive body image: (Re-)examining the mediating roles of connectedness to nature and trait mindfulness. *Body Image, 34*, 201–208. https://doi.org/10.1016/j.bodyim.2020.06.004

Triguero-Mas, M., Dadvand, P., Cirach, M., Martínez, D., Medina, A., Mompart, A., et al. (2015). Natural outdoor environments and mental and physical health: Relationships and mechanisms. *Environment International, 77*, 35–41. https://doi.org/10.1016/j.envint.2015.01.012

Ulrich, R. S. (1981). Natural versus urban scenes: Some psychophysiological effects. *Environment and Behavior, 13*(5), 523–556. https://doi.org/10.1177/0013916581135001

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science, 224*, 420–421. https://doi.org/10.1126/science.6143402

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Wohlwill, J. F. (1970). The emerging discipline of environmental psychology. *American Psychologist, 25*(4), 303–312. https://doi.org/10.1037/h0029448

Chapter 2
Nature and Attention

William C. Sullivan and Dongying Li

2.1 Introduction

Our ability to pay attention—that is, to engage top-down attention—underlies every human achievement. It is fundamental to learning, problem-solving, perseverance, and planning. It is necessary to maintain an ongoing train of thought, set goals, initiate and carry out tasks, monitor and regulate one's behavior, and to function effectively in social situations.

Unfortunately, top-down attention has become an increasingly taxed resource in our modern society. The explosion of information and ubiquity of digital communication and digital media have placed unprecedented cognitive demands on humans (Jackson, 2008, p. 14). In the face of this onslaught of information (Fig. 2.1), we have yet to recognize the importance of protecting and restoring our capacity to direct our attention. Just as we agree that measures need to be taken to restore natural resources (e.g., air, water, habitats, ecosystems) we need evidence-based discussions regarding our capacity to restore our attentional functioning after becoming mentally fatigued.

The two main points we make in this chapter are often under-valued. First, although top-down attention is fundamental to human success, it also fatigues with use (Faber, Maurits, & Lorist, 2012; Kaplan & Berman, 2010). While all of us have experienced this mental fatigue, we may not be aware of the price it exacts in terms of our effectiveness. When we are mentally fatigued, we have difficulty focusing

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Fig. 2.1 Our modern world requires us to pay attention to a constant stream of information. This relentless torrent of information impacts our ability to focus. To what extent does exposure to nature—even the kind of nature we find in cities—help people recover from the mental fatigue that results for the unremitting river of information we face today? Photo by author

and concentrating, our memory suffers, we miss subtle social cues, we are more likely to be impulsive and jump to conclusions.

Second, exposure to nature can support the process of restoring our attention and thus improve our effectiveness in almost every human endeavor. Below, we describe what we mean by contact with nature, especially as it relates to urban dwellers. Next, we describe how contact with nature impacts our capacity to pay attention and focus on the important role green settings have in restoring our attentional functioning. At the end of this chapter, we consider the implications of these ideas for supporting attention.

2.2 Nature

There is evidence that the general public conceives the world as consisting of features that are either "human made" or "natural" (Lindland, Fond, Haydon, & Kendall-Taylor, 2015). Within this dichotomy, urban settings are seen as the prototypical example of human-made and "pure" wilderness epitomizes the natural. Like most landscape architects, ecologists, parks managers, and urban foresters, however, we see the natural world as a continuum spanning from settings devoid of natural elements (e.g., vegetation, water, and animals) to wilderness settings. Cities fit within this continuum because they can contain nature in the form of the urban forests, street trees, parks, rain gardens, green roofs, vegetable or flower gardens, and bioswales. That is, experts see nature that has been designed and maintained by human hands as fully natural.

It is this conception of nature that we employ below. Indeed, we are particularly interested in nearby nature. That is, nature that is visible and accessible outside people's homes, schools, and workplaces.

2.3 Attention

Attention is the process of "taking possession by the mind," or the "withdrawal from some things in order to deal effectively with others" (James, 1890, p. 403). Our capacity to pay attention is one of our most powerful and essential resources. As anyone who has ever written a funding proposal or syllabus, graded final exams, planned a budget, solved a complex social problem, or even planned a vacation can attest, one's ability to pay attention is not only limited, it is also essential to accomplishing all our goals. As initially described by William James (1892), humans have two modes of attending to information: passive or involuntary attention and voluntary or directed attention, now often referred to as bottom-up and top-down attention.

2.3.1 Bottom-Up Attention

The first mode of attention is easy, effortless, and involuntary. Some objects, ideas, landscapes, and situations are effortlessly engaging and require no work as we take them in. This mode, called bottom-up attention, includes attending to things that are fascinating (Kaplan & Berman, 2010; Kaplan & Kaplan, 1989). Think of watching birds outside your window (Fig. 2.2), a waterfall, or a wild dog that has just crossed your path. When sitting by the waterfall, you don't make a conscious decision to

Fig. 2.2 Watching wildlife or viewing green landscapes from your window is an excellent way to have contact with nature. Photo by author

pay attention to the water. On the contrary, you most often find yourself absorbed by the movement of the water before you are aware of it.

There are a host of things and activities that are fascinating for humans. Some of these are softly fascinating—gardening, bird watching, walking in the woods. Attending to softly fascinating things allows you to carry out some task, working in the garden for instance, without filling your head—that is, you can pull weeds or turn the soil and still retain the capacity to think other thoughts. Other objects and activities are so fascinating that they completely absorb you and thus leave no capacity for thinking about other things. This so-called hard fascination includes such things as intense competitions, many television programs and movies, an object flying toward your head, and most forms of aggression and violence. No matter how interesting you find this chapter, if a fight broke out nearby as you are reading it, you would have to employ an extraordinary effort to focus your attention on your reading rather than watching the conflict play out.

2.3.2 Top-Down Attention

The second mode of attending to information requires one to pay attention (or concentrate). Paying attention requires effort (Kaplan & Berman, 2010). Paying attention allows you to manage your thoughts and emotions, including keeping information in mind as you use it, multitasking and switching between tasks, choosing what features to focus on, and being able to resist distractions (Katsuki & Constantinidis, 2014). In order to pay attention to this chapter, for instance, you have to exclude from your awareness two sources of distraction: activities and sensory input from your surrounding environment (e.g., the video in the background, the noise from children playing, the new text on your phone) and all the thoughts that are running around in your head. After a period of paying attention, your ability to keep these distractions at bay fatigues and it becomes harder and harder to keep your mind on the task at hand (Kaplan, 1995).

2.3.3 Mental Fatigue

Concentrating in this way—that is, expending effort to pay attention—for an extended period of time leads to mental fatigue (Faber et al., 2012). In order to engage top-down attention, we must block out distractions from the things going on around us and from the thoughts that are constantly swirling in our heads. The mechanism that blocks these distractions fatigues with use and after a while, it becomes increasingly hard to focus, make decisions, and remain at ease (Kaplan & Berman, 2010). This fatigue occurs even for topics that you enjoy and in which you

want to engage (e.g., playing chess, planning a vacation, solving a puzzle), as well as for topics that feel like hard work (e.g., grading essays, preparing a proposal). There is no shortage of opportunities for us to become mentally fatigued. We live with a constant torrent of information at work and, increasingly, in our leisure activities too, much of it designed to make us take some action that may be counter to our goals.

The costs of mental fatigue can be considerable (Sullivan & Kaplan, 2016). A person who cannot focus their attention is likely to miss important details and have trouble remembering details. Compared to someone who is not mentally fatigued, a person with low attention functioning is more likely to be irritable, have trouble with self-management, struggle to resist temptations, and miss subtle social cues. When a person is mentally fatigued, they are less effective in pursuing goals and interacting with others (Kaplan, 1995). A person with depleted attention is more likely to say or do things they might later regret, which can impact relationships, work performance, and even personal goals such as losing weight or saving money. In short, we are not at our best when our attention is depleted (Kaplan & Berman, 2010; Kaplan & Kaplan, 2003; Kuo & Sullivan, 2001; Poon, Teng, Wong, & Chen, 2016; Sullivan & Chang, 2011).

The cluster of symptoms associated with mental fatigue is important for at least two reasons. First, just about everything we seek to accomplish depends on our ability to engage our top-down attention. This includes accomplishing things that range from the mundane (e.g., getting to dinner on time) to things we care deeply about but with which we often struggle (e.g., responding to a loved one by actually listening, being a good and consistent parent, treating others with respect and kindness, coming up with a creative solution to a problem, making a difference in the world). Put another way, being able to pay attention is fundamental to functioning effectively in all aspects of life and to accomplishing everything we care about achieving.

Second, it is important because when individuals are mentally fatigued, they are often in an emotional state that works against their capacity to accomplish their goals. Mentally fatigued individuals are likely to experience emotional dysregulation and have difficulty modifying their emotional state toward goal-oriented behaviors. Mentally fatigued individuals are likely to feel irritable and impulsive—two of the most common side effects of mental fatigue (Kaplan, 1995). Compared to when you are not mentally fatigued, it is significantly more difficult to come up with a creative solution or listen with patience and respond with respect when you are mentally fatigued. Thus, being mentally fatigued reduces our competence and effectiveness in many domains.

Thus far, we have seen that we have two modes for paying attention. One takes little effort (bottom-up attention) and is not subject to fatigue. The other requires considerable effort (top-down attention) and is subject to fatigue. When we are mentally fatigued, we are in a state that works against our effectiveness or our capacity to achieve our goals. Next, we consider how contact with nature impacts mental fatigue.

2.4 Attention Restoration Theory

Attention Restoration Theory (ART) postulates that contact with nature helps people recover from mental fatigue. According to ART, having a view to a landscape that contains natural elements (e.g., trees, flowers, water), or actually being in such a landscape for a few minutes can restore your capacity to focus because it provides the mechanism necessary to block distractions an opportunity to rest and restore (Kaplan, 1995; Kaplan, Kaplan, & Ryan, 1998).

Think for a moment about a time when you were mentally fatigued—you may have just finished a major project, or perhaps you had simply been going about your daily routine. Now, imagine a place that would be restorative, a place that would allow you to clear your head and regain your capacity to focus, see things clearly, and feel on top of your game. ART proposes that such a restorative place should (1) allow you to be away physically or mentally from your everyday routine; (2) offer soft fascinations that effortlessly holds your attention; (3) provide you a sense of extent or being connected to a larger spatial or temporal world; and (4) be compatible with your purposes and facilitate achievement of your goals. A natural setting—even an urban setting that contains vegetation—often fulfills all these characteristics.

Kaplan and Kaplan (1989) have observed that these four characteristics of restorative places (being away, extent, fascination, and compatibility) are often available in green settings. Certainly, landscapes rich in nature are not the only settings that can relieve top-down attention fatigue. Compared to other interventions, however, seeking access to nature, even in urban settings, may be an effective way for individuals across various populations to restore their top-down attention. If that is the case, then gaining exposure to nature, especially green settings, on a regular basis, should have a positive impact on attention restoration. Is there evidence in support of such predictions?

2.5 Evidence Examining Attention Restoration Theory

ART postulates that contact with green landscapes should assist recovery from mental fatigue because green settings draw primarily on bottom-up attention, allowing top-down attention to rest and restore (Kaplan, 1995; Kaplan & Kaplan, 1989). Over the past quarter century, the number of empirical studies examining this relationship has been on the rise, reaching unprecedented levels in the recent few years. One review of evidence regarding nature and attention restoration reported some support (Ohly et al., 2016), while another review reported considerable support for ART (Stevenson, Schilhab, & Bentsen, 2018). Our literature review of recently published, peer-reviewed journal articles differs in emphasis from these prior reviews in that we aimed to assess only empirical studies that were driven by ART and to discuss possible reasons when the directions of the findings diverge. Accordingly,

rather than use of a typical keyword search syntax developed around key constructs, we took a citation chaining approach and started with a forward citation search. Below, we present the process by which we conducted the review, summarize our findings, and give some examples from additional studies that were stimulated by ART.

2.5.1 Literature Review Criteria and Screening

We included published studies that met the following criteria:

- The paper cited Kaplan's (1995) publication on ART.
- The main outcome included at least one objective measure of attention.
- The study design allowed some level of causal inference: experimental, quasi-experimental, or cohort study, including prospective and retrospective studies.
- The main intervention or explanatory variable involved variation in exposure to nature or urban green space.
- The study was published in English between 2011 and 2018.
- The article appeared in a peer-reviewed journal.

In order to identify recent articles that were grounded in ART, we took a citation chaining approach and searched forward for literature that cited Kaplan (1995). We identified articles by searching the Web of Science, Scopus, PsychInfo, and Google Scholar. For those databases that allowed search refinement, we specifically identified studies with a measure of attention by refining on the following keywords or phrases:

- Attention*
- Concentrate*
- Cogniti*
- Executive function*
- Working memory
- Executive control

The original search yielded 1595 articles, of which 1004 contained the above-mentioned keywords pertaining to attention. Those articles were subjected to title and abstract screening, after which 130 articles remained under consideration. We then conducted a full-text review of those 130 articles and selected 48 to be included. During the title, abstract, and full-text review steps, we excluded studies where the outcomes or measures were not directly related to attention. Thus, we excluded studies that focused on measures of vitality, academic performance, physical activity, social support, stress, neuroticism, time perception, creativity, and long-term memory. We also excluded studies that relied solely on self-reports of attention, such as ones that used the Perceived Sensory Dimension scale (PSD), Self-Rating Restrictiveness Scale (SRRS), Perceived Restorative Scale (PRS), Restorative Outcome Scale (ROS), or Self-Reported Restrictiveness scale (SRR). In addition,

we excluded studies that used scenario-based assessments in which participants were instructed to imagine a particular environment or activity. Finally, we excluded studies that evaluated treatments not directly related to nature (e.g., lighting conditions, building or indoor architectural designs, music treatments, or cultural heritage site visits). In the case of multiple articles reporting results from a single study, only one was included. Table 2.1 describes the included studies and their characteristics.

2.5.2 Characteristics of the Included Studies

Of the 48 articles included in our analysis, almost half (23 studies) were published in 2017 and 2018, suggesting an increasing trend in publications focused on ART (Fig. 2.3). The majority examined adults (37 studies), but studies investigating attention restoration in children are on the rise; in 2017 and 2018 alone, eight articles reported effects on children within varying developmental phases. About half (24 studies) included university students or university staff members. Only one study concerned older adults. Most studies included participants from the general population; five included populations that either are formally diagnosed with or have self-perceived physical or mental health disorders such as major depressive disorder, exhaustion disorder, chronic heart failure, or depressive or stress symptoms.

All but two of the 48 included studies employed experimental or quasi-experimental research designs; the exceptions used longitudinal designs to investigate developmental outcomes in children. Most of the experimental and quasi-experimental studies employed treatments focused on the physical environment—that is, real places experienced by being immersed or through sense of sight (28 studies); about one-third used photos, videos, or some other form of simulation-based stimuli that varied in terms of natural content or exposure to nature (18 studies). Four experimental studies used a combination of physical and simulation treatments. Taken as a whole, the included studies encompass a wide variety of outdoor and indoor experiences and therefore are diverse in the types of exposure to

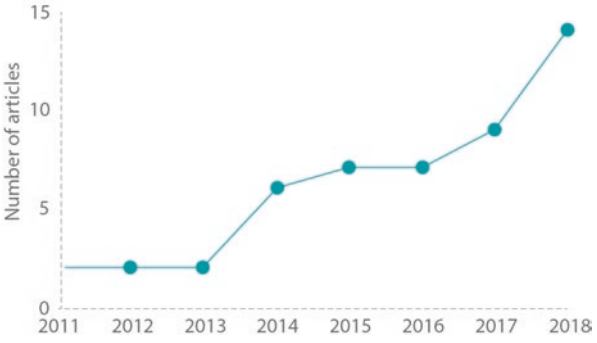

Fig. 2.3 Number of peer-reviewed articles testing ART published between 2011 and 2018

Table 2.1 For our literature review, we took a citation chaining approach and searched forward for literature that cited Kaplan (1995). We included only studies from recently published, peer-reviewed journal articles that were centered on Attention Restoration Theory. Our review included the 48 studies identified here

ID	Author(s) and year	Age group	Research design	Treatment of physical nature	Physical or virtual nature	Measure	Associations between nature and attention restoration
1	Raanaas, Evensen, Rich, Sjøstrøm, and Patil (2011)	Adult	Experiment or quasi-experiment	Indoor plants and view	Physical	Reading or spatial span	Positive
2	Shin et al. (2011)	Adult	Experiment or quasi-experiment	Walk	Physical	Trail making test	Positive
3	Berman et al. (2012)	Adult	Experiment or quasi-experiment	Walk	Physical	Digit span forward or backward	Positive
4	Joye, Pals, Steg, and Evans (2013)	Adult	Experiment or quasi-experiment	NA	Virtual	Dot probe paradigm	Positive
5	Tanaka, Yamada, Nakamura, Ishii, and Watanabe (2013)	Adult	Experiment or quasi-experiment	View	Physical	Trail making test	Positive
6	Emfield and Neider (2014)	Adult	Experiment or quasi-experiment	NA	Physical	Digit span forward or backward; Attention network task	None
7	Gamble, Howard Jr, and Howard (2014)	Older adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward; Attention network task	Positive
8	Lin, Tsai, Sullivan, Chang, and Chang (2014)	Adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward	Positive
9	Sonntag-Öström et al. (2014)	Adult	Experiment or quasi-experiment	Walk, and sit or quiet relaxation	Physical	Necker cube pattern control task	Positive
10	Szolosi, Watson, and Ruddell (2014)	Adult	Experiment or quasi-experiment	NA	Virtual	Recognition memory task	Positive
11	Weng and Chiang (2014)	Adult	Experiment or quasi-experiment	NA	Physical	Necker cube pattern control task	Positive
12	Bratman, Daily, Levy, and Gross (2015)	Adult	Experiment or quasi-experiment	Walk	Physical	The operation span task; change detection task; Digit span forward or backward; Attention network task	Partial

(continued)

Table 2.1 (continued)

ID	Author(s) and year	Age group	Research design	Treatment of physical nature	Physical or virtual nature	Measure	Associations between nature and attention restoration
13	Craig, Klein, Menon, and Rinaldo (2015)	Adult	Experiment or quasi-experiment	NA	Virtual	Sustained attention to response task	Partial
14	Evensen, Raanaas, Hagerhall, Johansson, and Patil (2015)	Adult	Experiment or quasi-experiment	Indoor plants and view	Physical	Reading or spatial span	Partial
15	Lee, Williams, Sargent, Williams, and Johnson (2015)	Adult	Experiment or quasi-experiment	View	Physical	Sustained attention to response task	Positive
16	Rogerson and Barton (2015)	Adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward	Positive
17	Valtchanov and Ellard (2015)	Adult	Experiment or quasi-experiment	NA	Virtual	Number of fixations and eye travel distance; blank rates	Positive
18	Wilkie and Clouston (2015)	Adult	Experiment or quasi-experiment	NA	Virtual	Proofreading task	None
19	Abbott et al. (2016)	Adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward	Positive
20	Chen, He, and Yu (2016)	Adult	Experiment or quasi-experiment	Sit or quiet relaxation	Physical	Necker cube pattern control task	Partial
21	Haga, Halin, Holmgren, and Sörqvist (2016)	Adult	Experiment or quasi-experiment	NA	Virtual	Attention network task	None
22	Li and Sullivan (2016)	Children	Experiment or quasi-experiment	View	Physical	Digit span forward or backward	Positive
23	Rogerson, Gladwell, Gallagher, and Barton (2016)	Adult	Experiment or quasi-experiment	Exercise or play	Physical	Digit span forward or backward	positive
24	Sahlin et al. (2016)	Adult	Experiment or quasi-experiment	Sit or quiet relaxation	Physical	Necker cube pattern control task	positive
25	Wang, Rodiek, Wu, Chen, and Li (2016)	Adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward	positive
26	Brez and Sheets (2017)	Children	Experiment or quasi-experiment	Recess	Physical	Letter cancelation; Trail making test	None

(continued)

Table 2.1 (continued)

ID	Author(s) and year	Age group	Research design	Treatment of physical nature	Physical or virtual nature	Measure	Associations between nature and attention restoration
27	Chiang, Li, and Jane (2017)	Adult	Experiment or quasi-experiment	NA	Virtual	Stroop test	Positive
28	Dadvand et al. (2017)	Children	Longitudinal	NA	Physical	Conners' Kiddie Continuous Performance Test; Attentional Network Task	Partial
29	Han (2017)	Adult	Experiment or quasi-experiment	Exercise or play	Physical	Reading or spatial span	Positive
30	Jung et al. (2017)	Adult	Experiment or quasi-experiment	NA	Virtual	Multi-Source Interference task; Digit span forward or backward, Trail making test, Stroop test	Partial
31	Schutte, Torquati, and Beattie (2017)	Children	Experiment or quasi-experiment	Walk	Physical	Conners' Continuous Performance; Go/No go task; Reading or spatial span	Partial
32	Ulset, Vitaro, Brendgen, Bekkhus, and Borge (2017)	Children	Longitudinal	NA	Physical	Digit span forward or backward; hyperactivity symptom	Positive
33	Van der Jagt, Craig, Brewer, and Pearson (2017)	Adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward	Positive
34	van Praag et al. (2017)	Adult	Experiment or quasi-experiment	NA	Virtual	Response-time task	Positive
35	Amicone et al. (2018)	Children	Experiment or quasi-experiment	Exercise or play	Physical	The Bells test; Digit span forward or backward; Go/No go task;	Positive
36	Bailey, Allen, Herndon, and Demastus (2018)	Adult	Experiment or quasi-experiment	Exercise or play	Physical	Stroop test; Digit span forward or backward	Partial
37	Bourrier, Berman, and Enns (2018)	Adult	Experiment or quasi-experiment	NA	Virtual	Digit span forward or backward; Raven's progressive matrices	Positive

(continued)

Table 2.1 (continued)

ID	Author(s) and year	Age group	Research design	Treatment of physical nature	Physical or virtual nature	Measure	Associations between nature and attention restoration
38	Burmeister et al. (2018)	Adult	Experiment or quasi-experiment	NA	Virtual	Psychomeda Konzentrationstest	Negative
39	Fuegen and Breitenbecher (2018)	Adult	Experiment or quasi-experiment	Exercise or play, and Sit or quiet relaxation	Physical, Virtual	Digit span forward or backward; Symbol Digit Modalities Test	None
40	Kim, Cha, Koo, and Tang (2018)	Adult	Experiment or quasi-experiment	NA	Virtual	Response-time task	Partial
41	Kuo, Browning, and Penner (2018)	Children	Experiment or quasi-experiment	Class	Physical	Observed redirect of attention or off-task	Positive
42	Largo-Wight et al. (2018)	Children	Experiment or quasi-experiment	Class	Physical	Observed redirect of attention or off-task	None
43	Lee, Sargent, Williams, and Williams (2018)	Adult	Experiment or quasi-experiment	View	Physical	Proofreading task	Partial
44	Lymeus, Lindberg, and Hartig (2018)	Adult	Experiment or quasi-experiment	Outdoor program	Physical	Trail making test; Letter-Digit substitution test	Partial
45	Pasanen, Johnson, Lee, and Korpela (2018)	Adult	Experiment or quasi-experiment	Walk	Physical	Sustained attention to response task	Partial
46	Van Dijk-Wesselius, Maas, Hovinga, Van Vugt, and Van den Berg (2018)	Children	Experiment or quasi-experiment	NA	Physical	Sky search task; Letter-Digit substitution test	Positive
47	Wallner et al. (2018)	Children	Experiment or quasi-experiment	Recess	Physical	d2-R Test of Attention	Positive
48	Yin, Zhu, MacNaughton, Allen, and Spengler (2018)	Adult	Experiment or quasi-experiment	Indoor plants	Physical, Virtual	Reaction time task; Stroop test; Reading or spatial span	Partial

nature that participants received. These types of exposure included outdoor classes and recesses, outdoor exercise or play sessions, outdoor sitting or quiet relaxation, outdoor walking, outdoor or wilderness experiences, and indoor activities in proximity to plants or with window views of nature.

The most frequently used nature treatments were classic ones: variation in nature exposure as seen through a window view and variation in nature exposure during an outdoor walk. Across all experimental or quasi-experimental studies, the duration of

a single treatment session ranged from less than 1–90 min, with a median of 10 min. For studies that involved exposure to physical settings, the median duration of exposure was 30 min. For studies that involved simulations, the median duration of exposure was considerably lower at 6.5 min.

The included studies also employed a wide variety of neuropsychological assessments to objectively measure attention. About one-third used digit span forward or backward (17 studies). When considering digit span combined with reading, visual, or spatial span (6 studies), the use percentage grows to just under half. Other popular tests were the go/no-go or sustained attention to response task (5 studies), attention network task (4 studies), Necker cube pattern control task (4 studies), Stroop test (4 studies), and the trail making task (4 studies). Thirteen other tests were used at least once in the set of included studies.

2.5.3 Findings

Overall, findings from these studies show considerable support for Attention Restoration Theory. Among the 48 studies, 28 (58%) demonstrated clearly positive effects of nature exposure on attention. An additional 13 (27%) identified positive effects for a particular group in terms of one or more measures of attention. Meanwhile, although six articles (12%) had no significant results, only one article reported negative associations between nature exposure and attention.

The study with the sole negative finding (Burmeister, Moskaliuk, & Cress, 2018) had participants experience virtual reality scenes, either an indoor office or an outdoor recreational scene, before measuring their attention via the Psychomeda Konzentrations test (KONT-P). As the aim of the study was to assess work-related concentration, it may be that the indoor office setting was more compatible with the expectations of a work setting than the outdoor recreation scene, hence the negative finding. The KONT-P test used to assess work-related concentration may also differ in psychometric attributes compared to other scales.

In examining the effects of physical versus virtual nature experiences on attention, we found that physical nature tended to incur more positive attentional functioning (Table 2.2). However, the difference between physical and virtual experiences was not statistically significant by Fisher's exact test ($p = 0.23$). We also investigated the extent to which different types of neuropsychological tests accounted for differing results between studies. As a wide variety of tests were used in the set of included studies, we broadly used three main categories of cognition and attention that were assessed: working memory, sustained and selective attention, and visual scan or processing speed (Table 2.3). More than one of these aspects can be simultaneously assessed by a given test; for example, the Stroop test assesses both selective attention and processing speed. Analysis based on these aspects revealed that those studies that assessed working memory had a slightly greater tendency to yield positive associations than those evaluating the other two aspects. These differences, however, did not reach statistical significance by Fisher's exact test ($p = 0.62$).

Table 2.2 Breakdown of positive and negative associations in reviewed articles by environment type. In our systematic review of the literature examining Attention Restoration Theory from 2011 to 2018, articles employed exposure to nature in physical environments, virtual environments, or a combination of the two. We classified the results from each article as either positive, partial, negative, or none

		Positive association	Partially positive association	Negative association	No association	Total
Treatment environment	Physical	16	9	0	3	28
	Virtual	12	3	1	2	17
	Physical and virtual	0	1	0	1	3

Table 2.3 Breakdown of positive and negative associations in reviewed articles by the aspect of cognition/attention assessed. The reviewed articles used different neuropsychological tests to measure attention (e.g., digit span backwards, Necker cube pattern control, Stroop test). We examined whether each study used any test that assessed working memory, sustained or selective attention, or visual scan or process speed, and binned results based on these assessment categories

Cognition or attention assessment	Positive association	Partially positive association	No association	Total
Working memory	14	6	2	22
Sustained and selective attention	13	10	5	28
Visual scan or processing speed	5	6	2	13

In summary, we identified a recent rise in studies examining the effects of nature on attention restoration, especially in vulnerable populations such as children and patients with mental health disorders. Recent studies also explored a wide variety of nature exposures or activities while participants were in natural settings. We found strong support for ART across populations, types of nature exposure, and different neuropsychological tests of attention. Because we aimed to trace studies that build upon and test ART, the search and screening protocol used here differed from that of a standard systematic review. As such, the articles reviewed may not form an exhaustive list of studies that examine the effects of nature on attention and our findings can complement recent systematic reviews on similar topics (Ohly et al., 2016; Stevenson et al., 2018).

2.5.4 Some Specific Examples

Quite a number of studies have examined the impacts of green landscapes on attention and the outcomes are clear. Exposure to green landscapes is likely to boosts a person's capacity to pay attention. The findings come not only from very green settings such as large and small forests (Shin, Shin, Yeoun, & Kim, 2011;