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

Springer

Nebraska Symposium on Motivation

Volume 67

Series editor

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ISSN 0146-7875
Nebraska Symposium on Motivation
ISBN 978-3-030-69019-9 ISBN 978-3-030-69020-5 (eBook)
https://doi.org/10.1007/978-3-030-69020-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_1

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.

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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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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_2

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

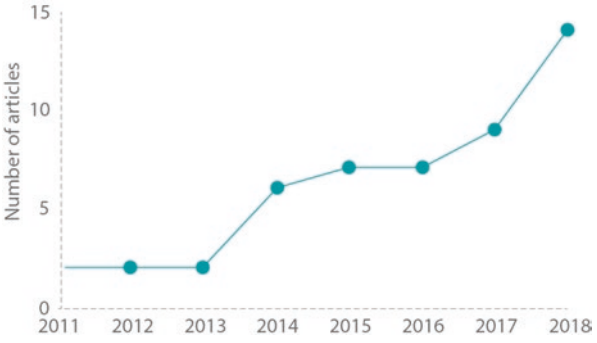

Fig. 2.3 Number of peer-reviewed articles testing ART published between 2011 and 2018

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;

Sonntag-Öström et al., 2014), rural areas (Roe & Aspinall, 2011), wilderness settings (Hartig, Mang, & Evans, 1991), and prairies (Miles, Sullivan, & Kuo, 1998), but also from more modestly green settings such as community parks (Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; Korpela, Ylén, Tyrväinen, & Silvennoinen, 2008), schools (Li & Sullivan, 2016; Matsuoka, 2010; Wu et al., 2014), and neighborhoods (Kuo & Sullivan, 2001; Taylor, Kuo, & Sullivan, 2001; Wells, 2000).

In one fascinating study, attention of adults was assessed in a University of Michigan laboratory (Berman, Jonides, & Kaplan, 2008). Following the assessment, each participant was asked to walk for 50 min in either downtown Ann Arbor (a small city) or in the University arboretum (a large green landscape with many trees). When they returned from their walk, their attention was assessed again. The following week, these individuals came back to the lab and repeated the same activities except those had who originally walked downtown walked in the arboretum and vice versa. The results were compelling. After the walk in the arboretum, participants' attentional performance improved by 20%, but no gains in performance were found after the walk downtown. A 20% improvement in one's capacity to pay attention is no trivial matter! It is on the order of a clinical dose of attention-deficit drugs such as Ritalin, Adderall, or Dexedrine. In other words, a 20% increase in attentional performance is a huge increase that will certainly have significant implications for a person's functioning.

Such an effect is not limited to adults, nor does it occur only when an individual spends time physically under trees. A study conducted by our group examined the extent to which having a view onto a green space would produce significant attention restoration for high school students who engaged in mentally fatiguing academic activities (Li & Sullivan, 2016). Students were randomly assigned to a classroom with three window conditions, i.e., window with a view onto a green space, window with a view onto a barren space, and no window at all. They were asked to perform a set of academic tasks, and then take a 10-min break in the classroom. When comparing their attentional performance, there was no difference among the groups at the end of the academic tasks: all groups' performance declined after the tasks. However, after the 10-min break, the group with a green window view performed significantly better than before the break and significantly better than the other two window treatments.

Is the effect of green landscapes on attention available to everybody or only a small segment of the population? The evidence from the literature shows that a wide variety of people benefit from exposure to green spaces (see an example of such a space in Fig. 2.4). Studies have demonstrated links between green spaces and higher performance on attentional tasks among public housing residents, AIDS caregivers, cancer patients, college students, prairie restoration volunteers, and employees of large organizations.

Perhaps most strikingly, children diagnosed with attention-deficit hyperactivity disorder (ADHD) have been found to benefit from exposure to urban parks and other green spaces near their homes. In a series of studies, such access has been consistently linked with a reduction in ADHD symptoms (Kuo & Taylor, 2004; Taylor et al., 2001; Taylor & Kuo, 2009). In findings similar to those in the University

Fig. 2.4 Research demonstrates that many green settings help people recover from mental fatigue. Photo by author

of Michigan study describe above, Taylor and Kuo report that children with ADHD concentrated significantly better after the walk in a park than after the walk downtown or in a neighborhood (2009).

The prevalence of smart phones and social media in our society raise another question about the effects of nature on attentional performance. When we talk about spending time in nature, we imply that any kind of activity in nature would help recovering from mental fatigue. However, one of our recent studies demonstrated that using an electronic device counteracts the attention restoration effects of nature. Participants who used their laptops in a green condition did not experience attention restoration (Jiang, Lee, & Sullivan, 2019).

In sum, there is considerable evidence to show that exposure to a green landscape—such as a walk in an urban park or a view to a green area outside a school window—is likely to reduce symptoms of mental fatigue. Evidence from a wide variety of settings and a great diversity of populations provides support for this conclusion, which surely has important implications for how we plan and design landscapes at a variety of scales. However, having an accessible green space or spending time there does not guarantee attention restoration. In the digital age, exposure to nature can be a powerful prescription to mental fatigue caused by the flux of information, but only if you are not using your phone while trying to recover.

2.6 Suggestions for Supporting Attention

We live in an information intensive world that requires us to engage our top-down attention and focus on a great number of things during nearly all our waking hours. Many of us also work in settings in which we are expected to respond to information quickly, whether we are at work or not. Such requirements put great demands on our attention and result in many of us feeling mentally fatigued a good deal of our adult lives.

If you find yourself mentally fatigued more often than you would prefer, you might consider running a small experiment or two. Small experiments involve paying attention to the impacts of small changes in the way you go about doing things (Irvine & Kaplan, 2001). You can run an experiment to see how modest changes in your life impact your ability to prevent or recover from mental fatigue. Here are some possibilities to consider.

2.6.1 Seek Out Nature

One of the most consistent findings from the research inspired by Attention Restoration Theory is that having regular contact with natural settings—including urban settings with green elements—has important consequences for your attentional functioning. That's because being in or looking at nature engages our bottom-up attention and thus allows our top-down attention to rest and restore.

You might explore the possibility that regular exposure to green spaces has tangible benefits for you personally. Perhaps that means re-arranging your office so you have a view to nature from your desk. Or maybe you can take a short walk a couple of times per day along a tree-lined street or in a nearby park. A vase with some flowers or some potted plants near your work space might have an impact. So too, might a poster-sized picture of a landscape that you like. The findings summarized above suggest that having a view to a real landscape, or perhaps better still, being in a green space, will have the most positive impact on your top-down attention.

2.6.2 Create More Urban Nature

You can support your attentional functioning and make an investment in your attentional functioning in the future by taking steps to create more nearby urban nature (see, for example, Fig. 2.5). Many urban neighborhoods lack street trees and parks. Too often school grounds consist of paved parking lots that lack vegetation. What happens when you work with your neighbors and community activists to seek more funding for urban parks, insist that trees be planted in neighborhoods, and help

Fig. 2.5 Green spaces in urban settings contribute to the ecological health and functioning of places and often to their beauty. Perhaps, just as importantly, they also contribute to the ability of people to achieve their goals in life because these green places help people recover from mental fatigue. Photo by author

make it possible for every child to go to a school that provides daily access to nature? There is a rich set of possible small experiments to run related to creating more nature.

2.6.3 Eliminate Distractions

Top-down attention makes the task you are focusing on more salient while dampening down two sources of distraction—(1) all the activities going on in the world around you and (2) all the thoughts swirling around in your head at any moment. The distractions in the physical world are seemingly endless. We get an alert when a new email arrives. Our phones vibrate when some distant friend posts on social media that they have enjoyed a meal. It vibrates again a minute later with an alert that a new podcast is available, or when there is a new weather forecast, sports score, or news of any sort. Any one of these distractions may seem trivial, but over the course of the day, they wear us down and reduce our effectiveness. These distractions fill our heads with ideas and issues that are almost always disconnected from our goals. And they produce invisible costs by making us more distracted, irritable, error-prone, and fatigued.

Can you run other experiments to get a sense of the extent to which eliminating distractions in your physical environment improves your ability to focus? What happens when you turn off all notifications and alerts for a period of hours? How effective are you when you work in a quiet place where you are not disturbed?

But what about the second source of distractions—all the distractions that come from your own mind? These are distractions that pull you away from the task at hand while your mind wanders to a conversation you had earlier, your plans for tonight, your hopes that you can solve that tricky social dilemma, or one or another of the limitless possibilities that spring up from our minds. To address this challenge, you might try mindfulness meditation. There is a growing body of evidence showing that mindfulness meditation increases one's capacity to stay on task (Jha et al., 2019), remember details better (Levy, Wobbrock, Kaszniak, & Ostergren, 2011), and reduce mind-wandering, worrying, and poor attention (Sood & Jones, 2013). And one does not have to be a Zen Master to see the benefits of mindfulness meditation—a few days of practice may be enough to increase attentional functioning (Chiesa, Calati, & Serretti, 2011; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010).

2.7 Conclusion

Exposure to natural settings (Fig. 2.6), even in the midst of urban settings, helps restore and replenish a resource that is essential to functioning in our modern world: our ability to engage our top-down attention. Spending time in nature near your

Fig. 2.6 Landscapes that have the largest impact on helping people recover from mental fatigue are easily accessible. They can be seen from an office or home or are a close walk away. Research suggests that daily contact with nature is an effective way to reduce mental fatigue and support your attentional functioning

home, work, or school, or even having a view to a natural setting through a window restores depleted top-down attention.

The consequences of alleviating typical levels of mental fatigue are far-reaching and consequential. When you are mentally fatigued, you are not at your best for accomplishing your goals or supporting your relationships. That's because mentally fatigued individuals are more prone to making errors, missing subtle social cues, impulsivity, and irritability (Kaplan, 1995).

Research shows that regular contact with nature, even urban nature—places with trees, grass, rain gardens, and the like—helps people recover from mental fatigue and this has far-reaching benefits for individuals, families, and communities (Kuo & Sullivan, 2001; Li, et al., 2019; Li, Chiang, Sang, & Sullivan, 2019). These urban green spaces need not be large or pristine to aid recovery from mental fatigue. They must, however, be easily accessible from a person's home or workplace.

Access to natural elements in the form of parks, interconnected green corridors, street trees, rain gardens, green roofs, and green walls do more that provide attractive places for people to live, work, and play. They help people recover from the attentional fatigue that is part of everyday life. In doing so, these landscape elements help us achieve our goals in life. One implication of these findings is that we should re-double our efforts to ensure that we provide nature at every doorstep.

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Chapter 3
The Natural-Built Distinction in Environmental Preference and Restoration: Bottom-Up and Top-Down Explanations

Agnes E. van den Berg

3.1 Introduction

Humans have come a long way from living in places filled with animals, plants, and trees to living in a world dominated by cars, concrete, and buildings. Judging from the unstoppable trend of global urbanization, people appear to prefer built over natural settings. However, this preference seems based mostly on practical advantages offered by urban environments, such as safety from natural threats, comfortable living conditions, and job opportunities—to name only a few (Meyer, 2013; Purcell, Peron, & Berto, 2001). When it comes to environments that are most aesthically appealing and restorative, most people, including those living in cities, prefer natural over built settings (Van den Berg, Hartig, & Staats, 2007). Indeed, many of today's city dwellers long to escape from the urban asphalt jungle and spend time camping or hiking in nature areas. This "back-to-nature" sentiment has become an important complement and counter-tendency to urban living (Schmitt, 1990).

These days, however, busy urbanites no longer need to get out of the city to get a dose of nature. Across the world, a movement to reconnect people to nature by greening cities is rapidly gaining ground (Beatley, 2012). This "green urbanism" reflects a growing recognition of the vital importance of nature and green space for people's well-being and health (Twohig-Bennett & Jones, 2018). Yet, while the evidence for benefits of contact with nature is piling up, an important question appears to be overlooked: What is it exactly about natural environments that renders these environments more aesthetically appealing and restorative than human-made built environments? What are the essential (or as one might say, healing) aspects of nature that are not (or not as readily) available in built environments? As long as we remain in the dark about this matter, the argument for urban greening and other

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_3

initiatives to reconnect people to nature remains incomplete because it leaves open the possibility that positive responses to nature reflect little more than a romantic ideal shaped by cultural and learned influences.

In what follows, I first reflect on the desirability and possibility of making a distinction between natural and built settings and discuss early findings demonstrating a natural-built distinction in environmental preferences. I then describe how the focus of research on positive responses to natural and built settings has shifted from visual preferences to restorative effects and health benefits of green space. These more personal observations are followed by a presentation of two alternative accounts for why more natural settings evoke more positive responses than built settings. The first is a bottom-up account in terms of intrinsic characteristics of natural environments that may have signaled adaptive values during human evolution. The second is a top-down account in terms of culturally transmitted views and personally learned positive experiences with nature. In subsequent sections, I critically review the empirical support for each account. I conclude the chapter with a discussion of non-visual bottom-up pathways and suggestions for future research into the direction of studying top-down resilience-building effects of experiences with nature.

3.2 The Distinction Between Natural and Built Environments

This chapter revolves around the distinction between natural and built environments. I have often noted that many people seem to have an intuitive aversion against such dichotomies, which are associated with rigid black-and-white thinking that is neglectful to instances that do not fall neatly into the dichotomous scheme. I agree there is a risk of oversimplification in looking at the world in terms of dichotomies. However, when I entered the field of environmental psychology as a PhD student in the early 1990s, I quickly became fascinated by the natural-built distinction in environmental perception and preference, as described by pioneering authors like Joachim Wohlwill (1983), Roger Ulrich (1983), and Steven and Rachel Kaplan (1982). They made me realize the profoundness and pervasiveness of this distinction, and its relevance for understanding effects of nature experiences on health and well-being (see also Hartig & Evans, 1993 for an excellent review and analysis of this early work).

The natural-built distinction may seem simple and crude because people make this distinction intuitively. From a more rational perspective, one might even question the distinction altogether because all built structures have to be manufactured from substances that are ultimately derived from natural matter (cf. Gibson, 1976, cited by Wohlwill, 1983, p. 12). Nevertheless, from a psychological point of view the distinction between natural and built is very real, and the principles that underlie it are far from easy to grasp. In fact, after decades of scientific inquiry, environmental

psychologists are just beginning to understand what may drive the natural-built distinction.

Most people will have a rough understanding of the concepts of natural and built environments or settings (I will use the latter two terms interchangeably). These concepts are, however, also quite broad and open to different interpretations. It, therefore, seems useful to clarify definitions before continuing with the main line of argument.

Within environmental psychology, the term "natural environment" (or setting) is broadly defined to include any outdoor or indoor place where vegetation and other organic or inorganic natural elements (such as water or rocks) are predominantly present (Van den Berg, Joye, & De Vries, 2019). Likewise, the term "built environment" broadly refers to any kind of outdoor or indoor place where human-made built structures and facilities devised for housing, transport, work, commerce, and other human needs are dominantly present (cf. Anderson, 2018). "Built environment" is sometimes used interchangeably with "urban environment." However, the term "urban" comprises not only geographical but also cultural and social aspects of living in cities and towns, and is therefore less appropriate as a counterpart of the term "natural."

As noted by Wohlwill (1983, p. 7), the distinction between natural and built environments is "far from iron-clad." Some places and settings seem to fall in between the two categories. For example, natural environments like the famous French gardens of the Palace of Versailles, or a row of neatly clipped animal shaped bushes, show such clear signs of human design and planning that they seem to lose their natural appearance. Within the built realm, organic buildings whose shapes and function mimic nature, such as Hunderwasser's tree tenant house in Vienna, or the nature-integrated structures built by Manrique on Lanzarote can also be considered boundary cases (see Fig. 3.1). Even in such cases, however, the setting will remain in its original category, no matter how much its natural appearance has decreased or increased. This suggests that there is something qualitatively different between natural and built settings that cannot easily be altered by human efforts.

Another type of boundary cases concerns natural settings that contain human artifacts, like buildings, roads and power lines, and built settings that contain natural elements, such as trees, plants, and water features. Regarding these mixed settings, Wohlwill (1983) proposed a predominance criterion, which states that a setting will be identified as natural or built as long as natural or built features remain the prevailing features. In addition, the categorization of a mixed setting as natural or built will depend on which setting it is compared to. Compared to grand, pristine nature scenes such as mountains, forests, and ocean beaches, a park surrounded by buildings will be classified as a built setting. However, the same park will be classified as natural when compared to a completely built area with no greenery. Responses to mixed urban-natural settings should thus be interpreted in relation to other settings in the stimulus set.

Fig. 3.1 Natural or built? Face fountain by César Manrique in the Jardin the Cactus at Lanzarote, photo by OxOx licensed under CC BY – SA 2.0

3.3 Preference for Natural over Built Settings

The first empirical evidence for a natural-built distinction in affective responses comes from visual preference studies. In this type of research, respondents are asked to rate a set of photos or slides of different environments on beauty, attractiveness, liking, pleasantness, and other affective dimensions (Ulrich, 1983). Using this approach, Kaplan, Kaplan, and Wendt (1972) found that natural scenes on average were rated one point higher than built scenes on a five-point like-dislike scale (see Fig. 3.2). The authors noted that "natural material was so vastly preferred over the urban slides that the two distributions hardly overlap" (p. 355). Furthermore, perceived complexity positively predicted preferences within the natural and built domains. Complexity could, however, not explain the greater preference for natural over built scenes—in fact, natural scenes were judged to be less complex than built scenes.

In the 1980s, it became clear that the natural versus built content of the scene was one of the strongest predictors of environmental preference (e.g., Bernaldez & Parra, 1979). In an early review of this research, Ulrich (1983, pp. 119–120) concluded that "one of the most clear-cut findings and potentially important findings to date is the consistent tendency for North-American and European groups to prefer

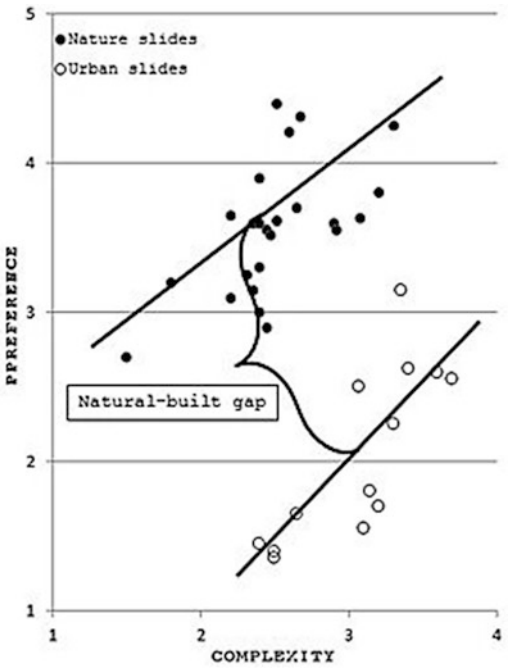

Fig. 3.2 The natural-built gap in environmental preferences. Figure adapted by the author from Kaplan et al. (1972)

even unspectacular natural scenes over the vast majority of urban views." In that same review, Ulrich proposed a tentative explanation of these findings. Building on emerging theories of emotions as innate phenomena that are inherently linked to actions, Ulrich suggested that preferences for natural over built environments might serve some deeper, adaptive function, in the sense that they serve as an action impulse, for behaviors that during human evolution in natural environments fostered well-being and functioning, and ultimately, the survival of the species. In particular, Ulrich proposed that preferences for natural environments, which are characterized by "mild-moderate interest, accompanied by preference/pleasantness, including calm and peacefulness," might signal opportunities for "psychophysiological restoration" (p. 94, Table 1)—an idea with a far-reaching impact.

3.4 From Beautiful to Restorative Nature

When I entered the field of environmental psychology as a PhD in the early 1990s, the focus of my research was on aesthetic preferences for natural landscapes (Van den Berg, 1999). Ecologists in the Netherlands were experimenting with a new nature management strategy, in which agricultural fields and other more cultivated nature areas were guided back into their more natural, wild state. Policy makers of the Dutch Ministry of Agriculture wanted to know more about public perceptions of

this new rewilding strategy. More specifically, they were interested in the aesthetic preferences of different user groups. This research question reflected the dominant focus of that time on visual quality and user values in the academic and policy discourse on nature experiences.

During my field work for the dissertation, I came to realize that the meaning of natural landscapes goes way beyond the aesthetic and the utilitarian. For one of the first studies, I had printed out large computer-simulated images of landscapes with varying degrees of naturalness and human influence (Van den Berg, Vlek, & Coeterier, 1998). When I asked farmers and other respondents, while sitting at their kitchen table, to rate the images for scenic beauty and other visual and user characteristics, they soon started to talk about their more personal experiences with the landscapes in which they lived, worked, or recreated. Respondents told me about how they recovered from burn-out by walking long hours with their dog through forests and fields. How they played as a child in the cornfields and how good it made them feel to think back to those days. Or how they found peace with the death of a loved one sitting on a bench listening to birds singing in trees. While listening to these stories, I felt that I fell short as a psychologist, not being able to capture the full meaning of nature for people with my visual preference research.

At the time, only some two decades ago, the idea that natural environments can promote health and well-being was not yet something most people would feel comfortable speaking about in public. In the Netherlands, one of the members of the Dutch royal family decided to cross the line and published a book in which she gave a very personal and intimate account of how she felt strengthened and comforted by her spiritual relationship with trees, plants, and animals (Lippe-Biesterfeld, 1995). The book was not received well in the media, and the princess was openly ridiculed for her confession that she communicated with trees. Politicians and other public figures were quick to distance themselves from her book. Indeed, during my interviews, respondents often felt the need to affirm, while they were describing their more personal experiences with nature, that "they are not the kind of person that talks to trees." However, it would not take long before the taboo on talking about health benefits of nature would be lifted.

Across the Atlantic, a new empirical line of research was rapidly gaining ground. In this research, people's affective, cognitive, and physiological responses were measured before and after real or simulated exposure to natural and built environments (Hartig, Book, Garvill, Olsson, & Garling, 1996; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mang, & Evans, 1991; Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998; Ulrich, 1979, 1981; Ulrich et al., 1991). Typically, participants in these studies suffered from experimentally induced or naturally occurring stress or mental fatigue and were in need of restoration from this depleted state. Hence why this line of research is commonly referred to as "restorative environments research." Results supported the greater restorative potential of natural, as compared to built, settings. A few years later, epidemiologists in the Netherlands and Japan began to document positive relationships between green

space in the living environment and health (De Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; Takano, Nakamura, & Watanabe, 2002). New empirical evidence, as documented in a report by the highly respected Health Council of the Netherlands (2004), bolstered the idea that nature is important for people's health and well-being and rapidly became mainstream.

Looking back, I am still struck by how quickly the "nature is healthy" message found its way into modern society. Apparently, this message struck a chord because it resonated with people's deeply felt personal experiences and beliefs about nature. Yet, the eagerness with which people have embraced the "nature is healthy" message also suggests that momentary popularity of ideas on health functions of nature can quickly decline or even be reversed. Indeed, the history of psychology is rife with short-lived trends which were just as easily abandoned as they were adopted. To prevent this same thing from happening to nature–health research, it remains vital for the field to develop strong foundations in scientific theory and empirical research. This includes a healthy dose of self-criticism and a willingness to continually examine and critically test even cherished assumptions.

3.5 Bottom-Up or Top-Down?

A core assumption of nature–health research is that restorative and health benefits of nature stem to a large extent from bottom-up sensory processing of intrinsic characteristics that differentiate natural from built settings (Geisler, 2008; Ulrich, 1993). In other words, natural environments are assumed to contain some essential components which are lacking in built environments and that set in motion a train of positive affective and health responses. This assumption is by no means trivial—it is a necessary premise for evolutionary theories wherein restorative responses are postulated to be an innate, hardwired reaction to these intrinsic characteristics (Joye & Van den Berg, 2011). Moreover, the assumption that nature is a unique, irreplaceable source of health and well-being has motivated societal initiatives to connect people with nature. These initiatives include efforts to "bring nature to people" through the greening of cities, schoolyards, workplaces, and hospitals, as well as efforts to "bring people to nature" by means of community gardening, horticultural therapy, and other nature-based therapeutic interventions (Van den Berg, 2017).

Nature–health researchers have also acknowledged that responses to natural environments are partly shaped by top-down influences of culturally transmitted views and personally learned associations of nature as something positive and healthy. The potential influence of cultural views was discussed by Ulrich (1983, p. 107), who noted it can be argued that natural settings elicit more positive responses than built settings because "landscape painters have taught us that it is beautiful, or because society has conditioned us to revere wilderness and dislike cities." Such cultural views are likely passed on from parents to children—many readers will

have childhood memories of their mother or father urging them to go and play outside "because it is good for you." With regard to personally learned associations, it has long been recognized that natural environments are free from many of the cognitive, social, and physical demands of everyday built environments, and that merely the absence of these "stressors" can already explain why exposure to nature is pleasant, restorative, and healthy (Hartig et al., 2010; Kaplan & Kaplan, 1982; Knopf, 1987; Reser & Scherl, 1988). The consensual theoretical view is that "both unlearned and learned factors" play a role (Ulrich, 1983, p. 120). However, top-down explanations of restorative and health benefits of nature have received much less attention than bottom-up explanations, and researchers have been reluctant to consider the possibility that more positive responses to natural versus built settings might be fully accounted for by top-down cultural and learned influences.

3.6 The Persistence of Evolutionary Assumptions

Research on restorative environments and health benefits of nature has been dominated by two theories: Stress reduction theory (SRT; Ulrich, 1983; Ulrich et al., 1991) and attention restoration theory (ART; Kaplan & Kaplan, 1989; Kaplan, 1995). The details of these theories have been extensively described elsewhere, and are not relevant for the main line of argument in this chapter (Hartig et al., 2010; Staats, 2012). What is relevant here, is that both theories propose a bottom-up mechanism for restoration. ART recruits the concept of soft fascination, referring to patterns of visual and other sensory information that capture attention in an involuntary and effortless way. SRT proposes that there is an automatic positive affective response to non-threatening natural environments with survival-promoting qualities, such as the presence of water (cf. Valtchanov, 2013).

The principles of SRT and ART were laid out many decades ago, long before the surge in studies on restorative and health benefits of nature. The findings of this new body of research have generally not been held critically against evolutionary assumptions of the two theories. Rather these assumptions have been taken as an "article of faith" (Hartig et al., 2010). An exception is formed by a paper entitled "is love for green in our genes?" that I wrote together with Yannick Joye in 2011. In this chapter, we systematically examine the viability of the evolutionary claims of SRT as the theoretical framework that has most extensively elaborated on the supposed evolutionary origins of restoration. Our conclusion was that neither current empirical evidence nor conceptual arguments provide any strong support for an evolutionary account of restorative responses to nature. We did not go as far, however, as to suggest a top-down account of restoration. Instead, we put forward an alternative bottom-up account, in which we explained automatic positive affective responses to nature as by-products of fluent processing of specific informational patterns in nature rather than "obscure evolutionary factors" (p. 266).

3.7 Conditioned Restoration

A first attempt to formulate a top-down theoretical account of restorative responses to nature has recently been undertaken as part of a Norwegian master thesis (Egner, 2016). Drawing on principles of classical conditioning, the author argues that restorative effects of nature can be described by a two-step model in which exposure to nature first becomes associated, or paired, with leisure-time activities that elicit a positive restorative emotion, and later the same emotion is retrieved when the person is exposed to nature. This "conditioned restoration theory" as yet has to be empirically tested. Nevertheless, some basic assumptions of the model can be compared to existing findings.

According to the conditioned restoration account, leisure-time activities are in themselves more restorative than work or school activities, independent of where one spends the time. Consistent with this, experience-sampling studies have demonstrated that mood tends to improve over the weekend, and falls back on Mondays, and that such variations can be understood by the presence or absence of work-related activities (Ryan, Bernstein, & Brown, 2010). In a similar vein, mood has been found to improve during vacation time, independent of where the vacation is spent (Strauss-Blasche, Ekmekcioglu, & Marktl, 2000). Thus, more positive responses to natural versus built settings may reflect a conditioned association of nature-based activities with positive mood states during leisure time, provided, of course, that nature contact more commonly takes place during leisure time than during working hours.

While for most people the distinction between leisure and work time will covary with the amount of time spent in natural and built settings, this does not hold for people with outdoor, nature-based jobs, such as foresters. For these groups, natural environments constitute a workplace instead of a leisure environment. A cross-sectional study among a random sample of the Swiss working population found that having a profession related to forests was related to a decreased sense of being away, which in turn negatively influenced self-reported restoration when visiting forests (Von Lindern, Bauer, Frick, Hunziker, & Hartig, 2013). In a similar vein, a study among children living in agricultural areas in Spain shows that children who help out on their families' farm experience less restoration and a lower sense of being away when spending free time in agricultural natural areas than children whose relationship with these areas is merely recreational (Collado, Staats, & Sorrel, 2016). These studies are consistent with a conditioned restoration account. Both studies did not, however, measure respondents' responses to built settings. It therefore remains unknown whether experiencing the natural environment as a workplace may remove, or even reverse, the natural-built distinction in affective responses to nature.

Feeling a responsibility to support and encourage community-based and other initiatives to reconnect people with nature, many researchers may not be keen to discard the bottom-up account and thereby run the risk of having to communicate a more mundane picture of nature as something that is not so unique and special after

all. Nevertheless, it seems timely to reflect on the consistency of empirical findings of research on affective, restorative, and health responses to natural and built settings with a bottom-up, evolutionary account.

3.8 The Natural-Built Distinction in Preference Research

The presumed universality of the visual preference for natural over built settings constitutes a cornerstone of evolutionary theories. However, there is a lack of strong empirical data to support such universal claims. As in many other areas of psychology, most of the research on visual preferences has been conducted with student and convenience samples, instead of more representative population samples (for an exception, see Stamps, 1996). Moreover, very few studies have ventured out of the Western context, and the studies that have done so have mostly been conducted in western-oriented countries such as South Africa, Japan, or South Korea. Findings appear to be mixed—sometimes confirming a preference for natural over built scenes (Nasar, 1984), and other times going against such a preference (Zube & Pitt, 1981), or findings have been difficult to interpret along this dimension (Yu, 1995). Nowadays, research interest in cross-cultural comparisons of the preference for natural over built settings seems to have stopped almost completely, and the universal nature of this preference remains largely an assumption instead of an empirically established fact.

Another question that has received little attention is whether the preference for natural over built settings also applies to children. A thorough investigation of this question would seem highly relevant for an evolutionary account of positive responses to nature. If such positive responses reflect innate, biological mechanisms, they can be expected to decrease as the children increase in age, as children become more socialized and culturally educated. Many studies have documented children's affinity with nature (Kahn, 1997; Moore, 1986; Rice & Torquati, 2013), but few have compared children's affinity with nature settings to their affinity with built settings. In one of our own studies, we showed children (aged 8–10) pictures of attractive indoor/built and outdoor/natural play settings (Van der Waal, Van den Berg, & Van Koppen, 2008). About 60% of the children expressed a preference towards the indoor/built settings, and this preference did not change after the children had participated in a nature experience program.

A recently published study confirms and extends these findings (Meidenbauer et al., 2019). In this study, 4-to-11-year-old children and their parents rated their preferences for images of "nature and urban" scenes. Children demonstrated robust preferences for urban over natural environments, and the urban preferences significantly decreased with age. Nature exposure around the home and nature-related activities, as reported by parents, did not predict children's preferences (see also Rice & Torquati, 2013). Furthermore, children's preferences became more similar to their own parents' preferences with increasing age. As noted by the authors, these

findings "provide greater support for a learned affinity for nature, rather than an affinity that has been genetically programmed and present from birth" (p. 9).

3.9 The Natural-Built Distinction in Restorative Environments Research

Research on restorative environments has accumulated at such a rapid rate that it is now possible to conduct systematic reviews and meta-analyses. Unlike traditional narrative reviews, in which a content expert writes about a particular topic, systematic reviews, and meta-analyses use explicit and reproducible criteria designed to reduce bias, and the included studies are critically appraised in terms of methodological quality (Littell, Corcoran, & Pillai, 2008). A consistent finding from these reviews and meta-analyses is that the strength of the evidence for greater restorative effects of natural compared to built settings varies between outcome measures (Bowler, Buyung-Ali, Knight, & Pullin, 2010; Corazon, Sidenius, Poulsen, Gramkow, & Stigsdotter, 2019; McMahan & Estes, 2015; Mygind et al., 2019; Ohly et al., 2016; Stevenson, Schilhab, & Bentsen, 2018; Thompson Coon et al., 2011). In general, the strongest support is found for self-reported improvements in mood, while evidence for improved cognitive and physiological functioning is weak and inconsistent.

With regard to mood, a systematic review of 32 studies found that exposure to natural environments was associated with a moderate increase in positive affect and a smaller, yet consistent, decrease in negative affect relative to comparison conditions (McMahan & Estes, 2015). There is some support for improved cognitive functioning during exposure to natural versus built settings, but effects are weak and only found for a limited number of measures (Ohly et al., 2016; Stevenson et al., 2018). For example, a meta-analysis of 49 studies showed improvement in cognitive functioning after exposure to natural environments for only three out of eight cognitive domains, with low to moderate effect sizes (Stevenson et al., 2018). Support for improved physiological functioning in response to nature exposure is generally mixed and inconclusive (Corazon et al., 2019; Mygind et al., 2019). For example, a meta-analysis of 29 studies found that only studies of low or moderate quality reported some improved outcomes in the nature-exposure groups compared to control groups (Mygind et al., 2019). Studies of higher quality reported no differences. According to the authors, this indicates that the literature may be skewed towards positive findings being based on predominantly low to moderate quality studies.

In addition to these outcome-specific analyses, several systematic reviews on the added benefits of nature exposure to moderate forms of exercise (mostly walking) have taken a wider scope and included studies with different outcome measures (Bowler et al., 2010; Lahart, Darcy, Gidlow, & Calogiuri, 2019). Findings from these studies converge that acute bouts of outdoor green exercise are accompanied by somewhat more positive mood and feelings of enjoyment, but do not have any

measurable effect on biological markers. In a discussion of these findings, Bowler et al. (2010, p. 8) state that: "Given these [mood] data were self-reported, they were therefore potentially open to bias depending on prior beliefs of the participants. The blinding of participants to the research question in these studies is problematic as in many cases the hypothesis could be guessed by participants based on the study design. Thus, it cannot be ruled out that findings may have been affected by participants' pretest opinions/beliefs on the likely effects of a natural environment rather than any actual changes in their mental health or well-being."

Overall, the results of systematic reviews and meta-analyses provide only weak support for a natural-built distinction in restorative responses, and to the extent that they do, the findings are most pronounced for more cognitively elaborate outcome measures and therefore more supportive of a top-down than a bottom-up evolutionary account.

3.10 Scene Type Variations in Restorative Environments Research

In contrast to visual preference studies, which typically include multiple natural and built settings, most studies on restorative effects have compared only one type of natural to one type of built setting. This practice is partly due to the experimental setup of restorative environments research, which is much more time-consuming than simply asking people to rate their preference for a set of photos or slides. But one may wonder why so few studies have included multiple natural settings. This would seem a logical approach, that is necessary for identifying the components of natural settings that are responsible for their restorative potential. Identifying these components is not only practically useful to create optimal restorative environments. It is also vital for testing theoretical notions on bottom-up influences of evolutionary significant characteristics on restoration, such as the presence of water. The answer may lie in publication bias: studies with multiple natural environments tend to yield non-significant results, which are more difficult to publish than significant results.

Because there are so few studies with multiple natural (and built) environments, there are no systematic reviews or meta-analyses of these types of studies. However, a number of individual studies have reported no differences in restorative effects between different natural settings. Among these is one of the first and most widely cited studies by Ulrich et al. (1991) which revealed no differences in psychophysiological restoration between exposure to a video of a vegetated scene dominated by trees and other plants, and a video of a water setting dominated by a fast-moving stream. Another study by my own research group also found no differences in restorative effects between viewing videos of natural and built settings with and without a water feature (Van den Berg, Koole, & Van der Wulp, 2003).

In 2009, I was contacted by landscape architect Anna Jorgensen from Sheffield. She asked if I would be interested in participating in a project on the impact of perceived naturalness on restorativeness. The idea behind this study was to empirically demonstrate, using the method of the 2003 study, greater restorative impacts of viewing photo/video presentations of more natural wild woodland compared to tended woodland and parkland. Despite my gut feeling that such a study would not yield any differences between the different types of natural settings, we started the collaboration and carried out the study. The results, as published in the Journal of Landscape and Urban Planning in 2014, confirmed my expectations: Participants in the natural conditions showed stronger recovery on all self-reported measures than those in the urban street condition (Van den Berg, Jorgensen, & Wilson, 2014). Differences in recovery among the natural settings did not reach statistical significance.

A potential explanation for the non-significant findings is that in all these studies participants were passively viewing simulated nature, instead of being taken out to different types of real outdoor natural environments. Viewing nature may not be an ecologically valid method to study people's restorative responses as they actively engage with the environment (Heft, 2010, see also the concluding chapter of this volume). This does not, however, seem to be a viable explanation. Results of a well-controlled, randomized, cross-over, field experiment in which participants' mood, cognitive function, restoration experiences, salivary cortisol, and heart rate variability were measured before and after a walk in a pleasant residential environment and natural environments with and without water showed that mood and cortisol improved in all environments (Gidlow et al., 2016). There were no differences on any of the outcome measures between natural environments with and without water; both natural environments were associated with greater restoration experiences and cognitive function improvements than the built environment (see also Tyrväinen et al., 2014).

In general, both lab and field experiments on restorative effects of nature have thus far failed to uncover consistent differences between different types of natural settings in their effectiveness in supporting psychophysical restoration from stress or other detrimental conditions. These findings could indicate that the physical features responsible for nature's restorative powers are ubiquitous in nature. However, the findings may also point to the irrelevance of physical features to restorative effects of nature.

3.11 Preference and Restoration: (How) Are They Related?

Taken together, much of the available empirical evidence appears to favor top-down, rather than bottom-up, accounts of the natural-built distinction in both environmental preferences and restorative effects. As attentive readers may note, this goes against the findings of an early study of my own group in which we used mediational analyses to empirically demonstrate that aesthetic preferences for natural

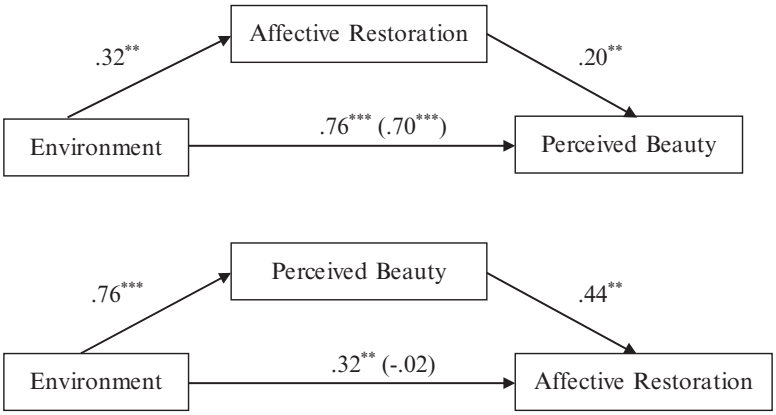

Fig. 3.3 Mediation test of the effect of environment (natural, built) on perceived beauty via affective restoration (top panel) and the reverse mediation test of the effect of environment on affective restoration via perceived beauty (bottom panel) based on data from the study by Van den Berg et al. (2003). Values represent standardized regression coefficients; the values in parentheses represent the direct (mediated) effects

over built settings can be partly explained by the greater, presumably bottom-up, mood-improving effects of the natural settings (Van den Berg et al., 2003). Within the dominant evolutionary theorizing of that time, this seemed the most logical way to interpret the interrelationships between preferences and restorative effects. It is important to point out, however, that mediational analysis cannot be used to determine causal direction, and the data may just as well be interpreted in terms of restorative effects being mediated or caused by (learned) aesthetic preferences (Lemmer & Gollwitzer, 2017). In fact, as shown in Fig. 3.3, a reverse mediation test of the data from that 2003 study shows full mediation of perceived beauty by affective restoration—which suggests that the alternative model, in which the independent variable X (natural versus built environment) influences the dependent variable Y (affective restoration), via a causal influence on variable M (perceived beauty) is the best-fitting model.

Within this reverse mediation model, it is still possible that perceived beauty as a causal mediating factor reflects a bottom-up influence of evolutionary-based intrinsic qualities of nature. However, an equally plausible interpretation of the findings is that mood-improving effects of nature are a by-product of culturally and personally learned aesthetic appreciation of natural environments.

3.12 Health Benefits of Green Space

In addition to experimental research on restorative effects of nature exposure, epidemiological studies have examined relationships between the amount of "green" and "blue" space in people's living environment and health outcomes, such as

perceived general health, perceived mental health, morbidity, and mortality. The number of studies investigating these relationships has also increased rapidly and has been summarized in systematic reviews and meta-analyses (Browning & Lee, 2017; Gascon et al., 2015, 2016; Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017; Kabisch, Van den Bosch, & Lafortezza, 2017; Van den Berg et al., 2015). Results generally support positive relationships between living in green environments and health, in particular mental health (e.g., a reduction of mood disorders and stress complaints), and mortality.

An inherent limitation of cross-sectional research is that relationships cannot be causally interpreted. People with lower incomes tend to have less healthy lifestyles and, as a consequence of more limited resources, will live in less green neighborhoods (see Wells, Chap. 7, this volume). It can therefore not be ruled out that the relationships reflect residential selection, a causal relationship in the opposite direction. Moreover, epidemiological studies typically do not include any measures of the amount of time spent in or near green space, thereby allowing for the possibility that the relationships reflect effects of confounding variables like diminished traffic noise and exhaust fumes that covary with amount of green space.

In the absence of solid support from studies in which people are directly exposed to natural and built environments, the epidemiological evidence for health effects of living in greener environments remains largely circumstantial. Nevertheless, assuming some form of causal relationship, these findings suggest that (mental) health benefits of nature are mostly realized through more chronic, long-term engagement with real outdoor natural settings. This might point towards the operation of non-visual pathways, such as the ingestion or inhalation of certain health-promoting substances in the air and soil of natural areas (cf. Franco, Shanahan, & Fuller, 2017). Before discussing research on such alternative non-visual pathways, I will first address research on positive responses to fractal patterns in nature as a potential visual pathway that has recently received growing attention in the field of nature–health research.

3.13 Visual Pathways: Fractals and Fluency

Research and theorizing on bottom-up processes underlying more positive responses to natural versus built settings has mostly focused on visual pathways (Hägerhäll et al., 2018; Kardan et al., 2015). In particular, it has been suggested that the greater aesthetic appeal and restorative potential of natural, as compared to built, settings, may derive from certain types of low-level "fractal-like" patterns that are ubiquitous in nature (Aks & Sprott, 1996; Hägerhäll et al., 2015; Joye, 2007; Patuano, 2018). These low-level patterns are characterized by the recurrence of broadly (but not exactly) similar patterns on finer scales, building shapes of immense complexity. Examples of such random (or statistical) fractal patterns can be observed in trees, whose fine-scale twigs approximately resemble the course-scale patterns created by thick branches (See Fig. 3.4). While fractal patterns are visually and geometrically

Fig. 3.4 Example of a random fractal-like pattern in a tree, with the branches of the tree looking like small-scale copies of the entire tree when zooming in (photo made by the author)

highly complex, the internal repetition of visual information in fractals creates higher levels of visual redundancy which makes such patterns relatively easy to process. According to the perceptual fluency account, as proposed by Yannick Joye and myself, this "easy processing" of fractals provides a possible explanation for the greater aesthetic appeal and restorative potential of natural versus built settings (Joye, 2007; Joye, Pals, Steg, & Lewis Evans, 2013; Joye, Steg, Ünal, & Pals, 2016; Joye & Van den Berg, 2011). In addition, it has been suggested that the human visual system itself operates according to fractal principles and during evolution in natural environments has become optimally adapted to processing scenes with fractal characteristics (Redies, 2008; Taylor, Spehar, Hägerhäll, & Van Donkelaar, 2011).

Using a stimulus set that included both natural and built scenes, Berman and colleagues have shown that low-level fractal-like image features, like a high density of curved and fragmented edges, positively predict perceived naturalness, and in turn, perceived beauty, especially when beauty ratings are made rapidly (Redies, 2008; Taylor et al., 2011). In one of our own studies, we took a more subjective, psychological approach by using perceived complexity of highly magnified parts of natural and built scenes as a subjective indicator of fractality (Van den Berg, Joye, & Koole, 2016). Results showed that greater perceived restorative quality and longer viewing times (as a measure of interest) of the unmagnified natural scenes, as compared to the unmagnified built scenes, were partly mediated by the higher perceived complexity of their magnified parts.

The research on fractals provides some first steps towards a better understanding of the critical low-level visual components that underlie the natural-built distinction in environmental perception (i.e., the basic visual cues that people use to discriminate between natural and built settings). Among other things, these findings strengthen the case for biophilic architecture, in which fractal patterns are integrated in buildings to create more natural-looking and beautiful cities (Joye, 2007; Kellert, Heerwagen, & Mador, 2011). But do fractals also have some inherent, restorative quality, as suggested by the perceptual fluency account?

Findings of a recent experiment speak against such a bottom-up pathway leading from low-level image features to restoration (Menzel & Reese, 2019). In this study, which followed a classic restorative environments research design with pre- and post-measures of self-reported restoration and cognitive functioning, participants were randomly assigned to viewing four types of images of natural and built settings

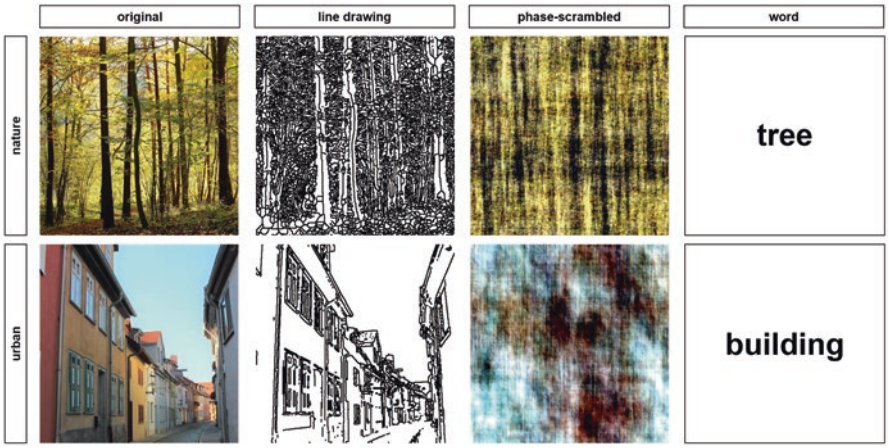

Fig. 3.5 Example of original and phase-scrambled images of natural and built scenes used in the study by Menzel and Reese (2019), unpublished materials reprinted with permission of the authors

(Fig. 3.5): original photos of natural and built settings, phase-scrambled versions of the same images, in which several low-level properties are kept constant while spatial information is randomized, line drawings of the settings, and a condition in which the settings were only described with words. Results show that self-reported restoration was different for natural versus built environments when confronted with original photographs, line drawings, and words. No differences between natural and built settings were found for the condition in which the environment could not be identified due to randomizing the spatial information. The authors conclude that they were unable to demonstrate a clear contribution of lower level processed image properties to restorative outcomes in natural versus built conditions. The results also suggest that the typical difference in restoration potential when comparing natural to built settings cannot occur without higher level processing.

3.14 Auditory Pathways: Nature Sounds

Humans are multisensory. It seems likely that many benefits are delivered through the non-visual senses (sound, smell, touch, and taste) and that these are potentially pathways through which bottom-up physiological influences of contact with nature on health may be obtained. With respect to the auditory pathway, several studies have shown that listening to bird song and other natural sounds can support restorative experiences (Alvarsson, Wiens, & Nilsson, 2010; Krzywicka & Byrka, 2017; Ratcliffe, Gatersleben, & Sowden, 2018). Natural sounds can provide information on species, season, and temporality, and it is conceivable that the human species has evolved to be attuned to such survival-relevant auditory cues (Franco et al., 2017). Findings of a recent study on restorative effects of listening to nature sounds are,

however, difficult to reconcile with such an account (Haga, Halin, Holmgren, & Sörqvist, 2016). In this study, participants conducted cognitively demanding tests prior to and after a brief pause. During the pause, participants were exposed to an ambiguous sound consisting of pink noise (a smooth and soothing form of white noise) with some static white noise interspersed. Participants were randomly assigned to different stimulus-source conditions in which they were either told that the sound originated from a nature scene with a waterfall, or that it originated from an industrial environment with machinery. Participants who were told that they were listening to a waterfall felt more restored after the pause, as indicated by a decrease in self-reported mental exhaustion. By contrast, participants who listened to the same sound thinking it was produced by industrial machinery showed a slight increase in mental exhaustion. These findings, which have been corroborated by other studies (Van Hedger et al., 2019), clearly sit uneasy with a bottom-up evolutionary account of restorative multisensory experiences with natural environments.

3.15 Olfactory Pathways: Phytoncides and Negative Air Ions

Human olfaction relies on old neural circuits in the brain stem, the reptilian part of the brain that developed first (Doty, 2015). These circuits have a direct link with the limbic system, which has allowed humans to rapidly assess, without much time for reasoning and reflection, whether something is edible or dangerous. In line with the evolutionary adaptive function of smells of nature, several studies have reported positive effects of inhaling smells of edible plants, like peppermint, rosemary, citrus, and vanilla on cognitive performance, psychophysiological stress and mood (for reviews see Franco et al., 2017; Hägerhäll et al., 2018). However, a number of systematic reviews of aromatherapy and essential oils, published in mainstream journals suggest that the evidence for health benefits of inhaling smells of nature so far remains inconclusive (Dimitriou, Mavridou, Manataki, & Damigos, 2017; Lee, Choi, Posadzki, & Ernst, 2012; Posadzki, Alotaibi, & Ernst, 2012).

Notably, it has been suggested that breathing in natural air may influence health without any conscious experience of smell (Franco et al., 2017; Kuo, 2015). When attacked by harmful insects and microbes, plants and trees give off certain antimicrobial organic compounds to protect themselves. A number of Japanese studies have shown that inhaling such “phytoncides” may strengthen human immune system function (Li, 2010). However, a closer look at these studies shows that participants were exposed to essential oils that were vaporized in the air through humidifiers. Essential oils are indeed a subclass of phytoncides, which themselves are a subcategory of a broad range of biochemical substances that are released by microorganisms and plants to attack other harmful plants and organisms, or warn other plants against such attacks (Rice, 2012). These biochemical substances are studied in a field called “allelopathy” (derived from the Greek “to suffer from each other”), and include antibiotics (substances used for interactions between microorganisms), kolines (used for plant to plant interactions), marasmins (used for

microorganism to plant interactions), and phytoncides (used for plant to microorganism interactions). While the antibacterial properties of these substances are well studied and have been successfully applied in medicine, the effects of inhaling these substances on humans remain largely unknown.

Negative air ions, which are formed when a gas molecule or atom gains enough energy to release an electron, are another type of odorless air-borne substances that have recently been linked to health benefits of exposure to natural environments (Kuo, 2015). Negative air ions can be found throughout nature, with particularly high concentrations in places that are traditionally prescribed for health treatments, such as mountainous areas and seashores. The presence of negative air ions has been associated with many health outcomes including improved mood (Goel & Etwaroo, 2006) and enhanced vaccine induced mucosal immune response (Grafetstätter et al., 2017). However, experimentation in this area has been hampered by serious methodological flaws (Yates, Gray, Misiaszek, & Wolman, 1986), and a recent systematic review showed no consistent or reliable evidence for therapeutic effects (Jiang, Ma, & Ramachandran, 2018).

In sum, the available evidence for bottom-up olfactory pathways from antibacterial compounds and negative air ions to health is mixed and inconclusive. Research in these areas has been plagued by a low quality of the studies and publication bias, which makes effects and interventions seem stronger than they actually are. Although there are enough positive findings to warrant further exploration, it seems unlikely that these pathways can account for the substantive and consistently positive relationships between green space and health.

3.16 Where to Go Next

So where do we go next—now that the case for bottom-up restorative effects of short-term exposure to natural over built environments is getting weaker with every new systematic review and critical experimental study being published? Is it time to abandon the whole idea that restorative and health effects of natural environments reflect evolutionary influences of some unique characteristics of these environments that cannot be found in built settings? I think it would be premature to draw such a drastic conclusion. After all, results of meta-analyses are only as strong as the studies they are based on, and the quality of the majority of studies in restorative environments research is still low or at best moderate. To me, the most reasonable next step would be to reassess the strength of the existing evidence base, by trying to replicate the findings of some of the most cited studies, preferably by means of large, well-powered multi-lab studies.

Recently, I participated in one of the first of such multi-lab replications of the seminal Ulrich et al. (1991) study, led by VU University of Amsterdam. This multi-lab study, which included 10 labs and almost a 1000 participants, failed to reproduce the impacts on physiological parameters as reported in the original study. Only if and when such replications and further critical experimental studies continue to

yield negative results, it would seem timely to let go of the now dominant view that restorative and health benefits of nature are guided by intrinsic visual and other sensory cues that signal information that was once important for human survival in natural environments. In the meantime, another possible non-sensory bottom-up pathway may be explored, which I will discuss in the next section.

3.17 Microbes and the Immune System: The Old Friends' Hypothesis

A different perspective on health benefits of nature is provided by the so-called old friends' hypothesis, formerly known as the "hygiene hypothesis," proposed by Graham Rook (Rook, 2013; Rook, Raison, & Lowry, 2014). The bottom line of this hypothesis is that some originally harmful microbes have co-evolved with human beings. To function correctly, the immune system needs "data inputs" from these "old friends." These inputs, which come from bodily exposure to natural environments and animals, are crucial in early life, but continue to be important in adulthood and old age. Without appropriate microbial inputs the regulation of the immune system is faulty, and the risk of chronic inflammatory disorders increases (Fig. 3.6).

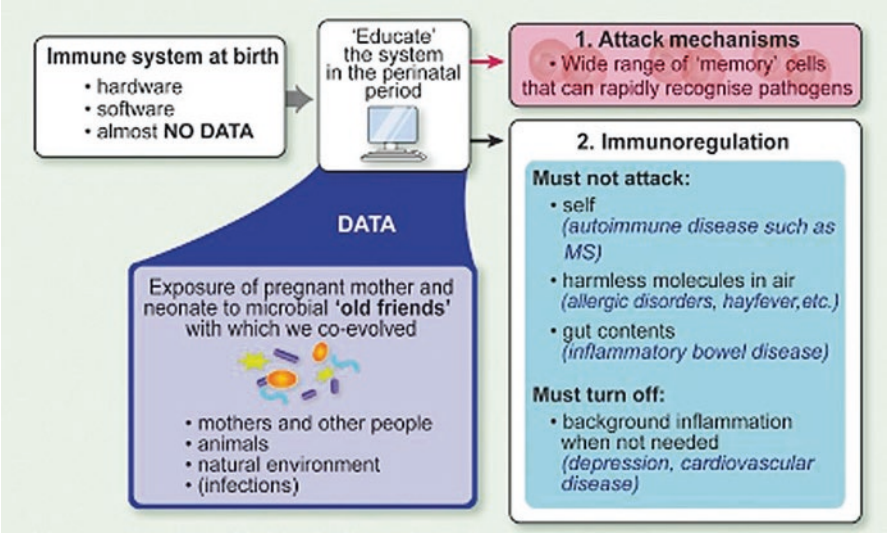

Fig. 3.6 Graphical illustration of the Old Friends Hypothesis (reproduced from Rook et al., 2014). According to this hypothesis, the immune system requires "educational" input. The microbiota of organisms from the natural environment and other tolerated organisms (such as helminths) with which humans co-evolved are required to expand the regulatory branches of the immune system to permit an appropriate immune response

The old friends' hypothesis fits in several ways with the findings from research on restorative environments and health benefits of green space. First, immune-regulating functions of microbial inputs only become effective with more prolonged exposure, which could explain why epidemiological studies have yielded more support for health benefits of nature than short-term experimental investigations. Second, chronic inflammatory disorder has been associated with lifestyle-related diseases, including anxiety and depression (Foster & McVey Neufeld, 2013), cardiovascular disease (Frostegård, 2013) and obesity and type 2 diabetes (Karlsson, Tremaroli, Nielsen, & Bäckhed, 2013) for which the strongest relationships between green space and health are found. Third, biodiversity is one of the few qualities of urban green space that predicts health outcomes and self-reported restoration (Aerts, Honnay, & Van Nieuwenhuyse, 2018; Wood et al., 2018).

Taken together, the old friends' hypothesis could be a bottom-up biological pathway through which nature benefits are delivered. It is a well-studied pathway that fits within a broader perspective of enhanced immune function as a central pathway in relationships between nature and health (Kuo, 2015).

3.18 Building Resilience: A New Focus for People-Nature Studies

Based on my analysis so far, it seems inevitable that nature–health research will move away from assessments of short-term restorative effects of visual exposure into the direction of benefits of more long-term direct exposure assessed with methods from epidemiology, immunology, ecology, and other natural and medical science fields. What could be the contribution of environmental psychology to this new perspective on nature–health relationships? A complementary contribution could be to show that embodied engagement with nature not only builds resilience at a biological/physical level, but also at a psychological level (see also Wells, Chap. 7, this volume). As described by the Dutch princess Irene, trees can be such good "old friends" in times of need and desperation. Every time people make a real, deeply felt connection with nature, their resilience to cope with adversities and to grow as a person is strengthened (Zelenski & Nisbet, 2014).

Thus far, research and theorizing on resilience-building experiences with nature has mostly been carried out in the context of wilderness programs and other organized nature-based therapeutic activities (Bettmann, Gillis, Speelman, Parry, & Case, 2016; De Pater, 2012; Russell, 2001). The positive outcomes of such programs on measures such as improved problem-solving ability, and positive changes in self-concept, self-esteem, and body image have been well documented (Bettmann et al., 2016; Driver, Nash, & Haas, 1987). A difficulty with this type of research is that effects of nature experience are confounded with effects of the therapeutic program and structured group activities carried out within the natural setting. Nevertheless, as pointed out by Hartig et al. (2010), there are reasons for assuming

that the natural environment itself contributes to resilience-building outcomes of wilderness programs and nature therapy. Besides a sense of "being away" from the cognitive, social, and physical demands posed by everyday urban settings (Kaplan & Kaplan, 1989), these reasons relate to more positive characteristics of natural settings, which include, but are not restricted to: the natural environment being impartial or indifferent, and giving little negative or judgmental feedback (Grahn, Tenngart Ivarsson, Stigsdotter, & Bengtsson, 2010; Wohlwill, 1983), the natural environment being a source of deeply rooted fears, which are often exaggerated in modern times and thus easy to overcome (Öhman & Mineka, 2003; Van den Berg & Ter Heijne, 2005), and the natural environment offering many affordances that promote acquisition of sensory-motor skills and mastery and a sense of competence (Fjørtoft, 2004). These characteristics may not be unique or intrinsic to natural environments. However, they are more abundant in natural than built settings, which makes natural settings effective places for resilience building.

It would seem timely for environmental psychologists to critically examine these resilience-building experiences with more rigorous empirical methods, in more varied natural settings. It is beyond the scope of this chapter to give a detailed outline of such a new approach. However, it is possible to list some topics worth examining with more controlled research designs that allow for comparison between natural and built settings, and shed more light on the possible conditions that facilitate connecting experiences that build resilience. These topics may include:

- Magical moments and other "peak experiences" with nature during childhood, which make children realize they are part of a larger universe and form the basis of a life-long affiliation with nature (Chawla, 2002; Van der Waal et al., 2008, see also the chapter by Chawla in this volume).
- Extreme experiences in wilderness settings that confront youth at risk, and other groups with their deepest fears, and helps them to overcome these fears (Bettmann et al., 2016; Lekies, Yost, & Rode, 2015).
- Hands-on experiences with nature during gardening and other tactile ("hands in the earth") contact with nature and animals (Buck, 2016; Gross & Lane, 2007).
- Episodes of heightened sensory experience, when the whole natural world seems to look new and different, as when people for the first time step out of a hospital after being treated for a life-threatened disease.
- Sublime encounters with nature which make people realize the power of nature and their own significance in the grander scheme of things (Joye & Bolderdijk, 2015; Van den Berg & Ter Heijne, 2005).

An important challenge for this experimental "resilience by nature" research is to study nature experiences in a systematic and controlled manner while preserving the authenticity of the experiences. One suitable approach is provided by ecological momentary assessment, which involves the repeated sampling of thoughts, feelings, or behaviors as close in time to the experience as possible in the naturalistic environment (Beute & de Kort, 2018; Moore, Depp, Wetherell, & Lenze, 2016).

3.19 Conclusion

Writing this chapter has turned out to be a journey through my career, reflecting on issues related to differential experiences with natural and built settings that have long since fascinated me, and finding out where we stand with these issues. While I used to think that experimental research on restorative environments provides more convincing evidence for health benefits of nature than epidemiological studies, I am now inclined to think that the reverse may be more true.

I would like to point out that my analysis does not contest the restorative qualities of contact with nature—they only open up the discussion on the origins of these qualities, which seem to be more top-down cognitively influenced than is generally assumed. There is no doubt that nature is a very powerful source of restoration and other health benefits. However, in terms of Kaplan and Kaplan's Attention Restoration Theory, much of the short-term benefits seem to be related to a sense of "being away" from the environmental and social pressures of living in urban environments, rather than a bottom-up "soft fascination" with intrinsic visual qualities.

Perhaps the most important lesson that I have learned is that we are still mostly in the dark about what it is that draws people to nature. Yes, countless people sense that making contact with nature is important and meaningful. But what makes experiences with nature so important and meaningful that we keep passing the message on to next generations? Can scientific methods help us to get to the heart of this experience? And if so, which methods are most useful for studying the deep affective affiliation we have with nature? A key challenge for future research is to develop an increasingly fine-grained understanding of these issues, with an open mind that is receptive to different—bottom-up and top-down—ideas and possibilities.

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Chapter 4
An Environmental Neuroscience Perspective on the Benefits of Nature

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The field of *environmental neuroscience* offers an important opportunity to study how and why interacting with nature has beneficial psychological effects. Environmental neuroscience is a field devoted to understanding the bi-directional interplay between the physical environment and individual brain processing that produces behavior (Berman, Kardan, Kotabe, Nusbaum, & London, 2019; Berman, Stier, & Akcelik, 2019). The environmental neuroscience approach is multidisciplinary, drawing from various fields such as psychology, neuroscience, genetics, sociology, anthropology, economics, and computer science. It is also a multi-scale science, meaning that the spatial levels of analysis that it explores can be as small as molecules to as large as cities and spans time scales as short as milliseconds to as long as years or centuries.

Simultaneously, there has been enormous growth in the field of *environmental psychology* examining how interacting with different physical environments, such as natural environments (e.g., parks and other more natural areas vs. more built or constructed areas such as a mall), can be salubrious to human psychological functioning. Experimental research has shown that going for nature walks or interacting with real natural environments can increase attention and working memory performance (Berman, Jonides, & Kaplan, 2008; Berman et al., 2012; Berto, 2005; Bratman et al., 2012; Bratman, Daily, Levy, & Gross, 2015; Stenfors et al., 2019), reduce rumination (Bratman, Paul Hamilton, Hahn, Daily, & Gross, 2015), reduce ADHD symptoms (Faber Taylor & Kuo, 2009), reduce breast cancer symptoms (Cimprich & Ronis, 2003), and improve mood (Berman et al., 2008; Bratman, Daily, et al., 2015; McMahan & Estes, 2015). Similar effects have been demonstrated when utilizing more artificial nature stimuli such as pictures (Berman et al., 2008; Berto, 2005), videos (Bourrier, Berman, & Enns, 2018), and sounds (Van Hedger et al., 2018).

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_4

Other impressive studies have shown the benefits of nature in less experimentally controlled, but more ecologically valid settings. Researchers have found a positive relationship between green space around schools and cognitive development in children (Dadvand et al., 2015), as well as an association between green views at home and self-control behaviors in young girls (Faber Taylor, Kuo, & Sullivan, 2002). In a study with adults, researchers also found that residents living in greener public housing buildings showed higher attentional functioning (Kuo & Sullivan, 2001a) and reduced aggression and criminal behavior (Kuo & Sullivan, 2001b). All of these results point to significant effects of interactions with nature on human psychological well-being.

With that said, it is still unclear exactly why interactions with nature have such effects. In this chapter, we outline how an environmental neuroscience perspective may be fruitful in elucidating the mechanisms for why interactions with nature have salubrious effects on human psychological functioning.

4.1 A Multi-Scale Science

Environmental neuroscience considers how processes and factors that vary across multiple scales of temporal and spatial resolution interact to produce behavior. In order to explicitly model the dynamics of these environment-by-brain interactions, environmental neuroscience borrows some of the ideas from other multi-level frameworks such as social neuroscience (Cacioppo & Decety, 2011) and network neuroscience (Bassett & Sporns, 2017). These frameworks focus on using multiple levels of analysis in order to qualitatively guide and interpret research. Here, it is important to model interactions within a level (e.g., brain network connectivity) and also between levels (e.g., the relationship between brain network connectivity and genomic function). Environmental neuroscience builds on these ideas by measuring the spatial and temporal dynamics of interactions between levels of analysis, such as how being a carrier of certain genetic polymorphisms (Belsky et al., 2009) may affect how interactions with urban green space may benefit an individual (Berman, Kardan, et al., 2019; Berman, Stier, & Akcelik, 2019). We believe that examining all of these levels at different temporal and spatial scales will lead to advances in understanding much of human and non-human animal behavior. In addition, the collection of data across these scales and measuring their interactions will generate rich datasets that will continue to yield insights as new ways to model complex multi-level systems are developed.

The goals of environmental neuroscience include: (1) placeing the physical and social environment at the forefront and to link human and non-human animal research together by finding brain measures that could be compared across species (e.g., network properties, nonlinear dynamics); (2) identifying the qualitative and quantitative relationships between different levels of biological and environmental analyses; (3) examining humans across the life span; (4) comparing complex human physical and social environments to other species' native complex physical and

social environments and to potentially manipulate those non-human environments in ways that humans have manipulated their own environments; and (5) using this information to design physical environments to improve human psychological functioning (Berman, Kardan, et al., 2019; Berman, Stier, & Akcelik, 2019).

The vast spatial scales, from synapses to cities, and vast temporal scales, from milliseconds to millennia, over which interactions between the socio-physical environment and our brains occur presents environmental neuroscientists with a large phenomenological space to explore (Berman, Stier, & Akcelik, 2019). For example, understanding the impact of urban green space on human behavior and well-being (Berman et al., 2008; Kardan et al., 2015) requires understanding what types of behaviors urban green space mediates (e.g., individual cognition, psychopathology, family dynamics, neighborhood crime levels), the amount of exposure required for the effects to manifest (e.g., individual effects may be realized after seconds of exposure; Van Hedger et al., 2018; Kotabe, Kardan, & Berman, 2016a) or after years (Chetty, Hendren, & Katz, 2016; Kardan, Gozdyra, et al., 2015), how the effects may vary for individuals (e.g., different genetic sensitivity or different personality variables), and how urban green space may induce structural or functional changes in the brain. In general, the processes that environmental neuroscience aims to study operate across various spatial and temporal scales.

4.2 Theories for Nature's Psychological Benefits

Before delving into an environmental neuroscience approach to examine how and why interacting with nature has psychological benefits, it is important to briefly review some of the theorizing about why interacting with nature is beneficial. Stress reduction theory (SRT), proposed by Ulrich (1983), suggests that a positive emotional response to nature allows a person to return from a stressful state to a more relaxed state. According to SRT, interacting with non-threatening natural environments can reduce stress and negative affect, while increasing positive affect. These changes in affect and reductions of stress then allow a person to maintain higher levels of sustained attention, which leads to cognitive benefits (Ulrich, 1983). While a recent meta-analysis shows evidence for improvements in mood following exposure to nature (McMahan & Estes, 2015), our analyses have shown that mood effects are not correlated with the cognitive benefits (Stenfors et al., 2019), thus countering the proposition that mood changes drive the cognitive effects as posited by SRT.

Attention restoration theory (ART), on the other hand, claims that perceptual features of natural environments capture one's bottom-up involuntary attention, while simultaneously allowing finite, top-down directed attention resources a chance to replenish (Kaplan & Berman, 2010; Schertz & Berman, 2019). This perceptual feature of natural environments is called "soft fascination." Other features of restorative environments posited by ART are environments that provide: (1) a sense of being away (i.e., mental separation); (2) a feeling of extent (i.e., large enough

environments to be explored); and (3) compatibility with goals (Kaplan, 1995). The feature of compatibility is thought to be one of the ways that the same environment could have different restorative effects for different people, or even for the same person at different times (Schertz & Berman, 2019). For example, if you have a walking commute through a park, you are unlikely to feel the same restorative benefits on days when you are running late for work (Schertz & Berman, 2019). Thus, compatibility can be thought of as how a person interacts with their environment at any given time and how it matches with their current goals and state.

The perceptual fluency account (PFA) relates our positive affective responses to natural stimuli to the ease of processing such stimuli and posits that attention restoration and stress reduction are by-products of this processing fluency (Joye & van den Berg, 2011). For example, fractalness is proposed to be influential in determining how fluently a scene is processed as it increases perceptual predictability. The idea is that fluency would induce less effortful processing, a concept similar to soft fascination in ART. However, in PFA, effortless processing increases positive affect which increases attention, and in ART, effortless processing acts directly to increase attention (Schertz & Berman, 2019). In both ART and PFA, additional research is needed to determine what features make an environment fascinating/fluently processed and how to measure that fascination/fluent processing in an independent way.

Prospect-refuge theory does not focus on an urban-nature dichotomy, but rather on an aesthetic judgment of landscapes. This theory suggests that people prefer landscapes that offer both prospect (a clear field of view) as well as refuge (places to hide; Appleton, 1975). Supporting this theory, research has shown that nature walks that had high prospect led to higher cognitive restoration compared to nature walks with low prospect (Gatersleben & Andrews, 2013).

The biophilia hypothesis (Kellert & Wilson, 1995) suggests that human preferences for nature arise from humans evolving in natural environments. Though there is disagreement on how this might occur—whether this innate affinity is genetically programmed or works through a form of biologically prepared learning—a common explanation for why nature is preferred is that only a small fraction of evolutionary history has occurred within our current urban environments, and the remainder in more natural environments (Meidenbauer et al., 2020). Therefore, in modern times, as we are more distant from nature, we may not be satisfying these innate urges to commune with nature which can lead to cognitive deficits. As such, if we can interact with nature, we can satisfy these innate nature preferences, which will leads to cognitive benefits. Recently, work has shown that children do not prefer nature, and rather prefer more urban environments (Meidenbauer, Stenfors, Bratman, et al., 2019), which is somewhat problematic for accounts that suggest that humans inherently prefer nature as the mechanism for why interacting with nature yields psychological benefits.

Other theories posit that interacting with natural environments is beneficial because natural environments have more affordances than non-natural environments (Chawla, 2007). Affordances relate to the number of relational properties that an environment or a stimulus may have (Heft, 2010). For example, a tree branch can be climbed, sat on, swung from, etc. These theories posit that more benefits from

interacting with nature will be gleaned from interacting with "real" natural environments rather than from interacting with natural environments via images, sounds, or videos because the simulated nature will not carry affordances. The assumption here is that interacting with actual nature vs. viewing pictures of nature lead to qualitatively different outcomes. Here is an example wherein environmental neuroscience approaches could be useful to compare brain processes when individuals interact with vs. more passively view actual vs. simulated environments and measure the diversity or similarity of neural processes activated. Work from embodied cognition approaches and visual imagery suggests that there is a large overlap between taken actions and those imagined (Barsalou, Kyle Simmons, Barbey, & Wilson, 2003; Hauk, Johnsrude, & Pulvermüller, 2004; Kosslyn, Ganis, & Thompson, 2001), suggesting that many psychological benefits can be obtained from processing simulated nature. This is corroborated by the immense literature showing that psychological benefits can be obtained from viewing nature images (Berman et al., 2008; Berto, 2005; Stenfors et al., 2019), listening to nature sounds (Van Hedger et al., 2018), and watching nature movies (Bourrier et al., 2018). This is not to say that the benefits from interacting with real vs. virtual nature are the same (Stenfors et al., 2019), rather that some similar benefits can be obtained, suggesting that some of the effect is due to perceiving the features of natural environments (Schertz & Berman, 2019).

4.3 Examining the Different Scales of Nature Research

Research examining the benefits of nature have varied in terms of temporal and spatial scale. Most experimental studies typically involve recruiting some number of participants, ~20–40, and having them interact with a natural or urban environment, and examining changes in cognitive performance, affect, and other psychological measures before and after the interactions. These interactions typically last between a few minutes and an hour. These are the most common types of studies, and we term them meso-scale studies. Other studies look at nature at smaller scales by trying to decompose nature into its low-level perceptual features (such as curved edges) to try and understand why simply perceiving nature stimuli, such as viewing nature images or listening to nature sounds, leads to benefits. We consider these micro-scale studies. At the other end of the spectrum, there are studies that look at large populations of people who live near various amounts of natural green space, and how living near nature may be related to physical health and many other psychological factors such as working memory, affect, and school performance. These studies have much larger sample sizes, and the exposure duration may be on the order of years depending on how long the residents have lived in those neighborhoods. Typically, these studies are correlational/observational. We consider these macro-scale studies. Next, we outline the results of these different studies that examine the effects of nature from these different spatial and temporal scales.

4.3.1 Meso Scale

The most common form of nature studies has been experimental studies where a small set of participants (around 20–40) are exposed to natural or urban environments for brief exposures (on the order of 10–60 min). Researchers then measure changes in different psychological variables before and after these exposures to assess changes in performance due to environmental exposure. These studies are often a mix of between-subject designs (where participants are only exposed to one environment type) and within-subject designs (where participants are exposed to both environment types, separated by some amount of time).

These experimental studies have used a wide range of stimulus types, including images (e.g., Berto, 2005), sounds (e.g., Van Hedger et al., 2018), and real-world exposure (e.g., Berman et al., 2008, 2012), to show that exposure to natural environments can improve participants' cognitive performance relative to exposure to urban environments. Many of the cognitive tasks that show the greatest improvement are tasks that involve working memory, and the backward digit span is one of the more commonly used working memory tasks (Schertz & Berman, 2019; Stenfors et al., 2019). The backward digit span task requires participants to repeat back sequences of numbers, of varying length, in reverse order (Stenfors et al., 2019; Stevenson, Schilhab, & Bentsen, 2018). In general, cognitive tasks that require working memory and cognitive flexibility improve the most after nature exposures. In addition, tasks requiring attentional control also show some improvements. More mixed results have been seen for tasks that involve impulse control, visual attention, vigilance, and processing speed (Stevenson et al., 2018). It is possible that these tasks may not tax directed attention enough, as is theorized by attention restoration theory as a critical resource that is replenished after interactions with nature (Kaplan & Berman, 2010). Here, too, is a place where an environmental neuroscience approach may be helpful as a way to uncover what brain processes are altered after interactions with nature, which can then be used to predict what types of cognitive tasks might benefit from nature interactions.

4.3.2 Micro Scale

One potential mechanism that has emerged for these effects involves the perception of the low-level features of the environment (Schertz & Berman, 2019). As discussed in the theories section, additional work is necessary to understand what makes an environment softly fascinating (ART) and/or fluently processed (PFA). In the visual modality, low-level features include color properties such as hue, saturation, and brightness (value), as well as spatial properties such as the density of straight and non-straight edges, and entropy (see Fig. 4.1; Schertz & Berman, 2019). Interestingly, these "low-level" features have also been found to carry semantic information (Berman et al., 2014; Kardan et al., 2015; Kardan, Gozdyra, et al.,

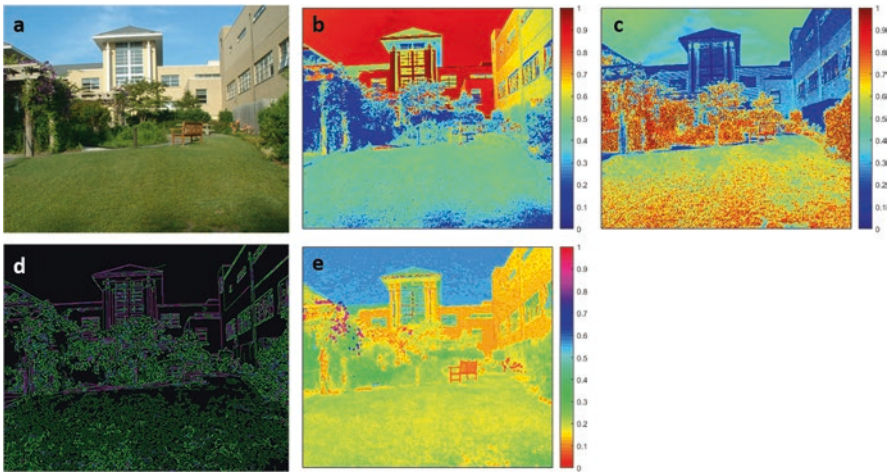

Fig. 4.1 (**a**) Example original image with visualizations of (**b**) brightness (value), (**c**) saturation, (**d**) straight (purple) and non-straight (green) edges, and (**e**) hue. This figure was reproduced with permission from Schertz and Berman (2019)

2015; Kotabe et al., 2016a; Kotabe, Kardan, & Berman, 2016b; Kotabe et al., 2017). For example, some of these visual features can significantly predict people's preference and naturalness judgments for a wide range of images. Natural environments in general have more non-straight edges, less color saturation, and less variability of hues. In addition, perceiving the low-level features of the environment can influence complex cognitive and self-regulatory processes, such as thought content (Schertz et al., 2018; Schertz, Kardan, & Berman, 2020) and the propensity to cheat (Kotabe et al., 2016a). When shown images that were higher in non-straight edge density, people were more likely to think about topics related to spirituality and one's life journey, compared to viewing images with lower non-straight edges, independent of the perceived naturalness of the scene (Schertz, Kardan, & Berman, 2020; Schertz, Sachdeva, et al., 2018).

Just as in the visual domain, participants show increases in working memory performance after listening to nature sounds relative to urban sounds (Van Hedger et al., 2018). There are many low-level acoustic features that can be quantified such as spectral entropy, a measure of noisiness of the sound, and dominant frequency. Importantly, these features often significantly differ between natural sounds and urban sounds and can be used to categorize sounds as originating from nature or urban sources (e.g., nature sounds tend to have higher spectral centroids and higher spectral entropy; Van Hedger et al., 2019). People tend to prefer natural sounds, but only when they can be identified as such. Thus, when urban and natural sounds were presented in an unidentifiable manner (i.e., hearing only a 100 ms duration sound), the low-level acoustic features remained different between nature and urban sounds, but, importantly, preference levels did not differ (Van Hedger et al., 2019). This indicates that the low-level acoustic features alone do not predict preferences, but

rather interacted with semantic information. The same could also be true for the cognitive benefits seen after interacting with nature and urban stimulation—where cognitive benefits may or may not be seen after perceiving natural features in isolation from semantic context (Schertz & Berman, 2019).

Aside from perceiving the low-level features of natural environments, others have posited different mechanisms for why nature might be restorative, such as breathing in improved air quality (Dadvand et al., 2015), being exposed to phytoncides (antimicrobial volatile organic compounds; Li et al., 2006; Li et al., 2009) and negative air ions (Li, 2010) as well as being exposed to the diverse microbacteria that exist in nature (Lowry et al., 2007). All of these mechanisms require that an individual be exposed to real nature. While much more research in these areas needs to be done to experimentally link these features of nature to psychological benefits, they suggest a need to study these benefits from a more biological perspective and to look at small scale phenomena that can have implications on psychological performance. This is a topic that is very much aligned with the goals of environmental neuroscience.

4.3.3 Macro Scale

While a large portion of environmental neuroscience studies occur at the meso level of analysis, macro level investigations have produced invaluable contributions to our understanding of how interacting with nature may provide benefits to human well-being, psychological functioning, and behavior. Through transdisciplinary efforts between the fields of psychology, neuroscience, sociology, epidemiology, economics, geography, and ecology, macro-level studies in environmental neuroscience provide an excellent opportunity to generate hypotheses regarding the boundary conditions and minimal and/or necessary conditions required for the positive effects of nature, which can then be tested later at the meso and micro scales. In addition, macro-level investigations allow for the exploration of nature effects in more ecologically valid conditions that contain highly complex and dynamic variables such as social networks, demographic changes, and shifting climate patterns.

Investigations at the macro scale have yielded a large number of results indicating a beneficial association with nature for outcomes such as general health (Dadvand et al., 2016; Kardan, Gozdyra, et al., 2015; Sugiyama et al., 2016), mental health (de Vries, van Dillen, Groenewegen, & Spreeuwenberg, 2013; Engemann et al., 2019; McEachan et al., 2016; Sarkar, Webster, & Gallacher, 2018), obesity (Ellaway, Macintyre, & Bonnefoy, 2005; Lovasi et al., 2013), birth weight (Hystad et al., 2014; Markevych et al., 2014), childhood behavioral development (Amoly et al., 2014; Balseviciene et al., 2014), childhood brain development and cognitive function (Dadvand et al., 2015), mortality (Donovan et al., 2013; Mitchell & Popham, 2008; Villeneuve et al., 2012), development of social networks (Dadvand et al., 2016; Eriksson & Emmelin, 2013; Fan, Das, & Chen, 2011; Maas et al., 2009), and active lifestyle promotion (Almanza, Jerrett, Dunton, Seto, & Ann Pentz,

2012; de Jong, Albin, Skärbäck, Grahn, & Björk, 2012; Fan et al., 2011; Gidlow, Randall, Gillman, Smith, & Jones, 2016; Giles-Corti et al., 2005; Mytton, Townsend, Rutter, & Foster, 2012). While this list may be overwhelming, these studies share several characteristics. Many of these studies are observational, in contrast to interventional, meaning that there is no experimental manipulation by researchers. Thus, while researchers are able to formulate and test hypotheses in these studies using correlational methods, they are unable to make causal inferences. A related consequence of this is that macro-scale studies tend to characterize explanatory mechanisms as occurring over large temporal scales, often on the order of an individual's life course. This is in stark contrast to the more "immediate" temporal scales characteristic of the many studies at the meso and micro scales.

Many of the studies at the macro level have often been reported under the umbrella term of "ecosystem services" which refers to the "many and varied benefits that humans freely gain from the natural environment and from properly-functioning ecosystems" (Carpenter et al., 2006; Millennium Ecosystem Assessment (MEA), 2005). Historically, according to the MEA, "ecosystem services" have been considered along four categories with relevance to research in ecology, economics, and public policy. They are: (1) supporting/habitat services (i.e., maintenance of biodiversity, conservation, conservation of habitats for species); (2) provisioning services (i.e., food, water, and raw materials); (3) regulating services (i.e., air quality, waste treatment, disease control, soil quality); and (4) cultural services (i.e., recreation, tourism, inspiration for art and design, spiritual experience, and sense of being). Research highlighting the benefits of these categories has been reviewed elsewhere (Chiabai, Quiroga, Martinez-Juarez, Higgins, & Taylor, 2018; Markevych et al., 2017). However, there has been much less focus on what Bratman et al. (2019) have termed "psychological ecosystem services," which highlight the positive benefits of engaging with nature on mental health, psychological well-being, and cognitive and affective functioning.

Macro-scale studies vary in the way that they measure "natural features," and many rely on measures such as satellite-based indices and GIS-based land use variables in order to calculate tree canopy or local vegetation indices (Markevych et al., 2017). These measures are limited by the resolution and quality of the data, and also by the strength of the classification methods (e.g., if an algorithm can distinguish between trees, shrubs).

A second consideration for macro-scale studies is the type of exposure, or the amount of contact that an individual has with nature (Bratman et al., 2019). As with the previous step, researchers are limited by the resolution of their data and tend to adopt one of two assumptions: either they will (1) take a cumulative opportunity approach by computing the percentage of an area of interest (such as a zip code or residential block) that is made up of nature elements, or (2) will take a proximity measure, such as a physical distance from an individual's estimated home location using a circular buffer to approximate an individual's roaming space (Ekkel & de Vries, 2017). A recent investigation by Liqing Zhang and Puay Yok Tan (2019) in Singapore indicated that the association between urban green space and health was dependent on the size of the area they investigated around an individual (finding

optimal associations between 400 and 1600 m) and the type of land cover variable they used, finding a stronger association when using tree canopy versus the presence of shrubs, grass, or parks. More recently, researchers have quantified how often people in different neighborhoods visit parks outside of their neighborhoods using cell phone trace data (Schertz et al., in press). The authors found a significant correlation between the amount of park visits in different neighborhoods with reduced crime, controlling for age, education, income, and other demographic variables. These results illustrate the importance of choosing an appropriate measure of natural features and exposure when attempting to quantify the characteristics of a nature interaction.

A third important consideration is to try to quantify the "dose" amount of nature "absorbed" by an individual (Bratman et al., 2019). Absorption is a term borrowed from toxicology and epidemiology; the amount of nature "absorbed" by two individuals with the same nature contact will vary according to different levels of attention, preference, and feelings of personal connection with nature (Bratman et al., 2019). It is here where environmental neuroscience investigations at the meso and micro level may elevate and illuminate phenomena observed at the macro level. Such an example can be observed with the cellphone trace data in Schertz et al. (in press) (See *Combining Scales* section), where one can quantify how often one visits a park and for how long.

Research at the macro level has also identified a number of challenges that present interesting opportunities for future environmental neuroscience research. Following the suggestions of studies showcasing the different use of park and green spaces by non-White populations due to sociocultural moderators and uneven spatial distributions of green space within cities (Byrne, 2012; Byrne & Wolch, 2009), a few studies have investigated the connection between green space and health by exploring the moderating effect of racial/ethnic identity and socioeconomic status. Under a broader interdisciplinary body of literature titled "environmental justice," research in this area, as defined by the US Environmental Protection Agency (EPA), focuses on the "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (US EPA, 2012). In support of this approach to prioritizing equity, studies have highlighted that the positive effects associated with nature may be swamped out by structural- and societal-level factors that create social and physical barriers, such as lack of opportunities, inadequate amenities, and racial prejudice (Bratman et al., 2019; Casey, James, Cushing, Jesdale, & Morello-Frosch, 2017; Jennings, Larson, & Yun, 2016; Rigolon, Toker, & Gasparian, 2018). Furthermore, these same studies underscore the inequitable distribution of green spaces and their high spatial correlation with areas of greater socioeconomic prosperity (see Fig. 4.2), which, as a corollary, associate the deprivation of nature to areas already experiencing socioeconomic deprivation. Specific to mental health, some studies have identified what they term an "equigenic effect," such that a greater nature benefit is observed in areas of lower socioeconomic status (Mitchell, Richardson, Shortt, & Pearce, 2015),

Fig. 4.2 Choropleth plot showing the distribution of green space across neighborhood clusters in Chicago. Darker green areas have higher tree canopy. The height of each neighborhood represents how affluent each neighborhood is. Plots like this can be used to examine the equitable or inequitable distribution of green space in large urban areas

suggesting a positive effect to nature exposure even in the context of socioeconomic disparity (Mitchell & Popham, 2008).

Most studies at the macro level are correlational due to the financial and logistical difficulties with executing an experimental study (i.e., increasing green space in certain neighborhoods). One promising study that did achieve this was an experiment reported by South and colleagues (2018), in which the city of Philadelphia took part in a version of a randomized control trial in which a number of city lots were treated with one of three conditions: (1) greening the lot; (2) removing trash; or (3) a no-intervention control. The results of this experiment showed better mental health outcomes for individuals within a close proximity to lots in the greening condition.

In summary, the variety of macro-level studies investigating the positive benefits of nature provide an opportunity to observe effects seen at meso and micro levels within the context of complex sociopolitical variables, and exposures at greater temporal scales. Although these studies are mostly correlational, they likely show the impact of multiple mechanisms occurring at once, such as reductions in stress, increases in social cohesion, increases in physical activity, and restoration of cognitive capacity to name a few. By highlighting these candidate mechanisms at grander scales in ecologically valid contexts, macro-scale studies set the scene for more controlled environmental neuroscience studies at the meso- and micro-scale levels, while also providing enough population-level information to be relevant to public policy, epidemiology, and other fields in the social sciences.

4.3.4 Missing Factors: Neural and Genetic Scales

While certainly not the only missing factors, here we focus on two smaller spatial scales, neural and genetic, that may be important to study to obtain a fuller understanding of how and why interacting with nature may be beneficial. These are two scales to which an environmental neuroscience approach lends itself well.

4.3.4.1 Neural

Many of the theories that posit that nature is restorative claim that processing natural stimulation is more effortless or easier to process. To strongly validate those claims, one should examine if the brain more easily/efficiently processes natural scenes. One way to do so would be to look at some newer research which has found that the brain is in a more scale-free/fractal state when it is exerting less effort (Barnes, Bullmore, & Suckling, 2009; Churchill et al., 2015, 2016; He, 2014; Kardan et al., 2020). Here, scale-free/fractal state is quantified by plotting the spectral power curve of the temporal signal and quantifying the relationship between Power, $P(f)$, and frequency, f, where $P(f) \propto f^{-\beta}$. These types of signals are scale-free/fractal when the exponent, β is close to 1. In other words, for those signals, it does not matter at what temporal window/scale you decompose the signal, the spectral power curve will always have the same $1/f$ shape.

This research implies that when one is processing more natural stimulation, the brain will be in a more fractal state relative to processing more urban environmental stimulation. This has not yet been tested, but a strong experimental result would demonstrate that when one is seeing or listening to nature stimulation relative to urban stimulation, the brain would be in more fractal state and the amount of increase in fractalness would be accompanied by an improvement in cognitive performance (i.e., a behavior change).

Some have even suggested that it is the spatial fractal patterning of nature that may be why processing natural stimulation is restorative. Researchers have found that statistical fractal patterns found in nature induce brain signals related to a wakefully relaxed state (Hagerhall et al., 2015). As such, the fractalness of natural scenes may have an optimal mix of variation and predictability to make them fluently processed, while still interesting enough to hold attention (Hagerhall et al., 2015). However, this study did not have a concomitant behavioral measure to show that these brain signals related to a relaxed state were actually related to improvements in performance, which is critical. Otherwise, it is difficult to interpret a brain effect in isolation and there could be many reasons why a brain state may be induced that may not necessarily produce the same behavioral outcome. Even so, this area of research is quite promising by identifying brain states that may signal less effortful processing, and determining if the brain is more likely to reach these states after an interaction with nature.

4.3.4.2 Genetic

One element that is often overlooked in this research is that of individual differences. For example, interacting with nature may not affect individuals in the same way. Seminal research has shown that individuals may be more or less affected by different environments based on their carrier status of certain genes, such as the seratonin promoter gene, 5-HTTLPR (Belsky et al., 2009). Individuals who are s/s carriers on the 5-HTTLPR gene are more sensitive to the environment in a "for better or for worse" manner, meaning that if an s/s carrier is exposed to a positive environment (loving, enriched, etc.) early in life that person will be less likely to develop depression, but if that same person is exposed to a negative environment (abusive, maltreatment, etc.) early in life, that person will be more likely to develop depression (Belsky et al., 2009). l/l carriers, on the other hand, are less affected by the environment either positively or negatively. As such, individuals who are s/s carries may be more sensitive to the environment in general and hence more affected by natural environments specifically (Berman, Kardan, et al., 2019; Berman, Stier, & Akcelik, 2019). In other words, we would expect that s/s carriers might benefit more from natural environment exposure than l/l carriers. In addition, it would be interesting to see if these differences only manifested themselves when exposed to actual environments, or if these differences could be seen after simply processing the features of nature via videos or sounds. Importantly, it is highly possible that these effects would only be seen after long-term exposures to these environments, but that is an empirical question (i.e., would s/s carriers show larger effects after a brief nature walk or would these gene × environment interactions only show themselves for individuals who reside in more natural vs. more urban environments where the cumulative environmental exposure is much larger). As such, an environmental neuroscience approach would be to take individuals who have different carrier statuses on the 5-HTTLPR gene and measure their exposures to green space or better yet, attempt to manipulate their exposure to green space via some kind of long-term exposure intervention program.

4.4 Environmental Neuroscience: Combining Scales

It is clear that examining the salubrious effects of nature across varied spatial and temporal scales provides a more comprehensive understanding than any singular scale can provide on its own. The programs of research conducted at micro, meso, and macro scales are vitally important, and by aggregating the effects, we can fill in the gaps of knowledge at any particular scale (see Fig. 4.3). For example, meso-scale studies involving walks in natural and urban environments (Berman et al., 2008, 2012; Bratman, Daily, et al., 2015; Bratman, Paul Hamilton, et al., 2015) allowed for empirical testing of the correlation between long-term nature exposures and cognitive functioning (Kuo & Sullivan, 2001a), as well as examining the mechanisms underlying large- (or macro-) scale relationships between nearby green

Fig. 4.3 The many different scales of Environmental Neuroscience. At the micro level, studies examine the perceptual features of nature that may drive psychological effects as well as the neural and genetic mediating factors. At the meso level, studies may expose people experimentally to real natural or urban environments or to virtual environments via head mounted displays. In addition, these studies will often measure cognitive performance via tasks like the backward digit span task. At the macro level, studies examine how longer term exposure to green space affects cognitive and affective processing and health (including mental health). Environmental neuroscience stresses the importance of using tools that can link and cross scales, such as brain imaging, genomic measures, and smartphone apps, which will help to elucidate the mechanisms that drive the positive effects of interacting with green space. Understanding these effects will also help with the design of built spaces that can improve psychological functioning

space and mental health outcomes (Beyer et al., 2014; Francis, Wood, Knuiman, & Giles-Corti, 2012; Nutsford, Pearson, & Kingham, 2013). These observational studies, which cover considerable temporal and spatial scales, provide insight into the generalizability and magnitude of the results observed in meso-scale laboratory studies.

Further, the knowledge obtained from one scale can inform research in others. One such example of this approach was conducted by Schertz, Kardan, and Berman (2020) with their analysis of thought content from park visitors' anonymous journal

entries, and how these thoughts can be influenced by the low-level visual features of the park that they are visiting. The first study of this multi-step research project was to take ecologically valid but correlational data from over 11,000 journal entries and quantify the main themes or topics of these journal entries. Then the frequency of these topics could be correlated with the visual features extracted from photos of the parks in which the entries were written. For example, the researchers found that the amount of curved edges in the park photographs was correlated with the propensity of the park visitors to write about topics related to spirituality. Schertz and colleagues then replicated this effect in an experimental study, conducted online, showing pictures of other scenes that varied on naturalness and curved edges and had participants select thought topics that matched the scenes. Participants selected thought topics related to spirituality significantly more often if the scene had a high amount of non-straight edges (Schertz, Sachdeva, et al., 2018). To take this even further, in follow-up work, the authors displayed abstract images to participants, which lacked semantic content but varied in the amount of curved edges. The results of this study (Schertz et al., 2020) showed that even with abstract images, the more curved edges, the more people thought about topics related to spirituality. Here the authors began with a correlational study, but then followed up that work with smaller scale experimental studies to isolate the effects and determine causal mechanisms. Importantly, this work shows that the effects may not be due to nature per se, but to a feature of nature, namely perceiving curved edges.

Thus, we can think of combining these scales as creating a body of research that is greater than the sum of its parts. This is especially apparent when employing research methodologies that are designed to span multiple spatial or temporal scales. A recent mobile application developed by Schertz, Kardan, and Berman (2018) was created with this in mind. The app, called ReTUNE (Restoring Through Urban Nature Experience), uses green space data (LiDar data), sound data (SoundScore data), and crime data (taken from the City of Chicago open data portal) as inputs and generates the optimal "restorative" walk from point A to point B, by maximizing green space, minimizing crime, and minimizing sound. The ReTUNE app (Schertz et al., in press; Schertz, Kardan, & Berman, 2018), while in its infancy, employs a novel methodology to influence long-term nature exposure through its suggested routes, and will ideally reach a point where measures of cognitive fatigue or restoration, mood, or thought content can be measured within the app itself. This would allow for large-scale monitoring of the psychological effects of a more or less restorative walk and provide an opportunity for experimentation as parameters of interest (green space, noise, crime) can be adjusted. Thus, the application allows both manipulation of factors thought to influence restoration and evaluation of long-term or dose-dependent responses to nature. In doing so, this approach would allow for a line of research spanning the meso scale via controlled experimentation, and the macro scale via ecologically valid interactions with actual (non-simulated) environments over time.

A related concept to the ReTUNE app is that of experience sampling from individuals either during experimenter-specified walks in natural, urban, or residential areas (Ryan et al., 2010), or by sampling alongside GPS satellite data from

individuals' everyday experiences (MacKerron & Mourato, 2013). Experience sampling methods (ESM) typically employ a mobile application or tool which monitors experiences of interest by regularly pinging participants to answer survey questions regarding mental state, and relating responses to environmental factors present at the time of assessment. Research of this type has identified stable, long-term relationships between subjective well-being and spending more time in natural outdoor environments compared to urban ones (MacKerron & Mourato, 2013). An experience sampling technique reduces memory distortions and poor recall associated with retrospective self-reports, allowing for frequent monitoring over long time scales (Doherty, Lemieux, & Canally, 2014). ESM approaches also benefit from the potential to study the role of other relevant variables, such as daylight, amount of physical activity, and weather (Beute & de Kort, 2018; MacKerron & Mourato, 2013; Ryan et al., 2010). Furthermore, these frequent assessments of psychological state can be examined in conjunction with relatively constant, trait-level factors. Due to the repeated measures data gathered within individuals in ESM, such research provides a more reliable examination of what stable, dispositional factors may be important in reaping the benefits of natural environments (Bakolis et al., 2018), which is difficult to examine in studies comparing across groups. By utilizing these experimental designs which span the standard micro, meso, or macro research scales, we can obtain detailed knowledge about the extent and scope of nature's benefits, and better account for individual differences that are hard to examine at a singular scale.

4.4.1 Using Neuroscience Methods Across Scales

One dynamic factor that is important to consider across all scales is that of neural responses to natural environments. Psychophysiological sensors measuring heart-rate, blood pressure, or skin conductance allow measurement of peripheral nervous system function, which can be used to assess levels of stress or arousal during and after exposure to different environments (Ulrich et al., 1991). However, to gain insight into how natural environments influence neural processing in humans, functional neuroimaging techniques must be employed.

Because theoretical accounts of nature's cognitive benefits differ in the extent to which changes in affective state are assumed to matter, the use of neuroscientific methods may be particularly helpful to address discrepancies. For example, SRT (Ulrich, 1983) suggests the cognitive benefits arise from changes in mood and reductions in psychophysiological arousal, whereas ART (Kaplan & Berman, 2010) proposes that the affective benefits are unrelated to the cognitive benefits. This debate would benefit from examining the established behavioral measures in conjunction with functional neuroimaging methods to elucidate changes in affective and cognitive processing in the brain. It is also worth noting here that none of the prominent theories of nature's benefits (SRT, ART, PFA, Prospect-refuge, Biophilia) attempt to explain how nature interactions influence neural functioning, and instead,

focus solely on behavioral outcomes. Not addressing how the brain processes different environments is a key limitation of these theoretical frameworks, especially considering the variety of other biologically based, health benefits that nature exposure is known to afford (Frumkin et al., 2017).

Unfortunately, while many meso-scale studies rely on behavioral measures such as self-reported mood, performance on cognitive tasks, or other questionnaire data, very few have attempted to identify neural correlates of nature interactions. One study (Bratman, Daily, et al., 2015; Bratman, Paul Hamilton, et al., 2015) examined resting state functional MRI data from participants before and after a 90-min walk in a natural environment compared to an urban walk and found decreased activity in the subgenual prefrontal cortex (sgPFC) and lower self-reported rumination after a nature walk versus an urban walk. The identification of decreased sgPFC activation bolstered the behavioral reports by providing a potential biologically-based explanation for how nature interactions might improve human psychological function. However, this study did not explicitly test whether there was a significant association between rumination change and sgPFC activation, so further evidence would be needed to draw strong conclusions about the neural mechanisms at play.

Another study (Tost et al., 2019) demonstrated the utility of combining neuroscience methods with experience sampling to examine the positive effects of urban green space on mental health in city dwellers. The researchers used location tracking to measure daily exposure to green space and routine assessments of emotional well-being during a 7-day period and related this information to fMRI activity during a task that required regulation of negative emotions. This study found reduced activation in the dorsolateral prefrontal cortex (DLPFC) in regulating responses to aversive stimuli that was linked to increased nature exposure taken from the geolocation data. By combining such approaches, a robust link between emotion regulation and green space was found that could potentially be explained on a neurobiological level. Here, including functional neuroimaging sheds some light on potential mechanisms by which nature exposure may have a positive effect on the processing of negative emotions, with clear implications for the observation of higher psychopathology occurrence in urban centers (Peen, Schoevers, Beekman, & Dekker, 2010). However, as in the study by Bratman, Daily, et al. (2015), a key limitation of this work is the lack of a reported relationship between DLPFC activation and a behavioral index of emotion regulation, which limits what inferences can be drawn. Likewise, a recent EEG study found differences between viewing nature and urban images in several event-related components and alpha power density, which are thought to relate to attentional processing (Grassini et al., 2019). However, this study also failed to relate the electrophysiological results to any performance changes on the cognitive task. Future research is therefore needed to draw stronger conclusions about the interactions between exposure to different environments, brain, and behavior.

While important and informative, these studies did not measure neural activity during exposure to nature nor did they relate the neural activity to behavior, and therefore it remains an open question as to how the brain may differentially respond to natural versus urban environments. Doing so is not trivial, though. Ideally,

neuroscience research on the topic would not only measure real-time brain activity during exposure to the environments of interest, but also incorporate behavioral measures with objective (task performance) and subjective (fatigue, perceived restoration, state affect) components, and control for extraneous factors such as aesthetics and preference as in many studies natural environments are confounded with preference, making it difficult to attribute the results to the environment (nature vs. urban) or to preference (simply being exposed to an environment that is more preferred independent of its naturalness; Meidenbauer, Stenfors, Bratman, et al., 2020; Meidenbauer et al., 2019). For example, one approach would be to conduct an EEG or fMRI study which includes an attention-demanding task both before and after exposure to simulated nature and urban environments (using pictures, sounds, videos, VR, etc.) which are equated on aesthetic preference, as well as gathering data on self-reported affect, perceived restoration, or other factors of interest at various points of the study. By examining neural dynamics during nature compared to urban exposure, one could examine patterns of activity linked to reduced cognitive effort, such as the scale-free or fractal state alluded to previously (Churchill et al., 2015, 2016; Kardan et al., 2020), or activation across functional groups of limbic and cortical regions implicated in affective processing (Kober et al., 2008; Lindquist, Satpute, Wager, Weber, & Barrett, 2016).

Still, it should be noted that for all the insight which would be gleaned from lab-based neuroscience experimentation involving virtual nature, analyzing brain function during exposure to real natural environments is still necessary. One approach is to use EEG in naturalistic environments. A recent study examining the effects of nature on children's cognitive functioning collected EEG recordings while children performed attention-demanding tasks in both an outdoor nature and indoor environment. This study found several behavioral and event-related component markers of improved attention in the outdoor setting (Torquati, Schutte, & Kiat, 2017). Though this study had a relatively small sample, it is an encouraging demonstration of how neuroimaging may be used in ecologically valid settings.

Additionally, though fMRI benefits from precise spatial resolution of the whole full brain, studies using this technique are limited to virtual nature stimulation such as sounds, images, or videos. Importantly, research using a method that is also related to blood oxygenation similar to fMRI, functional near-infrared spectroscopy (fNIRS) is gaining traction in cognitive neuroscience research and provides a unique opportunity for the measurement of brain function in naturalistic settings (Yücel, Selb, Huppert, Franceschini, & Boas, 2017). fNIRS uses light spectroscopy to measure metabolic activity associated with activation in neural cortex and has impressive tolerance to motion artifacts and environmental noise (Pinti et al., 2020). This advantage of fNIRS, in particular, engenders the possibility of real-time neural measurement as participants interact with actual nature or urban environments. As both fMRI and fNIRS measure changes in the brain's hemodynamic response—with one limited to virtual nature but allowing for detailed neural activation patterns and the other allowing for ambulatory studies in naturalistic environments with decreased precision—conducting research with both methods has the potential to provide a

more comprehensive understanding of how the brain responds to natural environments.

In summary, neuroscience research could be vital in generating mechanistic explanations for many of nature's observed benefits and offers the possibility to disentangle the mechanisms that drive the psychological benefits, and broader health benefits, observed after interactions with nature. With the advancement of mobile neuroimaging technology such as fNIRS, and the combination of these methods with experience sampling (Tost et al., 2019) or longitudinal designs (Dadvand et al., 2018), understanding how nature exposure impacts neural functioning can be explored well beyond meso-scale laboratory experimentation.

4.5 Implications for Other Fields

4.5.1 Urban Planning and Design

Many of the implications of this environmental neuroscience approach to understanding how and why nature is beneficial is to actually alter the built environment to incorporate more natural features to improve psychological functioning. This of course is just a narrow benefit as incorporating more nature into urban areas is not just beneficial for humans, but also for many other species and for the planet in general. Bratman and colleagues described nature's benefits from an ecosystem services perspective, which includes the many contributions of nature to quality of life such as water purification, provision of food, stabilization of climate, and protection from flooding (Bratman et al., 2019). Bratman and colleagues argue, based on the extant literature, that another ecosystem service that nature provides is to directly improve human psychological well-being and mental health (Bratman et al., 2019). This means that urban planners and designers should not only build in nature in urban settings for the more traditional ecosystem services, but also for these psychological benefits. However, this might also require additional support from environmental neuroscientists, who can help to understand and determine what are the features of nature that lead to these benefits in order to design environments in optimal ways (Berman, Kardan, et al., 2019; Berman, Stier, & Akcelik, 2019; Bratman et al., 2019). For example, it is not entirely clear what types of nature, interaction form, or dose are required to obtain these benefits (Bratman et al., 2019).

It is also not entirely clear for some benefits if the nature interaction needs to involve actual nature at all. For example, architects and designers have theorized for a while that built spaces which mimic naturalistic forms and patterns may elicit positive psychological responses (Alexander, 2002; Kellert, 2005). Recent work from our lab has shown that individuals "see" nature in completely built spaces (e.g., building facades and building interiors) if those spaces have features that mimic natural patterns such as having high curved edge density, fractalness, complexity, and scaling (Coburn et al., 2019). In fact, these more "natural" architectural designs

are also more preferred by participants (Coburn et al., 2019), suggesting that some psychological benefits may be conferred from completely built spaces that contain no actual nature. This is not to say that architecturally built spaces can replace actual nature. This would be folly for both humans and for the millions of other species with whom we share this planet. However, it is important for researchers to understand what effects are specific to real nature and why, and what effects may be conferred by stimuli that may mimic certain features of nature. This type of understanding should lead to a physical environment that is better designed for psychological functioning. It is also possible that determining what features of nature lead to which benefits may require neuroscientific evidence for how humans process natural environment stimulation.

4.5.2 Conservation

This chapter has focused almost exclusively on how interacting with nature can improve human psychological functioning and why nature may lead to such benefits. Humans and other species are in trouble, though, if we do not make attempts to protect and conserve the nature that currently exists. Understanding how and when humans act in more environmentally friendly ways is an important area of research for an environmental neuroscience approach.

Some researchers have shown that after a positive interaction with nature, people do become more environmentally friendly (Zelenski, Dopko, & Capaldi, 2015). Importantly, the link between nature exposure and pro-environmental behaviors seems to rely heavily on whether an individual feels strongly about his or her connectedness to the natural world (Mayer & Frantz, 2004; Nisbet, Zelenski, & Murphy, 2009). This is true for stable, trait-level tendencies, as demonstrated by the high correlation between scales measuring connectedness to nature and self-reported engagement in sustainable behaviors (Diessner, Genthôs, Praest, & Pohling, 2018; Geng, Xu, Ye, Zhou, & Zhou, 2015; Nisbet et al., 2009). However, these individual differences also impact the efficacy of nature exposure in encouraging pro-environmental behaviors. Studies of adults and children have demonstrated that the relationship between exposure to natural environments and pro-environmental behaviors was influenced by individuals' connectedness to nature (Otto & Pensini, 2017; Rosa, Profice, & Collado, 2018). In one recent study, only participants with high implicit connectedness to nature increased their donation to environmental protection organizations after viewing a nature documentary (Arendt & Matthes, 2016).

Additionally, if acting in more environmentally conscious ways takes more self-control, requiring delay of gratification, we might expect that interactions with nature might increase due to self-control and delay of gratification both utilizing directed attention resources that would be improved after nature interactions (Faber Taylor et al., 2002; Kaplan & Berman, 2010). This latter possibility requires

substantial further investigation, but provides a second, complementary account of how nature exposure might have a positive influence on environmental behaviors.

More generally, there is a growing literature on this topic for how willing people are to believe that climate change is occurring, that human activity contributes to climate change, and the importance of protecting our natural environment. These topics range from how scientifically skeptical people are (Lewandowsky et al., 2014) to whether human moral judgments systems are equipped to deal with complex and large-scale problems such as environmental conservation and climate change (Markowitz & Shariff, 2012). In all, motivating people to value nature and protect it may take a lot more than simply having people interact with nature on a regular basis, though simply doing that may have some positive benefits on its own.

4.6 Conclusion

Enormous progress has been made in identifying the many ways in which interacting with natural environments can improve psychological functioning and also determining the strength of the effects. We believe that a next step in this field of research will be to understand more deeply why interacting with nature leads to these benefits. Taking an environmental neuroscience approach to this area of research may be fruitful in uncovering the multi-scale nature of these effects, from viewing photos of nature, to living next to a forest preserve. A thorough understanding of these effects could lead to transformations in the design of the built environment to improve human psychological functioning.

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Chapter 5
Restoration in Nature: Beyond the Conventional Narrative

Terry Hartig

5.1 Introduction

Consider first a broad context for this work: Many people today express alarm at the loss of possibilities for experiencing nature. Their alarm reflects beliefs that the experiences they and their children have in nature contribute to their health. Yet, arguments based on such beliefs have often failed to stop the construction of housing, hospitals, streets, and other structures that serve wants and needs aside from contact with nature. Populations will continue to grow and concentrate in urban areas over the coming decades (United Nations, 2019), and this will drive further loss of possibilities for experiencing nature insofar as other wants and needs continue to receive higher priorities.[1]

As a counterweight to this trend, research has arguably made it more difficult to disregard arguments for protecting natural settings as public health resources. Many epidemiological studies have found more green space near an urban residence to be associated with societally significant outcomes like less psychological distress (Astell-Burt, Feng, & Kolt, 2013), better cognitive development (Dadvand et al., 2015), and lower risk of future psychiatric disorders (Engemann et al., 2019). Other studies have described similarly salutary values of living near and visiting seashores and other blue spaces (Wheeler, White, Stahl-Timmins, & Depledge, 2012; White et al., 2010, 2019; White, Alcock, Wheeler, & Depledge, 2013). Such findings encourage efforts to ensure ample possibilities for contact with nature while trying to satisfy other wants and needs (Coutts, 2016; Lee, Williams, Sargent, Williams, & Johnson, 2015; Lindal & Hartig, 2015). The epidemiological research thus supports an integrated approach to societal sustainability that addresses its psychological, social, and cultural aspects together with its ecological aspects (Griggs et al., 2013; United Nations, 2015).[2]

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_5

Other research has shed light on the processes that could engender nature-health associations. In line with long-standing ideas in public health, early studies in environmental psychology (Kaplan, 1973; Ulrich, 1979), human geography (Appleton, 1975/1996), outdoor recreation (Driver & Knopf, 1976), and other fields helped to lay the foundations for understanding how nature experience can prove beneficial. Guided by the theories that subsequently coalesced, many experiments have shown that visits to parks and other seemingly natural settings can counter maladaptive rumination (Bratman, Hamilton, Hahn, Daily, & Gross, 2015), reduce anger and sadness (Bowler, Buyung-Ali, Knight, & Pullin, 2010), improve working memory and cognitive flexibility (Stevenson, Schilhab, & Bentsen, 2018), and produce other short-term benefits to a greater degree than ordinary outdoor built settings in an urban context. Such experimental evidence regarding the plausibility of causal mechanisms has encouraged the assumption that repeated contacts with nature cumulatively engender significant health benefits. That assumption motivates much of the research and practice in the area (cf. Hartig, 2007a).

In this chapter, I will build on traditions of inquiry within environmental psychology and allied disciplines to consider processes by which nature experience engenders health benefits. I start from a particular perspective on adaptation as a superordinate process joining people and the environment. This perspective focuses on one aspect of adaptation: the restoration of depleted adaptive resources. The restoration perspective is well represented in research on nature and health, and for good reason. Restoration has long stood out as an important theme in motives for visits to natural areas (Home, Hunziker, & Bauer, 2012; Knopf, 1983, 1987). In keeping with that motivational theme, forms of restoration are focal concerns for two seminal theories about psychological processes through which people benefit from nature experience (Kaplan & Kaplan, 1989; Ulrich, 1983). Ample evidence has affirmed that restoration constitutes a pathway from nature experience to health (Hartig, Mitchell, de Vries, & Frumkin, 2014; Health Council of the Netherlands, 2004). Accumulating evidence also points to ways in which expected and realized restoration work together with other pathways between nature and health, including physical activity (Mitchell, 2013; Pretty, Peacock, Sellens, & Griffin, 2005; Staats, Kieviet, & Hartig, 2003) and neighborhood social cohesion (Dzhambov, Hartig, Markevych, Tilov, & Dimitrova, 2018; Kuo, Sullivan, Coley, & Brunson, 1998). In brief, the restoration perspective has fundamental relevance for nature-and-health studies.

Yet, despite this fundamental relevance, much of the potential of the restoration perspective remains unrecognized. To help remedy this neglect, in this chapter I will indicate additional ways to draw from it as a source of insight for theory and empirical research. In the following, I first set out the basic premises of the restoration perspective and consider how it has come to have particular relevance for understanding the benefits of nature experience. I then consider research that has approached restoration as a set of processes through which nature experience can engender health benefits. In doing so, I focus on some of the main components of what has become a conventional theoretical narrative about restorative effects of nature experience, organized in a general framework for restorative environments

theory. Extending the general framework, I then put forward two additional theories. These call attention to the restoration of resources as held within closer relationships and as held collectively by members of a population. In closing, I consider ways to work with the general framework and further develop the narrative about nature, restoration, and health, with a view to implications for nature preservation efforts, urban planning, health promotion strategies, and ways of thinking about human–nature relations.

5.2 The Restoration Perspective: Basic Premises and Particular Relevance

The ability of individuals to successfully adapt in the face of environmental demands has long been a major concern in environmental psychology and allied disciplines. Grounded in evolutionary thought, this concern for behavior motivated by the goal of individual survival is central to those areas of research within what Saegert and Winkel (1990) refer to as the adaptive paradigm. Those research areas can be conveniently framed in terms of stress, coping, and restoration. They complement each other; they deal with necessarily related aspects of adaptation, but they differ in their focus. Research on stress has focused on the environmental demands that challenge adaptation and the physiological, psychological, and social consequences of efforts to face those demands (Evans & Cohen, 1987). Research on coping has focused on the physiological, psychological, and social resources people draw upon to meet environmental demands, and on the different strategies they apply when doing so (Lazarus & Folkman, 1984). Research on restoration has focused on processes by which people restore psychophysiological and cognitive resources that they have depleted while contending with demands, and on components of environmental experience that support the restoration of depleted resources (Kaplan & Kaplan, 1989; Ulrich, 1983).

Each of these three areas of inquiry builds on a distinctive set of theoretical and practical premises, and each set of premises constitutes a particular perspective on adaptation as a fundamental aspect of human–environment relations (cf. Hartig, 2001). The theoretical premise of the stress perspective is that when people face continuously heavy demands, adaptation can fail, as reflected in poor health (Cohen, Evans, Stokols, & Krantz, 1986; Evans, 1982). The practical premise then refers to ways to prevent that failure through interventions that reduce demands. In contrast, the theoretical premise of the coping perspective is that people can meet even heavy demands over long periods if they have sufficient physical, psychological, social, and material resources (Antonovsky, 1979; Lazarus & Folkman, 1984). The practical premise then refers to ways to help people more easily maintain adaptation by making resources more readily available to them or by helping them to make better use of those resources already available. In turn, the theoretical premise of the restoration perspective acknowledges that people can have ample protection from

unavoidable demands as well as ample coping resources, and yet still need periodic restoration, particularly insofar as the resources held by or between individuals commonly get depleted in the course of everyday activities (Hartig, 2004, 2017). The practical premise then refers to ways to enhance opportunities for people to restore depleted resources more easily, quickly, and completely. The different premises are summarized in Table 5.1 (cf. Hartig, 2008; Hartig, Bringslimark, & Patil, 2008; Von Lindern, Lymeus, & Hartig, 2017).

Human culture has deep roots in each of these three perspectives on adaptation, exemplified by the ways in which hominid apes organize their nest building activities to serve basic needs for sustenance, safety, sleep, social connection, and sanitation (James, 2010). These cultural roots have profound implications for the present discussion of restoration through nature experience; as part of human evolution, conceptions of "nature" and what is "natural" have evolved in relation to artificial features of the environment that resulted from efforts guided by one or more of the three perspectives (cf. Hartig & Evans, 1993). Across many millennia, people have taken myriad steps to protect themselves from environmental demands, to gain access to resources for coping, to better use available resources, to create new resources, and to preserve, create, and enhance opportunities for restoration. In doing so, they have developed increasingly complex technologies for housing, food production, sanitation, transportation, communication, recreation, health care, and so forth to serve their needs and wants. Those needs and wants have grown and complexified in tandem with growth in populations and the articulation of societies. In many societies, as more people could better satisfy their needs and wants in emerging urban contexts, and fewer stayed in rural contexts to secure food and materials for the population, much of what now gets viewed as "nature" came to be regarded less as the environmental settings in which to perform work and more as settings that support recreational and restorative activities (cf. Mercer, 1976). Within these long-running processes of population growth, socio-technical development, rural–urban migration, *et cetera*, popular conceptions of "nature" got shaped in opposition to conceptions of the "urban" that for more and more people encompassed conditions of everyday life that led them to need restoration, such as work in harsh settings and noise and crowding on busy streets (cf. Hartig, 1993).

With this coarse sketch, I do not mean to assert that such a conceptual opposition between the natural and the urban is somehow a complete description of actual circumstances, applicable to all areas identified as natural or urban across all scales

Table 5.1 Three complementary perspectives on adaptation as a superordinate process joining people and the environment

	Stress perspective	Coping perspective	Restoration perspective
Theoretical premise	Heavy demands can undermine adaptation	Readily available resources support adaptation	Adaptation requires periodic restoration
Practical premise	Interventions can eliminate or mitigate demands	Interventions can enhance the availability of resources	Interventions can enhance opportunities for restoration

and societal contexts. An urban area is after all situated within the natural environment considered on some scale, with sun above, sky around, soil below, water running through in various ways, and diverse non-human species going about their business, day and night. Moreover, humans in cities reproduce and perpetuate other natural processes as do other species in habitat they have selected and shaped.

Further, I do not mean to assert that a conceptual opposition of the natural and the urban maps perfectly onto experiences of restoration and stress. The natural environment continues to impose demands, some terrible, as with tornadoes and catastrophic earthquakes (that can reach into the largest urban areas), and some minor, as with irritating mosquitoes (that can disturb the peace found in an otherwise pleasant park). And for their part, towns and cities offer many possibilities for restorative experiences aside from those afforded by their green spaces, as in comfortable homes (Hartig, 2012), pleasant cafes (Staats, Jahncke, Herzog, & Hartig, 2016), and museums (Kaplan, Bardwell, & Slakter, 1993).

Rather, in sketching the evolution of this conceptual opposition of the natural and the urban, I want to shed light on reasons why the restoration perspective has come to have particular relevance for understanding salutary values attached to contemporary nature experience. Put simply, its relevance owes in large part to the probabilities of people having particular kinds of experiences in particular activities in particular settings at particular times. The "nature" of concern in such situations is not only some set of objectively measurable biological, physical, visual, or other attributes of the environment that might have effects on functioning and health understandable entirely in isolation from other aspects of the circumstances in which people live. Rather, the ways in which this "nature" figures in human functioning and health need consideration in light of the broader social ecology in which its various positively and negatively evaluated attributes contrast with those of other settings within and across which individuals, groups and populations have organized their activities and distribute their time (cf. Hartig, Johansson, & Kylin, 2003; Heft & Kyttä, 2006; von Lindern, 2015). The various settings in such a social ecological system are more or less likely to support particular activities and experiences, and they accordingly acquire meanings, individual and shared, that reflect on the activities and experiences they normally and predictably support. Differences in meanings emerge as people move among settings, in keeping with changing needs, imperatives, and goals. Patterns of movement and related meanings get reinforced and shaped, often intentionally, as through advertising for different recreational activities and the locations for them (e.g., Mercer, 1976). With the concentration of growing populations and their productive activity in urban areas, an increasingly prevalent pattern of movement involves leaving the built settings where the ordinary demands of life are situated for seemingly natural settings where people can gain distance from everyday tasks and worries, engage with positive aspects and affordances of the environment, and so satisfy needs for restoration. This pattern of movement can manifest on multiple spatial, temporal, and social scales, reflecting the restoration needs involved and the opportunities available, as with a solitary person walking in a near-home park after a trying day at work, or a couple spending a day at the beach after missing each other during the work week, or related families

regularly coming together from distant parts of a country to enjoy preferred activities in a national park during their annual summer vacations. As with meanings attached to "nature" and "urban" of themselves, labels and meanings get attached to the patterns of movement that link them and the time spent within them; witness expressions like "getting out of town for the weekend" and "going on vacation" (see Löfgren, 1999). Thus, as part of a sociocultural evolutionary process that has involved change in the likelihood of activities and experiences tied to particular settings and of movements between particular settings, conceptions of "nature" have increasingly become linked with restoration motives, memories, and meanings while conceptions of the "urban" have gotten grounded in the demands that increasing numbers of people face in their everyday lives.[3]

This account of the particular relevance of the restoration perspective for nature-and-health studies aligns the concerns of the adaptive paradigm with concerns of the two other research paradigms within which it is nested, as described by Saegert and Winkel (1990). Inquiry within the opportunity structure paradigm seeks to understand recurring patterns of behavior within and across settings that have spatio-physical, temporal, and social characteristics suited to programs of activities that serve the pursuit of particular needs and goals. Inquiry within the sociocultural paradigm addresses the individual as a social agent who can read, create, and contest meanings in the environment, and it approaches the challenge of survival "not as an individual concern [as in the adaptive paradigm], but as a problem for the social structure within which the individual is embedded, whether it be family, neighborhood, nation or even world society" (p. 457). Although Saegert and Winkel focus on environmental psychology in their account, they make clear that the three paradigms do not lie wholly within environmental psychology, but rather encompass areas of research activity that it shares with other disciplines, including anthropology, geography, gerontology, history, and sociology. Reaching across the different research paradigms and across disciplines, I assume that a person's or group's experience of some environmental feature or setting taken to be natural occurs within a particular historical, societal, and cultural context, as do the physiological, psychological, interpersonal, and social processes carried along in their experience and the various consequences generated by those processes, including cumulative health benefits. As knowledge of those processes and their consequences gets more widely disseminated, it shapes the expectations and behaviors of others in the same and subsequent generations, carrying the sociocultural evolutionary process further.[4]

5.3 Restorative Benefits of Nature Experience: The Conventional Theoretical Narrative

I have argued that the restoration perspective has particular relevance for understanding the salutary values of nature experience. This relevance increasingly gets "built in," as an emergent and still evolving conceptual distinction between built/urban and natural settings increasingly gets linked probabilistically with

experiences of depletion versus restoration, concomitant to the concentration of populations and productive activities in urban areas. For more and more people, "nature" has become an environmental setting or context into which they might move to restore resources after facing their ordinary demands in relatively built urban settings. However, although escape from mundane stressors in search of restoration has long been recognized as an important theme among motivations for visits to natural areas (e.g., Knopf, 1983, 1987; Mercer, 1976; Olmsted, 1870), the broader health implications of restoration through nature experience remained little studied until relatively recently.

A major impetus to intensified study came with the development and dissemination of two theories that proposed psychological mechanisms by which nature experience can engender restorative benefits: Stephen and Rachel Kaplan's attention restoration theory and Roger Ulrich's psycho-evolutionary theory. Their development can be traced through publications by their respective authors from the 1970s onward (e.g., Kaplan, 1973, 1978, 1983, 1995; Kaplan & Kaplan, 1982, 1989; Ulrich, 1977, 1979, 1981, 1983, 1993; Ulrich et al., 1991). Psycho-evolutionary theory conventionally gets referred to as stress recovery theory or stress reduction theory, and I will use the acronym SRT to reflect these naming conventions, which identify the restorative process itself, as with attention restoration theory (ART). Separately or together, SRT and ART inspired early true and quasi-experimental studies which found that outdoor environments and environmental imagery with prominent trees, vegetation, and other seemingly natural features appeared to better serve restoration than outdoor environments and environmental imagery dominated by buildings, streets, car traffic, and other urban features. Some of the benefits, like better proofreading performance, better inhibition of Necker Cube pattern reversals, and better serial recall were taken as evidence of attention restoration (e.g., Hartig, Mang, & Evans, 1991; Kuo & Sullivan, 2001; Tennessen & Cimprich, 1995). Other benefits, like reduced fear, anger, and systolic blood pressure were taken as evidence of stress recovery (Ulrich, 1979, 1981; Ulrich et al., 1991). Findings regarding the emergence and then dissipation or persistence of such effects during and after time in a natural setting reflected on the possibility that stress recovery and attention restoration could run together (Hartig, Evans, Jamner, Davis, & Gärling, 2003; cf. Ulrich et al., 1991). Such early evidence regarding the operation of plausible causal mechanisms provided support for the first large-scale epidemiological studies to uncover associations between the amount of residential green space and health outcomes (de Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg, 2006; Mitchell & Popham, 2007, 2008). These studies could take their findings to reflect, at least in part, on cumulative benefits of repeated restorative experiences.

Aside from this background, I do not intend to say more here about the historical development of research on nature and health (see Hartig et al., 2011) or the now extensive epidemiological literature on health values of urban green space and other settings for contact with nature (for reviews, see e.g., Frumkin et al., 2017; Gascon et al., 2016; Kabisch, van den Bosch, & Lafortezza, 2017; Markevych et al., 2017; Rojas-Rueda, Nieuwenhuijsen, Gascon, Perez-Leon, & Mudu, 2019; for reviews of

reviews, see Hartig et al., 2014; van den Bosch & Ode Sang, 2017). Instead, I will discuss the narrative about restorative effects of nature experience built around ART and SRT. I first explain why I refer to it as the conventional narrative, and why it has many variants. I then organize some of its components in a general framework for restorative environments theory. This will help to indicate some of the ways in which nature-and-health studies and research on restorative environments can look beyond the conventional narrative to realize more of the potential of the restoration perspective.

5.3.1 Why Refer to a "Conventional Theoretical Narrative"?

To begin with, consider what I mean by "theoretical narrative" here. Scientists can represent "theory" in quite different ways. Some may present a theory as "a comprehensive explanation of some aspect of nature that is supported by a vast body of evidence" (Institute of Medicine, 2008, p. 11). As an example, "the theory of evolution is supported by so many observations and confirming experiments that scientists are confident that the basic components of the theory will not be overturned by new evidence" (p. 11).

This characterization would distinguish a scientific theory as a reliable account of the real world. Not incidentally, reference to "the theory of evolution" in the quotation above could therefore give the impression that scientists have settled on a single formulation; however, many scientists would quickly disavow that impression (as the authors of the quotation above do later in their text). Although scientists agree on the "basic components" of evolutionary theory, like the significance of natural selection, that body of theory encompasses numerous complexities and contrasting formulations concerned with, for example, the sensitivity of different types of biological selective mechanisms to environmental change (e.g., Catalano et al., 2012, 2018; Catalano & Bruckner, 2006; Catalano, Saxton, Gemmill, & Hartig, 2016; Catalano, Zilko, Saxton, & Bruckner, 2010) and related questions about the time needed for populations to adapt biologically to environmental change (for a popular account, see Zuk, 2013). For such reasons, some scientists prefer a definition of theory that differs from the kind of characterization above. Consider the definition offered by the sociologist Hannu Ruonavaara (2018) for a similarly large body of theory also of relevance here:

> *Social theory*: A discourse that consists of a set of linked (a) concepts and (b) propositions to be used for hypothetical (i) redescription, (ii) explanation, and (iii) interpretation of some set of phenomena, relations, and processes (p. 181; italics in original).[5]

Ruonavaara's definition situates the contents of a body of theory within an ongoing discourse or exchange with particular types of actions: redescription, explanation, and interpretation. It thus acknowledges that theory remains fluid and "unsettled" as the discourse continues. It remains open, for example, to influences from other areas of research, and to the influence of observations of change in the phenomena of

interest. Such change can follow with change in the surrounding sociocultural circumstances, for example, those which influence the ways in which people encounter, engage with, understand and value "nature."

Implicitly, this definition allows for the emergence of particular ways of telling about the contents of theory, that is, a narrative about theory that applies some logical structure in presenting its different components and links among them. Whether it focuses on a single formulation (a theory) or multiple contrasting formulations (theories) within a body of theory (e.g., restorative environments theory), the narrative may also include an account of some problem in need of solution. This provides a context for the phenomena of interest and helps to establish the value of theorizing about those phenomena. For example, at the start of this Chapter, I explained that alarm at the loss of possibilities for experiencing nature reflects beliefs that nature experience contributes to health, and that such beliefs have been affirmed by research on health benefits of contact with nature. Many readers will have found this context-setting problem-description familiar; similar ones appear in many other texts on nature and health.

Within restorative environments research, some studies appear to have taken explicit guidance from only one theory. Why then refer to a narrative built around both ART and SRT as "conventional"? I see several reasons to do so. For one, a "two theories" narrative appears in one form or another in many peer-reviewed publications about benefits of nature experience. For example, at the time of writing, two articles, cornerstones of the narrative, have more than 1400 citations each in scientific publications listed in the Web of Science database. With this, they are the first and second most cited articles published in the *Journal of Environmental Psychology* in its now 40-year history (Kaplan, 1995, and Ulrich et al., 1991, respectively). Importantly, where one of the articles gets cited, the other often also gets cited.[6] And here I refer to only two publications; people who engage with the nature-and-restoration topic can base a version of the narrative on more than one publication from the authors of ART and SRT and from others.

Also importantly, many and diverse people convey and shape the conventional narrative. It gets carried along not only by researchers but also by people with whom they might interact within the different communities in which they work and live. Joint representation of the two theories has become a standard feature of textbooks in environmental psychology in multiple languages (e.g., Bell, Green, Fisher, & Baum, 2001; Devlin, 2018; Gifford, 1997; Johansson & Küller, 2005; Steg, van den Berg, & de Groot, 2013). Books in English for an international professional audience (e.g., Cooper Marcus & Barnes, 1999; Coutts, 2016; Nilsson et al., 2011; WHO, 2016) also directly or indirectly invoke ART and SRT in explaining how nature experience can serve health. So too do books for a broader public (e.g., Gerlach-Spriggs, Kaufman, & Warner, 1998; Logan & Selhub, 2012; Louv, 2008; Ottosson & Ottosson, 2006), news articles and opinion pieces that get published on the internet, and communication through other media that have a global reach, as with the film *Natura* by Pascale d'Erm and Bernard Guerrini (2018).

5.3.2 Variations in the Conventional Narrative

What then *is* this conventional narrative? The scientific, professional, and popular literatures include numerous variants. Variations in the presentation of the two theories have occurred and will continue to occur for readily understandable reasons. For one, Ulrich and the Kaplans gave somewhat different accounts of SRT and ART over the years, presumably reflecting new insights and how they read the work of others, reacted to reviewer comments, responded to inputs from students and other colleagues, grappled with their own observations, and so on.[7]

Variations in the conventional narrative have also arisen from the different ways in which other authors have represented ART and SRT. In deciding on what to include in an account and how to include it, authors could have based their choices on a number of considerations. Some would reflect their purposes; simply telling about the outcomes of main concern to the theories requires less elaboration than providing sufficient background to understand the hypotheses they base on the theories and the methods they use to address those hypotheses. Other considerations would include the author's understanding of what Ulrich, the Kaplans, and/or others wrote or said about ART, SRT, and perhaps other theories, as well as their own experiences and structured observations and matters such as the assumed expertise of the intended audience and limits on the amount of text they could write.

Although I see good reasons for variations in the conventional narrative, I do not mean to suggest that any particular variant is acceptable. Some may reflect misunderstandings about the theories. Consider for example an extension of the narrative implied in a report published by the World Health Organization (WHO, 2016). This report gives brief accounts of SRT and ART in setting out restoration as one among other pathways by which urban green space can serve health. It also states that both theories are "based on the biophilia hypothesis, which postulates that humans have an innate need to affiliate with the natural environment within which they have evolved (Wilson, 1984)" (p. 4). Here the report stands in error. Putting aside whether E. O. Wilson's writing on biophilia could have provided a substantive basis for ART and SRT, I note that none of his work was cited in the early articulations of those theories, which were published before his initial essay on biophilia (e.g., Kaplan & Talbot, 1983; Ulrich, 1983). The literature indicates that the authors of ART and SRT had already drawn on other sources in making the evolutionary assumptions underlying their theories (see, for example, the references to work by Ardrey in Kaplan, 1972). To verify this point, I wrote to Rachel Kaplan and Roger Ulrich to ask how much influence Wilson's thinking around biophilia had on the work they did over the years. Both replied that it did not have the influence implied in the WHO report (respective personal communications on January 23 and 27, 2020).

I have used one tiny part of a report to illustrate a problematic elaboration of the conventional narrative that does not correspond to the actual development of the underlying theories. I do not mean to discount the value of the report as a whole. Moreover, I can see how the error could enter. Discussions of the restorative benefits of nature experience now often occur in conjunction with discussions of biophilia,

and the two lines of thought can appear related in several ways. These include similarities in their assumptions about the slow pace of human evolution through natural selection; treatment of what now gets distinguished as the natural environment as the setting of human biological evolution; concomitant treatment of the urban environment as poorly suited for human habitation; links between natural settings and positive experience; and shared concerns for protecting good habitat for non-human species as well as for humans. The erroneous attribution to Wilson's work may simply have followed from the repeated pairing of discussions of biophilia and restorative effects of nature experience, much like the repetition that has made the SRT-ART narrative a conventional one. All of this said, the fact remains: Wilson's thinking on biophilia did not provide the basis for theorizing about restorative effects of nature experience in SRT and ART. Discourse should select against that notion and select for factually correct elaborations on the origins of the two theories. Those who really want to weave biophilia-thinking into the narrative can instead describe how Ulrich's work influenced Wilson's thinking.[8] More generally, as the discourse continues, it can select for or against aspects of the theories as articulated by their authors, and also for or against specifications, clarifications, extensions, and other elaborations offered by others, for the theories, and for the encompassing narrative.

5.3.3 Components of the Conventional Narrative

Where does the conventional narrative stand now? Instead of just presenting another textual account of SRT and ART, I will set some of the main components of ART and SRT into a general framework that supports comparisons between them. This will do more to show ways to extend the narrative with new lines of inquiry and so illuminate the further potential of the restoration perspective as a source of insight on nature-health relations. I will not give detailed accounts of ART and SRT, nor will I evaluate the evidence regarding the validity of claims based on those theories. For those who do not have a variant of the conventional narrative committed to memory, I suggest reading the texts by the authors of the theories (e.g., Kaplan, 1995; Kaplan & Kaplan, 1989; Kaplan & Talbot, 1983; Ulrich, 1983, 1993; Ulrich et al., 1991) as well as the early texts that contrasted the emerging theories (e.g., Hartig et al., 1991; Hartig & Evans, 1993).[9]

Theories encompassed by the restoration perspective have numerous components that can be included in a general framework to aid comparisons. For example, as theories rooted in the adaptive paradigm, they would represent views of the human condition and human–environment relations that emphasize basic matters of survival. They would accordingly make assumptions about human evolution, with regard, for example, to how natural selection works, its operation on particular aspects of human–environment relations (as in the shaping of habitat preferences), its sensitivity to environmental change, and the limits of adaptability to contemporary conditions. Variations in these components of theories about restorative

environments need further attention, but for present purposes I will focus on a smaller set of components, represented by the columns in Table 5.2. These will suffice as starting points for extensions beyond ART and SRT (Hartig, 2004, 2017).

Consider first the resources that could come into play, get depleted, and so need restoration. They take different forms. Psychophysiological resources enable mobilization for action aimed at some demand, whether acute, as when jumping back from a coiled snake, or prolonged, as when working hard to meet a deadline. Cognitive resources include the ability to willfully direct attention to some task at hand while filtering out distractions. These resources are focal concerns of SRT and ART, but they are not the only adaptive resources that might get depleted. Possible new theories about restorative environments could look to other forms of resources, such as the social support a person might receive from family, friends, and acquaintances at home, in the neighborhood, and elsewhere (e.g., Cohen & Syme, 1985).

Consider then the antecedent condition. Because a person depletes various resources in meeting everyday demands, a potential or need for restoration arises regularly. New demands will certainly come along, so the person must secure adequate possibilities for restoration or risk not being able to meet those demands. Insofar as a particular theory focuses on a specific resource or set of resources, it also focuses on the condition of a person who has depleted that resource or set of

Table 5.2 A general framework for theories about restorative environments. *SRT* stress recovery theory, *ART* attention restoration theory

Theory	Resource category	Antecedent condition	Features of P-E transactions that permit restoration	Features of P-E transactions that promote restoration	Outcomes that can reflect on restoration	Treatment of time
SRT	Ability to mobilize for action	Psychophysiological stress	Apparent absence of uncontrollable threat	Perception of natural contents; moderate levels of complexity, gross structure, and other visual stimulus attributes	More positive self-reported affects; lower blood pressure and cortisol levels	Focus on duration
ART	Ability to direct attention	Directed attention fatigue	Being away, compatibility	Fascination, extent, compatibility	Improved performance on standardized tests of cognitive abilities	Focus on duration
Possible	Ability to …	Depleted ability to …	?	?	?	?

resources. This could receive consideration as stress or mental fatigue, as in SRT and ART, or as some other form of depletion defined with regard to some other resource, such as a loss of access to instrumental and emotional forms of social support.

Consider then the environmental requirements of the process through which the depleted resource(s) can be restored. Restoration has two basic requirements in this regard. First, the environment permits restoration. Going there, a person gains distance from the demands that caused the given need for restoration, and when there the person does not face new demands that further tax the same depleted resource. Second, the environment promotes restoration. Some demands are not tied to any one place; a person could feel troubled and ruminate over them almost anywhere, further depleting resources. Insofar as an environment has features and affords activities that draw a person's thoughts away from demands, attracting and holding their attention, the person can better engage with the environment and thus prolong the restorative process(es). This presence of positive features, and not only an absence of negative ones, underlies a basic definition of a "restorative environment" as an environment that promotes, not merely permits, restoration (Hartig, 2004, 2017). Both SRT and ART represent this distinction with their specifications of components of experience though in somewhat different ways. SRT refers to the absence of threat as a permitting feature, one that could also figure in experiences of being away and compatibility as set out in ART; however, the ART concepts encompass more than threats, also including, for example, distance from routine mental contents. With regard to the promotion of faster and more complete recovery, SRT refers to gross structure, moderate depth, moderate complexity, the presence of a focal point, and the survival-serving natural contents a person sees in the environment, which are thought to rapidly evoke positive affect and hold non-vigilant attention, thus blocking negative affect and negative thoughts and so allowing recovery from the physiological arousal characteristic of stress. Some of these features, like gross structure, have commonalities with the bases of the extent construct as defined in ART; greater coherence and scope experienced in the environment can serve to sustain the effortless soft fascination thought to promote rest of the directed attention mechanism. For other resources, and so for other forms of resource depletion, possible theories might augment the descriptions of restorative environments given in SRT and ART and/or specify other kinds of restoration permitting and promoting features. For example, in addition to visually appealing features that would support stress recovery and attention restoration in an individual, the environment might offer distance from the ordinary settings and demands of work and family for both people in a couple, as well as affordances for mutually appreciated activities, including not only the sharing of a restorative interlude while viewing the scenery but also opportunities to have fun, explore, and make discoveries together; to talk about life circumstances; and to share intimacy (for an anecdotal example with links to natural settings, see Pascal, 2016).

Consider then the outcomes. Those measured in experiments anticipate the operation of the presumed causal mechanism during contact with nature versus some comparison condition in a specific situation. For experiments informed by SRT, this

has meant expectations of more positively toned affect, as in increased self-reported happiness and reduced anger, as well as reduced activity in one or more of the bodily systems that had previously mobilized for action (e.g., cardiovascular, endocrine, muscular) (e.g., Ulrich et al., 1991; for reviews, see Bowler et al., 2010; Corazon, Sidenius, Poulsen, Gramkow, & Stigsdotter, 2019). For experiments informed by ART, researchers have expected improved performance on tasks that challenge directed attention and perhaps other aspects of executive cognitive functioning, such as working memory and inhibitory control (e.g., Berman, Jonides, & Kaplan, 2008; Schutte, Torquati, & Beattie, 2017; for reviews, see Ohly et al., 2016; Stevenson et al., 2018; Sullivan & Li, Chap. 2, this volume). Similar expectations hold when the same measures are used in quasi-experiments and observational studies to assess cumulative benefits, as with lower chronic stress seen in patterns of cortisol secretion (e.g., Ward Thompson et al., 2012) or better executive cognition seen in standardized tests (e.g., Taylor, Kuo, & Sullivan, 2002; Dadvand et al., 2015). Taking guidance from SRT and/or ART, clinical studies have tested therapeutic interventions in which patients repeatedly perform some activity in a natural setting, and they have reported outcomes such as improved attentional functioning in breast cancer patients (Cimprich & Ronis, 2003), reduced severity of depression (Gonzalez, Hartig, Patil, Martinsen, & Kirkevold, 2010), and the motivation to change a depleting lifestyle following burnout (Sonntag-Öström et al., 2015). The cumulative effects assumption has also guided large-scale epidemiological studies that have reported better health among those with relatively greater amounts of green space near the residence, as reflected in self-reported health (e.g., Astell-Burt, Mitchell, & Hartig, 2014; de Vries et al., 2003) and the incidence of diverse forms of ill health and causes of mortality (e.g., Engemann et al., 2019; Maas et al., 2009). Several studies have also found that greater self-reported being away and fascination appear to mediate between more greenery or green space in the residential environment and distal outcomes like better self-reported health (e.g., Dahlkvist et al., 2016; Dzhambov et al., 2019). Research guided by other possible theories could similarly look to proximal and distal outcomes and hypothesized mediators as fitting with their concerns for other resources, antecedent conditions, and processes. For example, a study concerned with the renewal of bases for sharing of social support could measure variations in mutual trust and appreciation in relationships with relevant others.

Consider then the matters of time. Of temporal parameters that could be used to characterize a potentially restorative exchange between person and environment, it appears that duration has received the most attention, often reflecting constraints imposed by an experimental research setting (i.e., briefer periods for viewing photographs or other simulations in a laboratory, after Ulrich, 1979, and longer periods for walking in some field setting, after Hartig et al., 1991). Related parameters include the time required for different kinds of effects to emerge, the time that different effects persist, and the time allowed for restoration in relation to the time spent in an activity or activities through which the resource(s) in question became depleted (e.g., Hartig, Evans et al., 2003). These parameters help to describe what happens on a single occasion, within a specific situation defined in terms of a person, activity,

setting, and time. As noted earlier, those working with ART and SRT have from an early stage also attended to the potential significance of cumulative effects of repeated contact with the natural environment, as through window views at home (e.g., Masoudinejad & Hartig, 2020; Tennessen & Cimprich, 1995), at work (e.g., Kaplan, 1993; Shin, 2007), and in health care settings (e.g., Raanaas, Patil, & Hartig, 2012; Ulrich, 1984); however, matters of frequency, periodicity, and the distribution of time across multiple occasions have not received systematic attention. Such matters would presumably also have significance for other possible theories.

For the theories encompassed by the general framework in Table 5.2, the sequence of columns starts from a particular resource, proceeds to depletion of that resource, and then continues on to an environmental experience that could generate outcomes that reflect on restoration as it may have occurred in a given amount of time. The table thus does more than simply outline components of existing and possible theories; it also represents a way of telling about them. The table shows a narrative structure in which the respective components of a theory and the links among them follow in a sequence revealing the particular process. In other words, for each theory the given row reveals a classic plot line, proceeding from equilibrium (resource availability) through imbalance (resource depletion) to a new equilibrium (through restoration) (Robertson, 2017; Todorov, 1969). By tracing a process across the columns, one can recognize how the concerns of the stress and coping perspectives are necessarily bound together with those of the restoration perspective. Thus, as represented in Table 5.2, the structure of the conventional narrative incorporates an inherent logic of the adaptive paradigm and its subordinate perspectives on the efforts of the individual to survive.

5.4 Restorative Benefits of Nature Experience: Extending the General Framework

To this point, I have argued that the restoration perspective has particular "built in" relevance for understanding the salutary values of nature experience, and I have highlighted some of the main components of a conventional theoretical narrative about restorative benefits of nature experience. I organized those components in a general framework, which I also used to point out the possibility of constructing theories concerned with adaptive resources and restorative processes other than those in focus with SRT and ART. To exemplify the utility of the framework in this respect, I began to sketch a theory concerned with the loss of access to social support as an antecedent condition from which an individual might need to restore.

Now, toward extending the conventional narrative, I will build on that example and further elaborate theory concerned with the availability of social support. To do so, I first extend the general framework by adding the level of analysis as a component. This extension enables me to consider two additional theories here, one concerned with restoration of relational resources held between people in closer

relationships and the other concerned with restoration of social resources held collectively in a population. Following the naming conventions applied with SRT and ART, I refer to these two theories as relational restoration theory (RRT) and collective restoration theory (CRT), respectively.

Some of the phenomena addressed by RRT and CRT have already drawn much attention from scholars. I note some of the areas of overlap as I proceed, but in this and other respects more detailed accounts lie outside the scope of this chapter. The accounts I give here nonetheless suffice to identify RRT and CRT as distinct theories and so provide bases for novel research questions and hypotheses not derivable from SRT or ART or from each other. This will help to propel discourse within restorative environments theory, and it can also encourage dialog between restorative environments theory and other bodies of theory. All of this should contribute to a more encompassing narrative about nature experience and health, one that realizes more of the potential of the restoration perspective.

5.4.1 Relational Restoration Theory: Focus on Resources Held Within a Dyad or Small Group

In the account of RRT that follows, I first specify the level of analysis. I then apply the narrative logic used with SRT and ART and treat its respective components in a sequence that represents a process (see Table 5.3).

5.4.1.1 Level of Analysis

In discussing the contents of the general theoretical framework, I have so far only referred to processes on the individual level. However, a theory about the role of the environment in restoration of access to social support cannot be fully articulated only with regard to the person deprived of support; it must also attend to the person or persons who do not provide support and to the circumstances around the failure of the supportive exchange between them. Description of the restorative process must therefore look beyond individuals. RRT focuses on the exchange of instrumental and emotional support in closer relationships, as between civil partners, in a larger family, and among friends, co-workers, and neighbors.

5.4.1.2 Resource

An ability to rely on some close other for some form of support rests on the resources of the person or persons who could provide instrumental and emotional support, including those resources in focus with SRT and ART; however, it cannot be reduced solely to the functional resources that the other person(s) might deploy to provide desired support.

Table 5.3 A general framework for theories about restorative environments, extended with a theory about the role of the environment in the restoration of relational resources. *SRT* stress recovery theory, *ART* attention restoration theory, *RRT* relational restoration theory

Theory	Level of analysis	Resource category	Antecedent condition	Features of P-E transactions that permit restoration	Features of P-E transactions that promote restoration	Outcomes that can reflect on restoration	Treatment of time
SRT	Individual	Ability to mobilize for action	Psychophysiological stress	Perceived absence of threat	Perception of natural contents; moderate levels of complexity, gross structure, and other visual stimulus attributes	More positive self-reported affects; lower blood pressure and cortisol levels	Focus on duration
ART	Individual	Ability to direct attention	Directed attention fatigue	Being away, compatibility	Fascination, extent, compatibility	Improved performance on standardized tests of cognitive abilities	Focus on duration
RRT	Dyad or small group	Ability to rely on each other for support	Strained or weakened relationship (singular)	Arrangements for supportive exchange that enable distancing from demands	Arrangements for supportive exchange that enhance engagement with the setting; amplification of engagement through sharing of experience	Greater marital stability or satisfaction; greater work group cohesion	Focus on duration of time spent together and apart across situations

An ability to rely on some close other for support also rests on the arrangements that enable them to exchange support. These often follow from deliberate and extensive measures, such as a choice of a residential location, made with the expectation that diverse forms of supportive exchange will continue over an indefinitely long period and across many situations requiring cooperation and coordination. I refer to these as standing arrangements.

Perhaps most fundamentally, though, an ability to rely on some close other for support rests on aspects of the relationship between them. RRT focuses on interpersonal aspects such as trust; love; respect; common interests; mutual understanding; tolerance of the other's peculiarities; shared goals, hopes, and mutually reinforced optimism about the future; a shared commitment to another significant person or to an ideal, group, or organization; and a positive valuation of a shared history and of rituals and traditions held within the relationship. Some of these interpersonal aspects, like love and shared goals, may characterize only a few close relationships, while others, like trust and common interest, will also figure to some degree in relationships in the public realm, as between people who frequently meet while walking their dogs in a local park (e.g., Foa, 1971; Henning & Lieberg, 1996; Lofland, 1998).

I refer to these interpersonal aspects of relationships as relational resources; they do not exist in one person alone, independent of the other(s) (cf., Cordelli, 2015; Hartig, Catalano, Ong, & Syme, 2013). As a constituent of any closer relationship, they provide a basis for action by those involved, enabling and motivating the exchange of individual resources, including material as well as personal functional resources. The relational resources also provide a basis for individual and joint action in the completion of their respective personal projects as well as their joint projects and in meeting the role obligations and other demands faced by one or more of them. People commonly establish relational resources progressively, with one, like love, following from the presence of others, such as attraction and trust (cf. Altman, Vinsel, & Brown, 1981). Sustained, reciprocal exchange of support can therefore progressively deepen a pool that comprises multiple relational resources. In a relationship or a set of relationships with a deep pool of relational resources, as in many families and long-established work teams, those involved can hold strong expectations about reliable and sustained provision of that support which the other(s) actually can provide within the available arrangements for exchange.[10]

5.4.1.3 Antecedent Condition of Resource Depletion

In a given situation, one person may fail to get support from another for reasons related to any of the constituents of the ability to rely on another for support. Stress or fatigue may have undermined the other's capacity to provide support. Their arrangements for supportive exchange may have weaknesses, perhaps related to problems in movement between the settings and social roles specific to their family, work, and other life domains (cf. Chatterjee et al., 2020; Novaco, Stokols, & Milanesi, 1990). One person may be unwilling to help because some key relational resource has become depleted, as with a loss of trust; a loss of love; recurrent

unjustified failures in reciprocity; a loss of mutual commitment; diminished tolerance of the other's peculiarities; and/or abandonment of shared goals (cf. Buunk & Schaufeli, 1999; Lewicki & Bunker, 1995).

Although the supportive exchange in a given situation might fail for reasons specific to any one of the constituents of the ability to rely on another for support, some people must contend with stable circumstances in which problems with all three of the constituents cascade across situations that recur regularly in their multiple life domains. They struggle to fit restoration pieces into their "life puzzle" as they try to cope with unrelenting and conflicting demands from their own and others' activities across the settings and social roles of their different life domains. Time pressure, stress, and fatigue become chronic; their emotional well-being suffers; and their relationships get neglected and possibly strained (cf. Schulte, 2014).

When stable circumstances regularly generate situations that wear on the people involved, their relational resources can come to have superordinate significance in their ability to rely on others for support. Those who share a deep pool of relational resources commonly work together to resolve problems related to their standing arrangements for exchange. If possible, they change those arrangements, even when difficult, for example, by moving their residence. If they cannot make better arrangements, they may accommodate the negative consequences as part of their ongoing coping process, even though doing so wears upon them (e.g., Repetti & Wood, 1997; cf. Whitchurch & Constantine, 1993). They may do so with tolerance and sympathy if they know that the problems faced reflect on stable circumstances beyond the control of the person or persons in question (e.g., systemic racism; socioeconomic disadvantage).

RRT thus recognizes that people develop, deploy, and deplete their individual and relational resources in a complex set of arrangements and stable circumstances that have interpersonal, spatio-physical, temporal, and social aspects. In this, RRT has particular concern for depleted relational resources, assuming they have superordinate significance for an ability to rely on some close other(s) for support across situations that arise within the arrangements made for supportive exchange. Looking to the possibility for restoration, RRT assumes that the pool of relational resources has become depleted but not emptied. Relations between those involved have become weakened or strained; they want to bolster them and ease the strain; and they can take action toward that end, including changing their arrangements for exchange.[11]

5.4.1.4 Features of Transactions with the Environment That Serve Restoration

RRT recognizes that much as the stress and mental fatigue of the individuals involved can play a role in depleting relational resources, so can restorative person–environment transactions like those described in SRT and ART also play a role in relational restoration. Conversely, it recognizes that much as weakened or strained relations can exacerbate stress and mental fatigue, so can transactions between

people that ease strain in their relations also play a role in their respective personal restorative processes. Accordingly, RRT complements the individual-level theories about restorative environments by situating restorative person–environment transactions within the ongoing supportive exchange between the people involved.

To do this, RRT first explains how arrangements for supportive exchange can work *across* situations to shape what happens *within* a specific situation in which restoration might occur. In outlining that explanation here, I will focus on standing arrangements, although the account also bears on *ad hoc* supportive exchange. Ideally, standing arrangements help those involved to reduce or prevent needs for restoration; they sensitively accommodate the functional resource limitations of each person involved, their unavoidable personal needs for restoration, and their shared desire to care for their relationship(s) (cf. Clark, 2001). Insofar as their standing arrangements anticipate and provide for their various restoration needs, many of the situations in which restoration occurs will have a routine character; they will occur in particular settings at particular times, as with workday lunches and family dinners, and with particular movements between settings, as with travel home after work, before re-engaging with family responsibilities. When relations between those involved become weakened or strained, one can therefore look to the standing arrangements to see how the routines can be changed to more successfully reduce or prevent personal depletion, provide for personal restoration, and/or support care for relationship(s).

RRT attends to the integral aspects of standing arrangements that bear on how well personal restoration and care for relationships can succeed across situations. One of these integral aspects involves the regulation of social interaction by which an individual, dyad, or small group opens or closes to others (i.e., privacy regulation; Altman, 1975). This process runs continuously, within and across domains, with each person wanting solitude on some occasions and company on others. Within a given domain, the standing arrangements will to varying degrees allow those involved to permit and promote each other's movement into the different settings that are available, alone on some occasions and together on others. Both kinds of movement can bring personal restoration and care for relationships into congruence. Yet, each of those involved may also well know that the satisfaction of personal needs for restoration will in some situations call for togetherness, as when one would not feel safe going alone for a preferred activity in a preferred setting (cf. Staats & Hartig, 2004), and/or when all know that they would enjoy the activity and setting far more with the other(s) present (cf. Caprariello & Reis, 2013; Staats et al., 2016). By enabling any one of them to spend time alone and by offering means to enhance that person's experience while away, or by enabling time together and enhancing each other's experience in that situation, those involved in the standing arrangements can bring satisfaction of their personal restoration needs and care for their relationships into congruence. Conversely, in the way each person gets time alone versus together across situations, satisfaction of personal and relational needs can come into conflict. The manner in which standing arrangements serve privacy regulation thus bears on their success in satisfying needs for personal restoration and care for relationships within the given domain.[12]

Reciprocity is a second integral aspect of standing arrangements that bears on the success or failure of personal restoration and care for relationships across situations. Standing arrangements rest on reciprocity; those involved will assume some responsibility to provide support just as they form expectations about receiving support (Gouldner, 1960). As indicated earlier, standing arrangements also assume that those involved will develop some sensitivity and responsiveness to the restoration needs of the other(s), so that over time they come to know about each other's ability or inability to provide support in particular situations. Accordingly, those involved presumably evaluate reciprocity looking to how it holds across multiple situations across time, and not only with a view to immediately successive situations across which one might give and then hope to receive support. Any of those involved could tolerate a failure of reciprocity in a specific situation when it stems from some justifiable inability to provide support (cf. Buunk & Schaufeli, 1999). Insofar as those involved meet reasonable expectations of reciprocity to the extent possible across situations, they can maintain and deepen the pool of relational resources. In contrast, routine unjustifiable failures to reciprocate support will erode the trust, mutual regard, and other relational resources on which those involved have predicated their supportive exchange, making their standing arrangements unstable (cf. Buunk & Schaufeli, 1999; Gouldner, 1960). A persistent lack of reciprocity may prove particularly potent in straining their relationship(s) insofar as it also exacerbates the need for restoration of one or more of the others involved, increasing the burden on the other(s) while also denying them anticipated opportunities for restoration or degrading their restorative quality (cf. Buunk & Schaufeli, 1999; Siegrist, 1996). Conversely, reciprocation of support that involves occasionally forgoing one's own needed restoration to enable that of another in greater need may well deepen the pool of relational resources within the given domain.[13]

A third integral aspect of standing arrangements to mention here involves interdependencies between experiences in different situations. Those interdependencies include far more than a link between some acute need for restoration that arises in one situation and then satisfaction of that need in an immediately following situation, as commonly represented in experimental tests of the restorative effects of different environments (Hartig, 2011). They also involve the dependence of the experience of the present situation on what happened in situations that lie farther back in the past as well as on what will happen in situations in the immediate and perhaps more distant future. Those interdependencies inhere to individual and shared memories of past situations, good or ill, and they inhere to individual and shared anticipation of situations to come, good or ill. They figure in the assessment of reciprocity, with regard to support one has provided and received in the past and support that one expects to give or receive in the future; however, the memories and anticipation that constitute experiential interdependencies between situations need not only concern matters of reciprocity. Memories may, for example, concern what those involved have done previously to create relational resources in a situation that resembles the present one, as with recall of a shared milestone event in a particular setting. Memories may also concern experiences through which a setting has acquired particular value for its service in personal restoration and care for

relationships over repeated situations, as with the home, a favorite pub, or a local park (cf. Cooper Marcus, 1992; Knez, 2014). The expectations grounded in those memories may concern the availability of similar experiences in that setting in the future, as with the use of favorite places for emotion and self-regulation (cf. Korpela, 1989; Korpela et al., 2018; Korpela & Hartig, 1996). These diverse interdependencies can color the experiences that a person, dyad, or small group has across situations encompassed by their standing arrangements in the given domain. Even when seemingly alone in some setting, a person may through their memories and anticipation remain engaged with other people, activities, and settings in ways that enhance or degrade the restorative quality of their experience.

Together, as integral aspects of standing arrangements that reach across situations, privacy regulation, reciprocation, and experiential interdependencies can powerfully shape the personal and relational outcomes that those involved will realize in a specific situation in which restoration might occur. RRT calls attention to the way that many of the situations in which restoration occurs fit within standing arrangements; it recognizes that those situations occur with some regularity, within a pattern that combines particular times, settings, and people who can refer to past and coming situations in ways that influence their present experience. And, of course, RRT recognizes that, across situations, those standing arrangements attend not only to the personal needs of those involved but also to care for relationship(s), including the renewal of relational resources when necessary. RRT thus complements the accounts of restorative individual–environment transactions given by theories like SRT and ART by setting the situations in which they occur into the stream of situations encompassed by standing arrangements.

RRT also complements the individual-level accounts of restorative person–environment transactions by looking at the transactions between people *within* a specific situation entered for restoration. It acknowledges that people often do not go alone to natural and other settings for restoration. Accordingly, it considers how the transactions between them can shape the transactions they have with the environment, and, at the same time, how the transactions they have with the environment can shape the transactions between them.

In this respect, RRT builds on a line of studies initiated by Henk Staats. He noted that, like the search for restoration, being in the company of one's family and friends has long stood out as an important motive for recreational visits to natural areas (e.g., Driver, 1976; Knopf, 1987). To test the joint influence of these two motives, we had participants in an experiment judge the likelihood of restoration with a walk outdoors in a forest of city center (shown in photographic slides), either when alone or with a close friend, and when either mentally fatigued or fresh and alert (as described with scenarios; Staats & Hartig, 2004). Note that although the experiment focused on a specific recreation situation, it assumed the participants' judgments of the likelihood of restoration in the given environment/company condition would reflect their prior experience with the selection of environments for meeting their needs for restoration. In general, the participants indicated they would appreciate having the company of a friend in either of the settings. Of particular interest here, though, are the results we obtained with the ratings of perceived safety also

collected for the four environment × company conditions. We found that greater safety mediated a positive effect of company on the likelihood of restoration, but only for the forest walk. The results also suggested that if safety were guaranteed in the forest, the participants saw a greater likelihood of restoration if alone. These results supported discussion of in situ transactions between two people in terms of what permits and promotes restoration: company may enable restoration in a setting, as by ensuring safety, and it may also enhance or degrade restoration in various ways (see also Johansson, Hartig, & Staats, 2011; Staats, 2012; Staats et al., 2016; Staats, van Gemerden, & Hartig, 2010).

I will not try here to give a systematic account of the different ways in which having company can combine with features of the environment to enable and enhance restorative experience, or conversely deny or degrade it. It will suffice to point out that the concern for the influence of company distinguishes RRT from the theories of the conventional narrative. SRT and ART focus on an individual's transactions with the environment. Those theories do not address transactions among people or their joint transactions with the environment as focal concerns. Yet, person–person transactions and their interplay with person–environment transactions in a given situation may be an important source of individual benefits as well as shared relational benefits. For example, studies of shared attention and shared experience suggest that when two people in a close relationship can enjoy a positively valenced stimulus together (say, eating chocolate or viewing pleasant images), it amplifies the intensity of the pleasure each receives, even in the absence of communication about it (e.g., Boothby, Clark, & Bargh, 2014; Boothby, Smith, Clark, & Bargh, 2017; see also Shteynberg, 2015).

How does this all bear on understanding restoration in nature within a specific situation? Consider a couple walking in an unfamiliar forest on an early summer day. Their experience reflects on interdependencies across many situations that have occurred within their standing arrangements for supportive exchange. For example, their walk there fits within a history of shared recreational activity, and they have memories of many earlier forest walks. They are visiting the specific forest because they both have long wanted to see a particular species of orchid that they have heard blooms in abundance there at that time. They have also heard that the terrain is difficult, but they trust in each other's abilities and know they will be able to manage when they go together. Focus now on the transactions between them and the forest that further permit the restoration they need. They have gotten away from heavy demands at work, and this opens for restoration of their personal resources, as described in SRT and ART. Each thus has more capacity to attend to the other than they would have otherwise. The distance from their paid work demands has additional significance in that those demands have weakened their relationship by preventing needed discussion of some important matters; they need to talk over the possibilities and make some plans. An absence of other people and social strictures in the forest makes it easier to open for their intimate sharing, self-disclosure, and emotional expression. With their energetic and cognitive resources freed up, social constraints relaxed and communication open, they are better able to listen to and understand each other's attempts to make sense of and otherwise reflect on their

shared circumstances. Given that relational restoration gets permitted in these various ways, consider how the transactions the two have with each other and with the forest might also work to promote their restoration. They enjoy the sight and sounds of the birds, the smell of moss and leaves on the forest floor, and finally the discovery of the orchid they had so long wanted to see in the wild. Their ongoing engagement with the forest setting sustains restoration as described in SRT and ART, but their sharing of the experience intensifies their engagement; they enhance each other's experience through expressing their curiosity during the search for the orchid and their delight when they finally can see it together. They renew and reinforce their relationship, resolving undiscussed matters, reaffirming trust in one another, creating some new positive memories, and perhaps seeing new ways to appreciate each other or seeing again sides of each other that they had appreciated before.

This scenario is of course just one out of many that could be used to illustrate how individual and relational restoration processes are intertwined, both through standing arrangements for supportive exchange that run across situations and through the transactions that take place between people while in a specific situation and between those people and the given setting. Speculative and uniformly positive in tone, the scenario is nonetheless plausible; it accords not only with anecdote (Pascal, 2016) but also with findings from different kinds of empirical studies.

5.4.1.5 Outcomes That Reflect on Restoration of Relational Resources

Literature in diverse areas can inform understanding of relational restoration, how it may be intertwined with the restoration of personal functional resources, and how that can occur in natural and other settings. I have already indicated that research has long affirmed that restoration and being together with close others are persistent and important motives for outdoor recreation (e.g., Home et al., 2012; Knopf, 1987), and that people often have company in their outdoor recreation (e.g., Knopf, 1983). Korpela and Staats (2020) reviewed numerous studies speaking to values of solitude versus company while in natural areas, and they relate findings to restorative experience and privacy regulation. Various studies have also shown that movement into a natural setting for recreation can serve family cohesiveness, as through the sharing of pleasant activities and enhanced communication (e.g., Ashbullby, Pahl, Webley, & White, 2013; West, 1986; West & Merriam, 1970). Similar observations have guided practical applications in nature-based therapies for couples (e.g., Burns, 2000) and outdoor program activities that promote the development of relational resources held by parents and children (Davidson & Ewert, 2012). Literature on wilderness programs indicates how they can serve the development of communication and cooperation within groups (Ewert & McAvoy, 2000), and how the experiences they provide can be designed to enlist personal restorative processes in the development of desired social outcomes (Ewert, Overholt, Voight, & Wang, 2011). Holland, Powell, Thomsen, and Monz (2018) reviewed 235 studies of the outcomes of wildland recreation activities such as canoeing, camping, hiking, and

backpacking. They found that large proportions of the studies reported on positive mental restoration outcomes and positive pro-social outcomes like increased family cohesion. Epidemiological studies suggest that a pathway from urban residential green space to mental health goes through the perceived restorative quality of the green space and then neighborhood social cohesion, in serial; treating them as independent mediators obscures the way in which they can work together to promote mental health (Dzhambov et al., 2018; Dzhambov, Browning, Markevych, Hartig, & Lercher, 2020; cf. Kuo et al., 1998).

Yet, research has yet to address the assumptions and claims of RRT as such. In general terms, studies inspired and guided by RRT as a theory about restorative environments can focus on the roles that specific physical and social setting characteristics play in relational restoration, as reflected in change in the pool of relational resources or in a particular relational resource. Much as with research informed by SRT and ART, studies can approach such effects as the proximal outcomes of experience in a specific situation or as distal outcomes of experiences across repeated situations. However, with research informed by RRT, a focus on proximal outcomes calls for consideration not only of the transactions that each individual has with the environment but also of the transactions between them, as well as their joint transactions with the environment. Research focused on distal outcomes calls additionally for consideration of the characteristics of the standing arrangements in which the repeated situations occur, with regard to the ways in which privacy regulation, reciprocation, memories, and expectations work together (cf. Ratcliffe & Korpela, 2016). The relevant outcomes and mediators—for example, qualities of the environment and qualities of the interpersonal transactions—may be observed on the individual level or on the level of the dyad or group. Use of measures on both levels can support examination of how personal and relational restoration intertwine.

The account of RRT given here indicates numerous more specific directions for research. For example, experiments can examine how the person–environment transactions that support restoration in one or more of those involved also ease strain in their relations. Experimenters might, for example, artificially induce tension between two friends recruited as participants while also inducing stress and mental fatigue in each of them (cf. Yang et al., 2020). The experimenters might also assess how sharing the experience of the setting subsequently available for restoration (say, a lush tropical greenhouse versus a windowless room lacking decoration) amplifies or attenuates the positive or negative changes that occur during the recovery period, as assessed with measures of affect, cognition, and physiology. They might further test the hypothesis that a mutually amplified beneficial change in the natural setting in turn evokes assessments of relationship quality showing greater forgiveness in relation to the artificially induced tension between them.

To take another example, intervention studies could compare the effects of changes made in standing arrangements to establish new routines that might better serve personal restoration and care for relationships. This kind of study could draw on behavioral observation methods like those used to study patterns of solo and shared restorative activities in the daily life of families (e.g., Saxbe, Graesch, & Alvik, 2011; Saxbe, Repetti, & Graesch, 2011) or daily diary or survey methods like

those used in studies of recovery from work (e.g., Sonnentag, 2001; Sonnentag & Bayer, 2005). As another example concerned with the standing arrangements, surveys could examine how the members of a family or other group reciprocate in permitting and promoting each other's periodic withdrawal into preferred activities and environments for restoration, and how this relates to their assessments of relational resources like trust, mutual appreciation, and mutual commitment, as well as to distal outcomes such as marital stability.

5.4.1.6 Matters of Time

The shift from the individual to the dyad and small group level of analysis has important implications for the handling of matters of time in RRT. The duration of the encounter with the environment, the time required for effects to emerge, the period over which effects persist, and so forth, remain relevant for studies of what happens in specific situations. However, in that RRT encourages consideration of the specific situation as it occurs within arrangements for supportive exchange, it directs attention to some additional matters. One set of these has to do with the way in which past experience and the anticipated future shape the present experience of those in the specific situation. Another set of matters bears on how much time two or more people can spend together in a given restorative activity in a given setting, or how much time they can spend apart in separate restorative activities in separate settings, before they must go on to other activities and settings, together or alone. When people meet for some restorative activity, their convergence ordinarily implies that they have identified a suitable starting time and a suitable location where they can stay for some period (though not necessarily long enough to do what they want to do). As incorporated in their arrangements for exchange, this kind of convergence bears on the frequency, periodicity, distribution, and duration of restorative interludes within different social constellations and settings, and in turn on the distal personal and relational outcomes that research can assess. Here, then, the concerns of the adaptive paradigm, including the restoration perspective, can again be seen to align with the concerns of the opportunity structure paradigm for patterns of behavior that recur within and across settings with spatio-physical, social, and temporal characteristics.

In extending the scope of concern from restorative processes in individuals to the restoration of depleted relational resources held between people in closer relationships, RRT addresses additional layers of complexity, including the arrangements made for supportive exchange as they shape experience across situations and the transactions between people as they shape experience within situations. The present account of RRT does not address all of this complexity, but it suffices to distinguish RRT from SRT and ART and to provide bases for research questions and hypotheses not derivable from those theories. In doing so, it also identifies a significant limitation of those theories. The account makes apparent that restoration of personal functional resources does not occur in a social vacuum, even when a person is alone in a given setting. And insofar as people do go with others to natural settings for

restoration, theory should try to address the implications of having company for the restoration that they experience (cf. Korpela & Staats, 2020).

I began this account of RRT by adding the level of analysis to the general framework as a component of theories about restorative environments. That addition directed attention to the adaptive resources that people hold within closer relationships, and in turn the consequences of depletion of those resources and the environmental requirements of their restoration, including matters of time. This account of RRT has thus done more than move the theoretical discourse about restorative environments beyond the conventional narrative; it has also served to demonstrate the utility of the general theoretical framework in identifying possibilities for new theory. I will now demonstrate that utility again, moving up another level of analysis.

5.4.2 Collective Restoration Theory: Focus on Social Resources Held Collectively in Communities

Some aspects of relational restoration theory were first presented in a paper that also presented collective restoration theory in embryonic form (Hartig et al., 2013). That account of CRT referred to relational restoration in much the same way that the account of RRT here has referred to stress recovery and attention restoration; it assumed reciprocal influence between resource depletion and restoration processes across the different levels of analysis. I will not attempt a thorough account of CRT here, but I will give enough detail to identify CRT as a distinct theory, concerned with a resource, an antecedent condition of depletion, a restorative process, outcomes and matters of time that cannot be reduced to those described in SRT, ART, and RRT. The theory as sketched thus opens for another set of novel research questions and hypotheses. I again start with the level of analysis and then treat the other components in a sequence that represents a process (see Table 5.4).

5.4.2.1 Level of Analysis

Like individuals, dyads and small groups do not ordinarily exist in isolation. Just as stress or mental fatigue experienced by one person can cause problems for others, as through a diminished capacity to provide expected help, so can weakening of a relationship between two people impose demands on others around them. Conversely, just as benefits from one person's restoration can spread to others, as through a renewed capacity to provide support, so can benefits of relational restoration spread to others around those in the dyad or small group. Given that consequences of individual and relational depletion and restoration can spread to others, an understanding of the implications of that spread calls for research on a broader population level. As units of analysis, populations comprise sets of individuals and groups as well as the many relationships among them. Although their boundaries

Table 5.4 A general framework for theories about restorative environments, further extended with a theory of collective restoration. The framework represents both the necessary relatedness of the stress, coping, and restoration perspectives within the adaptive paradigm (across the columns) as well as the nesting of the adaptive paradigm within the opportunity structure and sociocultural paradigms (down the rows). *SRT* stress recovery theory, *ART* attention restoration theory, *RRT* relational restoration theory, *CRT* collective restoration theory

Theory	Level of analysis	Resource category	Antecedent condition	Features of P-E transactions that permit restoration	Features of P-E transactions that promote restoration	Outcomes that can reflect on restoration	Treatment of time
SRT	Individual	Ability to mobilize for action	Psychophysiological stress	Perceived absence of threat	Perception of natural contents; moderate levels of complexity, gross structure, and other visual stimulus attributes	More positive self-reported affects; lower blood pressure and cortisol levels	Focus on duration
ART	Individual	Ability to direct attention	Directed attention fatigue	Being away, compatibility	Fascination, extent, compatibility	Improved performance on standardized tests of cognitive abilities	Focus on duration
RRT	Dyad or small group	Ability to rely on each other for support	Strained or weakened relationship (singular)	Arrangements for exchange that enable distancing from demands	Arrangements for exchange that enhance engagement with the setting; etc.	Greater marital satisfaction; greater work group cohesion	Focus on duration of time spent together and apart
CRT	Community or population	Ability to rely on (possibly unknown) others for support	Aggregated depletion of individual and shared relational resources	Institutional arrangements that allow relaxation of demands on a large proportion of the community or population	Institutional arrangements for engagement in shared activities; conviviality among those present in public places	Positive emotional contagion and other spread of benefits; greater collective optimism	Focus on social regulation of time for others in diverse social constellations and locations

may be difficult to define, they do have internal coherence. Notably here, the standing arrangements that people in closer relationships can make for their supportive exchange are constrained and facilitated in various ways by the stable circumstances established through customs and laws that regulate the activities of individuals, groups, and organizations within the population. The standing arrangements made by the different groups in that population will therefore show similarities that reflect on the common constraints and possibilities that constitute the stable circumstances under which they live.

5.4.2.2 Resource

Like RRT, CRT refers to the support that people can provide to one another as a resource, and it assumes that the availability of support is predicated in part on relational resources that can become weakened or depleted, such as trust, respect, and optimism about the future. Unlike RRT, CRT extends consideration beyond relational resources held among people in closer relationships. It does not ignore them, but it also looks to resources that can inhere to relationships among people who do not know one another yet still have some common bonds, even if weak, for example, from living in the same community and following similar customs there, reacting to the events that take place there, and performing the duties expected of citizens, such as paying taxes for public services that benefit unknown others in addition to themselves. They may also participate more deliberately with unknown others in activities with some common civic purpose. The social resources to which I refer have been discussed widely, represented with terms like social capital (cf. Coleman, 1988; Putnam, 2000). Their development, deployment, depletion, and maintenance are influenced by social institutions, including mass media (Silverblatt, 2004). In brief, these resources underlie the implicit and explicit cooperation of people known and unknown to one another toward ends thought to serve the population or some substantial segment of it.

5.4.2.3 Antecedent Condition of Resource Depletion

Social resources held broadly or diffusely within a population can get weakened or depleted for various reasons. For example, Putnam (2000) has attributed a weakening of social capital to declining engagement in civic organizations. By his thesis, put simply, civic engagement fosters norms of reciprocity and helps to build trust within a society, so a decline in civic engagement translates into a decline in social trust and a weakening of norms of reciprocity. The reasons he sees for decline in civic engagement resonate in some respects with a concern acknowledged in RRT: stable circumstances on the population level can make it difficult or impossible for some people to establish satisfactory standing arrangements for supportive exchange, thus entailing chronic difficulties in resolving conflicts between demands in different life domains and in getting sufficient time to meet needs for personal

and relational restoration, potentially including time for involvement with activities in the community domain. Another possible reason for weakening or depletion of social resources involves destruction of a shared environment, or features of it, perhaps in connection with displacement, insofar as it undermines important bases for shared place- and community-attachments and identity (cf. Fried, 1963; Hull, Lam, & Vigo, 1994; Knez et al., 2018). One final cause of resource depletion to mention here involves the circumstances and events that shake the public's trust in institutions that they count on to fairly represent public interests and ensure their safety. Murders of political figures, terrorist attacks, and a case of massive loss of life due to a preventable accident have been approached as instances of communal bereavement and found to be associated with adverse population health outcomes, speaking to the way that distress can spread in the population beyond people directly impacted by the events (e.g., Catalano et al., 2016; Catalano & Hartig, 2001; Tsai & Venkataramani, 2015). While writing this chapter, I have witnessed a flood of commentary in the media on how governmental response to the COVID-19 pandemic has boosted or undermined the public's trust in institutions and the political leadership. This kind of commentary makes evident the vital importance of trust in institutions and leaders and the risks to society when that trust weakens.

5.4.2.4 Features of Transactions with the Environment That Serve Restoration

Given depletion of such widely held social resources, CRT takes interest in the process of their restoration. Here, I will focus on the process as it involves the stable circumstances on the population level. Again, these influence the standing arrangements for exchange and so the possibilities that members of the population have for entering settings that support restoration, of their personal and relational resources and of social resources held widely within the population.[14]

CRT takes particular interest in the ways in which the maintenance of these different kinds of resources is permitted and promoted through the provisions made by institutional actors for population access to suitable restorative settings. Those provisions bear on time away from some kinds of work and striving; social norms regarding taking that time; the availability of the settings where people can gather or to which they can disperse during the time available; and the restorative quality of those settings.

Provisions for time away from work have ancient provenance, as with religious holidays like the Judeo-Christian Sabbath. Such holidays may involve proscriptions on particular depleting activities together with prescriptions for activities expected to serve personal, relational, and collective restoration functions, such as sleep, special festive meals, and observance of rituals known to all who practice the religion (e.g., Shulevitz, 2011). When the time away from work gets embedded in a religious practice, social norms of participation may be particularly strong. Weaker norms of taking time off may follow when there is no overarching authority that permits such behavior broadly in a population. For example, Altonji and Oldham (2003) found

that having national vacation legislation did translate into a substantially lower average number of annual hours worked in several European countries when compared to the USA, where national vacation legislation does not exist. Moreover, the quality of the time away may be improved with a social norm that affirms the practice. When away from work, one need not worry that those who remain will express resentment. Lack of such a norm may be one among other possible causes of the nonuse of vacation days (cf. Fakih, 2018; Kuykendall, Craig, Stiksma, & Guarino, 2020).

Religious practices and legislation that bear on working hours, work days per week, public holidays, and vacation practices are of interest in CRT in that they permit large numbers of people within the population to simultaneously take time away from the demands of paid work and other obligations. The duration of the periods opened up by institutional actors for periods of leisure have particular significance. Unless other constraints apply, when greater numbers of people can spend longer periods away from their ordinary individual and shared demands, the number and variety of social constellations in which they might participate will increase, as will the range of depleted resources that might be restored (Hartig et al., 2013).

The provisions for time can better serve a broad range of restoration needs when provisions also have been made for access to a variety of different and yet suitable settings within reach during the time available. Governments and organizations on different levels have long made a variety of settings available for such public use, as through provisions for public parks (e.g., Grundsten, 2009; Muir, 1901/1981; Olmsted, 1870) and road systems that enable people to easily travel to distant parks from their homes in or near cities (Hartig, 2007b). Those provisions have also attended to issues related to the restorative and other qualities of the park experience, as with regard to the control of noise, conflicts between different kinds of recreational activities, the ease of orientation and movement (as with well-marked trails), and safety from dangerous animals (e.g., Johansson et al., 2019; Roggenbuck, Williams, & Watson, 1993). Some of the provisions for restorative quality address problems that arise when provisions for time enable many people to visit a particular setting simultaneously; they restrict access and prevent degradation of the visitor experience by crowding. This recreational carrying capacity issue has long been of particular concern with natural settings, for which people typically show strong preferences for relative solitude (Catton Jr., 1983).

Yet, in some circumstances, the restorative quality of the setting depends heavily on its being populated with people who, freed from some everyday demands, can relax and enjoy being with others to celebrate some event; conviviality and contagion of mood become more likely, spreading among those known and unknown to one another. I can mention many examples: New Year's Eve celebrations in Times Square, New York; the cheering crowds at Memorial Stadium in Lincoln, Nebraska while the Cornhuskers play well against a rival; the Papal blessing offered on Easter to the masses gathered in St. Peter's Square in Vatican City; and, once upon a time, Grateful Dead concerts in large indoor and outdoor venues in many American cities. In addition to opening for contagion of valued emotions, such events may work to

renew and reinforce a communal identity held by those attending (cf. Ehrenreich, 2007; Etzioni, 2000).

Even then, though, carrying capacity issues can be anticipated, and space limits will require that constraints are imposed on attendance to ensure public safety and the comfort of participants. And, of course, institutional provisions have their limits. Getting the time needed to travel as a family to some distant national park does not guarantee an excellent outcome; poor summer weather, for example, may dampen the enjoyment of all, potentially with negative consequences discernible in population health indicators (cf. Hartig & Catalano, 2013; Hartig, Catalano, & Ong, 2007).

5.4.2.5 Outcomes That Reflect on Restoration of Collective Resources

Amplification of benefits with shared experience constitutes a mechanism of collective restoration that might be studied as described earlier in the account of RRT. Population averages for some of the outcomes indicated by SRT, ART, and RRT may also help to address phenomena of collective restoration. Yet, other outcomes of interest cannot be discerned with such data and need assessment on the population level. For example, one recent study addressed collective optimism as a social resource, viewing it as a form of informal insurance on which members of a population could draw to sustain effort in their ongoing enterprises (Catalano et al., 2020). We assumed that parties to the myriad relationships among members of a population share expectations with their family, friends, and others, both known and unknown, regarding the circumstances they can realize together in the future, and that the optimism of any one of them could affect expectations of the others (p. 45). Reports from individuals and small groups cannot capture the aggregate effect of this spread of benefits. To observe collective optimism on the population level, we looked at variation over time in two seemingly disparate population-level variables that nonetheless reflect on willingness to invest in the future. One, the monthly number of suicides among women of reproductive age, reflected on conscious decisions to no longer invest in one's own life; in other words, a lack of optimism about a future worth living. The other variable was the monthly incidence of male twin births, which reflects on the spontaneous abortion of particularly vulnerable fetuses, which itself reflects on non-conscious biological decision processes regarding the continued investment of reproductive capability in the particular gestation (see also Catalano et al., 2014, 2018). With data aggregated for the Swedish population, the study found these seemingly disparate measures to nonetheless covary reliably during the period January 1973 through December 2016, in a manner consistent with expectations. What the study did not address is what caused collective optimism to go down in particular periods and to recover afterward.

One study that did look at causes of collective restoration considered the mental health consequences of national vacation legislation (Hartig et al., 2013). It used aggregate data on vacation-taking in Sweden, where legislation in place since 1977 makes generous provisions for paid vacation time and also ensures that workers can take up to four consecutive weeks of that time during the summer months (Ericson

& Gustaffson, 1977). As shown in Fig. 5.1, the legislation has enabled a distinct and regularly recurring pattern of collective behavior: during the 12+ years covered by the study, millions of workers concentrated their annual vacation time in June, July, and August. The total population of Sweden during the period ranged from ca. 8.7 to ca. 9.0 million people (Statistics Sweden, 2020), so the legislation has evidently served well to relax demands on a very large proportion of the working population at the same time.

Of interest to us in our test was whether mental health would improve during periods of relatively intensive vacationing, as reflected in the dispensation of anti-depressants to the population through the pharmacy system allied with the national health care system. Using nationally aggregated monthly data, time-series modeling uncovered negative associations between vacationing and aggregate dispensation of anti-depressants to adult women and men. As an indication that benefits spread among people, we found that the association held for dispensation to men and women of retirement age as well as to men and women of working age. Thus, it appeared that vacation-taking by people still in the work force had implications for the mental health of older people outside of the work force. Further analyses indicated the results could not simply be attributed to prescribing physicians also being away on vacation, but given the data available for the analysis, we could not address other alternative explanations, such as mental health benefits of travel by retired persons that did not involve meeting with relatives and friends who were on paid vacation.

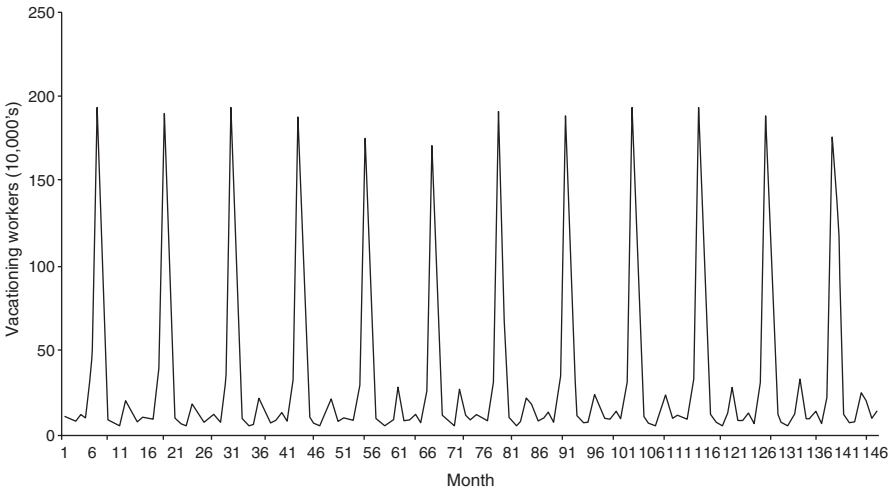

Fig. 5.1 Variation in the number of vacationing Swedish workers (in 10,000s) over the 147 months from January, 1993 to March, 2005. From Hartig et al. (2013)

5.4.2.6 Matters of Time

Unlike the other theories of the general framework, CRT takes particular interest in the social regulation of time. It recognizes that by regulating time for different activities, laws, and customs affect the ability of people to converge in particular settings and social constellations for activities that support restoration of individual, relational, and more diffuse social resources.

Further, and of particular importance here, CRT recognizes that the social regulation of time attends to well-known and highly predictable variations in the natural environment that have implications for visiting and enjoying outdoor settings. This is well exemplified by the circumstances addressed in the study of vacationing in Sweden. That initial test of CRT treated socially structured variation in time as a potential determinant of mental health; it did not directly address the matter of where people spend their vacations. It nonetheless bears on the support provided by the natural environment for collective restoration. Characteristic of higher latitudes, Sweden has dark and difficult winters, and those who live there place a high value on the summer as a season for outdoor leisure activities. This appreciation of summer conditions helped to shape the evolution of the vacation legislation, such that it eventually became possible to concentrate a large amount of vacation time in the summer months. That disposition of time was justified in statements about the superiority of summer conditions for recreation and restoration, made over a span of decades in legislative proposals [e.g., Kunglig Majestäts propositionen no. 286 (1938), cited in Andra Lagutskottet, 1953], inquiries commissioned by the government (Statens Offentliga Utredningar, 1944, 1967, 1975), and reports from legislative committees (Andra Lagutskottet, 1951). Those who developed the vacation legislation thus sought to ensure conditions for restoration not only in terms of time, but also in terms of the possibilities for performing particular activities outdoors in relatively warm and sunny conditions. In keeping with the preferences acknowledged in the legislation, and in keeping with the pattern of vacation-taking shown in Fig. 5.1, population surveys have found that people in Sweden generally do engage in more outdoor activity during the summer months than during cooler months (Statens Offentliga Utredningar, 1964; Statistiska Centralbyrån, 2004). In sum, by focusing on vacation as one manifestation of the social regulation of time, the initial test of CRT indirectly represented variation in restorative characteristics of the physical environment and movement into more restorative settings; the theory assumes that settings which support restoration are located not only in space but also in time, and that the social regulation of time addresses, among other concerns, the alignment between people's various needs for restoration and their possibilities for entering settings that well serve those needs at the given time, for the necessary duration.

This sketch of CRT has provided enough detail to distinguish it from SRT, ART, and RRT. It has also shown how CRT complements those theories in important ways. Its concern for the ways in which people are located in a socially regulated structure of time complements the approach characteristic of research guided by SRT and ART, which ordinarily focuses on what happens during the time a person spends in an environment but leaves implicit matters such as when they happen to be in the

given setting, how long it took them to get there, when and why they must leave, and how long it will take them to reach their next destination. CRT also helps to relate the theories of the conventional narrative to RRT by addressing processes that establish some of the stable circumstances to which people in closer relationships must adapt and to which they must orient their arrangements for supportive exchange. The theory as sketched thus does more than provide bases for novel research questions and hypotheses about restoration phenomena in populations; it also suggests new questions and hypotheses for research otherwise informed by SRT, ART, and RRT.

5.5 Toward a More Encompassing Narrative

I began this chapter by setting a context: urbanization reduces possibilities for experiencing nature, which provokes alarm and motivates research on the value of nature experience for health. I then argued that, as a necessary complement to the stress and coping perspectives on human adaptation, the restoration perspective has particular relevance for understanding how nature experience promotes health. This relevance has become more pronounced as the conceptual distinction between built/urban and natural environments has increasingly gotten linked with experiences of depletion versus restoration, concomitant to the concentration of populations, and productive activities in urban areas. Yet, despite this "built in" relevance, the restoration perspective has been underutilized as a basis for understanding nature-and-health relations. At present, the representation of the restoration perspective in nature-and-health studies follows a conventional narrative about stress recovery and attention restoration in individuals, to the neglect of restorative processes that involve multiple people. To remedy this neglect, I set out a general framework for restorative environments theory, into which I organized some of the main components of stress recovery theory and attention restoration theory. To extend the narrative, I then added the level of analysis as another component to the general framework, and I sketched some of the main components of two additional theories, one concerned with restoration of relational resources held by dyads and small groups and one concerned with restoration of social resources held collectively by members of a population. Now, in closing here, I will comment on further work with the extended framework as a whole and the need for attention to matters of the narrative as such. In doing so, I will raise some important considerations for nature preservation efforts, urban planning, health promotion strategies, and ways of thinking about human–nature relations.

5.5.1 Further Work with the Extended Framework

First, a caveat: In calling for a more expansive theoretical narrative, I have not meant to discount the seminal contributions of Stephen and Rachel Kaplan and Roger Ulrich nor the efforts of so many others to elaborate, test, and apply SRT and

ART. That work has played a crucial role in research and practice concerned with nature experience and health. Moreover, SRT and ART still have ample heuristic value, and I expect that they will inspire research and practice for years to come.

Some of that further effort will be directed toward needed critical assessments, of the empirical evidence that bears on one or both of the theories (cf. Ohly et al., 2016; Stevenson et al., 2018) and of the ways in which the assumptions and claims of the two theories have gotten represented in empirical research and the conventional narrative. I anticipate that other work will center on alternative accounts of restoration in nature that challenge SRT and ART, such as the perceptual fluency account put forward by Yannick Joye (2007) and colleagues (Joye, Steg, Unal, & Pals, 2016; Joye & van den Berg, 2011; see also Hagerhall et al., 2008). Such efforts should help to advance the theoretical discourse about restorative environments and dialog with other bodies of theory and practice.[15]

Further work with RRT and CRT will also serve those ends, and I have already indicated how each of the theories can guide research. What needs further discussion here is how, with the addition of RRT and CRT, the general framework, taken as a whole, can inform further work, whether it focuses primarily on individual behavior, the behavior of dyads and small groups, or collective behavior. I have already given some broad suggestions in that regard. I will now focus on how work with the extended framework can address two particular needs: for treatment of restoration in nature as a social ecological phenomenon and for further consideration of evolutionary assumptions invoked in discussions of restoration in nature.[16]

5.5.1.1 The Need to Treat Restoration in Nature as a Social Ecological Phenomenon

Recall that the columns of the general framework as represented in Tables 5.2, 5.3, and 5.4 reflect on the necessary relatedness of the stress, coping, and restoration perspectives within the adaptive paradigm. In a similar way, the successive rows of the extended framework reflect on the necessary relatedness of the three paradigms for research described by Saegert and Winkel (1990). The extension of the framework made here with RRT nests the concerns of the adaptive paradigm for individual survival within the concerns of the opportunity structure paradigm, for example, with regard to the spatial and temporal constraints on action that people must overcome in the pursuit of their personal and shared goals and projects. The further extension made with CRT in turn nests those concerns within the concerns of the sociocultural paradigm, which approaches the challenge of survival "not as an individual concern, but as a problem for the social structure within which the individual is embedded, whether it be family, neighborhood, nation or even world society" (Saegert & Winkel, 1990, p. 457).

The basic organization of the extended framework thus aligns with the assumptions of a social ecological model of stress, coping, and restoration: people normally cycle through processes of depletion and restoration as they confront and cope with demands from the environment; their stress–restoration cycles

correspond to a substantial degree with cycles of activity organized within arrangements for supportive exchange; and those arrangements show sensitivity to the stable circumstances in which members of a population live, as shaped by economic, political, social, technological, and other higher level processes (cf. Hartig, Johansson, & Kylin, 2003). Further, as I have shown in the accounts of RRT and CRT, influence can also flow in the other direction: excessive demands on individuals can engender problems with their standing arrangements (like a shortage of shared leisure time) which in turn can feed into collective efforts to identify and implement collective solutions, as with the institution of a national park system (Olmsted, 1865/1952) and the production of national vacation legislation (Hartig et al., 2013). With this representation of bidirectional influence and feedback between processes on multiple levels within an open system, the extended framework addresses a desideratum of further research that I mentioned earlier: the ways in which natural settings figure in health need consideration in light of the social ecology in which their various attributes contrast with those of the other settings within and across which individuals and groups distribute their time (cf. Hartig, Johansson, & Kylin, 2003).

Research that neglects this social ecology runs some significant risks. One involves treating psychological restoration as a pathway from nature to health that works independently of pathways that involve social resources, even though the pathways often work together (see Dzhambov et al., 2018, 2019). Another involves blindness to the tradeoffs that people may make in choosing between activities that serve only some individual restoration need (say, a solitary walk in the park) and activities that serve both individual restoration and care for relationships (say, watching television with family).[17] Still other risks involve failure to recognize the ways in which standing arrangements for supportive exchange and stable societal circumstances can prevent people from engaging with nature. Lack of attention to such matters can entail misunderstandings and misestimates that in turn risk shortcomings in practical application, with misguided interventions and missed opportunities. For example, more and better urban parks and green spaces may be greatly appreciated by the people who can look out on or visit them, but they may only provoke frustration among those who already stagger under an excess of demands and a shortage of time, and indeed they may have the undesirable consequence of driving up property prices so that people already in difficult circumstances may have to move away from the one favorite park or green space they can manage to visit on occasion. Those who want to preserve nature and ensure opportunities for all urban residents to engage with nature might therefore complement physical design and planning strategies by strengthening alliances with actors indicated by the analysis here, such as those trying to ensure access to affordable housing in city centers (e.g., Wolch, Byrne, & Newell, 2014) and those who would help people to "take back their time," as with passage of vacation legislation where it does not exist (e.g., de Graaf, 2003).

5.5.1.2 The Need for Further Consideration of Evolutionary Assumptions Regarding Restoration in Nature

When I first introduced the general framework (referring to Table 5.2), I mentioned that other components could be added to further aid comparisons among theories, taking their set of assumptions about human evolution as an example of such a component. As with the addition of the level of analysis to the general framework, addition of the set of evolutionary assumptions reinforces its representation of the social ecology of stress, coping, and restoration. Consideration of the evolutionary assumptions also indicates ways to revise the narrative about restoration in nature.

Put simply, SRT and ART assume that natural selection has made *Homo sapiens* well adapted to some features of the (natural) environment that had particular importance for survival in early hominin evolution but maladapted to some prevalent features of contemporary (urban) environments and related lifestyles. Those assumptions figure more or less prominently and with more or less detail in many variants of the conventional narrative. Portrayals of urban environments tend toward the malign: they lack perceptual features of habitability to which an evolved system of affective responding is attuned, thus engendering an ongoing low-level stress response (Parsons, 1991); and evolved cognitive capabilities cannot sustain the effortful processing of the large amounts of complex and uninteresting information to which one must attend while trying to act effectively in them, thus engendering mental fatigue (Kaplan, 1995). In contrast, natural environments are usually portrayed as benign: they have more of the survival-relevant icons that evoke biologically prepared positive affective responding (Ulrich, 1983); and processing of the intrinsically interesting (visual) stimuli that they present requires less cognitive effort (Kaplan & Kaplan, 1989). If one accepts the further assumption that natural selection works too slowly to have enabled biological adaptation to urban conditions that emerged over only a few millenia, then it might seem reasonable to expect that problems of stress and mental fatigue will become still more prevalent as populations continue to concentrate in urban areas. It follows that evolutionary assumptions like those in SRT and ART do more than simply align with the "built in" relevance of the restoration perspective for understanding why natural environments better support restoration than urban ones; they appear to reinforce that built-in relevance insofar as they are taken to mean that all those new urban residents would do well to turn for their recreation back to the natural settings they remain adapted to in some evolutionary sense.

Yet, theories that build on such evolutionary assumptions have long drawn criticism for their claims about prehistoric environmental features to which humans supposedly remain biologically adapted (e.g., Foley, 1995; Gould, 1978; Gould & Lewontin, 1979; Zuk, 2013). What such criticism means for restorative environments theory can become clearer by comparing the evolutionary assumptions of the different theories within the extended framework. One major difference quickly becomes apparent: the assumptions of RRT and CRT put more emphasis on selection for cooperation, acknowledging that individuals formed groups and helped each other survive in prehistoric environments, which they manipulated to serve

their individual and common needs using tools they created and refined, guided by knowledge they acquired and passed on with increasingly powerful language and learning capabilities. Those assumptions build on knowledge of the roots of language, sociality, social learning, and culture more generally; they recognize that humans have adapted biologically and culturally to a very broad range of environmental conditions; and they recognize that evolution has continued, with social and cultural selection still working together with natural selection to shape the genotype and phenotype, sometimes quickly, within relatively few generations (e.g., Runciman, 2009; Zuk, 2013). I will not elaborate this point here, though I can note that much other research in psychology and allied disciplines refers to similar assumptions when addressing topics like the need to belong as a pervasive behavioral motive (Baumeister & Leary, 1995); reciprocity as a basis for social exchange (Buunk & Schaufeli, 1999); tending and befriending as a biobehavioral response to stressors (Taylor et al., 2000); cooperation in the absence of egoistic incentives (Caporael, Dawes, Orbell, & van de Kragt, 1989); and the adaptiveness of emotional contagion (Hatfield, Cacioppo, & Rapson, 1994).

Because the evolutionary assumptions of RRT and CRT refer to characteristics of living conditions relevant to the survival of people in groups, they encourage a view of the urban environment within the social ecology of stress, coping, and restoration that differs from the view seemingly encouraged by the assumptions of SRT and ART. This alternative view does not focus narrowly on those urban conditions that do actually threaten the biological and psychological survival of the individual, and to which humans cannot readily adapt. Also, and importantly, it does not treat such conditions, for example, heavy air pollution, as necessary features of the urban environment, but rather as the consequences of particular approaches to serving particular wants and needs, like the use of private cars instead of bicycles and trams or the use of coal to generate electricity instead of solar- and wind-based technologies. This alternative view of the urban environment puts more emphasis on those of its features that might be considered necessary: many people living together, some unknown to others, cooperating in various ways, including in reproduction (sociocultural as well as biological) and the promotion of social learning.

Thus, while evolutionary assumptions of RRT and CRT may currently align with the "built in" relevance of the restoration perspective for understanding why natural environments better support restoration than urban ones, they challenge the necessity of that relevance rather than reinforce it; the urban environment need not be the source of stress and cause of depletion in relation to which the natural environment has special restorative value. By recognizing the adaptedness of humans to necessary features of urban environments, especially people living and cooperating with one another, and by recognizing the possibilities for adapting to urban living conditions, including elimination of harmful conditions, the promotion of more salutary conditions, and the integration of natural and artificial features and processes within urban areas, the evolutionary assumptions of RRT and CRT allow for the possibility that future generations will weaken the conceptual distinction between the urban and the natural as it is grounded in experiences of stress and restoration (cf. Hartig & Kahn, 2016).

Use of the framework to support comparisons of the evolutionary assumptions of different theories will thus help to clarify not only the differences between them, but also matters of some consequence for thinking about human–nature relations and the encompassing narrative about nature, restoration, and health. Neglect of urban conditions to which humans are persistently and necessarily adapted is just one side of the issue. One can also ask about neglected features of the natural environment to which humans obviously are adapted. One set of these in particular—the passage of days and seasons with the movement of the Earth in relation to the sun—further challenges the distinction between the urban and natural; it calls attention to the ubiquity of features of the natural environment with fundamental relevance for stress, coping, and restoration (cf. Hartig & Beute, 2017). I will however leave that topic for another occasion, and instead turn to further work with the narrative as such.

5.5.2 Attention to Matters of the Narrative as Such

Evolutionary theorists have long debated the relative significance for natural selection of cooperation versus competition between conspecific individuals. The choice of emphasis on one over the other has in some cases reflected on the theorist's own sociocultural position and the political-economic narrative in which they situated their evolutionary thought (see Todes, 1987). Speaking to this difference in emphasis on cooperation versus competition and the way it figures in narratives about nature and society, Gould (1988) explained his own approach to such matters:

> … I like to apply a somewhat cynical rule of thumb in judging arguments about nature that also have overt social implications: When such claims imbue nature with just those properties that make us feel good or fuel our prejudices, be doubly suspicious. I am especially wary of arguments that find kindness, mutuality, synergism, harmony – the very elements that we strive mightily, and so often unsuccessfully, to put into our own lives – intrinsically in nature (p. 21).

Whether cynical or suitably skeptical, I think Gould's rule of thumb warrants application in the further development of the narrative about nature, restoration, and health. The assumptions made about our evolutionary past have a bearing on our evolutionary present and future.

Recall that just before introducing the narrative concept in this chapter, I gave a definition of theory as discourse. As such, theory remains open to the influence of observations of change in the phenomena of interest, which can reflect on change in the surrounding sociocultural circumstances. I then observed that the definition of theory admits the emergence of a particular way of telling about the contents of theory—a narrative—that may also include an account of a problem. As part of the narrative, the statement of the problem provides a context for the phenomena of interest and helps to establish the value of theorizing about those phenomena.

What I left implicit then is that development of a narrative around some body of theory can be part of the change in sociocultural circumstances that shape the

phenomena of interest to it. Yet, I had already given an example of how that can happen. Recall, once again, that at the start of this chapter I asked you to consider "a broad context for this work." Note: not "the" broad context, but one possible context among others. In those opening paragraphs, I did what many other authors in the nature-and-health field have done and implicated urbanization as a driver of the loss of opportunities to experience nature, with attendant threats to human health. I then explained how research guided by restorative environments theory countered this trend by making it more difficult to disregard arguments for protecting natural settings as public health resources. I indicated that research guided and informed by the two theories of the conventional narrative has supported practical measures for the preservation of nature and the promotion of health through nature experience. I might have gone on to explain that knowledge of the science of restorative benefits of nature experience has become widespread, and that it has shaped how people encounter, engage with, understand and value "nature," as reflected for example in newly popular cultural practices like "forest bathing" (after the Japanese term, *shinrin-yoku*; Park, Tsunetsugu, Kasetani, Kagawa, & Miyazaki, 2010).

Well and good of itself it would seem, but a context-setting problem formulation that establishes the value of theorizing about restorative experiences in nature can have unintended and undesirable consequences if it rests on evolutionary assumptions that reinforce a conceptual opposition between the natural and urban environment and the "built-in" relevance of the restoration perspective. With the addition of RRT and CRT to the general framework, and the re-consideration of evolutionary assumptions that their addition encourages, I have laid foundations here for an alternative narrative that addresses problems with that conceptual opposition.

This set of problems is old, both in kind and content. With regard to its kind, I can first note that evolutionary explanations for many behavioral phenomena apparently appeal to many people. Perhaps it is because they seem to speak to how we *really* are as humans. Perhaps it is because the logic of natural selection seems so intuitively plausible and unassailable, lending credence to accounts of how natural selection shaped the capabilities reflected in patterns of present behavior. But, as Gould (1978) argued, some such accounts are "just-so stories," problematic because "all bits of morphology and behaviour" do not "arise as direct results of natural selection," and there may be more than one selective explanation for each bit (p. 530). Without discounting the potential value of story-telling as a step in the scientific process (Gardner, Marsack, Trueman, Calcott, & Heinsohn, 2007), further work with the narrative as such will gain from applying Gould's (1988) rule of thumb, scrutinizing what may be just-so stories and considering how their evolutionary assumptions might be challenged and falsified. Ulrich's (1993) discussion of biophilia versus biophobia offers one example with its reference to carefully designed experiments on biologically prepared responses to fear-relevant natural stimuli (see endnote 8). Joye and colleagues also helpfully demonstrate a critical stance toward evolutionary assumptions in their commentaries on SRT, ART, and the biophilia hypothesis (Joye & De Block, 2011; Joye & Dewitte, 2018; Joye & van den Berg, 2011). The evolutionary assumptions of the perceptual fluency account, RRT, CRT, and other theories that can fit in an extended framework and a more

encompassing narrative will also require ongoing critical assessment. That work will do well to also consider how human evolution has continued since those earliest millennia of our prehistory.

With regard to how work with an alternative narrative can address the problem of content—the conceptual opposition between natural and built/urban environments and the "built-in" relevance of the restoration perspective for a narrative about nature, restoration, and health—I can turn to another suitably skeptical scholar for some help. In a history of exhaustion, Schaffner (2016a) writes:

> There is much we can learn from past theories of exhaustion that can help us make sense of our own experience of exhaustion today. Almost by default, historical analyses render apparent the relativity of our own attitudes and values, which we often tend to experience as absolute truths (p. 12).

And:

> Rather than perpetuating the myth that our own is the most exhausting age and lamenting the vampirically depleting horrors of modernity, perhaps we should acknowledge that exhaustion is simply an essential part of human experience. … What changes throughout history is not the experience of exhaustion as such, but rather the labels we invent to describe it, the causes we mobilize to explain it and, of course, the specific cultural discontents that we tend so readily to map onto the condition. (Schaffner, 2016b, p. 339):

With regard to the recruitment of evolutionary assumptions in explanations for exhaustion, and by implication processes of restoration, she provides an example that also illustrates a point I want to make here. Discussing a past theory of exhaustion and its cultural context, she cites Richard von Krafft-Ebing's (1898) argument for why the emancipation of women underlied common forms of psychopathology then diagnosed among them:

> Only over the course of many generations can the capacity of the brain that is necessary for succeeding in formerly exclusively male scientific or artistic professions be acquired by a woman (pp. 57–58; cited in Schaffner, 2016a, p. 141, with her translation from the original German).

Therapeutic recommendations that followed with this kind of thinking would have women abstaining from those forms of artistic and intellectual activity then reserved as the province of men. "Rest" meant returning to a focus on childcare and other domestic activities.

In the present case, I call attention to the "relativity of our own attitudes and values" with regard to cities and urban life versus the natural environment and nature experience. The ways in which these attitudes and values have been expressed in research on nature, restoration, and health have emphasized negative aspects of unnecessary features of cities and urban life and discounted positive qualities of their presumably necessary features. It concerns me that the way in which evolutionary arguments get recruited in narratives around nature, restoration, and health reinforces this negative bias, despite abundant and obvious evidence that humans are well-adapted to the necessary features of urban environments and urban living. This neglect of evidence that runs counter to the conventional evolutionary arguments aligns with the defense of particular cultural biases like those that have

aroused Gould's cynicism, and which in their practical effects of maintaining a harmful status quo resemble those which von Krafft-Ebing packaged in arguments about the roots of psychopathology in women.

A more skeptical stance toward assumptions about our evolutionary past might open for a more optimistic view of our evolutionary present and future. This stance would align with scholarly challenges to anti-urban bias (e.g., Lofland, 1998) and recurrent practical efforts to bring natural and artificial features of human environments together in more beneficial ways, as with the garden city movement (Howard, 1902), green infrastructure (Coutts, 2016), and various architectural programs, such as biophilic design (Kellert, Heerwagen, & Mador, 2008). As it stands, though, research has done little to reconcile the narrative about nature as an antidote to urban pathologies with understandings of how urban living does in fact promote public health (cf. Hartig et al., 2020; Hartig & Kahn Jr., 2016). A more encompassing and in my view more accurate narrative would have a context-setting problem-description that does not force urbanization and nature preservation into some necessary opposition but rather emphasizes how further development of urban environments can proceed as a component of human evolution in which we coordinate our needs with those of other forms of life.

5.6 Concluding Comments

A conventional narrative reflects measures of agreement and trust among members of a community, and it can provide important benefits. It can aid communication about a body of theory and the activities guided by that theory. It can support the dissemination and assimilation of new knowledge relevant to those activities. It can thus promote community-building efforts; it can provide a locus around which a growing number of people with similar scholarly interests and practical concerns can gather to more effectively and efficiently coordinate research, teaching and practical efforts.

Yet, a conventional narrative also entails risks. The advantages it confers may get offset by, for example, a lack of critical self-reflection, and perhaps blind loyalty to one particular theory and a biased or lack of due regard for others. A conventional narrative may perpetuate misunderstandings and flawed reasoning and biased representations of the state-of-knowledge. It can undermine community-building efforts and practical efforts around which people might gather as a community; it can alienate some who would offer critical perspectives, turn away others who might otherwise want to do so, and have undesirable practical consequences.

As in other fields of activity in which people can become invested in particular approaches and positions, path dependencies in a field of science can maintain the stability of a narrative despite recognition of a need for change in its fundaments (cf. Thelen, 1999). The community gathered around a narrative can gain by acknowledging this possibility; its members perform a service when they offer reasoned criticism, new claims, and new observations bearing on the body of theory and the

narrative built around it. Fortunately, the community gathered in the study of restorative environments and restorative benefits of nature experience has a wealth of members who want to provide this service. The discourse within the community can refine or reject existing assumptions and theoretical claims, select for or against new claims, and in other ways drive the further evolution of restorative environments theory and a narrative built around its constituent accounts. It can thus better serve understanding and practical applications.

The conventional narrative about restorative effects of nature experience became conventional for good reasons, and it has served research and practice well in many ways. This said, I see good reasons to move toward a more encompassing narrative, one that respects the historical and lasting values of SRT and ART and honors the efforts of their authors while also acknowledging the limitations of those theories and calling attention to a broader range of phenomena, problems, and possible solutions. This will make more of the potential of the restoration perspective.

Acknowledgments I thank Anne Schutte, Julia Torquati, and Jeffrey Stevens at the University of Nebraska for their invitation to present this work at the 67th Annual Nebraska Symposium on Motivation, for their warm hospitality during my stay in Lincoln, and for their patient encouragement and other editorial inputs in the preparation of this chapter. I have also presented parts of this work at the 25th Conference of the International Association for People-Environment Studies (Rome, July 2018); the Institute for Global Health (Barcelona, March 2019); the World Conference on Forests for Public Health (Athens, May 2019); the 31st Conference of the European Network for Housing Research (Athens, August, 2019); the International Conference on Environmental Psychology (Plymouth, September, 2019); and the Population Wellbeing and Environment Research Laboratory at the University of Wollongong (November 2019). This work has benefitted from helpful comments and encouragement offered by many colleagues at these gatherings, and I wish to thank the following people in particular for supporting the presentation of this work: Giuseppe Carrus and Stefano Mastandrea; Margarita Triguero-Mas; Christos Gallis; Emma Baker and Rebecca Bentley; Sabine Pahl and Mathew White; and Xiaoqi Feng and Thomas Astell-Burt. I also wish to offer special thanks to Mathew White for his helpful comments on an earlier draft of this chapter, and, belatedly, to Irwin Altman, who commented on a much earlier forerunner to this chapter (and whom I failed to thank when that paper got published in 1993). This work also benefitted from a Brotherton Fellowship from the School of Psychological Sciences at the University of Melbourne; I thank Katherine Johnson, Kathryn Williams, and Kate Lee for hosting me there, and for our enjoyable and rewarding discussions of some of the ideas presented here. Henk Staats also provided thoughtful comments on an earlier draft; I am grateful for those inputs and for many valuable discussions of restorative environments theory in our long-running, productive, and enjoyable collaboration. I completed much of the first draft of this chapter during a sabbatical visit to the University of California, Berkeley; I am grateful to Ralph Catalano for hosting me there, for his helpful comments on an earlier draft of this chapter, and for his generous and enthusiastic participation over decades in theoretical developments presented here and elsewhere.

Notes

1. The “nature” considered here primarily comprises environmental features, settings, and processes not apparently created or influenced by humans and which humans ordinarily can perceive without special instruments or sensory aids. Its representations include trees and other vegetation; the forests, grasslands, and other areas where vegetation dominates; wild-

life; clouds and other meteorological phenomena; bodies of water and movements of water; seasonal variations in all the foregoing; and much more. This meaning of "nature" overlaps substantially with the meaning of "natural environment" as a large outdoor area with little or no apparent evidence of human presence or intervention (Pitt & Zube, 1987), the visible aspect of which is commonly referred to as the "natural landscape" (Daniel, 2001). Consequently, "nature," "natural environment," "natural landscape," or simply "landscape" and terms like "green space" and "blue space" get used somewhat interchangeably in this research area. This said, settings such as botanical gardens, golf courses, and urban parks may be artificial in many respects and yet be seen as natural because they mainly consist of vegetation and other natural-appearing features. Further, a person might enjoy some representation of nature while situated in what objectively could be described as an artificial environment, as when viewing natural scenery displayed in photos, films, or virtual reality setups. In light of these often-considered definitional issues, psychological research in the area assumes the relevance of biophysical or ecological or other attributes of environments as they might be objectively measured; however, it also assumes the importance of subjective and intersubjective aspects of the experience of the environment, as reflected in the widespread use of terms like "nature experience" and "contact with nature" (e.g., Bratman et al., 2019; Hartig et al., 2011; Hartig & Evans, 1993; Mausner, 1996; Wohlwill, 1983).

2. As this paragraph illustrates, those working with nature-and-health questions ordinarily assume an expansive definition of "health" like that offered by the World Health Organization (1948): "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." By calling attention to a person's physical, mental, and social condition, it affirms a view of health as multidimensional and invites consideration of how health arises from the interplay of multiple factors. By referring to well-being, it invites consideration of how health rests on subjective experience. By downplaying the absence of disease and infirmity as the main criteria for health, it emphasizes the importance of diverse health promotion and disease prevention efforts, including those to be discussed in this chapter. For further details, see Hartig et al. (2011).
3. For additional discussion of changing conceptions of nature and human–nature relations, see for example Glacken (1967), Huth (1957), Macfarlane (2007), Marx (1964), Nash (1982), Schama (1995), Thomas (1983), and Tuan (1974). For the sake of simplicity here, I refer to this kind of change as part of a "sociocultural" evolutionary process; however, I note Runciman's (2009) objection to this usage:

> No less important than the recognition that natural selection cannot by itself account for the diversity of collective human behavior-patterns is the recognition that cultural and social selection, which have too often been assimilated … under the rubric of 'sociocultural evolution', are… not at all the same thing. There are not two but three levels at which evolution drives human populations down the open-ended, path dependent trajectories which continue to generate new patterns of collective behavior out of old (p. 3).

4. Like other efforts involving cross-paradigm synthesis, this one reflects recognition of the limits of the different paradigms and their allied disciplines. Commenting on contributions from environmental psychology to the different paradigms, Saegert and Winkel note that "the psychological heritage of most researchers leads to a focus on the characteristics and dynamics of persons; and although the field has always offered a contextual critique of psychology (Little, 1987), the call for interdisciplinary, systems-oriented, and problem-centered research has not been easy to answer (Proshansky, 1987)" (p. 442). They accordingly express concern for "the extent to which advances in environmental psychology confront the fact that many of our experiences in and uses of environments must be understood in the context of broader physical, economic, historical, and political forces" (p. 442). Engaging with the multidisciplinary character of the broad field in which environmental psychology is situated, they nonetheless point to the particular contributions it can offer as a discipline: "While environmental psychologists often give too short shrift to context, scholars from other disciplines who work on an articula-

tion between the individual and broader economic, social, and political structures often skip lightly over the acting, experiencing person" (p. 443). In attending to the different paradigms and with them to the reality of processes that work across different levels of analysis, Saegert and Winkel state a position also assumed here:

> Historically developed conditions (including ecological conditions) and the social structural forces of any particular period form the preconditions for individual and group action. Because they precede individual activity and are organized beyond the reach of most individual actions, they have greater weight in maintaining conditions and directing change (p. 445).

The present cross-paradigm synthesis builds on an earlier one that also acknowledged the interdependence of processes working across levels of analysis. In that earlier account, I described general (population) and specific (individual) transactions with the environment that occur within and shape nature experience, and how those transactions relate across the different levels of analysis within sociocultural evolution (Hartig, 1993).

5. This definition does not refer explicitly to a predictive function of theory, but neither does it exclude the use of theory for prediction. Similarly, it does not refer explicitly to qualities of theories often held up as desirable, such as parsimony and falsifiability. Yet, the discourse to which it refers would address such theoretical desiderata insofar as they are relevant to the subject of the theory. For example, a theorist offering an account for how some political-economic structure became established in a society may have little interest in prediction. Note that social theory comprises diverse specific formulations, or theories; one can similarly speak of restorative environments theory as a body of theory with multiple formulations, including but not limited to SRT and ART.

6. *Nota bene*: I cannot offer a specific number for the incidence of such conjoint representation of SRT and ART, only an impression based on my reading over the years.

7. One can find this kind of development described in their texts. For example, in the chapter on "The Restorative Environment" in their 1989 book, the Kaplans wrote as follows:

> The wilderness research (discussed in chapter 4) played a particularly important role in the development of the ideas about what constitutes a restorative environment. In the context of that research we also began to examine the puzzles of mental fatigue more closely. As a framework emerged, it became apparent that the results of many of the other studies (particularly the gardening satisfaction research discussed in chapter 5) were equally applicable (p. 177).

8. Subsequent to his 1984 essay, Wilson's thinking drew on Ulrich's research on positive affective responses to natural environments. Ulrich approached such responses as positive or restorative analogs to very rapid, biologically prepared phobic responses, such as uncovered by Arne Öhman, Ulf Dimberg and others at Uppsala University in experiments with snakes and spiders as fear-relevant stimuli. Ulrich described that research in his chapter for the book that Wilson co-edited with Stephen Kellert, *The Biophilia Hypothesis* (Kellert & Wilson, 1993), and Wilson acknowledges that work in his own chapter. On August 26, 1992, during a meeting at Woods Hole, Massachusetts held in conjunction with the development of that book, Wilson gave Ulrich a copy of his book, *The Diversity of Life* (Wilson, 1992), on the title page of which he inscribed a gracious acknowledgement of Ulrich's influence (personal communications from Roger Ulrich, May 18 and 20, 2020, the latter with a scanned copy of Wilson's inscription).
9. The 1991 article in *Environment and Behavior* presented results from two studies, one the basis for Marlis Mang's doctoral dissertation (*The restorative effects of wilderness backpacking*; Program in Social Ecology, University of California, Irvine; 1984) and the other the basis for my master's thesis (*Testing the theory of restorative environments*; Program in Social Ecology,

University of California, Irvine; 1990). Both of these studies were completed with primary supervision from Gary Evans and oriented primarily to Kaplan and Talbot's (1983) formulation of what became attention restoration theory. Both were also informed by Ulrich's work, as reflected in the measures they used, but they engaged with his theorizing to different degrees. For example, Mang did not cite the 1983 chapter in which Ulrich first elaborated his theory, even though it was published in the same volume as the Kaplan and Talbot chapter. The master's thesis study was designed as a companion to Mang's dissertation study, and it drew on Ulrich's work to a greater degree theoretically and methodologically. I completed data collection for that study during the Spring of 1987, and later that year, at the 4th World Wilderness Congress, I presented a paper with results from both of the studies. That conference paper served as the basis for the 1991 article, in which we clearly juxtaposed the programs of research by the Kaplans and Ulrich to enable a discussion of results in terms of "different theoretical models of restorative experience" (p. 23). I subsequently gave further thought to the complementarity of the two theories, in a chapter written with Gary Evans (Hartig & Evans, 1993) and in my doctoral dissertation, the title of which acknowledges not one theory but rather a body of theory (*Testing restorative environments theory*; School of Social Ecology, University of California, Irvine; 1993). The main results from the dissertation study got published as a journal article only much later (Hartig, Evans, et al., 2003), for reasons that could also be considered within discourse extending into the conventional narrative.

10. Note the reference to "the pool of relational resources." In the following, I will continue to use this encompassing concept rather than go into the details of specific relational resources. To help keep an already complicated discussion relatively simple, I will set aside matters of how, across relationships or within relationships across time, the pool in question comprises trust, mutual respect, mutual understanding, and other possible relational resources to varying degrees. I also set aside their relative importance as a basis for supportive exchange, as well as matters of their substitutability, susceptibility to depletion, dependence on some individual resource, amenability to restoration, necessary conditions for restoration, *et cetera*.
11. Although I have to this point indicated diverse interpersonal, spatio-physical, temporal and social aspects of the arrangements and stable circumstances in which people develop, deploy, deplete, and potentially restore relational resources, I have also glossed over numerous complexities. Although the discussion can apply for diverse people, it assumes a relatively high functional capability of those involved. I do not engage with the additional complications that could follow when one or more of them struggle with, for example, addiction, chronic mental illness, or irreversible cognitive or physical limitations. Neither do I engage with complications around relationships that persist although negative interactions predominate over positive ones (e.g., House, Umberson, & Landis, 1988; Rook, 1984); the discussion here assumes that particularly the adults involved have a measure of control and the ability to choose whether or not to continue a relationship. Further, I do not engage fully with various aspects of the development, deployment and depletion of relational resources. These include, for example, how a person's ability to deploy functional resources in providing support will normally vary across the life course, and how expectations about and arrangements for supportive exchange will vary accordingly; how relational resources commonly develop in the performance of social roles, and how the deployment and depletion of those resources often occur while fulfilling role obligations; and how anticipation of reciprocity can span widely different time frames, from the momentary to the life course, as when a helpless baby grows to become an adult child that a parent looks to for help. Despite their relevance, I must set aside a deeper treatment of such matters for the sake of simplicity.
12. RRT also accommodates cases in which a person feels isolated and lonely, as may happen when a retired person lives alone (cf. Perissonotto & Covinsky, 2014). Such a person may have family and friends that they value deeply, but they may only seldom meet them because of age, infirmity, and/or the geographical distance between them. In that privacy regulation involves opening and closing to others to achieve a desired level of social interaction, the relevant arrangements for supportive exchange would be those that extend across domains, as when a retired widow

regularly goes for a walk in a nearby park with her unthreatening dog, where she can enjoy interactions with others that start from comments of the type, "Oh, what a cute little dog!" Such interactions may continue over years of meeting again in that setting, and even if those involved never interact outside that setting, they may nonetheless value their routine pleasant exchanges (cf. Lofland, 1998). Similar kinds of friendly relations can develop with people in other public places where people can easily go to be around others (i.e., the "third places" discussed by Oldenburg & Brissett, 1982). Thus, the person, whether of their own initiative or with assistance, enters arrangements to ensure more or less routine social contacts across domains, thereby preventing some feelings of isolation and loneliness or reducing them when they do occur. Parks and other natural settings with relatively high levels of visitation may serve in reducing and preventing loneliness insofar as the people there have gotten away from daily demands elsewhere, can slow down and relax, and so may present a happier and possibly more open social partner (Astell-Burt et al., in press); however, they address intimate, relational and collective dimensions of loneliness to widely varying degrees (cf. Cacioppo, Grippo, London, Goosens, & Cacioppo, 2015; Perissonotto, Holt-Lundstad, Periyakoil, & Covinsky, 2019).

13. Here, too, I set aside numerous complexities, acknowledging that a person's or group's expectations regarding reciprocity and fair treatment may depend on diverse personal and contextual characteristics, such as personality characteristics, social roles, gender, ethnicity, and so forth.
14. Here I perhaps unfairly set aside a relevant topic. Insofar as the lost social resources had inhered to features of the physical environment that got damaged or destroyed, restoration of those resources may follow from the efforts of those affected to recreate the environment, which in some cases would have involved settings within their standing arrangements. Such a restorative process is illustrated by efforts to restore urban forests in cities that had sustained heavy damage during wars, which involved private as well as institutional actors of different kinds (see Cheng & McBride, 2006, writing of Tokyo and Hiroshima; Lacan & McBride, 2009, writing of Sarajevo; and Stilgenbauer & McBride, 2010, writing of Hamburg and Dresden).
15. The further discourse within restorative environments theory can now build on a voluminous body of empirical findings, critical commentary, and other forms of experience concerning validity and utility issues related to the two theories. These include, for example, the validity of their evolutionary assumptions (e.g., Haga, Halin, Holmgren, & Sörqvist, 2016; Joye & Dewitte, 2018; Joye & van den Berg, 2011); the representation of their core constructs, with related issues of research design, measurement, and analysis (e.g., Basu, Duvall, & Kaplan, 2019; Berto, Massaccesi, & Pasini, 2008; Beute, Kaiser, Haans, & de Kort, 2017; Chang, Hammitt, Chen, Machnik, & Sua, 2008; Han, 2018; Hartig & Jahncke, 2017; Hartig, Korpela, Evans, & Gärling, 1997; Herzog, Maguire, & Nebel, 2003; Laumann, Gärling, & Stormark, 2001; von Lindern, 2015); the representation of particular settings in environmental sampling, from beaches, botanical gardens, cafes, and cemeteries to monasteries, museums, town squares, and zoos (e.g., Carrus et al., 2017; Colléony et al., 2017; Hidalgo, Berto, Galindo, & Getrevi, 2006; Kaplan et al., 1993; Nordh, Evensen, & Skår, 2017; Oullette, Kaplan, & Kaplan, 2005; Scopelliti, Carrus, & Bonaiuto, 2019; Staats et al., 2016; Thwaites, Helleur, & Simkins, 2005; White & Gatersleben, 2011; Wyles et al., 2019); the representation of multiple sensory dimensions, as with soundscape (e.g., Benfield, Taff, Newman, & Smyth, 2014; Jahncke, Eriksson, & Naula, 2015; Ratcliffe, Gatersleben, & Sowden, 2013); and the need for sampling of people that addresses particularities of different groups, for example, as related to occupations (e.g., Betrabet Gulwadi, 2006; Cordoza et al., 2018) or life cycle stages (e.g., Collado, Staats, & Corraliza, 2013; Larson et al., 2018; Schutte et al., 2017; Scopelliti & Giuliani, 2004). As for opening for further dialog with other areas of theoretical and practical endeavor, the further work with SRT and ART can build on examples that have addressed phenomena such as creativity (Atchley, Strayer, & Atchley, 2012; Williams et al., 2018); emotion-regulation and self-regulation (e.g., Beute & de Kort, 2014; Korpela, 1992; Korpela, Hartig, Kaiser, & Fuhrer, 2001; Scopelliti & Giuliani, 2004; Taylor et al., 2002); place attachment and place identity (e.g., Knez & Eliasson,

2017; Korpela & Hartig, 1996; Ratcliffe & Korpela, 2016); pro-environmental behavior (e.g., Collado & Corraliza, 2015; Hartig, Kaiser & Strumse, 2007); and salutogenesis (Von Lindern et al., 2017). Similar dialog also shows in many practical arguments for using natural elements and settings to promote effective functioning and health, as with acquisition of mindfulness meditation techniques (Lymeus, Lindberg, & Hartig, 2018, 2019; cf. S. Kaplan, 2001); the treatment of depression (e.g., Berman et al., 2012; Bratman et al., 2015; Gonzalez et al., 2010; Stigsdotter et al., 2011); and prevention and reduction of stress and mental fatigue in classrooms (e.g., Li & Sullivan, 2016; van den Berg, Wesselius, Maas, & Tanja-Dijkstra, 2017), offices (e.g., Evensen, Raanaas, Hagerhall, Johansson, & Patil, 2015; Jahncke, Hygge, Halin, Green, & Dimberg, 2011; Kaplan, 1993), factory canteens (Bellini, Hartig, & Bonaiuto, 2019), diverse health care settings (e.g., Dijkstra, Pieterse, & Pruyn, 2006; Raanaas et al., 2012; Ulrich, Bogren, Gardiner, & Lundin, 2018), and the residential context (e.g., R. Kaplan, 2001; Kuo & Sullivan, 2001; Wells & Evans, 2003).

16. It perhaps goes without saying, but in speaking of the extended framework here, I am not only referring to the contents of Table 5.4 but also the accounts of the respective theories given in the text here and elsewhere.
17. I am probably not the only person of my generation who still enjoys pleasant childhood memories of joining my parents and siblings on Sunday evenings to watch Mutual of Omaha's Wild Kingdom, following zoologists Marlin Perkins and Jim Fowler as they engaged with exotic nature we wouldn't otherwise ever see together, and during time we could all relax after sharing a good meal. Such experiences stand in stark contrast to discussions of effects of television watching by Herzog, Black, Fountaine, and Knotts (1997) and Kaplan and Berman (2010).

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Chapter 6
Knowing Nature in Childhood: Learning and Well-Being Through Engagement with the Natural World

Louise Chawla

6.1 Introduction

In 2019, the journal *Frontiers in Psychology* published a special section on "nature-based learning"—a new term introduced to the field of psychology through this collection of articles (Kuo & Jordan, 2019). Nature-based learning forms one piece of a large field of study of benefits and risks associated with people's direct contact with nature. This research shows that when people have nature around them in safe green spaces, they benefit in many aspects of their lives: physical health, mental health, cognition, social connection, and happiness (van den Bosch & Bird, 2018). In these studies, "nature" covers everything that has its own dynamic of growth and change independent of human creation: from microbes to mountains, from wilderness to urban gardens and potted plants.

Nature-based learning is a multi-faceted term that applies to all ages. It includes nonformal learning during programs in parks, nature centers, zoos, and other places that bring nature to people; informal learning when people freely engage with nature on their own or with family and friends, and formal learning when nature is introduced into universities, schools and preschools, or students have lessons outdoors in natural surroundings (La Belle, 1982). It covers both active engagement and passive exposure during learning processes:

> Nature-based learning, or learning through exposure to nature and nature-based activities, occurs in natural settings and where elements of nature have been brought into built environments, such as plants, animals, and water. It encompasses the acquisition of knowledge, skills, values, attitudes, and behaviors in realms including, but not limited to, academic achievement, personal development, and environmental stewardship. (Jordan & Chawla, 2019, p. 2)

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_6

Nature-based learning involves learning with nature in nearby surroundings, even when nature is reduced to plants and animals in a room or views of trees outside a window, and even when the focus of attention is another subject or skill. A number of controlled studies, for example, show that children perform better in school and feel more positive about their classroom when they have trees and other vegetation in their school surroundings (Browning & Rigolon, 2019), take lessons outdoors in green areas (Kuo, Browning, & Penner, 2018), or have potted plants or green walls indoors (Han, 2009; van den Berg, Wesselius, Maas, & Tanja-Dijkstra, 2016).

This chapter focuses on one part of this broad field of study: learning about nature through direct engagement, during the period from infancy through adolescence. It considers what children learn when they engage with nature through their body, senses, understanding, and emotions—often through spontaneous exploration. In this process, children discover properties of the natural world *and* their own capabilities relative to nature. When other people are present, nature-based learning includes discovering how others respond to nature, and coordinating shared engagement.

By focusing on "knowing nature" in the sense of direct engagement with nature, this chapter emphasizes young people's agency in relationship with nature. Keywords here are "relationship" and "agency." This emphasis distinguishes the literature reviewed in this chapter from studies that seek to determine the "dose" of nature needed for measurable benefits for human health and well-being (Shanahan et al., 2016; White et al., 2019). Like the broad definition of nature-based learning, research on effective doses includes passive exposure to nature, such as trees outside a window or a walk through a park with other preoccupations on one's mind. Finding salutary doses of nature that improve public health is important for the planning of cities and the siting of buildings, but a "dose of nature" suggests a medical model of passive patients under treatment by experts. Through its sole focus on what people receive from nature, this approach neglects what they do in relationship with nature, and what these relationships may contribute to well-being. Reviews of research on children and nature show that children gain significant benefits whether they are passively exposed to nature or actively engaged (Chawla, 2015; Kuo, Barnes, & Jordan, 2019; McCormick, 2017; Norwood et al., 2019; Tillmann, Tobin, Avison, & Gilliland, 2018; Vanaken & Danckaerts, 2018; Wells, Jimenez, & Mårtensson, 2018). Opportunities for agency, however, are essential for young people's development as well-functioning people (Bandura, 1997; Ryan & Deci, 2017). Therefore, this chapter focuses on opportunities for agency that the natural world affords and the relationships that children form, with nature and other people, as they encounter the natural world.

This chapter begins by putting this subject in context. The nature that people currently know is undergoing rapid change and degradation. According to the Intergovernmental Panel on Climate Change (2018), the viability of the biosphere is at risk as the atmosphere is warming from emissions of greenhouse gases. One effect, according to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019), is the accelerating extinction of species, with at

least a million species at imminent risk. This rate of loss threatens to dismantle basic functions of ecosystems on which all life on Earth depends. In the face of this crisis, some natural and social scientists are arguing that it is critical to broaden the current emphasis on what people take or passively receive from nature, as a measure of human well-being, to include the quality of human relationships with nature (Chan et al., 2016). Their arguments reinforce the importance of understanding what people do *with* nature, beyond what nature does *for* people.

This chapter begins by noting this relational shift in current thinking about the importance of nature for human well-being. It then places children's evolving agency and relationship with nature in a capabilities approach to human development, with attention to the claim by Nussbaum (2011) that affiliation with nature is a core human capability and an essential dimension of a fully realized human life. Because the ecological psychology of Gibson (1979) is grounded in agency, relationship, and people's evolutionary embeddedness in the natural world, this chapter also places itself in this theoretical framework. With this foundation, it identifies key experiences as young people come to know nature through direct engagement, and how these experiences affect their relationship with nature and other people, as well as their general well-being. Because survival of the habitats and species that children are coming to know cannot be taken for granted, the chapter closes by examining how young people are confronting information about global environmental change. Research on this topic indicates that a sense of social trust and a sense of personal and collective efficacy can help prepare young people to maintain hope as the world around them undergoes radical change. The conclusion revisits the themes of agency and relationship in children's encounters with nature, arguing that they deserve a prominent place in the study of nature-based learning and children's well-being.

6.2 A Relational Turn in Ecosystems Thinking

The premise of this chapter, that active engagement with nature is critical for children's learning and well-being, is consistent with the new attention to relational values of ecosystems (Chan et al., 2016). This turn to relational values fits well with children's active ways of knowing nature, and it invites appreciation for children's embodied, imaginative and creative ways of engaging with nature as forms of relationship with merit in the moment, as well as preparation for later stages of development. It also entertains ways that different cultures value the natural world, including indigenous cultures, and acknowledges that there can be many motivations for protecting and restoring ecosystems. This section explains the significance of this shift by placing it in a brief history of contrasting views of how people value nature.

In the Western world, a belief that people can find restoration and well-being in a simple life in nature extends back to the pastoral poetry of ancient Greece and Rome. As the Industrial Revolution gathered momentum, Romantic poets like William Wordsworth expanded the pastoral theme when they turned to nature as a

source of health, restoration, spiritual renewal, creative inspiration, and connection with all living things (Weinfield, 1991). Wordsworth presented the child as a being who is innately open to intuitions of a spirited universe (Chawla, 1994). In the United States, Romantic ideas found expression in Transcendentalism (Myers Jr., 2012). Frederick Law Olmsted, the founder of American landscape architecture, cited this tradition when he argued for the necessity of extensive urban park systems, claiming that, "Charming natural scenery is . . . a therapeutic agent of vital value" (Olmsted, 1881, p. 22).

In the United States, westward expansion pushed aside Native Americans and their relationship with the natural world, which was deeply rooted in ancestral places. In this indigenous view, people belong to the land—they are not its "owners," and all living things and elements of nature are relatives (Whitt, Roberts, Norman, & Grieves, 2001). Because humans and other species are joined to each other through reciprocal respect and obligations and know each other through intimate communication, people have a responsibility to maintain health, balance and survival for the land and all its beings as well as human cultures. These voices were largely silenced as the New World was aggressively exploited for food and industrial products for growing urban populations.

The destruction of wild ecosystems in the nineteenth century led to two major reactions. One, in the Romantic and Transcendentalist tradition, sought to protect nature for its intrinsic value and as a place where urban people could find health and restoration. A leading voice was John Muir, who campaigned for the protection of wilderness and the establishment of national parks (Kline, 1997). Olmsted (1881) made a similar argument for the importance of parks in urban areas. The conservation movement emerged with other motives, advocating the wise management of land and waters so that resources could be sustained for present and future generations. President Theodore Roosevelt expressed these objectives when he supported scientific forest management: "Forest protection is not an end in itself; it is a means to increase and sustain the resources of our country and the industries which depend upon them" (cited in Gottlieb, 1993, p. 23). The term "conservation" was coined under Roosevelt's administration to represent this idea of the regulated use of natural resources. Proud of their role as scientists, Roosevelt's advisors for natural resource management rejected unscientific "romantics" like Muir (Kline, 1997).

Valuing nature for what it provides for people and industry, using market-based calculations, has persisted in the science of ecosystem management. In the twentieth century, "services" like the production of soil and oxygen and the purification of water and air were added to traditional "goods" like minerals, timber, crops, and fish as benefits that humans derive from nature (Costanza, Perrings, & Cleveland, 1997). At the beginning of the twenty-first century, the Millennium Ecosystem Assessment (2005) divided all benefits into three types: provisioning services (or "goods"), regulating and maintenance services like soil production and water purification, and cultural services like aesthetic values, spiritual values, cultural identity, and recreation in nature. This new category of cultural services recognizes nonmaterial benefits. In the latest revision of the Common International Classification of Ecosystem Services, cultural services are divided between active interactions like recreation

and "more passive and intellectual operations" like education and aesthetic experiences, but the well-established benefits for health and well-being that people gain from direct contact with nature remain absent (Haines-Young & Potschin, 2018).

Chan et al. (2016) challenged the purely instrumental view of nature's value reflected in classifications of ecosystem goods and services, which only accounts for what nature does *for* people. He and his colleagues observed that many people value their experience of nature as a relationship *between* themselves and nature. They argued that, for too long, discourse about nature has been divided between nature's intrinsic value that requires protection and its instrumental value that motivates conservation. Although both are important, they noted, "thinking only in these terms may miss a fundamental basis of concern for nature"—people's enjoyment of relationship with nature as an end in itself (Chan et al., 2016, p. 1463). Opening the door to relational values invites attention to experiences like love and care for nature, feelings of kinship with other living things and the Earth, environmental identities, place attachments, a sense of accountability to nature, the satisfaction people feel when they conserve and restore nature, and the social and community bonds that they build when they engage with nature together. Expanding an appreciation of ecosystem services in this way creates a space where Romantic and Transcendentalist voices, indigenous voices, and children's ways of knowing nature can be heard. Chan et al. (2016, p. 1465) contend that, "Attending to such values is key to the genuine inclusion of diverse groups in environmental stewardship and to achieving social-ecological relationships that yield fulfilling lives for present and future generations."

This chapter will seek to demonstrate that relational values are central to children's engagement with nature. Research that measures doses of exposure to nature may be accurate to describe adults strolling through a park or looking out a window, and many studies with young people suggest that they too benefit from passive exposure to nature around their homes and schools (Faber Taylor & Kuo, 2009; Faber Taylor, Kuo, & Sullivan, 2002; Han, 2009; Kuo et al., 2018; Torquati, Schutte, & Kiat, 2017; van den Berg et al., 2016). Yet when children are free to meet nature on their own terms, they commonly engage through full-bodied movement (Hart, 1979; Kreutz, 2015; Moore, 1986; Sobel, 2002) and express their nature experiences with words of interaction and relationship (Green, 2018). This chapter presents active relationships with nature as an important dimension of children's development and well-being.

6.3 A Capabilities Theory of Human Relations with Nature

Chan et al. (2016) refer to indigenous beliefs, feminist ethics of care, Pope Francis's encyclical *On Care for Our Common Home* (Francis, 2015), and Aristotle's concept of *eudaimonia* in the *Nichomachean Ethics* (fourth century B.C.E./2014) as examples of relational values. They note that good relations depend on qualities like respect, trust, empathy, care, reciprocity, mindfulness, and ethical purpose, whether

relations extend to other people or the natural world. Regarding Aristotle, they observe, "Value is derived from a thing's or act's contribution to a good life, including adhering to one's moral principles and maintaining the roots of collective flourishing" (p. 1464). The ethical foundation of this chapter is the work of Sen (1993) and Nussbaum (2011), who combined Aristotle's ideas with contemporary perspectives on human rights as they created their capabilities approach to human development. Their work is relevant because they emphasize the importance of providing conditions that enable people to realize all their capabilities and because Nussbaum (2011) proposed that "affiliation with other species" is a central capability that must be realized for a fully flourishing human life. She defined it as "being able to live with concern for and in relation to animals, plants, and the world of nature" (p. 34). She observed that this capability is fundamental for the enjoyment of other capabilities because it includes care for the natural world, and thriving ecosystems are vital for human well-being now and in the future (pp. 163–164).

Following Aristotle, Sen (1993) and Nussbaum (2011) note that each species is distinguished by a set of central capabilities, or capacities "to be and to do," and individuals flourish when they find conditions to exercise all capabilities associated with a complete life for their species. This means that central capabilities are not just instrumental to achieve other ends—they have value in themselves. Humans flourish under conditions that enable them to exercise their full range of capabilities in accordance with virtue, which Aristotle defined as the balanced use of judgment and action to maintain integrity and health within the self and to establish good relations with other individuals and society (*Nichomachean Ethics*, Book I.7). According to Sen (1993) and Nussbaum (2011), societies need to collectively debate the capabilities that are essential for well-being; but as an invitation to discussion, Nussbaum (2011) proposed 10 central capabilities: life; bodily health; bodily integrity; control over one's environment; senses, imagination and thought; emotions; play; practical reason; affiliation with other people; and affiliation with other species. Implications of these capabilities for children's relations with nature are explored in Chawla (2015) and suggested in Table 6.1, and different forms of engagement with nature that support the development of central capabilities are summarized in Table 6.1.

Capabilities are interdependent. Children's ability to play, for example, exercises their senses, imagination and thought, and relies on these capacities in turn. Children draw on social affiliations for group play, and play is a way to form friendships and learn social cooperation and negotiation. Children often seek out secret spaces or build playhouses where they can control their environment, and these spaces become a locus for play and imagination and for gathering with friends. When children engage with others to negotiate control of shared environments, practical reason becomes important (the ability to identify good ends and the means to achieve them), and it develops through these activities. When children participate in any of these activities in nature, they have opportunities to develop affiliation with the natural world. This co-creation of capabilities will be described in examples of learning in nature in this chapter.

Table 6.1 How children's learning in nature promotes the development of central capabilities

Ten Central capabilities	**Benefits of Learning in Nature for Children's Development**
(Adapted from Nussbaum, 2011)	A summary of research presented in this review
Life: Being able to live to the end of a life of normal length Not dying prematurely **Bodily health:** Being able to have good health **Bodily integrity:** Being able to move freely from place to place **Senses, imagination, and thought:** Being able to use the senses and have pleasurable experiences; to imagine, think, and reason **Emotions:** Being able to have attachment to things and people outside ourselves; to feel a range of emotions; not having one's emotional development blighted by fear, anxiety, or restricted experiences **Practical reason:** Being able to form a conception of the good and engage in critical reflection about the planning of one's life **Affiliation:** Being able to live with and toward others, to recognize and show concern for other human beings **Other species:** Being able to live with concern for and in relation to animals, plants, and the world of nature **Play:** Being able to laugh, to play, to enjoy recreational activities **Control over one's environment:** Being able to hold property and have property rights; having the right of political participation	• Learning affiliation with nature, which is a precondition for sustaining life across generations • Moderate and vigorous physical activity • Physical fitness, balance, and coordination • Freedom to move, explore, and manipulate the environment • Rich multisensory experiences in the natural world • Imaginative and creative play; resourceful use of nature's loose parts • Extended dramatic play narratives • Understanding dynamics of natural processes • Experiencing the range of emotions that discoveries in nature evoke • Experiences of environmental competence • Refuge and reverie in nature • Establishing and maintaining play cultures in nature • Confronting environmental challenges and working with others to address them • Cooperative social play in nature • Sharing interests in nature with others • Apprenticeships with others, and teaching less skilled others, to competently accomplish goals and tasks in nature • Learning about nature from direct engagement • Empathy and concern for animals and plants by witnessing their lives • Socialization to express care for other living things • Childhood play in nature forms a foundation for lifelong care for nature and adult recreation in nature • Creative play in nature, alone, and with others • Appropriating and creating personal spaces in nature • Engaging in collective efforts with others to protect and restore the natural world

6.4 A Psychology of Agency and Relationship

Two theoretical frameworks in psychology are especially compatible with the *Nichomachean Ethics* and a capabilities approach to development. Ryan and Deci (2017) align their theory of basic psychological needs with Aristotle's principles of eudaimonic happiness, and they agree with the claim of Sen (1993) and Nussbaum (2011) that societies have an obligation to create conditions that support human flourishing. Rather than the 10 central human capabilities that Nussbaum suggests, they propose that three basic psychological needs must be realized for well-being: autonomy, competence, and relatedness. Within this framework, they recognize the importance of nature experiences. Referring to their own studies and work by others, they note that being outdoors in nature is associated with a sense of vitality, and that exposure to nature enhances people's valuing of intrinsic goals, feelings of autonomy, prosocial choices, community cohesion, and sense of relatedness with nature (Ryan & Deci, 2017, pp. 263–266). Like Nussbaum, they suggest that nature experiences may be vital for healthy development.

Ryan and Deci's theory of self-determination offers a useful perspective on the value of children's relationship with nature, as this chapter shows that children express agency, autonomy, and relatedness in nature. Primarily, however, this chapter builds on the ecological theory of James Gibson (1979). Like Sen (1993), Nussbaum (2011), and Ryan and Deci (2017), ecological psychology shares an emphasis on the importance of agency and choice in engaging with the world, along with the need for supportive environments. In addition, it pays close attention to embodied experiences of the physical world and the role of physical as well as social environments in constraining or enabling development. Therefore, where Sen and Nussbaum provide an ethical framework for this chapter, the ecological psychology of Gibson and his colleagues provides its guiding psychological theory—though one with similar ethical implications.

The work of Gibson and his colleagues is well adapted to the study of children in nature because it is grounded in the evolutionary theory of Darwin (Heft, 2001). It assumes relationship between people and the rest of nature as our human origin: relation with nature is not something that people construct, it is a given that they ignore at their peril. Key principles of ecological psychology provide terms for investigating this relationship.

Gibson (1979) noted that humans, like other animals, alter the environment to provide themselves with more of what they want and less discomfort and danger. He cautioned, however, that "It is a mistake to separate the natural from the artificial as if there were two environments; artifacts have to be manufactured from natural substances" (p. 130). He also rejected any form of dualism that puts the human mind in a realm apart from the natural environment:

> It is also a mistake to separate the cultural environment from the natural environment, as if there were a world of mental products distinct from the world of material products. There is only one world, however diverse, and all animals live in it, although we human animals

> have altered it to suit ourselves. We have done so wastefully, thoughtlessly, and, if we do not mend our ways, fatally. (Gibson, 1979, p. 130)

For Gibson, knowing is always embodied, and in the end, human knowledge and constructions must respect the limits and possibilities of the natural world in which people are embedded.

6.4.1 The Legacy of William James

In taking this position, Gibson follows William James, whose ideas he absorbed primarily through his graduate advisor at Princeton, Edwin Holt, a former student of James at Harvard (Heft, 2001). James, Holt, and Gibson integrated the evolutionary theory of Darwin into psychology, which required rejecting a dualist separation between the human mind and the natural world. James's (1912/1976) alternative to dualism was his philosophy of radical empiricism, which proposed that the world consists of primal material, which appears to organisms as a ceaseless stream of experience that they can directly apprehend. Like James, Gibson (1979) began with the position that organisms can directly know the world, as each species co-evolved with its surrounding habitat with perceptual systems adapted to detect resources needed for healthy functioning and survival. From this common starting point, both men proceeded to the following areas of agreement (Gibson, 1979; James, 1912/1976; see also Heft, 2001).

1. In contrast to psychologies that assume that human minds impose value, meaning, and structure on a world that is otherwise a neutral ground or a disconnected series of sense data, they begin with a world that comes already full of value, meaning, and structure for organisms to detect.
2. Organisms live in a continuous stream of experience that is effectively infinite in its complexity and possibilities for perception and action. Therefore, the defining characteristic of knowing, for humans as well as other species, is selectivity. From the multiplicity of information around them, organisms select objects and events to notice.
3. Every place and every object and organism in it has a history that it brings to the current of experience. Each moment in time and place is a meeting point where these histories come into relation with each other. People, for example, may bring immediate needs, like a hungry person attracted to a ripe fruit. They also bring habits and predispositions that they acquire from family, friends, teachers, and others regarding what to notice and how to respond. Their responses also reflect the temperament and talents that mark them as individuals.
4. Perception of the world is always embodied. The world experienced comes at all times with an individual's body as its center—center of vision, center of action, center of interest, center of emotions. Therefore, perceiving the world always involves co-perceiving the self.

On the foundation of immediate experience, people construct thoughts, imaginings, meanings, and purpose.

People think about what they perceive, turn their thoughts into concepts, and fix their concepts in words and representations. At this point, James (1911, pp. 52–53) noted, "Percepts and concepts interpenetrate and melt together, impregnate and fertilize each other." Concepts enable people to communicate through words and pictures and build societies and sciences. They give people efficiency and power as they shape their world collectively. Both James (1911) and Gibson (1979) cautioned, however, that as well as accurate representations of direct experience, concepts can include fictions, distorting stereotypes, and sciences built on false assumptions. James (1911, pp. 78–97) warned against the hazards of concepts that are not continually re-evaluated and revised against direct experience. Similarly, Gibson viewed human ideas and constructions as ultimately accountable to the realities of the natural world (Gibson, 1979, p. 130).

6.4.2 Key Concepts in Ecological Psychology

James Gibson, his wife Eleanor Gibson, who was a prominent psychologist in her own right, and their colleagues in ecological psychology gave fresh expression to the preceding principles that they share with James. Gibson (1979) gave a distinctive emphasis to the role of movement and action in detecting and selecting information in the world. This facet of his work is especially relevant to young children's ways of knowing, which Piaget (1952) aptly characterized as sensorimotor in the first 2 years of life. Gibson (1979) demonstrated, however, that sensorimotor engagement remains essential for knowing how to function in the world at every point in life. As people move through the world, see it, touch it, grasp it, taste it, hear it, they learn its multisensory properties in three dimensions.

Through his concept of affordances, Gibson created a language to talk about how possibilities for perception and action emerge in relations between an organism and the world. According to Gibson (1979, p. 127), "The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill." In the words of Reed (1996a, p. 8), "Affordances are the *use values* of objects, places, and people. As such they are not merely properties of the environment, but properties of the environment as they relate to human use and abilities." In this relationship, duality between a subject and object dissolves. Gibson (1979, p. 129) explained: "An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior." Affordances are present in the environment whether an organism detects and uses them or not, but they come to life, so to speak, when they are actualized through use. Both Eleanor and James Gibson (Gibson, 1969; Gibson, 1979) demonstrated that people have an inborn tendency for perceptual learning in order to read important features of their environment, like affordances, with increasing accuracy.

Affordances vary between species, depending on the features of the environment that species are adapted to detect and use for survival. They also vary at different stages in an organism's life and between individuals. A patient dog, for example, affords patting and tail grabbing for a toddler, but the dog affords the game of throw-and-fetch with a ball only for an agile older child or adult. During the game, the ball affords catching in the dog's mouth and the child's hand only if it is the right size for each to grasp. These features are only relevant, however, if the child is not afraid of dogs.

Gibson (1979) recognized that the information in the environment that people notice and the affordances that they use are influenced by their culture and society. People have massively transformed environments to serve human convenience, comfort, and safety. In this sense, children are born into worlds that are simultaneously natural and artificial. But even when people enter natural environments, the experiences, and affordances that they seek vary across cultures. Outdoor practices of children in the Menominee Indian tribe in Wisconsin, for example, typically place nature in the foreground, such as forest walks, berry picking, harvesting medicinal plants, hunting, fishing, and trapping; whereas children of European descent usually go outdoors for activities that background nature, like soccer, dirt biking, snowmobiling, and boating (Bang, Medin, & Atran, 2007). Others have taken social and environmental implications of Gibson's ideas further, and this chapter will weave their work into the following sections.

The pages ahead apply principles of ecological psychology as they address children's engagement with nature and the functions that it serves in development. Gibson's belief in direct perception of the world, his emphasis on movement and agency in coming to know the world, and his concept of affordances are central ideas. Eleanor Gibson and colleagues (E. Gibson, 1969; Gibson & Pick, 2000) studied perceptual learning and social referencing, which help explain how children learn to notice and respond to features of their environment. Edward Reed (1996b) argued that dynamic interactions, when people share joint attention to objects, play a formative role in shaping what children notice and value. During joint attention, companions can also encourage children's tendency for empathy with other living things. Reed also discussed how other people both promote and constrain children's opportunities for free action in the environment (Reed, 1993, 1996b), and why freedom to engage with the world directly and autonomously is essential for creative discovery and collaborative action (Reed, 1996c). Building on the ideas of Gibson and Reed, Kyttä (2006) defined characteristics of environments which most effectively promote children's competent development. The following sections weave these voices in ecological psychology together with other scholars who have done related work.

The three sections that follow review three major means through which children know nature: social interactions with other people during joint encounters with nature, autonomous free agency and discovery, and social action to address environmental challenges. In taking up these topics in turn, this chapter moves roughly from early childhood, to the middle years of childhood, to adolescence—but only roughly, as all of these ways of engaging with nature can occur at every age. As it

moves through these topics, the chapter assembles evidence for benefits of nature-based learning for child and adolescent development. When Kuo et al. (2019) reviewed research on nature-based learning, they found converging evidence that learning in nature enhances academic achievement, personal development, and environmental stewardship. In seeking mechanisms that might explain these results, they proposed that being in nature has direct positive effects on learning: restorative effects that promote focused attention, reduce stress, and contribute to impulse control; increased physical activity and fitness; and a high level of motivation, enjoyment, and engagement. All of these benefits are associated with better learning. Natural settings also provide a more supportive context for learning: more prosocial and cooperative social relations; loose parts for creative self-directed play; and calmer, quieter, and safer surroundings. This chapter gathers evidence for these outcomes.

6.5 Social Encounters with Nature

"What is the developmental legacy of the sensorimotor period?" asked Fogel (2003, p. 219), who studied preverbal infants. He proposed that it constitutes the origin of the embodied self, when "the individual acquires ways of relating, of being-in-the-world, that are foundational to every later experience of relationship" (p. 219). During this time, infants and toddlers establish a connection with their physical bodies, their senses and feelings. They establish a connection with important other people, and they establish a connection with the natural world. Fogel (2003, pp. 228–229) suggested that "Spending early infancy in direct contact with nature—smelling the earth and feeling the sun on one's body or in a primarily manufactured indoor environment—can lead to a lifelong pattern of relationship of connection to or of disconnection from the earth." He was concerned that infants who lack direct experience of sunlight, night, the climate, seasons, elements of the earth, plants, and animals "may unwittingly indulge in a relational pattern of control rather than creativity, of totalizing the earth rather than seeing its infinite possibilities" (p. 230). He suggested that a legacy of an infancy exposed to nature's diverse tastes, textures, sights, sounds, and smells may be an appreciation for the enrichment of the senses for their own sake. He also suggested that experiences like the morning sun create a corresponding way of relating to the self, in this case feeling happy, warm, and comforted in the sunlight.

Fogel (2003) noted that there is little research that explores his suggestions. This remains true today. Longitudinal research is lacking to understand how experiences of nature in infancy may contribute to a connection to nature in later life; and given young children's rapid learning and adaptation, it would be difficult to isolate the influences of infant experiences. What is clear is that other people mediate an infant's relations with nature. As humans evolved, all experience was in nature; but currently, other people determine how much nature infants experience. They

construct worlds where nature is nearby in farms, parks, and gardens, or entirely built over. When nature is nearby, they control children's access to it.

The ecological psychologist Edward Reed (1993, 1996b) described interactions between children, their environment, and other people as fields of promoted action, constrained action, and free action (adapting ideas in Valsiner, 1987). When others make nature accessible and encourage children to engage with it, they create a field of promoted action. When they allow children to engage with nature on their own terms, with little direction or interference, they give children a field of free action for autonomous exploration. Reed (1996b) noted, however, that much of early child rearing consists of creating fields of constrained action to protect young children from dangers in the environment. The younger the child, the less likely he is to be left on his own outdoors and the more likely he is to be carried on a caretaker's body or contained in a crib.

6.5.1 Social Referencing, Observational Learning, and Joint Attention

For a child who is not yet walking and running, being carried about can be a field of promoted action as well as a constraint. It enables an infant to move through space and see sights she could not reach on her own. In the process, three critical means for learning about meaning and values in the world come into play: social referencing, observational learning more generally, and joint attention.

Social referencing occurs when children encounter a novel situation in the environment and they are uncertain how to respond. They look to others, such as their mother, for cues (Gibson & Pick, 2000). For example, if a boisterous dog comes bounding up and mother smiles, the situation is evidently safe. If she looks alarmed, it is not. For babies and young children, who encounter many things that are novel and uncertain, social referencing is an important guide to learning how to respond to the world.

In a general sense, observational learning includes any process of learning social expectations and appropriate behaviors by paying attention to what others do, and it remains important across the life span (Bandura, 1986). It is a means by which people learn "propriety," as Gibson (1950) called the practice of socially established norms. Along with explicit teaching, it is how children become what Reed (1996b) called "a proper person" who complies with the conventions of society.

By 3–6 months, infants begin to follow the gaze of another person, and by 12 months, most can engage in joint attention with their caretaker in the sense that two or more people direct their attention to the same object, event, person, or place, with mutual understanding that they are sharing attention (Carpenter & Liebal, 2011). Reed (1993, 1996b) observed that the achievement of joint attention is a major milestone as children begin to coordinate with others what to notice in the world, how to interpret what it means, and how to respond. If, as James (1912/1976)

and Gibson (1979) claimed, selectivity is the defining characteristic of knowing, joint attention is the means through which people select what to know together. Formative in childhood, it remains fundamental for social interactions, social learning, and the use of language across the life span (Mundy & Acra, 2006).

Joint attention combines with social modeling, when others suggest through their own behavior the appropriate way to act, and it commonly evokes emotion (Bandura, 1986). Observations of 1-year-olds and their mothers sharing attention to toys in laboratories show that they exchange emotion through facial expressions, gestures, intonations, and communicative looks, conveying in effect, "That's intriguing!" or "That's not interesting—let's look for something else" (Carpenter & Liebal, 2011). As children learn what others notice, and how others respond, they learn how the meanings and values inherent in things are interpreted by their family and society. No research has yet examined how different responses to nature during episodes of joint attention influence a child's subsequent encounters with similar phenomena; but Rachel Carson's book *The Sense of Wonder* is largely in praise of shared appreciative attention to nature by young children and caretakers, from details like seedlings and sand crabs to panoramas of awe like the star studded sky and the ocean (Carson, 1956). In Carson's view, these experiences encourage a sense of wonder about the universe that can last a lifetime, opening both child and adult companion to the joy, excitement, and mystery of the natural world (see Fig. 6.1a, b).

The most systematic glimpse into a small child's developing relationship with nature is *The Goodness of Rain* by Ann Pelo (2018), an early childhood educator who spent a year taking a little girl into nature near her suburban Seattle home, as she grew from 12 to 24 months. Each morning, they ventured into nature together, to the trees and gardens that lined neighborhood streets, and to local parks, rivers, and lakes. Each afternoon, as the child napped, Pelo recorded how they spent their time, what captured the little girl's attention, and how they each responded.

For example, Pelo described their encounter with a sunflower, when the baby was strapped to her chest, eye level with the flower:

Fig. 6.1 (**a**, **b**) Through joint attention, a boy and his father indicate to each other what is worth noticing and how to respond to it. Photos by Karen Malone

> The flower blooms in bold yellow perfection. Moving purposefully across the flower's dark center, a bee gathers pollen. We watch, Dylan and I, as the bee burrows into the bristle-stiff stamens, dusts its belly with pollen and, then, with quick flicks, transfers the yellow dust from its body into the pouches on its back legs. The bee's movements are elegant and compelling, and Dylan and I watch long and in silence as it flies from one tiny patch of the sunflower's center to another, burrowing, then combing the pollen from its belly. (Pelo, 2018, p. 41)

Pelo had alternatives. She could have chosen not to stop at the flower, or if she stopped, she could have cried in alarm, "A bee! Bees sting!" and rushed them away. In contrast, the silent minutes at the sunflower carried the implicit message that the flower and bee were worthy of attention. They merited slowing down and taking time to watch. By not disturbing the bee or the flower, Pelo and the baby allowed these other living things to exist in their own ways of being—a rudimentary form of respect. Because Pelo let the baby watch unhurriedly, she also communicated respect for the child and her interests.

This episode challenges a popular theory often used to explain why people benefit from exposure to nature, the Attention Restoration Theory of Kaplan and Kaplan (1989; also Kaplan 1995). The Kaplans drew on a distinction made by William James (1892) in *Psychology: The Briefer Course* between voluntary attention that is employed when something does not attract attention of itself, but it is nevertheless important to attend to, and involuntary attention that requires no effort. They proposed that voluntary attention fatigues the mind, whereas involuntary attention allows the mind to rest, and that nature is restorative because it contains abundant opportunities for involuntary attention. Heft (2010; Chap. 8 this volume) challenged this reliance on James, noting that James never proposed that attention is something that can be depleted. With Neilson, Craig, Travis, and Klein (2019), he also noted that the notion of attentional fatigue has no clear connection to the sciences of information processing and attention. The theory is also problematic relative to the episode of the baby, companion, flower, and bee.

To claim that attention to the flower and bee were "involuntary" twists the normal usage of this word, which according to the *Oxford Dictionary of English* (Stevenson, 2010) applies to actions done without will or conscious control. Neither baby nor companion were compelled to stop at the flower and watch for an extended time. Although the baby was strapped to Pelo's chest, she showed no resistance. Their attentiveness was not involuntary in the sense of compelled or unconscious, but neither was it voluntary in the sense that they needed to pay attention to the bee and flower even if these things did not attract attention of themselves. Acknowledging that "voluntary" and "involuntary" can be confusing, Kaplan (1995) suggested substituting the words "directed attention" and "fascination": but these words also fail to fit the experience at the flower. Clearly Pelo and the baby were fascinated by the bee in the sunflower, but to claim that fascination was opposed to directed attention in this case is to again twist the ordinary meaning of words. According to the dictionary, "directed" means supervised or controlled, as well as aimed or focused in a particular direction. No one outside the child-caretaker dyad was directing their attention, yet the incident was guided in the sense that Pelo stopped at the sunflower

and let the baby observe the bee at eye level. It was a "field of promoted action," to use Reed's (1993, 1996b) term. Their attention was directed in the sense that they focused on the bee in the flower rather than spending these minutes looking in other directions; but it was simultaneously directed and fascinated.

The child and caretaker at the flower exemplify some characteristics of a naturalist's attention: close, extended, directed attentiveness to animals, plants, landforms, and weathers. Gardner (1999) proposed that there is a naturalist's intelligence: that some people are adept at understanding the natural world and recognizing and classifying its species and ecological relationships. This might be so; but it is also possible that the behavior of the baby strapped to Pelo's chest was not unusual, and that many babies would spend minutes observing a bee in a flower if they were given a chance. According to Nussbaum (2011), affiliation with nature—which attraction to the bee and flower exemplify—is a basic human capability. The episode invites psychologists to consider that there may be many different kinds of attention to nature beyond the dichotomy of voluntary/involuntary or directed/fascinated, and to investigate this variety in open ways.

Research into significant life experiences of people who study natural history or take action to protect nature show that one of the most frequent experiences in their background is an adult who exemplified appreciative attention to the natural world (Chawla, 2007; Chawla & Derr, 2012; D'Amore & Chawla, 2020). Usually it is a family member, but it may also be a teacher or mentor. Matthews (1992), who asked amateur entomologists to describe how they first became interested in the study of insects, found that many described "a contagious attitude of attentiveness" to insects among significant adults in their childhood (p. 326). In comparative studies, such "companions in wonder," as Dunlap and Kellert (2012) called them, form one of the experiences that distinguish people who later show interest and concern for nature from others who show little interest (Chawla & Derr, 2012). As Crain (2003) noted from his observations of children in public parks, caretakers often act differently, admonishing their young charges or hurrying them away when they show interest in something in nature. How different qualities of joint attention to nature influence children's developing relations with nature is an open area for research.

6.5.2 Empathy, Sympathy, and Imitation

Joint attention is a component of prosocial learning when others encourage young children's tendency to empathize with another living thing, in the sense of feeling what others feel, and to translate these feelings into sympathetic understanding of the other's situation and appropriate helping behaviors (Hoffman, 2000). Myers (2007) observed the development of empathy and sympathy during a yearlong study of a preschool class of 3–5-year-olds with a menagerie of animals: a resident toad, guinea pig, goldfish, and doves, as well as a visiting dog, monkey, turtles, slugs, ferrets, tarantulas, and pythons. In the following records, Mr. Lloyd helps children apply language to what they are noticing about turtles' behaviors and feelings.

> Mr. Lloyd: "How do you think it feels, what does it feel like to be a turtle?" Solly: "Safe . . . *Safe*." Mr Lloyd: "You think it feels safe, why?" Solly: "Because you have a shell." (Myers, 2007, p. 60)

On another day with the turtle:

> Mr. Lloyd: "What does he do when you touch his tail, what does he do?" All the kids are looking very closely. They pull back as Toby answers: "He puts it inside his shell." Mr. Lloyd: "He pulls it inside his shell. Why do you think he does that?" Toby: "Maybe um . . . " Dmitri (interrupting): "Cause he's scared." Mr. Lloyd: "Cause he's scared. He doesn't want . . . " Toby (interrupting): "Maybe he doesn't want us to do that." (Myers, 2007, p. 92)

In this class where respect for animals was encouraged, children were not afraid to challenge adults when they considered treatment of an animal wrong. When a woman brought a spider monkey to class she held its tail to prevent it from moving freely, although it was not dangerous, and several children objected strongly to this violation of the monkey's autonomy, telling her, "Let go!" "When will you let go?" "Why don't you let go of his tail?" (Myers, 2007, p. 50).

In the young children, imitation often suggested empathy, when the children put themselves in an animal's body, so to speak, by reproducing its bodily motions and expressions. A 5-year-old girl, for example, liked to watch the doves, standing rapt in front of their cage and mimicking their body positions. When Mr. Lloyd asked another girl if she would like to be a turtle, she responded by hunkering down in a turtle position with her arms and legs tucked in and moved toward the corner, climbing onto a shelf, a tight spot only a little bigger than herself: a safe space away from classroom activity. Myers (2007) noted that imitation suggests children's awareness of similarities *and* differences between themselves and the bodies and behaviors of other animals. For example, the first girl "flew" away from the dove's cage flapping her arms, associating arms with wings; but she also had to reshape her body to reproduce the birds' distinctive movements.

In observations of students in nature kindergartens and an elementary school in British Columbia, Blenkinsop and Piersol (2013) and Elliot, Ten Eycke, Chan, and Müller (2014) found that children were attuned to the aliveness of trees and other plants as well as animals. Some believed that they could feel the feelings of plants, hear them, communicate with them, and be heard. When Gebhard, Nevers, and Billmann-Mahecha (2003) gave children in Germany environmental stories for moral reasoning, they found that many 6–10-year-olds believed that trees feel pain if they have nails hammered into them or limbs chopped off, but by ages 12–13, a belief in trees' sentience was rare, and by ages 14 to 16, never voiced. In indigenous cultures, family members and elders may encourage children to maintain a belief that all species of animals and plants, as well as elements like stones and landforms, are relatives with whom they can communicate.

6.5.3 *Apprenticeships in Nature*

When children engage in joint tasks and joint problem-solving with more skilled people, they enter into apprenticeships (Reed, 1996b). Guided participation in formal or informal apprenticeships include face-to-face and side-by-side communication, which may involve words or just demonstration, such as when a father shows a daughter how to cast a fishing line. In this case, joint attention is central to the practice. As apprentices become more skilled, they can assume increasing levels of responsibility for increasingly complex tasks (Rogoff, 1993).

Competence in nature involves many skills that children and adolescents learn through apprenticeships, during formal instruction or informal relationships: for example, wayfinding, camping, kayaking, bird watching, hunting, fishing, foraging, and gardening. (See Fig. 6.2) In a review of research on pathways into nature-based activities, Bixler and James (2016) found that adults who seek out wild areas for recreation repeatedly report unstructured childhood play in nature, followed by apprentice-like relationships with family members, peers, or guides in summer camps, scouting, or after-school programs. These mentors coach them in the technical competence that different nature-based activities require. For children in families that live off the land, guided participation in tasks like herding and animal care often begins in early childhood (Nabhan & Trimble, 1994).

Fig. 6.2 A nature center apprentices children in the skill of bird banding, as part of an international program to monitor bird migration. Photo ©Thorne Nature Experience

6.6 Agency, Discovery, Creativity, and Refuge in Nature

6.6.1 The Joy of Being a Cause

In 1959, Robert White wrote a landmark article that synthesized research from child psychology, animal psychology, and psychoanalytic theory to make the case that organisms find intrinsic pleasure and satisfaction in exploring, experimenting, and seeing the effects of their actions on the environment. White noted that the philosopher of play, Karl Groos (1912), called this experience "the joy of being a cause." White proposed calling it a feeling of efficacy associated with competence in interacting with the environment.

White (1959) drew on the learning theory of Hebb (1949) to explain when people are most likely to engage with the environment. According to Hebb, the ideal environment for exploration and sustained interest presents "difference-in-sameness," when an organism is not overwhelmed by newness nor bored by familiarity, but the environment contains much that is familiar along with some features that are novel. In this case, White noted, there is "something still to be found out" and "learning still to be done." He argued that children's playful engagement with the environment serves a serious evolutionary purpose, as it prepares for a life of self-determination and control over the environment, which is vital for survival.

Ecological psychology begins with the similar premise that organisms evolved to know the world through movement and active engagement in order to uncover the structure of affordances necessary for survival (Gibson, 1979; Reed, 1996b). Agency, in the sense of power to originate actions with a purpose and control one's own activity and external events, is a defining feature of animate, sentient beings, as it is how they discover and use key resources. Survival in changing environments depends on competent and adaptive agency. Animals often practice functional activities during play, but play exists for the intrinsic pleasure of the activity itself (Reed, 1996b).

A sense of agency is fundamental for healthy functioning and well-being. It is central to the theory of efficacy of Bandura (1997), who emphasized the importance of a sense of self-efficacy, or belief in one's capability to execute actions required to attain desired goals. In the self-determination theory of Ryan and Deci (2017), agency promotes a sense of competence, or confidence in one's ability to control outcomes and experience mastery. Many studies connect perceived self-efficacy and competence to better physical and mental health (Bandura, 1997; Ryan & Deci, 2017).

6.6.2 *Children's Agency and Creativity in the Natural World*

The natural world is a fertile field for agency. It contains abundant information for selection, revealing diverse affordances for action (Gibson, 1979; James 1912/1976). Hebb (1949) proposed that difference-in-sameness encourages exploration and engagement. The natural world presents uniqueness-in-sameness. Consider a forest or a prairie grassland. Everywhere people turn, they find similar patterns in branching trees or clumps of grass, but as they move across the terrain, they find these patterns assembled in never-exactly-repeated constellations of landforms and species. In each weather, each season, each period of day and night, the setting shifts. Reed (1996c) argued for the necessity of primary experiences—direct full-bodied encounters with the world when people gather information for themselves with all their senses—because this multisensory flow of information is unrivaled in the opportunities for action and discovery that it presents.

Children often have to rely on adults to promote their engagement with nature: to take them to parks and seaside vacations, adopt pets, naturalize school grounds, and give permission to play in local wild areas. Once in nature, children are likely to encounter larger fields of free action than they find in built environments, which are commonly constrained by social rules and scripts. Observations of children in nature—made by accompanying them into the field or sending them out with wearable cameras—show them engrossed in self-chosen activities: exploring to discover what the environment holds; finding and making pathways; finding and making hiding places; manipulating things to see how they respond; constructing things; turning nature's loose parts into props for pretend play; setting challenges to demonstrate physical skills; and sometimes sitting in quiet reverie (Derr, 2006; Green, 2018; Hart, 1979; Moore, 1986; Sobel, 2002) (See Fig. 6.3)

As James (1912/1976) and Gibson (1979) observed, perceiving and acting in the world always simultaneously mean co-perceiving the self. As children engage with nature, they are learning what they can do as well as what nature does. The multitude of affordances in nature enable them to find the right level of challenge. For example, if a 10-year-old and a 4-year-old go into the woods together, they are both likely to find a tree to climb, though the 10-year-old may head high into upper branches, while the 4-year-old finds a perch on a low bough. Both are learning the properties of their tree—the texture of its bark, the form of its leaves, the scent of its sap, the flexibility and strength of its branches, the insects that inhabit it. They are also learning their abilities to engage with it. Opportunities for free action like this encourage autonomy, agency, a sense of competence, and relatedness with nature (Heft & Chawla, 2006; Ryan & Deci, 2017).

In early childhood, the world is full of surprises, and understanding how things in nature function is an important form of mastery. The excitement this can generate is evident in Pelo's (2018) account of taking the toddler in her care to a park with a low-lying bridge over a stream. It was autumn, and the 15-month-old began to drop leaves into the water on the downstream side of the bridge, watching the leaves spin in the current until they floated out of sight. When she and Pelo turned to the

Fig. 6.3 Discovering properties of the world simultaneously involves discovering one's own capabilities, with the pleasure that a sense of competence involves. Photo by Emily Stanley

upstream side and the girl dropped a leaf into the water, it disappeared under the bridge. Bemused, the child stared at the stream for long moments—then tried another leaf, which also disappeared. Pelo suggested that after she drop the next leaf, they cross to the downstream side, and the girl agreed. When she saw the next leaf emerge, she cried, "Leaf!" At that point, she tossed leaf after leaf upstream and hurried to see it reappear downstream, laughing, clapping, and crying, "Leaf! Leaf!" The game became a ritual that she and Pelo played each time they returned to this park.

When children are very young and still forming a basic understanding of the world—like the trajectory of an object when it passes behind a screen and the dynamics of a stream—there is joy in understanding how things are connected, just as there is joy in being a cause. Nature is full of material to create experiments. In later childhood, children show excitement in exploring alternative pathways and learning how the local geography connects, as they master free ranging movement through their surroundings (Derr, 2006; Hart, 1979; Sobel, 2002). Hart (1979), for example, found that some of the "short cuts" that children revealed to him were long and adventurous ways around.

By middle childhood, children's manipulation of nature often includes complex constructions like forts and playhouses (Derr, 2006; Hart, 1979; Sobel, 2002; Stanley, 2011). Building forts, dens, playhouses, and play shops involves

reconnoitering the environment for materials, learning construction methods, making tools, and finding loose parts for furnishings or trade with other forts. In the process, children immerse themselves in nature—and in a culture of their own creation (Sobel, 2002; Stanley, 2011). In these special places, children form worlds of their own under their control, that they create with siblings and friends. When there are other nearby forts, they negotiate conflicts and alliances. During Emily Stanley's extended observations of the fort culture of 6–12-year-olds with woods at the edge of their school ground, an 8-year-old boy expressed these possibilities: "For me, it's like making my own business or small country. I think it gives you a sense of power. And maturity. . . . And it's definitely a good way to make friends" (Chawla, Keena, Pevec, & Stanley, 2014, p. 6).

A long history of research shows that children's play is more creative and socially cooperative in natural environments (e.g., Cloward Drown & Christensen, 2014; Dowdell, Gray, & Malone, 2011: Faber Taylor, Wiley, Kuo, & Sullivan, 1998; Fjørtoft, 2004; Grahn, Mårtensson, Lindblad, Nilsson, & Ekman, 1997; Herrington & Studtmann, 1998; Kirkby, 1989; Kuh, Ponte, & Chau, 2013; Lucas & Dyment, 2010; Moore & Wong, 1997; Morrissey, Scott, & Rahimi, 2017; Samborski, 2010). Most of these studies compare play in natural and built areas of school grounds, or before and after school ground renovations to introduce more elements of nature. Nature is unrivaled in the "loose parts" that it affords. According to Nicholson's (1971) theory of loose parts: "In any environment, both the degree of inventiveness and creativity and the possibility of discovery are directly proportional to the number and kind of variables in it" (p. 30). Another important feature of natural environments is that they offer vegetated "green rooms" that children can occupy with a few friends, inviting quiet refuge and pretend play (Herrington & Studtmann, 1998; Kirkby, 1989).

Because natural objects like tree branches, grasses, leaves, and rocks were not manufactured for predetermined social purposes, children have to invent the uses that they will serve during play, and they often do this together. When Herrington and Studtmann (1998) and Moore and Wong (1997) compared play before and after the naturalization of preschool and elementary school grounds, they found that play shifted from demonstrating physical prowess on built equipment to a reliance on imagination and social skills. Natural areas support more sustained play activities (Dowdell et al., 2011) and more extended dramatic play narratives (Grahn et al., 1997; Herrington & Studtmann, 1998; Kuh et al., 2013; Luchs & Fikus, 2013). Because the natural world was not created by human beings to support socially defined roles, it invites mixed-gender play (Änggård, 2011; Kirkby, 1989).

When children in early and middle childhood have natural areas for play, the diverse and uneven topography, vegetation, and pathways promote moderate and vigorous physical activity (Boldemann et al., 2006; Coe, Flynn, Wolff, Scott, & Dunham, 2014; Cosco, 2007; Dettweiler, Becker, Auestad, Simon, & Kirsch, 2017; Dyment & Bell, 2007; Dyment, Bell, & Lucas, 2009; Wheeler, Cooper, Page, & Jago, 2010). A Swedish study that compared levels of physical activity among 7–14-year-olds in urban schools versus schools with large fields and adjacent woodlands found, overall, that younger students were more physically active than older

students, boys more than girls, and students with access to fields and woodlands more than urban students (Pagels et al., 2014). Having fields and woodlands helped girls maintain their levels of physical activity, despite the trend for girls to become less active as they get older. When Fjørtoft (2004) compared 5–7-year-olds who played in a forest adjacent to their school with others who played in traditional school playgrounds, she found a significant increase over the course of the school year in motor fitness, and significantly better balance and coordination, in favor of the children with the natural playscape. Others have also found that natural environments promote children's balance, agility, and coordination (Grahn et al., 1997; Hanscom, 2016; Müller et al., 2017).

When teenagers are asked to identify natural areas that they visit in their regions, they photograph and describe three primary types of places: social spaces like parks where they have fun with friends and gather with their families; places for risk, challenge, and active recreation like hiking, skiing, surfing, and games of wild adventure; and "breathing spaces" where they go alone or with close friends to get away from family and peer pressures, relax, and feel free (Owens & McKinnon, 2009; Ward Thompson, Travlou, & Roe, 2006). At all ages, young people's attraction to nature depends on their perception that places are safe and free from threatening adults and peers (Chawla, 2002; Hart, 1979; Milligan & Bingley, 2007; Ward Thompson et al., 2006).

This section has emphasized opportunities to engage with the natural world, develop physical and social skills, gain competence, and learn about nature through all the senses. Another aspect of agency and autonomy is the freedom to choose quiet disengagement; and nature offers this too. When young children seek out green rooms and hiding places in nature, their behavior is consistent with the research by Wachs (1979) regarding children's need for "stimulus shelters" where they can retreat from noise and other people's interference. Teen "breathing spaces" serve a similar purpose. When Hart (1979) observed Vermont children in nature, he named one of their activities "reverie," when they appeared lost in the moment, quietly sitting in a tree or dabbling in a stream. In studies of 6–12-year-olds at recess in a wooded area, 9–13-year-olds doing assignments in a naturalized outdoor classroom, and teens in high school gardening programs, Chawla et al. (2014) found that nature often served as a haven from stress. Parents of the younger children talked about the importance of free time in the woods for their children's management of classroom stress. By the upper elementary school grades and high school, when young people had self-awareness and language skills to speak for themselves, they frequently described the outdoor classroom and gardens as "calm," "peaceful," and "relaxed," and expressed the importance of these places for escape from social pressures and other stresses at home and school.

6.7 The Role of Nature in Optimal Child and Youth Development

In her discussion of the capabilities theory of development, Nussbaum (2011) noted that capabilities are interdependent. Realization of capabilities of one kind supports the accomplishment of other capabilities. The research that has been reviewed up to this point shows that living in relation to animals, plants, and the world of nature supports young people's competence in moving through their world, using their senses, controlling their environment, taking advantage of nature's affordances, gaining physical skills, building social skills, exercising creativity and imagination, and finding breathing spaces to relax (see Table 6.1). This section reviews four studies that have investigated associations between children's relatedness to nature and general measures of healthy functioning and well-being. They rely on measures of connection to nature, which is associated with time spent outdoors in nature (Chawla, 2020).

In Hong Kong, Sobko, Jia, and Brown (2018) created a Connectedness to Nature Index for parents of 2–5-year-olds to fill out. They gathered parents' reports of their children's enjoyment and awareness of nature, empathy for nature, and demonstrations of responsibility toward nature, along with assessments of their children's general functioning. They found that Connectedness to Nature was positively associated with prosocial behavior and negatively associated with hyperactivity and inattention, conduct problems, peer problems, and emotional problems.

Parents were a common factor in these measures. Do some parents tend to view their child positively, or negatively, across different areas of functioning? Or is it the case that parents who stop to let their young child admire a flower, listen to a bird sing, or pet an animal, show more respect for their child's feelings and needs in all domains of life, thereby promoting general healthy functioning? Or do young children's interactions with nature influence other areas of their lives, or reflect general strengths and difficulties? This study invites the pursuit of these questions.

In South Carolina, Larson, Bowers, and Stephens (2017) investigated relations between time in nature, measures of nature connection, and five dimensions of positive youth development in racially and ethnically diverse 11–14-year-olds. More time in nature was related to higher levels of nature connection; and connection with nature was positively associated with all five areas of positive youth development: competence, confidence, social connection, caring behaviors, and character in the sense of taking responsibility and living by positive principles and values. Greater connection with nature also predicted that youth were more likely to believe in a positive future. In England, Richardson, Sheffield, Harvey, and Petronzi (2015) found that a sense of connection with nature was positively related to self-rated health and well-being in 10–11-year-olds. In Singapore, Leong, Fischer, and McClure (2014) found that 13–17-year-olds who expressed greater connection to nature had higher scores for self-perceived general health, mental well-being, and positive emotions. These studies invite further research to understand developmental processes that explain these relationships.

After Kyttä (2006) studied children's independent mobility and use of environmental affordances in Finnish and Belarussian neighborhoods at different levels of urbanization, she proposed that children's environments can be categorized into four types—three problematic, and one providing optimal conditions for healthy development. In "wastelands," children can move about freely, but the environment is barren and boring. In a "cell," children are so restricted that they are ignorant of what the larger environment affords. In a "glasshouse," children see, or hear, that the environment is rich in affordances, but they are forbidden to engage with them. Kyttä named the ideal environment for growing up "Bullerby," after the town where the Swedish storybook heroine Pippi Longstocking had her adventures. Here, children's freedom to move about reveals many affordances for engagement, which motivates further exploration and mobility.

Chawla (2007) applied Kyttä's positive cycle of mobility, access, and engagement to children's relations with the natural world. When children are given freedom to explore the environment autonomously and there are natural areas nearby, they encounter responsive affordances. Acting on the world, and seeing the effects of their actions, they build a sense of agency (Heft & Chawla, 2006). The diversity of affordances in nature enable children to set, and master, the level of challenge that fits their current stage of development. These positive experiences of agency motivate children to continue exploring and using the environment—and in the process, children develop growing environmental knowledge and competence (See Fig. 6.4)

6.8 Social Action to Protect the Natural World

6.8.1 Knowing Nature in a Changing World

This chapter has noted that experiences described in the preceding sections commonly characterize the lives of youth and adults who take action to protect the natural world. More than any other experience, people who report taking action to conserve nature spent extended time in childhood play and exploration in nature. This connection holds whether people report private conservation behaviors like saving energy and water at home, civic behaviors like voting for "green" policies, or dedicated environmental activism, and whether outcomes are assessed through qualitative interviews, large quantitative surveys, or longitudinal studies (Chawla & Derr, 2012; D'Amore & Chawla, 2020; Evans, Otto, & Kaiser, 2018; Wells & Lekies, 2012). Another common childhood experience in the lives of people who show active care for nature is a family member or other adult who modeled appreciation, care, and empathy for nature (Chawla & Derr, 2012; D'Amore & Chawla, 2020). Although these studies do not use terms like "joint attention," "observational learning," and "apprenticeship," a close examination of formative memories shows that these socialization processes were often involved (Chawla, 2007). Recent

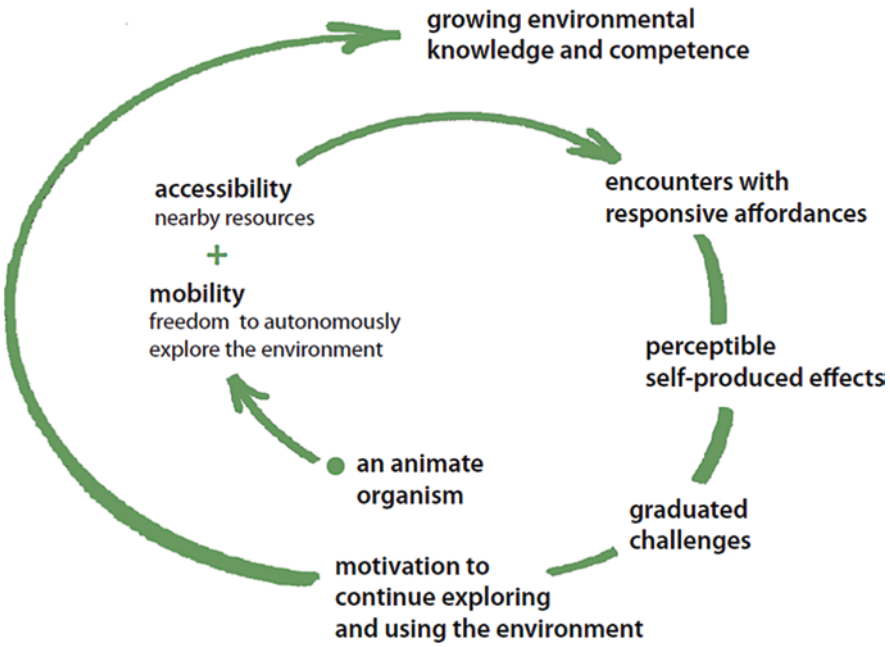

Fig. 6.4 Positive cycle of growing environmental knowledge and competence (adapted from Kyttä, 2006)

thinking about relational ecosystem values is partly inspired by a seven-nation European study with similar findings: People committed to conserving nature described connecting with nature in childhood through extended intense encounters, as well as supportive mentors and exemplars who protected or guided their exploration (de Groot, Dedeurwaerdere, Bonaiuto, & Knippenberg, 2016).

Since these studies of significant life experiences associated with pro-environmental action began 40 years ago, the context of children's lives has changed. There is growing evidence that many contemporary children no longer experience free ranging agency in nature (Louv, 2008; Natural England, 2009; Skår & Krogh, 2009; Woolley, 2015). Parents are more likely to remember exploring outdoors and encountering nature as they grew up than allow this freedom to their children (Kinoshita, 2009; Laird, McFarland-Piazza, & Allen, 2014; Tandy, 1999). At the same time, nature itself has retreated as urban areas have become more densely built, with heavier traffic; and children's out-of-school lives have become more programmed, protected, and contained indoors in front of digital screens. This means that many children live in "cells," "glasshouses," and "wastelands" rather than optimal environments for development (Kyttä, 2006). Increasingly, their television sets and computer screens tell them that nature is a scene of loss and destruction, or they experience natural disasters like flood, fire, and drought directly (IPBES, 2019; IPCC, 2018).

Research indicates that young people respond to news about environmental loss in different ways. Some are preoccupied with other things and apathetic, some deny that changes are happening or that they are serious, and some assimilate what they hear and respond with varying levels of worry (Lawson et al., 2019; Ojala, 2016). Around the world, surveys and interviews indicate that young people are feeling worry, sadness, frustration, and anger over the changing environment, not only for fear of impacts on themselves and their families, but also impacts on other people and animals (Hicks & Holden, 2007; Jonsson, Sarri, & Alerby, 2012; Ojala, 2012a, 2012b; Strife, 2012; Wilson & Snell, 2010; Zeyer & Kelsey, 2012). Most research has been conducted with older children and adults, but even young children worry about "the Earth getting too hot" and animals dying (Davis, 2010). When knowing nature means experiencing rapid environmental change and loss, how can young people be supported to maintain well-being as they confront these challenges?

The preceding sections built on decades of research regarding young people's encounters with nature and basic processes of child development. This section considers new research directions into the uncertain territory of global environmental change. The evidence that it gathers suggests that young people are better prepared for change when they have opportunities to cultivate social trust and a sense of collective agency to address environmental problems. Many of the studies presented here assess young people's responses to what they learn about nature second-hand through news media and conversations in their families and classrooms. The conclusion of this section suggests that a promising direction for future research will be exploring what young people gain from opportunities to address environmental threats through primary experiences *in* nature to protect and restore the natural world, working with nature's own processes of renewal.

6.8.2 Cultivating Constructive Hope

In addition to childhood play in nature and companions who encouraged appreciative and caring attention to the natural world, other influences on people who take action for the environment include witnessing the destruction of valued places in nature and opportunities to work for nature with others (Arnold, Cohen, & Warner, 2009; Chawla, 1999; Chawla & Derr, 2012; Fisher, 2015; Howell & Allen, 2016; Kempton & Holland, 2003; Li & Chen, 2015; Pearse, Goodman, & Rosewarne, 2010; Sivek, 2002; Tanner, 1980). First-hand experiences of favorite places lost to bulldozers or pollution can motivate action, but for sustained action to protect the natural world, people need to learn how to do this strategically through environmental clubs or inspiring mentors in childhood and youth, or later in life through career choices or volunteering in environmental organizations (Kempton & Holland, 2003).

Ojala (2017), a Swedish researcher who has systematically studied how children 11 and older and emerging adults respond to information about large-scale environmental shifts like climate change and species loss, terms the ability to acknowledge the seriousness of threats and uncertainties ahead, yet take action to address these

challenges, "constructive hope." It combines a recognition of risks with constructive action. In studies in Sweden and the United States, both concern and hope motivate young people to take action for the environment, whereas feelings of helplessness and despair are negatively related to action (Li & Monroe, 2019; Ojala, 2012c, 2013; Stevenson & Peterson, 2015; Stevenson, Peterson, & Bondell, 2018).

In surveys of self-reported environmental behaviors, young people almost always report individual actions in the private sphere, such as conserving energy or water at home (Ojala, 2012a, 2015; Stevenson & Peterson, 2015). Ojala (2012b, 2013) found that young people who report taking individual action often report a sense of environmental efficacy, but a significant proportion also report low levels of subjective well-being. She noted that this is consistent with general research on coping in childhood and adolescence, which shows that when a problem is larger than a young person can solve alone, individual strategies can reduce well-being and leave a sense of futility (Clarke, 2006).

When young people reframe environmental threats in a positive way and find meaning in the struggle to address a problem, this form of coping can buffer distressing emotions. Some young people believe that climate change and impacts like species loss are great problems, but societies are better informed now and people with influence are taking the problems seriously, like scientists and civic leaders. When they see problems through this perspective, they are more likely to express positive emotions and life satisfaction (Ojala, 2012b, 2013). Critical here, Ojala (2017) noted, is a sense of social trust: confidence that one is not alone with a problem, but others are also responding and it may be possible to create positive change together.

A number of people who conduct research with young people or engage them in environmental education emphasize the importance of social trust and cultivating collective as well as individual agency to address environmental problems (Brown, 2016; Kelsey & Armstrong, 2012; Li & Monroe, 2019; Monroe, Plate, Oxarart, Bowers, & Chaves, 2017; Ojala, 2017; Sobel, 2008). Dimensions of social trust include believing that others will listen openly to one's feelings about environmental threats rather than dismissing or deriding them. Ojala and Bengtsson (2018) found that adolescents were more likely to find efforts to address climate change meaningful and take action themselves if their fathers, mothers, and friends were solution-oriented and supportive when they brought up the subject, rather than dismissive or voices of doom-and-gloom. Similarly, adolescents were more likely to express constructive hope if they thought their teachers respected their feelings about serious societal issues, including environmental issues, and offered support, rather than acting dismissive (Ojala, 2015). Like respectful joint attention, when an adult participates in a child's interests, ideas, and emotions about an object, receptive listening conveys respect for young people and their feelings.

Other dimensions of social trust are believing that other people share the same concerns and they are also taking action, and friendships formed with others during shared efforts to address problems (Ojala, 2017). Although few young people report experiences of collective action (Ojala, 2012b; Stevenson & Peterson, 2015), when they have this opportunity, the impact can be powerful (Arnold et al., 2009; Chawla,

1999; Fisher, 2015; Johnson, Johnson-Pynn, Sweeney, & Williams, 2009; Li & Chen, 2015; Sivek, 2002). As a Canadian environmental leader in her late teens said after a youth gathering: "When I see other people that think the way I do and have the same point of view about the environment, it just kind of gives me faith and helps me want to make a difference. Because they want to too, it's not futile if there are other people" (Arnold et al., 2009, p. 33). An evaluation of impacts on older teens and emerging adults who gathered for Jane Goodall's six-day Global Youth Summit in 2008 found that their belief in their ability to create meaningful social and environmental change in their communities increased more than any other measure. As one participant explained: "I thought few people cared about wildlife and the environment but now I realized there is a whole network of people that are literally spread across the globe as devoted to those issues as I am. This has given me so much more inspiration . . . but also many new approaches that I can take to see the changes that I would like to see in the world" (Johnson et al., 2009, p. 81).

These feelings are consistent with Bandura's (1997) synthesis of research on perceived self-efficacy and collective efficacy, as well as Snyder's (2000) work on hope. Bandura (1997) showed that a sense of efficacy is fostered, above all, by achieving valued goals through one's own effort or collective actions in a group, but also by seeing others achieve related goals, and by other's coaching and encouragement. He noted that personal efficacy and collective efficacy are interdependent. The achievements of a group depend on the skills and commitment of individual members, but members put forth their best efforts when they trust the competence and common aim of their group. Similarly, Snyder (2000) associated hope with a sense of successful agency to reach goals, or willpower, and the capacity to envision pathways to the goal, or "waypower."

6.8.3 Taking Action in Collaboration with Nature

When Li, Monroe, and Ritchie (2018) created and evaluated a curriculum for high school students in the Southeastern United States to learn how people can promote resilience to climate change in regional forests, they integrated activities based on Snyder's (2000) theory of hope. When students learned about climate change, what others were doing to help forests adapt, and what they could do themselves, their sense of hope increased. These results are consistent with a review of 49 program evaluations in climate change education, which found that young people learned about climate change most effectively when they engaged in issues that were personally meaningful for their schools and communities, discussed what they were learning with each other, and interacted with scientists who were working on the same issues (Monroe et al., 2017). In addition, Li et al. (2018) found that as students learned about forest ecosystems and forests' inherent potential to adapt to change resiliently, their sense of hope increased.

When people come together in hands-on physical work to create community gardens or enhance and restore local ecosystems, Krasny and Tidball (2015) call

these practices "civic ecology": community environmental stewardship, which requires learning to work with ecosystems as well as learning to work together. Many of their examples are intergenerational or feature adolescents, like turning derelict vacant lots into biodiverse parks and gardens or restoring wetlands to protect coastal communities from storm surges. In a recent guide to *Placemaking with Children and Youth*, Derr, Chawla, and Mintzer (2018) show how young people of all ages, from the preschool years through late adolescence, can join with adults in their communities to create environments that are more sustainable and resilient, both socially and ecologically.

Practices of civic ecology bring this chapter back to where it began: to the importance of relational values—relationships with nature and with other people who seek to protect the natural world. Relational values resonate with the premise of ecological psychology that people are best prepared to live in harmony with nature when they engage with the world directly, through their bodies and all their senses, in social groups that support attentive ways of detecting environmental information and applying this information to live within the imperatives of the natural world (Gibson, 1979; Reed, 1996b, c). Reed (1996c, p. 153) noted that hope "is not a subjective feeling but an objective property of our encounters with the world. In its broadest sense, hope means that a goal is *achievable*." He believed that hope is realized when it moves beyond private fantasies into realms of public experience and public action, where it can be rooted in people's direct experiences of learning together how to pursue and achieve shared goals.

During civic ecology practices, people are not only joined through social trust and collective action, but they are working with nature's own potential for resilience, with nature as a collaborating agent. In the field of environmental education, a number of studies show that when young people engage in hands-on projects to create and protect natural habitats in their communities, their sense of connection with nature increases (Chawla, 2020). In their survey of high school students studying forest ecosystems, Li et al. (2018) found that learning how forests can be resilient contributed to a sense of hope. In a qualitative study of teens in school and community garden programs, a number described feeling that they were working in alliance with nature as a living system (Chawla et al., 2014). As one boy explained: "It all connects in one way or another. I figure that I'm helping the environment, it's helping the garden, I'm helping myself. It's not that everything is about me. It's that everything is about everything else" (p. 9). When young people experience collective initiatives that work *with* nature *for* nature and human communities, can it simultaneously increase their sense of efficacy, social trust, connection with nature, and hope? This is a significant question for future research to explore.

6.9 Conclusion

This chapter has attempted to make a case for the importance of agency and relationship with nature for health and well-being. As the opening of this chapter noted, research on nature-based learning and contact with nature more generally show benefits from passive exposure when nature is viewed from a distance or it forms a background to other activities, as well as benefits from active engagement with nature. In the study of positive outcomes for health and well-being from contact with nature, discussions about "doses of nature" are salient and research models commonly present nature as a treatment to be administered by decision-makers in urban planning, design, public health, and other fields with influence over the form of buildings and communities (e.g., van den Bosch & Bird, 2018). Certainly, this research calls for weaving nature into the everyday fabric of people's lives—and for the well-being of children, into residential neighborhoods, schools, preschools, and child care centers. But when this medical model is imported into psychology, it becomes a variation of stimulus-response theory. Presented with stimuli in nature, the body automatically responds.

This model is the premise, for example, in the Attention Restoration Theory of Kaplan and Kaplan (1989), which was previously discussed, and the psychoevolutionary theory of Ulrich (1983), who proposed that because humans evolved in natural landscapes, their bodies respond to natural surroundings through automatic beneficial physiological reactions. It characterizes explanations that refer to greater perceptual fluency in natural environments (Joye & van den Berg, 2011) and better conditions for the immune system (Kuo, 2015; Li, 2018). These ideas are consistent with medical models that seek to identify physiological mechanisms that promote health, and they are an important line of research to pursue. But for the purposes of this chapter, it is notable that these medical models neglect the role of people's agency and active, intentional relationships with nature.

The ecological theory of James and Eleanor Gibson (Gibson, 1979; E. Gibson, 1969) originated, in part, in reaction against stimulus-response theory in psychology by putting the organism at the center—with its agency and ability to make choices as it intentionally interacts with its environment. This chapter has argued that ecological theory is especially well suited to the study of children in nature, given their strong drive to learn about the world and about their own capacities for agency in interaction with the environment: but the principles of ecological psychology apply to all ages. Some reviews of pathways to health in nature include physical activity and social interactions in nature, in addition to automatic stress reduction and other physiological processes (e.g., Braubach et al., 2017; Hartig, Mitchell, De Vries, & Frumkin, 2014; Markevych et al., 2017). Physical activity and social interaction in nature imply agency: but how natural settings facilitate agency and the kinds of agency that they encourage remain under-explored. The influence of different qualities of relationship with nature on well-being has also been neglected, outside of a significant literature on nature connection (Tam, 2013). Ward Thompson and Aspinall (2011), who draw on Gibson's ideas, are distinctive

in including competence and accomplishments in nature, and the value of having a positive impact on ecosystems, in their discussion of health and quality of life impacts from engagement with nature.

This chapter has argued that the emphasis on agency and interaction with the environment in ecological psychology accommodates the relational turn in ecosystem values (Chan et al., 2016), which claims that campaigns for people to conserve nature are more likely to be successful if they go beyond appeals to what nature does *for* people to include intrinsic values of being in relationship *with* nature. Valued relationships include love and care for nature, a sense of kinship with other living things, attachment to places in nature, and the social bonds that develop among people who enjoy nature together or work together to protect it. Research on people's self-perceived connection with nature shows that a greater sense of connection with nature is associated with more subjective happiness and satisfaction with life (Capaldi, Dopko, & Zelenski, 2014; Cervinka, Röderer, & Hefler, 2012), and that enjoyment of nature, in particular, is associated with better mental and physical health (Dean et al., 2018). According to the capabilities approach to development of Nussbaum (2011) and the ecological psychology of Gibson (1979), being in relationship with nature in accurate and caring ways is not just one factor among many that contributes to health and well-being: finding ways to live in harmony with the earth is a precondition for health, well-being, and long-term survival across generations.

In seeking to account for converging evidence for advantages of nature-based learning, Kuo et al. (2019) proposed a number of possible mechanisms. Their suggestions include restorative effects that promote focused attention, reduce stress, and strengthen impulse control, which automatic physiological reactions may help explain. They also noted that nature forms a conducive setting for learning by providing for physical activity and increased physical fitness, motivation, and enjoyment in learning, loose parts that promote creativity, quiet and peaceful surroundings, and prosocial and cooperative social relationships. In addition to physiological reactions, their list includes active ways of knowing nature that this chapter has reviewed—including children's enjoyment of free movement, play, and exploration in nature and attraction to places of calm refuge.

These suggestions by Kuo et al. (2019) invite further research to explore how these different mechanisms to explain benefits of nature-based learning may be interdependent. For example, if loose parts in nature encourage cooperative social relations, do cooperative social relations encourage creativity with loose parts? Does enjoyment in learning in nature motivate physical activity, while physical activity contributes to joy in learning? Like Nussbaum's (2011) list of central capabilities, mechanisms of nature-based learning may support each other. But Nussbaum's theory of capabilities suggests that this list of mechanisms that may explain benefits from nature-based learning can also be looked at in a different way. In addition to treating this list as mechanisms that contribute to the outcome of learning, it can be viewed as a set of interdependent goods in the unified life of a child, for whom learning cooperatively, creatively, exuberantly, or peacefully are inherent experiences of living well, and not just instrumental means to other ends.

The prosocial and cooperative social relations that natural settings promote, for example, do not just contribute to children's successful learning: they have value in themselves. According to Nussbaum's (2011) list of central capabilities, so does free physical movement, enjoyment in learning, creativity, play, and influence over the environment. Similarly, Nussbaum advised, affiliation with other species and the world of nature is an intrinsic good. This chapter has sought to suggest how different ways of knowing nature contribute to multiple dimensions of children's development and well-being, as well as forming intrinsically valuable experiences in themselves.

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Chapter 7
The Natural Environment as a Resilience Factor: Nature's Role as a Buffer of the Effects of Risk and Adversity

Nancy M. Wells

7.1 Introduction

What role might the natural environment play in resilience? Are people who live near a park or who have a view of trees from their workplace more able to face life's stressors? Do individuals living in greener neighborhoods cope more effectively with risk and adversity? Is it possible that nature could be a resource that can help to mitigate race- and income-based disparities in health outcomes? If so, why might this be the case? What is the evidence linking nature to resilience and what are the plausible mechanisms underlying such a connection? These are among the questions I explore in this chapter.

This chapter has two key aims. The first aim is to apply a resilience framework to evidence linking the natural environment to human health and functioning. Despite a long history of psychological resilience literature (Benard, 2004; Masten, 2014) and parallel robust evidence documenting the natural environment's influence on human health and functioning (see reviews: Chawla, 2015; Frumkin, 2001; Frumkin et al., 2017; Hartig, Mitchell, De Vries, & Frumkin, 2014; Wells & Phalen, 2018), there has been, with few exceptions (Besthorn, 2005; Chawla, 2014; Chawla, Keena, Pevec, & Stanley, 2014; Wells, 2014), a gulf between these two bodies of research and theory. The second, related aim is to suggest that the role of nature as a moderator is under-explored and under-appreciated. In other words, within the context of resilience, nature may buffer (dampen) the impact of risk and adversity on human health, development, and functioning. I present evidence that the natural environment can contribute to resilience by moderating or "buffering" the impact of risk on health, well-being, and related outcomes. I focus on four health-related outcomes: (1) mental health, (2) physical health, (3) birth weight, and (4) academic

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_7

achievement. I consider plausible mediating (i.e., explanatory) pathways for such moderation in the context of inequity, vulnerability, and challenge, and finally I consider whether access to nature itself is inequitable.

7.1.1 Risk and Resilience

To begin, before considering the role of nature, I briefly discuss resilience and risk, risk prevalence, and the linkages between risk factors and health outcomes. While resilience has been variously defined, here I employ the definition derived from developmental psychology: "positive adaptation in the context of risk or adversity" (Masten, 2014, p. 9). I focus primarily on resilience at the individual level, but recognize that resilience scales—from individuals to families to neighborhoods and to society.

7.1.1.1 Risk and Adaptation

Two key factors define resilience: risk and adaptation. *Risk* refers to challenges that threaten the system. Fundamentally, risk is a statistical concept indicating an increased probability of a negative developmental trajectory and/or outcome. Risk factors include both chronic adversity such as poverty or persistent racism; and acute adversity such as a death in family, a separation, or divorce. Risk has been operationalized in myriad ways. While many studies examine the impact of a singular risk factor such as housing quality (Evans, Wells, & Moch, 2003) or parental divorce (Lansford, 2009), others examine a composite of risk factors in an aggregate score such as stressful life events or cumulative risk (Evans, Li, & Whipple, 2013). Aggregated measures of risk may comprise as few as two or as many as 40 risk factors and may include: child neglect, housing quality, housing insecurity, homelessness, noise, pollution, family turmoil, parental alcoholism, parental mental illness, exposure to violence, racism, and poverty. In this chapter, we use the term "risk" or "risk factors" to include this wide range of adversity that threatens human health, development, and function.

Broadly, adaptation refers to adjustment or modification in response to various environments or experiences. In the context of resilience, *adaptation* concerns how well a person responds in the face of adversity. Is the person able to function well, build social relationships, maintain good health, despite exposure to various risk factor(s)? Ordinary human adaptive systems are key to resilience. Positive adaptation, development, and well-being when confronted with risk and adversity depend on a variety of human adaptive systems within individuals, cultures, and societies (Masten, 2014). In this chapter, we examine four health outcomes in the context of adversity, as indicators of adaptation and resilience.

7.1.1.2 Risk Prevalence

According to data from the 2011 U.S. Behavioral Risk Factors Surveillance System (BRFSS), 55% of adults retrospectively report having experienced at least one risk factor and 14% report having experienced four or more risk factors during childhood (Campbell, Walker, & Egede, 2016). Risk prevalence varies by race, by ethnicity, and by income. According to the 2016 National Survey of Children's Health, Non-Hispanic African-American children are 1.6 times more likely to experience parental divorce or economic hardship, two times more likely to be exposed to violence, and 1.5 times more likely to live in a disrupted household compared to the overall average. Moreover, poverty tends to be associated with a potent combination of risk factors (e.g., poor housing quality, crowding, food insecurity, less responsive parenting) (Evans, 2004). Children with family income levels lower than the federal poverty level (FPL) are 2.5 times more likely to experience parental divorce, 7.8 times more likely to experience economic hardship, 3.9 times more likely to have exposure to violence, and 2.5 times more likely to live in a disrupted household compared with those with family income levels higher than 400% FPL (Crouch, Probst, Radcliff, Bennett, & McKinney, 2019).

7.1.1.3 Risk, Adversity, and Health

There are documented linkages between risk factors and health as well as between risk and health-related behavioral outcomes across the life course (Evans et al., 2013). Figure 7.1, for example, illustrates the relation between seven risk factors and behavioral problems among homeless youth (Masten & Sesma, 1999). While there are myriad health and behavioral outcomes that could be examined, this chapter examines four outcomes: mental health, physical health, birth weight, and

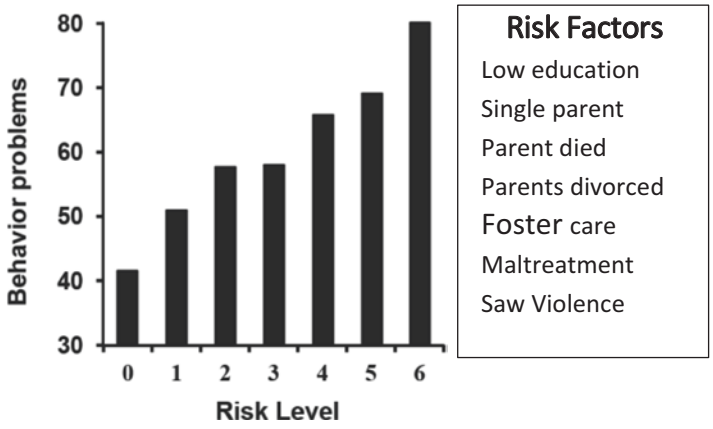

Fig. 7.1 Cumulative risk factors associated with behavioral problems (figure derived from Masten & Sesma, 1999)

Fig. 7.2 Relations between risk factors and positive outcomes related to health and function

academic achievement. Next, I consider evidence linking risk and adversity to each of these outcomes (Fig. 7.2).

Risk → Mental Health There is a clearly documented association between risk and mental health. In the United Kingdom, Michael Rutter's study of psychiatric disorders among 10-year-olds found that although one single risk factor did not significantly increase the overall likelihood of developing a psychiatric disorder, four or more risk factors increased the risk for a psychiatric disorder fourfold (Rutter, 1979). Among pre-school age children, those exposed to 5+ risk factors have 3× level of psychological distress in comparison to peers with 0–1 risk factors (Sameroff, Seifer, Zax, & Barocas, 1987). The more risk factors that children face, the worse their developmental outcomes (Gutman, Sameroff, & Eccles, 2002). Among adults, a similar dose–response relationship has been found between risk factors and mental health problems such as drug use, moderate to heavy drinking, suicide attempts, and depressed affect (Merrick et al., 2017). Data from several countries document that people with four or more risk factors are more likely to: have a lower sense of well-being and life satisfaction and to never or rarely feel close to others (Hughes, Lowey, Quigg, & Bellis, 2016); suffer from depression and insomnia and attempt suicide (Ramiro, Madrid, & Brown, 2010); have alcohol problems in adulthood (Qin, Ma-Xia, Jie, Wen-Xian, & Dong-Qing, 2008). Moreover, there are clear associations between poverty and mental health. Early life socioeconomic disadvantage, in particular, is consistently linked to adverse mental health outcomes later in life (Bridger & Daly, 2017; Brooks-Gunn & Duncan, 1997; Chaudry & Wimer, 2016; Repetti, Taylor, & Seeman, 2002). In addition, lower income women have higher risk of depressive symptoms (Kahn, Wise, Kennedy, & Kawachi, 2000).

Risk → Physical Health Risk factors are linked to both mortality and morbidity. For example, a California study found that people who experienced six or more risk factors died nearly 20 years earlier than those with no risk factors (Brown et al., 2009). Risk is also linked to several chronic diseases, including, for example, chronic obstructive pulmonary disease (Cunningham et al., 2014). By affecting both biological and behavioral pathways, early life risk factors can impact diet, physical activity, and other health-related behaviors, ultimately increasing the risk of overweight and obesity (Miller, Dawson, & Welker, 2017) and related disease.

Socioeconomic status (SES) in general, and poverty, specifically, are consistent predictors of morbidity and mortality. Individuals who are lower on the "SES ladder" suffer disproportionately from nearly every disease and have higher rates of mortality than those who are more affluent (Adler & Rehkopf, 2008; Adler & Stewart, 2010; Braveman & Egerter, 2008; LeCounte & Swain, 2017; Marmot, 2015a, 2015b; National Center for Health Statistics, 2016; Robert Wood Johnson Foundation, 2015; Sarsour et al., 2011; Woolf et al., 2015; Woolf, Chapman, Scutchfield, & Douglas, 2016). Compared with affluent adults, poor adults are nearly five times as likely to report that their health is "poor" or "fair." Nearly one out of every three poor adults has an activity limitation due to chronic illness, compared with fewer than one out of ten among the highest income adults. Similarly, children in poor families are seven times more likely to have poor or fair health than children in affluent families (Braveman & Egerter, 2008). As with mental health, poverty early in life is consistently linked to later-life physical health outcomes (Bridger & Daly, 2017; Brooks-Gunn & Duncan, 1997; Chaudry & Wimer, 2016). The lower the SES of a child's parents, the greater the likelihood that the child will experience health problems such as asthma, injury, or chronic illness (Adler & Stewart, 2010). Income is also linked to life expectancy. A person in the highest income group is likely to live 6.5 years longer than an individual in the lowest income group.

Risk → Birth Weight Low birth weight has serious health implications in infancy as well as in childhood and adulthood (Blumenshine, Egerter, Barclay, Cubbin, & Braveman, 2010). Low birth weight is a major cause of neonatal and infant mortality (Horbar, Onstad, & Wright, 1993; Santos et al., 2015) and is correlated with later-life adverse outcomes such as type 2 diabetes, hypertension, cerebrovascular disease, coronary heart disease, and all-cause mortality (Belbasis, Savvidou, Kanu, Evangelou, & Tzoulaki, 2016; Miles, Hofman, & Cutfield, 2005). Birth outcomes have also been linked to later-life educational attainment, test scores, and income (Almond & Currie, 2011).

Various socioeconomic risk factors such as maternal education level, household income, and occupational status are linked to adverse birth outcomes. Blumenshine et al. (2010) report that 92 of 106 studies found a significant association between socioeconomic status and adverse birth outcomes. Low birth weight as well as preterm birth and small for gestational age were most common among women in the most disadvantaged groups. For example, Gorman (1999) report significant effects of both individual-level SES and area-level SES effects on low birth weight among white, black, and Hispanic mothers.

Risk → Academic Achievement Although academic achievement is not a health outcome per se, early academic achievement is linked to a variety of later-life outcomes. Poor academic performance in childhood and adolescence can increase the likelihood of a life course trajectory of antisocial or delinquent behavior (Yoshikawa, 1995). Evidence from Werner's longitudinal study of children on the island of Kauai, Hawaii found that academic achievement (language development,

specifically) at age 2 years and 10 years protected against later delinquency (Werner, 1987). Early academic achievement—specifically math and reading achievement at age 7—is positively associated with mid-life SES (age 42), even after controlling for SES of origin and intelligence (Ritchie & Bates, 2013).

A variety of risk factors—studied singularly or cumulatively, cross-sectionally or longitudinally—are inversely linked to academic achievement. Among 6–9-year-olds, 59% with 5 or more risk factors are in the bottom quartile on standardized reading tests v. 7% of those with 0 risk factors (Luster & McAdoo, 1994). Nine and ten-year-olds who experienced 6 or more risk factors persist 50% less on learned helplessness tasks compared to children with 0–1 risk factor (Evans, 2003). Residential mobility, as a single risk factor, is linked to academic achievement (Obradović et al., 2009; Pribesh & Downey, 1999; Voight, Shinn, & Nation, 2012). Longitudinal evidence from Iceland links multiple risk factors to academic achievement in childhood and early adolescence; each additional risk factor was associated with a drop in academic achievement in both fourth and seventh grade (Ragnarsdottir et al., 2017). Among African-American seventh graders, having experienced a high number of risk factors was linked to school absenteeism, lower math tests scores, and lower GPA (Gutman et al., 2002).

The effects of poverty on academic achievement are well documented (Duncan, Yeung, Brooks-Gunn, & Smith, 1998; Lacour & Tissington, 2011). Typically, students from low-income families perform less well than high-income students on metrics of academic success—including high school completion rates, standardized test scores, college enrollment, and college completion.

Clearly, various risk factors—including poverty—have profound impacts on outcomes at birth as well as on lifelong health and success. These findings linking risk to mental health, physical health, birth weight, and academic achievement illustrate why a potential moderating factor merits attention, as a moderator can dampen or disrupt the strength of these relations and thereby reduce their impact. Next, I consider nature as a resilience factor.

7.2 Nature as a Resilience Factor

Despite the chasm between the theory and literature of resilience and the evidence of nature's effects on health and functioning, there have been a few scholars who have begun to thread these topics together. Citing evidence that plants and animals positively influence children's pro-social development, Fred Besthorn (2005) argued that the natural environment is a critical resource for the cultivation of resilience, particularly among at-risk children (Fig. 7.3). More recently, Louise Chawla and colleagues conducted a qualitative examination of the role of green schoolyards as contexts for refuge, restoration, and resilience among elementary and high school students (Chawla et al., 2014). Tidball and Krasny's (2014) edited volume "*Greening in the Red Zone: Disaster Resilience and Community Greening*" focuses on

Fig. 7.3 Access to nature may contribute to resilience

linkages between nature and resilience, not with respect to psychological resilience per se but on post-catastrophe community-based greening efforts and how these initiatives serve as a source of socio-ecological resilience (i.e., the capacity to adapt in the face of change within a social-ecological system (Folke, Biggs, Norstrom, Reyers, & Rockstrom, 2016)) (Tidball & Krasny, 2014). Several chapters within their book do explicitly link the psychological resilience and nature-health literatures. A chapter by Chawla et al. (2014), for example, documents the value of children's relationships with the natural environment and suggests the importance of green, healing spaces for children recovering from a natural disaster such as a flood or hurricane. Chawla points to environmental features such as views of nature, nature play, and animal care and their connection to children's resilience. Addressing similar themes, Wells (2014) demonstrates connections between the study of children's resilience and the evidence of nature's positive effects on health and well-being, with some focus on underlying explanatory mechanisms. Okvat and Zautra (2014) examine the role of community gardens in bolstering resilience in a post-disaster context and suggest beneficial effects on cognition, emotion, and behavior. The current chapter builds upon these prior efforts to link resilience theory and research with the nature-health literature. Next, we consider three models of resilience.

7.2.1 Models of Resilience

In order to consider nature's possible role in resilience, it is useful first, to describe three models of resilience presented by Masten (2014) (pp. 44–46). The simplest model of resilience is the ***main effect model*** in which assets and risks directly affect outcomes (Fig. 7.4). Risk factors negatively influence outcomes and assets positively affect outcomes. Some describe assets or protective factors as "promotive" (Weeland, Laceulle, Nederhof, Overbeek, & Reijneveld, 2019) or having "a direct protective effect" (Lösel & Farrington, 2012). A bipolar variable could have a positive or negative effect, depending on the value of the variable along a continuum. For example, parenting style may have negative or positive effects, and may change through intervention; good housing quality may have a positive effect but poor housing quality may have a negative influence.

Second, the ***mediator model*** of resilience, shown in Fig. 7.5, reflects the indirect effects of a risk factor on a health or developmental outcome, recognizing the explanatory pathway (mediator) through which the effect occurs. For example, economic hardship may negatively impact children through its effect on parents' mental health. In this case, parents' mental health would mediate the relation between risk and child outcomes.

Third, the ***moderator model***, shown in Fig. 7.6, considers the interaction of some variable with the risk factor to buffer or mitigate the impact of risk or adversity on some outcome of interest. The effect of risk on the outcome depends upon (in this case is dampened by) the moderating variable such that the strength of the association is diminished by the presence of the moderator, which may be referred to as a "protective factor" or a "buffering protective factor" (Lösel & Farrington, 2012).

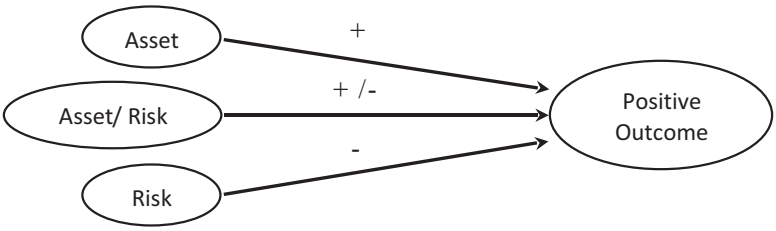

Fig. 7.4 Main effect model of resilience: direct effects of risk (negative), asset (positive), and a bipolar variable (positive or negative) on a positive outcome (Masten, 2014)

Fig. 7.5 Mediator model of resilience: indirect effects of a risk factor on an outcome are explained by a mediating variable (Masten, 2014)

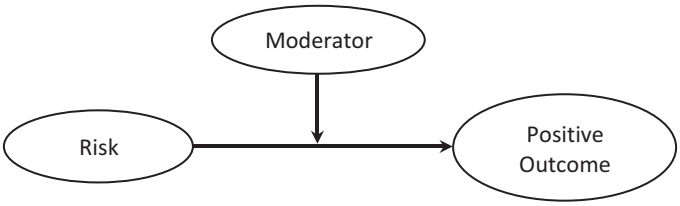

Fig. 7.6 Moderator model of resilience. The relation between the risk factor and the outcome is buffered or dampened by the presence of the moderator (Masten, 2014)

For example, community assets such as a YMCA or Boys and Girls Club could dampen the impact of risk factors such as poverty or child neglect on positive outcomes. Or, as we suggest in this chapter, there may be a nature by risk interaction such that nature is a protective factor that moderates the risk-outcome relation.

7.2.2 Nature as a Moderator

Herein, I focus on the moderator model of resilience, considering nature to interact with risk to buffer the relation between risk factors or adversity and positive, health-related outcomes. Considerable research has focused on the direct effects of nature on health, functioning, and well-being (see reviews: Frumkin et al., 2017; Hartig et al., 2014; James, Banay, Hart, & Laden, 2015; Russell et al., 2013; Seymour, 2016). Direct effects of nature, consistent with Masten's main effect model of resilience (Fig. 7.4), represent one way that the natural environment might contribute to positive outcomes. Far fewer studies, however, have examined the role of nature as moderator—as a resilience resource that buffers against the effects of risk and disturbance including poverty and disadvantage on positive health and developmental outcomes. Consistent with the moderator model of resilience (Fig. 7.6), I focus on the potential for nature to interact with a risk factor(s) and to thereby dampen the impact of risk or adversity (Fig. 7.7).

7.2.2.1 Why Focus on Moderation?

Moderation merits attention for several reasons. First, from a theoretical perspective, the examination of moderator variables (interaction effects) allows for a deeper understanding of the relations among variables. The notion that the strength of impact of a risk factor on health, functioning or development depends upon some third variable—in this case, the natural environment—allows for a more nuanced understanding of the phenomenon. For example, as discussed below, we can entertain what variable(s) explain—mediate—the moderating effect. In other words, what plausible explanatory mechanism(s) or pathway(s) underlie the buffering

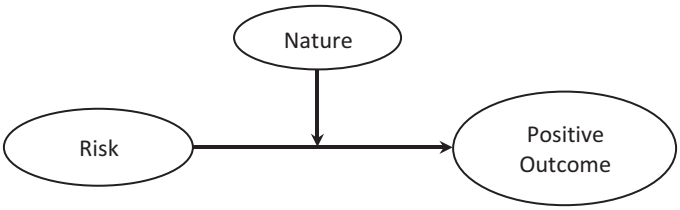

Fig. 7.7 A moderator model of resilience: Nature buffers the impact of risk on an outcome of interest

effect? Understanding these aspects of the risk by nature interaction has the potential to contribute to resilience theory as well as to nature-health theory. A second reason moderation merits attention is that moderators are practical. While we advocate for policies and programs to eliminate child neglect, poverty, homelessness, inadequate housing, violence, and other risk factors that undermine health and well-being, it is valuable, in parallel with those efforts, to identify strategies that will reduce the impact of these social ills. In this way, moderators provide additional leverage points for intervention that can be employed to reduce the impact of unfortunately inevitable risk factors. Lastly, as I explore later in this chapter, nature's role as a moderator of the relation between risk and health outcomes may ultimately help, even modestly, to reduce the pervasive income- and race-based health inequities that are linked to risk exposure. As we consider evidence of nature's role as a buffer and the possibility that access to nature might, in fact, have the potential to reduce health inequities, it is useful to keep in mind Michael Rutter's criteria for a protective effect—that the moderator "either has no effect in low risk populations or its effect is magnified in the presence of the risk variable" (Rutter, 1987, p. 317). In other words, we expect to see evidence of buffering among the most vulnerable or disenfranchised, those exposed to the most risk factors, and little or no impact among more advantaged groups.

7.2.2.2 Evidence of Nature as a Buffer

What evidence exists that nature moderates the impact of risk or adversity on health or developmental outcomes? Studies examining this question operationalize risk or adversity in various ways—from stressful events to income disparity, SES, and poverty. Moreover, while some studies explicitly examine nature as a moderator (e.g., nature by risk interaction; or nature by SES interaction (or "effect modification")) some studies do not explicitly examine an interaction, but instead conduct stratified analyses to consider whether effects of the risk factor differ at different levels of the second variable, nature. I now consider evidence of nature functioning as a moderator of the impact of risk on our four focal outcome variables: mental health, physical health, birth weight, and academic achievement.

7.2.2.3 Mental Health: Nature as a Moderator of the Risk-Mental Health Relation

One of the first studies to explicitly examine the role of nature as a moderator of the risk—mental health relation focused on the association between stressful life events and children's mental health (Wells & Evans, 2003). Children's stressful life events, measured using Lewis' 20-item scale, included being picked on by other kids, parents arguing, peer pressure to try smoking, and getting in trouble at school, for example (Lewis, Siegel, & Lewis, 1984). Results indicated that the association between stressful life events and mental health (psychological distress) was buffered by the presence of nature near the home. As illustrated in Fig. 7.8, findings indicated not only that the stressful life events—mental health linkage was dampened by the presence of nature near the home, but—consistent with Rutter's criteria for a protective mechanism—the effect was greatest for the most vulnerable children, those who experienced the most stressful life events.

Several other studies have examined stressful life events, singularly or cumulatively. In Spain, researchers studied a group of urban children ($N = 172$) to examine the role of perceived nature as a buffer of the impact of stressful life events (Corraliza, Collado, & Bethelmy, 2012). Results indicated that children's perception of near-school nature moderated the relation between specific stressful events (i.e., "having nothing to do" and "not spending enough time with parents") and feelings of stress. Van den Berg, Maas, Verheij, and Groenewegen (2010) found that the relation between having experienced a stressful life event and mental health was moderated by nature within 3 km though moderation was only marginally significant. In a study of "personal crises" such as death, divorce, or severe loss, Ottosson and Grahn (2008) found that the influence of a "personal crisis" on self-reported mental health

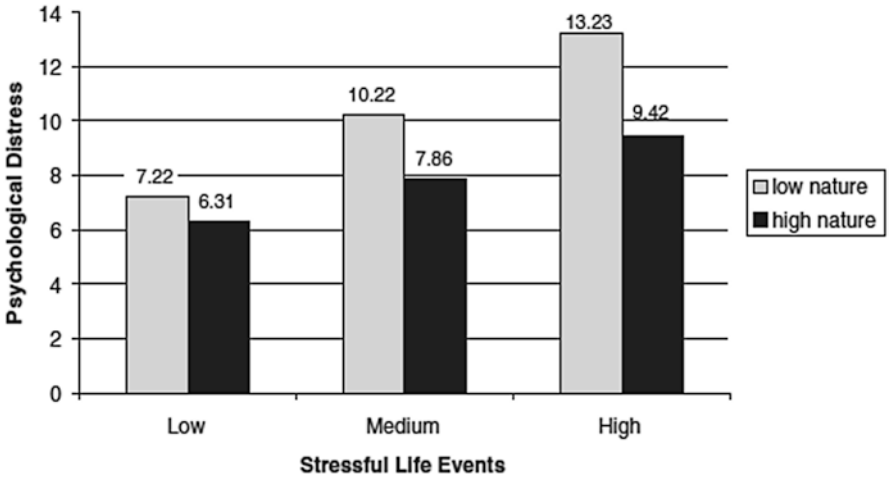

Fig. 7.8 Nature moderates the effect of stressful life events on psychological distress (mental health) (Wells & Evans, 2003)

(and attention) was dampened among people who spent considerable time in nature. Additional evidence of nature's role as a protective factor comes from a study of peripartum depression in England that found—in stratified analyses—that pregnant women in greener neighborhoods were less likely to report depressive symptoms than those in the least green areas; and the pattern was strongest among women in the lower socioeconomic group (McEachan et al., 2016). In a workplace study, the effects of job strain on job stress and intention to quit were moderated by a workplace window view of natural elements (trees, vegetation, foliage, and plants) (Leather, Pyrgas, Beale, & Lawrence, 1998).

Studying economic risk factors, Mitchell, Richardson, Shortt, and Pearce (2015) examined the relation between financial strain and mental health, considering five different neighborhood characteristics (green space, financial services, transport, and cultural facilities) that were plausible moderators of the relation. With a sample of more than 21,000 urban residents from 34 European countries, only neighborhood green space was a significant moderator of the financial strain—mental health relation. Among residents with good access to nature, socioeconomic inequality in mental health was 40% narrower, compared to those with less nature access (Mitchell et al., 2015). In a longitudinal study, Flouri, Midouhas, and Joshi (2014) found, in stratified analyses, that poor children with more green space in their neighborhood had fewer emotional problems from age 3–5 (but not age 5–7), compared with their counterparts in less green neighborhoods. However, green space did not moderate the effect of adversity or neighborhood disadvantage on emotional problems.

Some studies find no moderating effect of nature on the risk—mental health relation. Marselle, Warber, and Irvine (2019) explored whether nature (group nature walks) moderated the association between stressful life events and mental health but found no interaction effect. However, using a main effect model of resilience, the results indicated that the significant positive main effects of group nature walks on mental health were of greater magnitude than the negative effects of stressful life events on mental health. Contrary to moderation hypotheses, Weeland, Laceulle, et al. (2019) found that neighborhood greenness did not buffer the relation between stressful life events and externalizing behavior among adolescents; in fact, the association was stronger for those who grew up in less green areas. Altogether, despite some equivocation, the evidence suggests that green space and access to nearby nature has the potential to moderate the effect of various risk factors on mental health.

7.2.2.4 Physical Health: Nature as a Moderator of the Risk-Physical Health Relation

With respect to physical health, powerful evidence from large-scale epidemiological studies suggests that access to nature might dampen the impact of risk or disadvantage. Studying the population of England, Mitchell and Popham (2008) found that nearby green space moderates the income—mortality relation. The

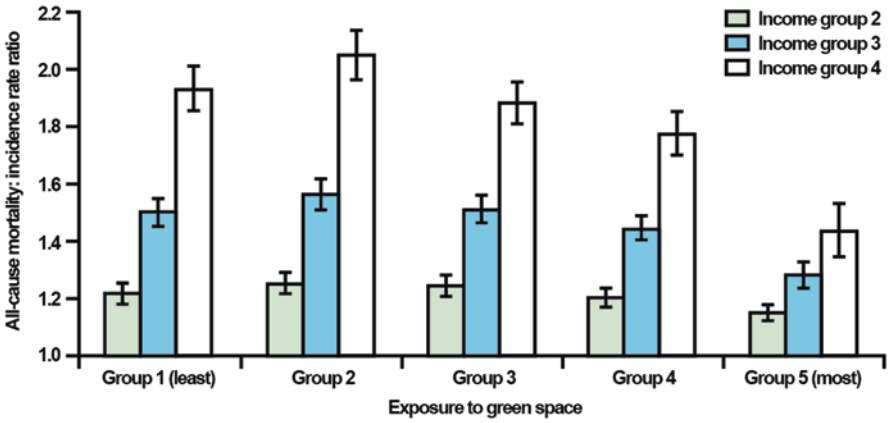

Fig. 7.9 Incidence rates of all-cause mortality by income-deprivation quartile, stratified by exposure to green space (derived from Mitchell & Popham, 2008)

income-based health inequalities for both all-cause mortality and for death from circulatory disease were lower among populations living in the greenest areas, as illustrated in Fig. 7.9. Moreover, consistent with the authors' differential hypotheses, there were no buffering effects of nature for mortality due to lung cancer or intentional self-harm, two causes of death that are less likely to be affected by nearby green space. Lachowycz and Jones (2014) similarly found an association between greenness and mortality but only in the most deprived areas. Mitchell and Popham (2007) considered the relation between nearby nature and self-reported health. They examined the interaction of green space with both urbanity and income deprivation and found that nature was associated with lower rates of poor health within urban high-income, urban low-income, and rural low-income areas. Consistent with Rutter's notion of a protective factor, there was no effect in suburban high income or rural high income areas. However, in suburban low-income areas more green space was associated with more reports of poor health. In the Netherlands, van den Berg and colleagues examined a sample of 4500+ Dutch citizens, operationalizing stressful life events dichotomously—whether a person had experienced a stressful life event such as serious illness, death of a close friend or family member, or divorce in the prior 3 months. Within 3 km, percentage of green space moderated the relations between stressful life events and general health; and between stressful life events and health complaints (Van den Berg et al., 2010).

Although relatively few studies have examined nature's role as a buffer of the risk-physical health relation, these studies provide compelling evidence that green space may dampen the effect of risk on health outcomes among vulnerable groups.

7.2.2.5 Birth Weight: Nature as a Moderator of the Risk-Birth Weight Relation

In the last decade, considerable research has focused on the relation between residential green space and birth outcomes, with a focus on birth weight (Banay, Bezold, James, Hart, & Laden, 2017; Blumenshine et al., 2010). As with most of the nature-health literature, the emphasis has been on the main effects of nature; however, some studies also examined whether nearby green space *moderates* the relation between a risk factor (or SES variable) and birth weight (Banay et al., 2017). In many cases, the concept of moderation is examined via stratified analyses focusing on the question of "for whom"— i.e., for which groups (e.g., high vs. low risk; high vs. low education; high vs. low SES) is green space linked to outcomes?

Several studies have found evidence of nature buffering the relation between SES and birth weight, using mother's education as an indicator of SES at the individual level. For example, in one of the first studies to examine the association between nearby greenness and birth outcomes, Dadvand et al. (2012) looked at a birth cohort in Spain and found no main effect of green exposure on birth weight. However, among the lowest education group who had higher nearby nature within 100-m range or lived close to major green space, birth weight was significantly greater. Other studies—from Spain, England, and Germany—found both a main effect of nature on birth weight and, in stratified analyses, a stronger association among disadvantaged groups. For example, evidence suggests stronger associations of green space and birth weight among infants whose mothers had low or moderate education (Dadvand et al., 2012; Markevych et al., 2014). Dadvand, Wright, and colleagues found stronger green space—birth weight associations among those with lower education and within low SES neighborhoods (Cusack, Larkin, Carozza, & Hystad, 2017b; Dadvand et al., 2014). Agay-Shay et al. (2019) who also examine area-level SES, found the strongest associations between nearby green space and birth weight among women living in low SES neighborhoods. Some studies find no evidence that nature moderates the SES—birth weight association (e.g., Ebisu, Holford, & Bell, 2016; Kihal-Talantikite et al., 2013).

Collectively, the evidence suggesting that associations between green space and birth weight are stronger among low SES individuals or within low SES neighborhoods—operationalized via education level or neighborhood deprivation—is consistent with the notion of nature operating as a protective factor, with the greatest impact among the most vulnerable.

7.2.2.6 Academic Achievement: Nature as Moderator of the Risk-Academic Achievement Relation

Might nature moderate the association between risk factors and academic achievement, and thereby potentially reduce the achievement gap? Despite some mixed results regarding the main effects of nature on academic achievement (Browning & Rigolon, 2019), there is evidence of moderation. Consistent with the notion that

nature may act as a protective factor, Sivarajah, Smith, and Thomas (2018) found that the effect of greenness on academic performance was most pronounced in schools with the highest community-level risk factors such as percentage of low-income families; adults with low education; single-parent families. In Kuo and colleagues' (2018) study of low-income Chicago schools, they found a greenness by disadvantage interaction such that the greenness-academic achievement relation varied by school-level disadvantage. While these researchers did not report that academic achievement disparities were dampened by the presence of trees, importantly, they note that disadvantage was inversely related to greenness; school grounds in poor communities were less green (Kuo, Browning, Sachdeva, Westphal, & Lee, 2018). Clearly, inequities in green access preclude the possibility for nature to moderate the relation between risk and academic achievement, a point that will be further discussed below.

As described above, some evidence suggests that nature may buffer or dampen the association of poverty or risk on mental health, physical health, birth weight, and academic achievement. However, it is important to note—as documented by Kuo and colleagues (2018) regarding schools—that in some places, nature, or greenness is associated with poverty, SES, and related risk factors such that greenness cannot be examined as a moderator (which must not be associated with the independent variable). The issue of inequitable distribution of nature will be explored further near the end of the chapter.

7.2.2.7 *Protective Mechanism*: Plausible Pathways Underlying Nature's Role as a Moderator of the Relation Between Risk and Health Outcomes

Given the evidence that nature may buffer the effects of risk and adversity, it seems reasonable to consider nature a "resilience resource" or a "protective factor." However, Rutter (1987) called for a move beyond "protective factors" to identify "protective mechanisms" that explain not merely *what* factors are at play but also *how* protection might operate. With that in mind, I consider mediating pathways that may explain how/why nature has a moderating effect, as illustrated in Fig. 7.10.

Mediators, Moderators, and Mediated Moderation Before delving deeper, it may be useful to provide some brief elaboration regarding the meanings of "mediator" and "moderator" as well as to discuss "mediated moderation," the focus of this section. We have briefly considered moderation or "effect modification" as described in Masten's moderator model of resilience (Fig. 7.6). A ***moderator*** is a variable that alters the strength and/or direction of the relation between an independent and dependent variable—in this case, the relation between risk and health outcome(s) (Figs. 7.6 and 7.7). A moderator, which must not be directly affected by or correlated with the independent variable, interacts with the independent variable to affect the dependent variable. Language associated with moderation includes "buffer," "attenuate," "exacerbate," and more generally "depends upon." For our purposes, a

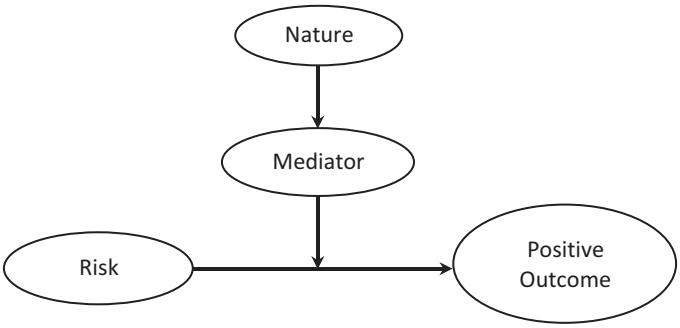

Fig. 7.10 A mediated moderator model of resilience: Through what pathway (mediator) does nature buffer (moderate) the relation between risk factor(s) and a health outcome?

moderator could be an intervention, an active independent variable—such as a tree-planting initiative or a parenting skills class; or an attribute variable such as income, education, or gender. The relation between risk and health differs depending on the level of the moderator variable (e.g., with vs. without tree-planting; low- vs. high-income; male vs. female). I also recognize and include in this discussion, analyses that employ stratification to examine differential impacts on at-risk groups.

Mediators, in contrast, are explanatory variables. As we "zoom in" with our magnifying glass, mediators reveal the underlying mechanism or pathway that links related variables. Mediators explain how or why one variable affects another. Typically, we consider mediators of a direct relationship between an independent and dependent variable (i.e., the independent variable affects the mediator, which, in turn, affects the dependent variable). The mediator is responsible—partially, or entirely—for the relation between the independent and dependent variable. For example, if nature has a direct effect on health, physical activity might explain—i.e., mediate—the nature-health relation. In this chapter, I focus on moderation (i.e., does nature buffer (moderate) the effect of risk and adversity on health) as well as ***mediated moderation*** (Figs. 7.10 and 7.11) (i.e., what variable(s) might underlie (mediate) nature's role as a moderator of the risk-health relation?) (Baron & Kenny, 1986). Having presented evidence of the relation(s) between risk factors and health outcomes and of nature moderating (in this case, buffering or attenuating) the association of various risk factors and health outcomes (Table 7.1), we now consider what mediating mechanism or pathway might explain nature's role as a moderator. Mediated moderation can be described as: "Given that the magnitude of the treatment effect depends on an individual difference or context variable, then the mediated moderation question is concerned with the mediating process that is responsible for that moderation. What is the process through which that overall moderated treatment effect is produced?" Muller, Judd, and Yzerbyt (2005, p. 853). We now consider—for each of our four health outcomes—two plausible mechanisms or pathways that might explain nature's buffering effect.

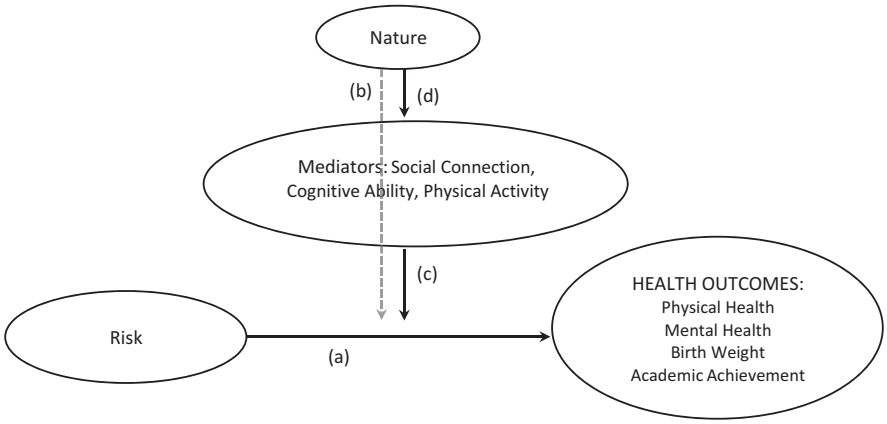

Fig. 7.11 Mediated moderation model: some plausible mediators that might underlie nature's potential to buffer the impact of risk/adversity on health outcomes. (a) Represents the association of risk with health outcomes; (b) expresses nature's role as a moderator of the risk–health relation; (c) conveys the potential moderating effect of the mediating mechanism; (d) refers to nature's direct effect on the proposed mediator

Table 7.1 Evidence or plausibility for mediated moderation. Columns (a) (b) (c) (d) correspond to Fig. 7.11

Outcome	(a) Risk factors associated with outcome?	(b) Nature moderates risk-outcome relation?	(c) Proposed mediator moderates the risk-outcome relation		(d) Nature affects proposed mediator?	
			Executive function	Social connection	Executive function	Social connection
Mental health	√	√	√	√	√	√
Physical health	√	√	√	√		
Birth weight	√	√	~	√		
Academic achievement	√	√	~	√		

√ solid evidence, ~ plausible but less evidence

Exploring Mediating Pathways Underlying Nature's Role as a Moderator There are a variety of plausible mediators that could underlie nature's role as a moderator. For a variable to be a candidate as a mediator of nature's moderating effect on the risk-health association, to begin, (a) the risk-health association must exist and (b) nature must moderate that relation ("a" and "b" in Fig. 7.11 and Table 7.1). In addition, (c) the factor must be plausible as a moderator of the risk-health association, and (d) the factor must be directly affected by nature (Fig. 7.11). With that in mind, I focus on two proposed pathways that might underlie nature's role as a buffer:

executive function and **social connection**. For each, I first consider evidence that this factor may moderate the risk-health relation—for each of the four health-related outcomes. Second, I briefly present evidence that the proposed mediator is impacted by nature. Lastly, I consider linkages to the resilience literature and Masten's (2014) "resilience short list." Note that other authors have provided detailed examinations of the *direct effects* of nature on health and the plausible mediators underlying those direct effects (Frumkin et al., 2017; Hartig et al., 2014; James et al., 2015; Lachowycz & Jones, 2013; McCurdy, Winterbottom, Mehta, & Roberts, 2010); however, my focus is explicitly on *moderation* and plausible mechanisms (mediators) underlying nature's *moderating effects* (Fig. 7.11).

7.3 Executive Function

7.3.1 Executive Function as a Buffer

Executive function comprises various cognitive abilities including working memory, attentional control, attention shifting, and inhibitory control (Jacob & Parkinson, 2015). Executive function is a compelling candidate that might underlie nature's role as a buffer against the effects of risk. Executive function and related traits, IQ or cognitive ability, have been examined as moderators of the risk-mental health relation with respect to both family-level and neighborhood-level cumulative risk, cross-sectionally and longitudinally. Mental health outcomes are typically operationalized via measures of internalizing symptoms such as anxiety, depression, social withdrawal or externalizing symptoms such as poor impulse control and conduct problems. Among preschoolers, both the effect of neighborhood-level deprivation on peer relationship difficulties (Flouri, Mavroveli, & Tzavidis, 2012) and the effect of cumulative family risk factors on conduct and emotional problems (Flouri, Tzavidis, & Kallis, 2010) were moderated by children's cognitive ability. Longitudinal evidence of children from age 3–7 years, indicates that the relation between family-level SES disadvantage and children's emotional problems (internalizing) was moderated by verbal cognitive ability (Flouri et al., 2014). Teenagers exposed to high levels of family adversity during childhood exhibit fewer externalizing behaviors (e.g., juvenile offending, substance abuse) if they have higher cognitive ability compared to their peers (Fergusson & Lynskey, 1996). A large (N = 13,000+) longitudinal study following participants from birth to age 50 years found that early childhood cognitive ability moderated the relation between early life social disadvantage and mental health in adulthood (Bridger & Daly, 2017).

There is similar though more limited evidence with respect to physical health. In their 25-year longitudinal study of predictors of mortality and morbidity in later life, Hart et al. (2003) found a significant childhood IQ by deprivation cross-over interaction effect on all-cause mortality. Childhood IQ dampened the relation between area-level deprivation and mortality; but there was no IQ by social class interaction. In addition to moderating the effects of disadvantage on mental health as noted

above; Bridger and Daly (2017) report that cognitive ability in childhood moderates the association between childhood disadvantage and physical health in adulthood. For a person living in poverty, having the cognitive resources to navigate the bureaucracy of the public housing, the healthcare system, student loan programs, or other public services or aid programs, may be protective against the physical impact of risk and disadvantage. Among poor women, day-to-day attentional capacity has been linked to the ability to manage major life issues (Kuo, 2001).

Mothers' cognitive ability may be a plausible moderator of the effects of risk on birth weight although it appears research has not explicitly addressed this question. It is well-documented that mothers with lower education levels are more likely to experience adverse birth outcomes including low birth weight (Blumenshine et al., 2010; Luo, Wilkins, & Kramer, 2006). Similar to the logic with respect to physical health, a mother's executive function would likely enhance her capacity to follow prenatal medical advice with respect to diet, smoking, and physical activity, which would contribute to positive birth outcomes and plausibly moderate the effect of risk factors.

Some studies examine the direct relation between executive function and academic achievement and suggest a modest association (Ackerman & Heggestad, 1997; Jacob & Parkinson, 2015). Some evidence that IQ attenuates the risk-academic achievement relation is provided by Masten and colleagues, who found that IQ moderated the effect of risk (stressful life events) on school competence operationalized as teacher ratings, peer assessments, and school records (Masten et al., 1988).

7.3.2 Executive Functioning: Link to Resilience

According to Masten's (2014) resilience short list "intelligence and problem solving skills" is among the most potent moderators of the relation between risk factors and adaptive outcomes. An addition short-list item is "self-control, emotion regulation, and planfulness" (Masten, 2014, p. 148). While these are two distinct protective factors, the protective function of above-average intelligence relates to better executive function, manifested in capacities such as self-control and information processing (Lösel & Farrington, 2012). As such, we consider these two protective factors in tandem. Many longitudinal studies have found IQ to have a protective influence (Werner & Smith, 1992, 2001), particularly in situations when adversity is very high (Lösel & Farrington, 2012; Masten et al., 1999). For example, a 10-year longitudinal study following children from childhood to adolescence found that better intellectual functioning was protective against adversity, particularly with respect to outcomes related to conduct and antisocial behavior (Masten et al., 1999) (Fig. 7.1). Intelligence and cognitive competences are also among the factors that buffer the impact of adversity on youth violence (Lösel & Farrington, 2012), a key aspect of conduct disorders, and externalizing aspects of mental health. Executive functioning, more specifically, appears to be an important protective factor that enables

high-risk children, living in the context of poverty, homelessness, and other adversity, to succeed (Masten, 2014).

7.3.2.1 Nature → Executive Functioning

Last, but not least, nature affects executive functioning ("d" in Fig. 7.11 and Table 7.1). Consistent with Attention Restoration Theory (Kaplan, 1995; Kaplan & Kaplan, 1983), many studies have documented the effects of nature views and nature access on executive functioning (Berman, Jonides, & Kaplan, 2008; Tennessen & Cimprich, 1995; Wells, 2000; see also Chap. 4, this volume). Within Chicago public housing, nature in the apartment window view predicted girls' performance on three tasks related to executive function: concentration, inhibition, and delayed gratification (Faber Taylor, Kuo, & Sullivan, 2002). Green space near home predicted parents' reports of their children's emotional and behavioral self-regulation problems from ages 3 to 5 years (Flouri et al., 2014). Recent meta-analyses suggest modest but significant positive effects of nature exposure on children's self-regulation (Weeland et al., 2019). A walk in a park, compared to a downtown or neighborhood walk, led to better concentration among children with attention-deficit hyperactivity disorder (ADHD) (Faber Taylor & Kuo, 2009), among a general sample of children (Schutte, Torquati, & Beattie, 2017), and among university students (Berman et al., 2008). Moreover, a study of 6500+ middle-aged civil servants found that controlling for individual and neighborhood SES indicators, higher residential greenness was associated with slower cognitive decline over a 10-year period (de Keijzer et al., 2018).

Studies from school environments offer additional evidence of nature's capacity to bolster executive functioning. High school students randomly assigned to a room with a green window view scored significantly higher on measures of attentional functioning than peers assigned to rooms without green views (Li & Sullivan, 2016). A study of outdoor versus indoor classroom lessons revealed that classroom engagement was better following lessons in nature—according to four out of five measures of engagement (i.e., teacher ratings, redirects, photo ratings, and a summary index) (Kuo, Browning, & Penner, 2018). A study of recess time found a greater increase in sustained attention, selective attention, and concentration from pretest to post-test within a natural (garden) setting than in the built (courtyard) setting (Amicone et al., 2018). A longitudinal study of more than 2500 students in 36 schools in Barcelona, Spain documented that students in greener schools had more rapid cognitive development (operationalized via working memory and attention tasks) over the course of a year (Dadvand et al., 2015). Taken together, there is robust, compelling evidence that exposure to nature enhances executive function.

We find persuasive evidence that executive function may be an explanatory pathway underlying nature's buffering effect on the risk-health linkages. While executive function is a particularly well-documented and compelling mechanism buffering the effects of risk on mental health and physical health, there is less evidence with respect to academic achievement. Regarding birth weight, the pathway is plausible

but relatively unexplored. Next, we consider social connection as a mechanism that may underlie nature's proposed role as a moderator of the risk-health relation.

7.3.3 Social Connection

7.3.3.1 Social Connection as a Buffer

Social connection is among the most plausible mechanisms underlying nature's moderation of the relation between risk or adversity and positive outcomes. I consider related constructs including social cohesion and social support, which may be examined at the individual- or community level. Social support, defined as the perception or experience that one is cared for and part of a supportive social network (Wills, 1991), may disrupt the linkage between poverty or risk and mental health. For example, among pregnant women with histories of maltreatment and household dysfunction, social support moderated the relation between these risk factors and health outcomes during pregnancy such that for women with high levels of social support, maternal adverse events were unrelated to health (Racine et al., 2018). Among adolescents, close relationship with a grandparent moderated the association of life stress on both hyperactivity and psychopathology (Flouri, Buchanan, Tan, Griggs, & Attar-Schwartz, 2010). Social support also buffers the impact of unemployment and economic crises on mental health (Glonti et al., 2015; Gore, 1978).

While the direct effects of social connection on physical health receive considerable attention (Cohen, Inagami, & Finch, 2008; Murayama, Fujiwara, & Kawachi, 2012; Wood & Giles-Corti, 2008), there is also significant evidence that social connection or social capital may buffer the effect of risk on health. Positive relations between parent and child can buffer the effects of childhood poverty on children's physical health (Chen & Miller, 2013; Evans & Kim, 2013). High levels of maternal warmth buffer the effects of low SES in early life on adult metabolic syndrome, a precursor to diabetes (Miller et al., 2011) and buffer the effect of poverty on allostatic load[1] (an indicator of physiological risk) (Evans & Kim, 2007). Longitudinal evidence suggests that positive social relationships are associated with reduced cardiovascular risk and inflammatory activity among older adults over an 18-month period. Moreover, consistent with Rutter's notion of a protective factor, the salutogenic (i.e., health-promoting) effect (Antonovsky, 1996) was evident only among lower income, not higher income participants (Vitaliano et al., 2001). Following factory shut-downs, social support has been found to moderate the impact of unemployment on health outcomes such as cholesterol levels and illness symptoms

[1] Allostatic load refers to the "price the body pays for being forced to adapt to adverse psychosocial or physical situations, and it represents either the presence of too much stress or the inefficient operation of the stress hormone response system, which must be turned on and then turned off again after the stressful situation is over" (McEwen, 2000, pp. 110–111).

(Gore, 1978). Social relations are protective against the effects of economic crises on health-related outcomes including physical health, mortality, suicide and suicide attempts, and health behaviors (Glonti et al., 2015). Among pregnant women, social support moderates the impact of their childhood risk factors on antepartum health risk (Racine et al., 2018).

Numerous studies—both observational and experimental—suggest that social support may be protective against the effect of risk on birth weight and related outcomes (Cobb, 1976; Hetherington et al., 2015; Norbeck, DeJoseph, & Smith, 1996; Orr, 2004). Consistent with the notion of buffering, stratified analyses indicate the strongest impact of social support on birth outcomes occurs among the most at-risk mothers, for example, those who experienced the most stressful life events (Norbeck & Tilden, 1983; Nuckolls, Cassel, & Kaplan, 1972), those who are youngest (i.e., mothers aged 17 years or younger) (Olds, Henderson, Tatelbaum, & Chamberlin, 1986) or those who are unmarried teenagers (Heins, Nance, & Ferguson, 1987). If we delve a layer deeper to consider how/why social support might buffer the effect of risk factors on birth weight, we might consider three types of social support: emotional, informational, and practical (Caplan, Cobb, French Jr., Van Harrison, & Pinneau, 1975). It is plausible for these various types of social support to affect health behaviors such as smoking or physical activity, depression (Orr, 2004), stress (Hetherington et al., 2015) as well as the diffusion of knowledge regarding health promotion (Murayama et al., 2012) and infant development (dos Santos, Diniz, & Koller, 2017) which could disrupt linkages between risk and birth weight.

For students, social support may act as a stabilizing factor, making them less vulnerable to the negative effects of poverty and other risk factors. Malecki and Demaray (2006) found that social support moderated the relation between socioeconomic status and academic performance among middle schoolers. Similarly, among homeless youth, parenting quality has been found to moderate the effect of risk on academic success (Herbers et al., 2011). Maternal responsiveness attenuated the effects of childhood deprivation on children's inhibitory control (Sarsour et al., 2011), which relates to executive functioning, as described above.

7.3.3.2 Social Connection: Link to Resilience

Social support and social relationships figure centrally in the resilience literature (Masten, 2014; Sippel, Pietrzak, Charney, Mayes, & Southwick, 2015). Consistent with attachment theory (Bowlby, 1977), relations with caring, pro-social adults are a key component of the resilience short list (Masten, 2014). In childhood, the role of the caregiver is paramount as secure attachment early in life provides a foundation for later-life relationships with close friends and romantic partners.

Nature → Social Connection For social connection to be a plausible pathway underlying nature's capacity to buffer the effect of risk on health outcomes, there must be a relation between nature and social connection ((d) in Fig. 7.11, Table 7.1). Considerable evidence suggests this is the case (see: Frumkin et al., 2017). Residents

of public housing buildings with nearby green space had stronger social ties than residents of identical buildings with little nearby vegetation, and the relation between green space and social ties was mediated by social interaction (Coley, Sullivan, & Kuo, 1997; Kuo, Sullivan, & Wiley, 1998; Sullivan, Kuo, & DePooter, 2004). Nearby nature has also been linked to social capital—i.e., the resources that are embedded within a social network or "…the stock of active connections among people: the trust, understanding and shared values that bind … networks and communities…" (Cohen & Prusak, 2001, p. 4). Greenery has been identified among the neighborhood elements associated with social capital (Wood & Giles-Corti, 2008). Neighborhood tree canopy (Holtan, Dieterlen, & Sullivan, 2015), community gardening (Alaimo, Reischl, & Allen, 2010), parks (Cohen et al., 2008) and green space (Broyles, Mowen, Theall, Gustat, & Rung, 2011) have all been linked to social capital or collective efficacy[2]. Moreover, Dutch researchers found that after controlling for socioeconomic and demographic variables, having less green space in the neighborhood was associated with feelings of loneliness and perceived shortage of social support (Maas, van Dillen, Verheij, & Groenewegen, 2009).

Green space might influence parenting. Within public housing communities, green space has been linked to more intergenerational interaction and children's access to adults (Coley et al., 1997; Faber Taylor, Wiley, Kuo, & Sullivan, 1998). Among low-income women, living near treed areas is associated with greater capacity to plan and navigate life challenges (Kuo, 2001) which is likely to free cognitive resources and facilitate more responsive parenting. Time in nature, compared to time indoors, contributes to stronger mother–daughter dyad cohesion as well as restored attention (Izenstark & Ebata, 2017). Moreover, pregnant women living with more green space in their neighborhood were less likely to report symptoms of depression (McEachan et al., 2016). Evidence of maternal depression adversely impacting parenting behavior (Lovejoy, Graczyk, O'Hare, & Neuman, 2000) suggests that nature access might promote parental responsiveness in part by reducing depression. By affecting social connection and via attention and mental health, nature may positively influence parenting behavior.

7.3.4 Mediated Moderation: Summary

I have examined the proposition that exposure to nature and proximity to green space may buffer the effects of risk and adversity on health and health-related outcomes. I have focused on four health outcomes—mental health, physical health, birth weight, and academic achievement—along with two plausible mechanisms—executive function and social connection—that may underlie the proposed mediated moderation model (Table 7.1). These four outcomes represent both fundamental

[2] Collective efficacy refers to "social cohesion among neighbors along with their willingness to intervene on behavior of the common good" (Sampson, Raudenbush, & Earls, 1997).

health indicators and a broad notion of "health and well-being" from birth through the life course. Evidence suggests that social connection may underlie nature's role as a buffer with regard to all four outcomes; while the evidence regarding executive function as a mediator is clearer for mental health and physical health than for birth weight and academic achievement. Although it is beyond the scope of this chapter to examine all the plausible pathways that might underlie nature's role as a buffer, it is important to acknowledge that many alternative (and complementary) mechanisms exist. These include increased physical activity, reduced stress, enhanced immune function, and improved air quality, which have been examined elsewhere as mediators of nature's direct effects on health (Browning & Rigolon, 2019; Frumkin et al., 2017; Hartig et al., 2014; Kuo, Barnes, & Jordan, 2019; Markevych et al., 2017; Wells, Jimenez, & Martensson, 2018) and may also be plausible mediators of nature's moderation of the effects of risk. Regarding nature buffering the effects of risk on birth weight, air quality appears to be among the most plausible mediators (Markevych et al., 2017). With respect to academic achievement specifically, school attendance and vision may mediate nature's moderating effect. Both nearby green space and particulate matter have been linked to school attendance (MacNaughton, Eitland, Kloog, Schwartz, & Allen, 2017). Green space near home and school has been linked to less use of spectacles among school children (Dadvand et al., 2017) and time outdoors has been inversely linked to myopia prevalence (Dirani et al., 2009; Rose et al., 2008).

Taken together, the research evidence suggests that access to nature and green space may indeed moderate the impact of risk on health and that executive function and social connection are among the plausible underlying mechanisms.

7.4 Discussion

7.4.1 The Natural Environment as Vehicle for Health Equity

In a world characterized by high rates of poverty and high prevalence of a wide variety of risk factors—from homelessness to poor housing to child neglect—and vast inequities of wealth and health, attention is warranted to environmental and policy strategies that may dampen the impact of poverty and risk on health. Ultimately, such strategies have the potential to reduce income-based, race-based, and place-based health disparities. Green space appears to be one such strategy. Further attention to nature's role as a buffer may ultimately make important differences in the health of individuals, communities, and populations. The notion that nature may moderate the impact of risk on health has been dubbed by Richard Mitchell as "equigenic effects" (Mitchell, 2013; Mitchell et al., 2015). Mitchell and colleagues state "If societies cannot, or will not, narrow socioeconomic inequality, research should explore the so-called equigenic environments—those that can disrupt the usual conversion of socioeconomic inequality to health inequality" (p. 80). This is not to say that access to nature is a panacea for social and economic inequity.

However, if green space can have even a modest equalizing effect, on the population level, the impact could be significant. For example, with respect to birth weight, consider that nearly half of the women who give birth in the United States are poor (Braveman, Marchi, Egerter, et al., 2010) and access to green space may reduce the impact of poverty on birth weight. Reducing rates of low birth weight, and in turn, rates of infant mortality and myriad outcomes associated with low birth weight (Blumenshine et al., 2010; Horbar et al., 1993; Santos et al., 2015) could be a substantial impact. Research evidence suggests that every $50 per capita a county spends on parks and recreation is associated with 1.25 fewer low birth weight cases per 1000, which across a population can contribute substantially to national goals to reduce low birth weight (Curtis, Fuller-Rowell, Vilches, Vonasek, & Wells, 2019). Similarly, consider the potential for nature to dampen linkages between risk or disadvantage and academic outcomes (Kuo, Browning, Sachdeva, et al., 2018). The moderating effect of nature could reduce, even modestly, the intractable race- and income-based disparities in academic achievement, helping to even the playing field for poor and minority youth. Moreover, the moderating effect of nature might result in cascading effects such that minor disruptions ultimately ripple into larger achievement—equalizing benefits downstream.

7.4.2 Nature Access: An Environmental Justice Issue

As we consider the potential for nature to buffer the impact of risk on health, it is essential to acknowledge evidence suggesting that nature access is often highly correlated with poverty, race, and other factors related to risk (Fig. 7.12). In many geographical areas, low-income and/or ethnic and racial minority individuals have less access to nature than wealthy or white people (Duncan, Kawachi, White, & Williams, 2013). Evidence of such disparities in access to parks and green space come from studies across the globe including examinations of golf courses (and other physical activity facilities) in the United States (Powell, Slater, Chaloupka, & Harper, 2006); parks, green space, bike paths, and sports areas in the United States (Powell, Slater, & Chaloupka, 2004); as well as parks and green space in Los Angeles, California (Wolch, Wilson, & Fehrenbach, 2005), Boston, Massachusetts (Duncan et al., 2013), Spain (Dadvand, de Nazelle, et al., 2012), and Australia (Astell-Burt, Feng, Mavoa, Badland, & Giles-Corti, 2014). A recent study examined between-city rather than between-neighborhood differences among US cities and found that cities with higher median income and lower percentages of Latino and Black residents had higher quality park systems (Rigolon, Browning, & Jennings, 2018). In Portland, Oregon and Austin, Texas, consistent negative associations have been documented between greenness and the percentage of household living under the poverty line, percentage unemployment, percentage Hispanic, and percentage without a high school education (Cusack, Larkin, Carozza, & Hystad, 2017a). Moreover, in a study of densely populated urban areas within the United States and Puerto Rico, Jesdale, Morello-Frosch, and Cushing (2013) found that

Fig. 7.12 Low-income and ethnic minority groups may have less access to nature

racial and ethnic minority residents were more likely to live in places with no tree canopy and with more than 50% impervious surfaces. In Tampa, Florida, black, low-income, renter neighborhoods have fewer street trees than those that are predominantly white, wealthy, and owner-occupied (Landry & Chakraborty, 2009). While some studies do not find a deprivaton of green space (proximity, quality, or quantity) among low-income or minority groups (Abercrombie et al., 2008; Duncan et al., 2013; Timperio, Ball, Salmon, Roberts, & Crawford, 2007), evidence clearly indicates that in many locales, proximity, and/or quality of nature access is inequitably distributed (see also Sullivan's chapter, this volume).

Equitable access to and quality of urban green space is not only just (Downey & Pribesh, 2004; Strife & Downey, 2009; Wolch et al., 2005), it is a key component of equitable communities and equitable health (Nesbitt, Meitner, Sheppard, & Girling, 2018; Shanahan et al., 2015). To deny large groups of people equitable access to nature is to perpetuate health disparities. If nature access is associated with risk factors, inequitable distribution of nature must be remedied before nature can be effectively leveraged as an equigenic tool.

7.4.3 Future Research: Conceptual and Methodological Considerations

7.4.3.1 Nature's Power to Moderate

The study of nature's effects on health have been dominated by a focus on main effects. I argue here that more attention ought to be paid to the role of nature as a moderator. As research examining nature's relation to health has burgeoned in recent decades, the focus has been predominantly on the direct effects of nature on health and well-being, with modest, uneven attention to nature as a moderator of the relation between risk or disadvantage and health outcomes. In some cases, extant data sets may include the variables necessary to examine nature as a moderator. It is common, for example, to treat poverty, SES, or other risk factors as covariates, the predictive power of which is statistically controlled for before examining green space as a predictor. Across the four outcomes examined in this chapter, there are countless examples in which SES and/or other risk variables are controlled for. Alternatively, researchers might more often focus on the risk factors including SES—at the individual, family, or community level—as predictors, with nature as a moderator or interaction term. For example, a recent longitudinal study conducted in Denmark, found that levels of childhood green space showed a dose–response relationship with the likelihood of developing a psychiatric disorder in adolescence or adulthood (Engemann et al., 2019). Specifically, those who lived in the least green settings as children had the highest likelihood of later developing a psychiatric disorder. Living in areas with the lowest amount of green space from birth to age 10 was associated with up to 55% greater likelihood of developing a psychiatric disorder compared to living in areas with the highest amount of green space. This study provides compelling evidence of nature's main effect on mental health and through stratified analyses, hints at the notion of nature as a "protective factor." A complementary or alternative analytic approach with such data sets would be to examine whether nature moderates the relation between risk factors such as socioeconomic status or parental history of mental illness and mental health outcomes (rather than statistically controlling for these variables).

7.4.3.2 Scale of Nature

The scale at which nature is operationalized may provide insight regarding plausible mediating mechanisms underlying a moderating effect of nature. Interestingly, some studies that report significant risk-by-nature interaction effects on health are in fact three-way interactions, with the spatial range at which nature is measured as a third variable in the interaction. In other words, for example, green space was associated higher birth weights or other positive health outcomes among low SES individuals (or neighborhoods) but only at some, not all, scales of nature. Different

underlying mediators may correspond to different scales of nature interaction—e.g., nature surrounding the home environment with which one engages directly; or the view—from home or from the car or train window. When effects are found for nature near the home environment—e.g., at 50 or 100 m—perhaps the mediator may more likely relate to spending time in green space or viewing nature from the window.

7.4.3.3 Collinearity of Risk and Nature Access

Related to inequity in nature access, one of the barriers to examining nature as a moderator of the risk-health association, is that fact that access to nature is often correlated with the risk factors. Poverty—chief among risk factors—is often associated with nature access or the quality of natural environments that are accessible (e.g., unsafe playgrounds). In addition to the social, political, and health issues related to inequitable access to green space, if nature is correlated with risk factors, and by extension with race or ethnicity, then nature cannot be examined as a moderator of the risk-health relation, because since, for moderator analyses, the two interacting independent variables must not be related to one another. In cases when the risk factor is correlated with nature access, it is valuable to document the disparities.

7.5 Conclusion

This chapter presents evidence that the natural environment ought to be considered a resilience factor—among the variables linked to positive outcomes among youth and others (Masten, 2014), among the factors that are protective against the impact of risk and adversity (Rutter, 1987). Nature buffers the relations between various risk factors—including poverty—and health-related outcomes. We have considered some of the plausible mechanisms that might underlie nature's role as a moderator. While nature is not a panacea for social ills, nature access may be a valuable tool to not only bolster resilience but to reduce income- and race-based health disparities across our populations. Ultimately, research focused on nature's role as a moderator can inform intervention strategies and contribute to both health and health equity.

Acknowledgments Thanks to Gary Evans for feedback on an early draft of this chapter. Thanks also to Bill Xu, Bunmi Osias, and Micah Baclig for assistance with literature review, reference management, and graphics.

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Chapter 8
Perceiving "Natural" Environments: An Ecological Perspective with Reflections on the Chapters

Harry Heft

8.1 Introduction

Starting in the late 1960s and early 1970s, and in conjunction with emergence of the global environmental movement, a relatively small number of researchers in psychology and allied disciplines such as geography and the design fields began to turn their attention to the study of psychological processes in the context of everyday environments. These empirical efforts were directed for the most part toward settings and circumstances beyond experimental laboratories. Broadly described, the goal was to gain insight into the relationship between the character of everyday environments and psychological well-being. What resulted was an interdisciplinary area of inquiry that came to be called *environmental psychology* (Craik, 1973; Proshansky, Ittelson, & Rivlin, 1970; Wohlwill, 1970).

Concern for psychological well-being in relation to everyday circumstances initially led to empirical inquiry on several interrelated fronts, as can be seen in the seminal handbook edited by Stokols and Altman (1987). Among these areas of inquiry was environmental perception and aesthetics. Some research in this area examined *the potential significance of natural environments for psychological well-being*. Over the past two decades, the pace of research on this matter has been accelerating—a trend that brings us to the focus of this volume.

The chapters assembled here offer an up-to-date overview and assessment of these research efforts that examine the potential psychological significance of exposure to and engagement with the natural environment. The principal aims of this chapter are twofold: first, to examine the concept of the natural environment and to consider how to approach its study from a psychological perspective; and second, to provide commentaries and reflections on the individual chapters with an emphasis on their theoretical commitments and the research questions that follow from them.

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5_8

Because the chapters represent a relatively diverse set of perspectives, the commentaries taken collectively are intended to offer thoughts about research and theory in this area of inquiry broadly considered. In order to pursue these two aims systematically, it will be necessary to offer some initial conceptual groundwork.

8.2 A Recurring Challenge

The common focus among the chapters in this volume on the natural environment might seem rather straightforward. After all, what the natural environment refers to in everyday discourse, at least, would seem to be rather obvious. And yet, when we try to articulate what exactly is meant by the natural environment, difficulties immediately arise. A clear-cut definition of the natural environment turns out to be difficult to nail down. Achieving some initial clarity on this our topic of study would seem to be a necessary first step.

Should we employ the descriptor "natural environment" to refer to those areas that are untouched by human activity? Surely, that is unrealizable because we would be hard-pressed to find many places meeting that criterion. The imprint of human activity is global. Perhaps, then, the designation "natural environment" should be applied to areas where there is a predominance of particular features, such as trees and plants. After all, it is likely that forests and parklands come to mind when we think about natural environments. But if the presence of trees and plants is the criterion for designating some area as natural, what about places lacking in these features that should surely count as natural such as polar regions and deserts? And certainly we need to include landforms that are the result of geological changes, not to mention rivers, streams, and oceans. By focusing on particular features, we are led to identify a multitude of natural environments—a catch-all that doesn't provide much specificity when in our research we designate an environment as natural. If, for example, it is claimed that exposure to natural environments is beneficial from a psychological standpoint, which among this variety of possibilities do we have in mind?

An alternative tack might be to include as "natural" anything in the environment that is not artificial, with artificial referring to those things constructed through human activities. The dichotomy of natural-artificial obviously breaks down, however, in light of constructions such as bird's nests, spider's webs, and beaver dams. Are they artificial as well? Humans are not unique among living beings in changing their habitat. Altering the environment in order to more readily function in it is ubiquitous among all living things from micro-organisms to mammals—an activity referred to as *niche construction* (Odling-Smee, Laland, & Feldman, 2003). Also, problematic is the fact that it is often not apparent which perceptible features of the environment are due to human activities. Consider, for example, lakes we encounter that turn out on examination to be the result of damming a river. Are they natural or artificial?

These considerations point to an enigma attendant to the chapters collected in this volume. The chapters do offer empirical documentation of discernible psychological and health effects of exposure to or engagement with what we take to be natural environments; and yet all the while, considerable ambiguity persists as to what precisely is meant by a natural environment.

A sister discipline, environmental philosophy, faces similar struggles about what constitutes the natural environment (e.g., Caldicott & Nelson, 1998; Cronon, 1996; Krieger, 1973; Rolston, 1997; Soper, 1995; Vogel, 1996, 2015), and psychologists have much to learn from this literature.

8.2.1 Adopting an Epistemological Orientation

How, then, should we begin to unravel these complicated issues? As a start, it is useful to invoke the philosophical distinction between matters of *ontology* and those of *epistemology*. Ontology concerns the "essence" of things—that is, what are the intrinsic qualities that make something an X rather than a Y? When we ask, then, what is a natural environment as opposed to one that is not, we are raising an ontological question. Epistemology concerns the basis for knowing. An epistemological question relevant to the topic of natural environments would be "what leads us to judge an environment as being natural or not?" That question concerns matters related to perception and cognition.

There is much to be gained in the study of the relationship between the natural environment and psychological processes by distinguishing between ontological and epistemological matters, and then focusing mostly on the latter. When we frame this topic as one concerning epistemology, our attention becomes directed toward the basis on which a perceiver experiences an environment as natural or not. Such an orientation may be more amenable to psychological analysis than questions concerning ontology. Also, framing inquiry in this manner establishes a research agenda from the outset by leading us to inquire as to the distinctive *perceivable qualities* of the variables in question.

8.2.2 Conceptualizing Perception

From a psychological perspective, it is by means of perceptual processes that environmental conditions affect the individual; and the perceptual process that has received the greatest attention within psychology is, of course, vision. We might then begin by considering how the environment is perceived visually and what visual properties of the environment are most relevant to our question. That path, however, is not necessarily straightforward because from the very outset of

experimental psychology in the nineteenth century, psychologists have differed about how perception should be understood (Hatfield, 1990). Since then, the manner in which perceptual processes are most adequately conceptualized has continued to be a matter of considerable debate within the psychological and cognitive sciences (see, Goldstein, 2009; Palmer, 1999; Turvey, 2019; Wilson & Keil, 1999).

Bearing such differences in mind, it is critically important for our purposes here to note—although often it goes unrecognized—that one's theoretical stance on *the nature of perceiving directly influences what we take to be the environmental basis for perceiving*. To explain, if it is assumed that perceptual experience is a result of a concatenation of sensory elements or individual "low level" features, then we may be inclined to identify as their environmental correlates *elementary* units of physical stimulation and features. If, however, perceptual experience is assumed to be structural in character, marked by the recognition of patterns and forms, then the environmental correlates for perception might tend to be conceptualized in corresponding *structural* and even holistic terms. Alternatively, as a third possibility, if perceptual experience is considered to be a result of an organism's behavioral activity in particular circumstances, one's approach to conceptualizing the environment may take a form of considering the *opportunities* it offers to an organism for action. In short, the manner in which we conceptualize perceptual experience, and the processes that subserve it, can have a direct bearing on how we approach at the outset an analysis of the environment from an epistemological point of view.

In light of these considerations, we should expect to find a diversity of approaches concerning how the natural environment is conceptualized for the purposes of visual perception. That is indeed the case among the chapters collected in this volume. Let us begin by offering a template for organizing them.

8.3 Approaches to Environment–Person Relations

An examination of the chapters in this volume will be well served if we begin by drawing on a meta-theoretical essay offered decades ago by Joachim Wohlwill, one of the pioneers in the study of environmental perception within environmental psychology (Heft, 1988, 1998). Wohlwill (1973a) differentiated among psychological theories with respect to how they conceptualize the basis of perceptual experience. Each approach to perception that he identified has a long history that can traced back several centuries (Pastore, 1971). While it is certainly true that in the end the worth of a theory rests on supporting evidence, the more immediate effect of adopting a particular theoretical approach is to structure thinking, which includes singling out potentially valuable variables and fertile concepts, and devising appropriate methods for testing its claims.

8.3.1 An "S" or Stimulus Approach

First, Wohlwill singled out a cluster of theories that attribute the experience of the environment to influences originating "outside" of the organism. In the domain of perception, these outside influences have been traditionally described and measured with reference to physical energies that are the bases for sensory stimulation. Sensory stimulation, from this stance, initiates neural processes by innervating sensory receptors, with the resulting neural activity proceeding in a mostly linear, causal manner along visual pathways to sites in the brain. In our post-computer era, sensory stimulation is typically referred to as input. Input is assumed to be "processed" by the brain by means of computational operations. Output from these operations is typically considered to be resulting mental states (e.g., percepts, affect) Hypothesized operational phases in this sequence are characteristically indexed temporally and often considered to be structured hierarchically. The so-called lower level processes are assumed to be initiated by sensory input from receptor activity and are the first in a mostly linear sequence of processes. These are to be distinguished from the subsequent so-called higher level or top-down processes that operate in a "downward" fashion, to influence lower level bottom-up processes (McClellend & Rumelhart, 1988; Peterson, 1999). Several chapters in this volume adopt this broad perspective.

Taking a longer view across the decades of twentieth century psychology, this linear manner of conceptualizing environment–organism relations has its origins in a mechanistic form of behaviorism (S->R models), later modified when feedback processes were added with the development of cybernetics and computer models (Miller, Galanter, & Pribram, 1960). Although the cognitive psychology that was inspired by these advances in computer technology professed a rejection of behaviorism, what it rejected mostly was behaviorism's sidelining of mental processes. Otherwise, it retained S-R behaviorism's mechanistic and reductionistic approach (Bruner, 1990).

Although no doubt sensory stimulation produces receptor activity and relevant brain processes are required, many perceptual and learning theorists have taken the position that analyses *at the level of neural and brain processes* alone are ill-suited to account for perceptual phenomena at a *psychological level of analysis* (e.g., Gibson, 1960; Hochberg, 1970; Tolman, 1933). The question is whether the concepts used to describe processes at the neural level of analysis are adequate to capture the character of perceptual experience (Miller, 1985). In this respect, the identification of perceptual phenomena at an experiential level sets the agenda for an analysis at the level of neuroscience that has relevance to psychology. Simply put, what we experience (psychologically) directs what might be looked for at the level of brain processes.

Especially critical for our purposes here, a distinctive feature among S or mechanistic approaches is a view of the organism as essentially a *passive* (stationary) *receiver* of input. That is to say, the perceiver is not viewed as engaging the

environment, but rather as reacting to it. Although computer-inspired information-processing approaches distance themselves from S-R behaviorism by claiming to be "active"; in fact, activity in this context refers to post-input computational processes attributed to the brain by way of analogy to computer operations. Actions *qua* motor behaviors are, at best, incidental to perceiving in such models; and when they are introduced it is typically as outcomes of input.

Because this latter point can be a source of confusion, and because terminology such as actions or operations is so commonplace in much of cognitive science and neuroscience, it important to recognize that action in a behavioral sense has a special significance for those psychologists who take it *to play a formative role in perception and cognition* (see below). For the latter, action means literally (motorically) engaging features of the environment beyond the body boundaries, rather than "activities" confined within an intra-cranial domain or within a central processor. Abundant evidence demonstrates the distinctive effects of self-produced motor action on perceiving (e.g., Held & Hein, 1963). Among other evidence for the necessary role that action plays in perceiving, we can point to the vast research literature on adaptation to prism-altered vision that dates back over a century (e.g., Gibson, 1969; Harris, 1963; Welch, 1969).

8.3.2 An "R" or Response Approach

In contrast, Wohlwill (1973a) also identified a set of approaches that take as their central focus the psychological consequences of the organism *acting on the environment*. From this standpoint, psychological experience and knowledge stem from action. R or response approaches treat *psychological processes as forms of action* that are characteristic of all biological systems. For this reason, they are sometimes referred to as organismic approaches (Langer, 1969; Lerner, 2018). Organisms' engagement of current circumstances stem from biological dispositions for activity as well as a developmental history of engagements with the environment. These ongoing activities can have a transformative impact on an organism's developing psychological structure, thereby influencing the character of future actions. This approach is evident in Piaget's (1971) concept of accommodation, Vygotsky's internalized culturally based practices (Cole, 1998), and embodied cognition (see Shapiro, 2014).

8.3.3 A Transactional Approach

There is "a third way" to conceptualize environment and organism relations which will be referred to here, following Pepper (1942) and Altman and Rogoff (1987), as "transactionism." From a philosophical standpoint, transactionism has its roots in the writings of William James, John Dewey, and others in the American pragmatist

tradition. Briefly, transactionism adopts the view that organisms discover features of the environment through goal-directed actions, and thereby developing their own possibilities for action in relation to those features. In those respects, psychological processes and experience *are jointly anchored* both in environmental structures and an organism's action possibilities.

For this reason, transactionism rejects from the very outset dualistic formulations that posit a physical world "out there" and a subjective mental realm. As perceivers, we are directly confronted with what James (1904) called "immediate experience," whereas the distinction between separable objective and subjective domains are understood to be products of *post hoc* analysis when one reflects in a detached manner on immediate experience (Dewey, 1896, 1925; James, 1890, 1904). Immediate experience itself has a *relational* character, pointing both to the environment encountered and to the individual knower. In contemporary psychology, Gibson's concept of "affordance" exemplifies this transactional, relational perspective (see, Heft, 1989, 2001, 2003).

To illustrate the relational character of affordances, a stick lying on the ground may afford grasping for an individual owing to its diameter (an object property) *in relation to* that individual's hand size and her ability to grasp it (properties of the person). In immediate experience, the stick is perceived as or affords being graspable. It is through action that the individual initially discovers that a stick of a particular perceptible diameter is graspable—that is, one of its functional properties is revealed through action—and it is through acts of grasping that skills in this regard are honed. That which is grasped and that which does the grasping are reciprocal facets of a unified act of perception-action (Dewey, 1896).

In sum, from a transactional perspective, psychological experience of the environment is neither attributable solely to stimulus input nor to the character of an organism's responses. Instead, psychological experience is *of* environmental features taken *with reference* to an individual's action possibilities.

8.4 What Do We Mean by a Natural Environment?

In spite of the complexities and challenges involved in attempting to define a natural environment, the term natural environment does seem to be meaningful *in our everyday discourse*. As evidence of that, it is not very difficult for individuals to sort a stack of photographs into a category of natural environment versus those that are not (Wohlwill, 1976). But when we designate some environment as natural, on what basis do we do that?

One approach to addressing that question is suggested by those instances when one mistakenly takes a feature as being natural only to learn later that it is due to human intervention. As mentioned above, why take a body of water that unknowingly was produced by a dam, or similarly, a grassland or pasture created years earlier by extensive clearing of trees and other plant life, as being natural? An obvious answer is that in these instances the actions that created them are not available

to be perceived, and the results of those actions no longer perceptible except to those with a trained eye. As regards their origins, however, the lake and the pasture are no different from buildings and streets and other products of human construction. The critical question here then is why were they taken at first to be natural; and indeed what makes them different from buildings and the like which would be judged as non-natural or built? What these examples indicate is that what is judged to be natural in everyday experience is largely a matter of *what is perceived*—and this is a matter of epistemology rather than ontology, as discussed above. What individuals take to be "natural" as opposed to not may be most clearly and consistently linked to the appearances of things—how the environment looks to them.

The upshot of these considerations is the following: referring to some region as a natural environment does not carry very much meaning for research purposes until we specify its perceptual properties. These considerations suggest a research agenda; namely, that we try to establish what is generally meant by "the natural environment" on *perceptual grounds*. This is the very strategy that Wohlwill (1983) proposed. Let us turn to that source for the purpose of identifying some perceptual criteria by which individuals may take an environment as natural.

8.5 An Ecological-Perceptual Approach to Differentiating the Natural and Built Environment

Wohlwill (1983) marks somewhat of a departure from most of his previous groundbreaking work in the 1970s on environmental perception. That earlier work demonstrated some support for an arousal-based approach to environmental preference, as well as pointed to one way of distinguishing natural and built environments—namely, their intrinsic levels of diversity/complexity (Wohlwill, 1976). Natural environments did not tend to reach the levels of complexity found in built environments. Even so, natural environments were consistently preferred over built environments even at comparable levels of complexity. How then do we explain these latter differences?

In order to answer this question, Wohlwill (1983) gravitated toward the view that an approach based on abstract properties, such as complexity, does not take us far enough in understanding the perceptual basis for the natural-built distinction. Such properties are *analytical* in character—that is, they refer to structure abstracted from any meaningful perceived content (see, Heft, 2003). As such, they are rather removed from the immediate experience of environments and, importantly, from action. Abstract, in this vein, designates "something which exclusively occupies a realm of its own without contact with the things of ordinary experience" (Dewey, 1925, p. 6). They are also temporally static when assessed in photographs—the most common method of study—which by their very nature are still images. Seeking a more grounded, richer, and dynamic approach to the consideration of environments as perceived, Wohlwill turned to the perceptual framework developed by James and Eleanor Gibson.

8.5.1 Ecological Optics and Perceptual Systems

James Gibson developed an approach to visual perception based on his unique analysis of "ecological optics," which considers the ways in which light reflects off of surfaces in the environment. On that basis, he demonstrated that reflected light can carry structure (i.e., potential information) that specifies the environmental layout (see, Gibson, 1966). Importantly, an examination of the array of reflected light in a given region of the environment from the perspective of ecological optics reveals that potential visual information, and the features of the environment it specifies, is available to be perceived by an individual. Perceivers with requisite perceptual learning experience—which was the primary focus of Eleanor Gibson's (1969) work—can perceive the layout and its features directly through the pickup of this information, that is, without the mediation of non-perceptual processes (e.g., inference, hypothesis).

This proposal of direct perception stands in contrast to the long dominant assumption that the character of the environment must be constructed "in the mind" from proximal cues produced by sensory stimulation—cues that are equivocal with regard to their distal sources. From that standpoint, the environment is necessarily perceived indirectly based on mediating mental structures, e.g., mental representations, and inference-like processes. The ecological approach holds instead that the layout of the environment, much of the time, is sufficiently specified by information available in the array of reflected light that supplementary mediating processes are superfluous, particularly when we add a second consideration—the functioning of a *perceptual system*.

From an ecological perspective, the traditional notion of the senses as conveyors of stimulation to a stationary perceiver at a fixed observation point is replaced by the notion of a *perceptual system*. The visual perceptual system includes not only the eyes and the visual pathways, but also the whole body, as movements of the organism play an essential role in revealing invariant perceptual information in the context of a changing visual array (for details see Gibson, 1966, 1979; a brief overview can be found in Mace & Heft, 2010). Perceiving, then, is not a result of mental construction based on sensory stimuli, but rather it involves the pickup of available information in the surround through perception-action.

While there is no question that an analysis of *sensory processes*—rather than perceiving—requires an account of anatomical features and neurological activity at the receptor level, when we are considering *perceiving* from the point of view of perception-action—that is, when our focus is on an active, embodied organism as a whole—we are operating at a level of analysis that is not reducible to sensory processes. Approaches to perceiving based on the analysis of sensory processes, and the putative physical energies that initiate neural processes, has led to centuries of seemingly intractable epistemological difficulties (Gibson, 1967; Hamlyn, 1961; Reed, 1996a, 1996b; Turvey, 2019). It is for this reason that many philosophers of late have been drawn to the ecological approach (see Dreyfus & Taylor, 2015). From an ecological perspective, perceiving is an exploratory process through which

informational structure in the environment that specifies its features is revealed while also guiding action. That perspective is squarely in the tradition of Darwinian *ecosystems thinking* with its emphasis on dynamic processes of adaptation in relation to the character of econiche (Walsh, 2015).

8.5.2 *Perceiving a Natural Environment and a Built Environment*

The important point for our purposes at this juncture is that Wohlwill (1983) recognized in the Gibsons' ecological framework a promising basis for differentiating natural and built environments:

> Gibson's emphasis on *the information-laden character of the everyday world* that the individual normally perceives . . . and the demonstration by him and his associates that the perceiver is indeed sensitive to such information – or can be made so through focused experience – provide a potential underpinning for a stimulus-based analysis [although Gibson would say 'information-based' analysis] of the differentiation between the natural and the non-natural domains. (pp. 12–13, emphasis added)

From that point of view, what then are some possible environmental properties carried in visual information on which individuals may differentiate natural from built environments? Wohlwill proposed in a preliminary manner the following properties:

- *Rectilinear versus curvilinear shapes and patterns*.
- Rectilinear forms are characteristic of human-built structures, but they are quite rare among material features in the natural domain in the absence of human intervention.
- *Smooth textured, regularly patterned surfaces versus rough textured, irregularly patterned surfaces.*
- Encountering a smooth, object-free path is typically an indication of human intervention. Likewise, regular patterns in surfaces, from tiled, tessellated floors and walls to plowed fields, reveal human activity usually having occurred over a comparatively short time scale. With a few exceptions, rough texture and irregular patterns are usually indicative of external sculpting processes occurring over long periods of time that are relatively independent of human actions.
- *Contrasting colors, abrupt changes in texture versus gradual change in color, and texture resulting in a fittedness or blending in of adjacent surfaces.*
- Typically, in what is often considered a natural environment, there are gradual transitions between adjacent colors and textures although there are notable exceptions in the case of some geological strata, as well as flowers that benefit through selection from standing out against a background. Signs of human activity are often marked by abrupt changes in color and textures, which is indicative, for example, in the colored surfaces and shapes making up a cityscape

- *Abrupt, sudden onset of events versus smooth transitions between events.*
- This dimension, unlike the preceding, concerns perceptible change over time—that is, events. The abrupt onset of events in built environments, such as sudden movements or sounds, have comparatively few counterparts in nature; and those that do occur are usually harbingers of potential danger, such as lightning flashes and potential predator strikes. Breezes and even strong winds typically have a gradual onset, as do rock slides and waves in spite of their dramatic appearance. Sudden sounds such as thunder claps are comparatively infrequent occurrences, and when they do occur it is often within a limited time frame. The frequent and abrupt onset of sounds, particularly of a high intensity, as well as the persistence of their intermittency, may be one of the hallmarks of the human life-world in modern settlements.
- *The apparent availability of affordances*
- This category did not appear in Wohlwill's initial list, but I include it here in keeping with the influence of Gibson's work on his consideration of the richness of information available to be perceived. Wohlwill did not include them because he saw affordances with their emphasis on functional concerns to be a departure from the information-based focus of the other properties. However, Gibson (1979) claimed that affordances are specified by perceptual information, which has been shown experimentally (e.g., Mark, 1987; Warren, 1984).

The previous list was offered as some possible visible properties on the basis of which individuals may differentiate natural from built environments. Can the presence of affordances be utilized in that way as well? On the one hand, affordances are available in both natural and built environments; however, factors relating to *the apparent availability* of affordances may be pertinent.

We can conjecture that what is typically taken to be a built environment is a locale where affordance possibilities are particularly prominent. That is because the intention of design, in part, includes the provision of specific affordance possibilities. When we enter a setting where there are smooth and obstacle-free ground surfaces, chairs, and door handles, then affordances for walking, sitting, and grasping, respectively, are apparent. The setting was designed (or furnished) with particular affordance possibilities explicitly in mind. The affordance possibilities may even "invite" action (Withagen, Araujo, & de Poel, 2017).

In contrast, affordance possibilities in some settings may need to be sought out and, in some instances, fashioned on the spot. That may be indicative of those settings that we take to be natural. Consider the case where one is hiking in a forested area and feels the need for a break. The individual may look around for an object to sit on and that could be a rock or the trunk of a fallen tree. One may also alter the setting by clearing off a surface in order to be able to sit down on it. These circumstances, as compared to the settings referred to above, do not differ with respect to the presence of affordances—they are present in both cases—but instead with respect to the apparent availability of affordances. Affordance possibilities may be less immediately obvious in what we perceive as natural environments, as compared

to built settings where they are more prominent because in the latter case they were intentionally put in place with potential users in mind prior to action.

Still, in at least two respects it might be said that places where there are more perceived affordance possibilities are indicative of what we take to be natural settings. Returning to a prior example, possible places to sit in a forest area are more varied in scale than what one typically finds in a designed setting, which means that individuals of varying ages, and therefore height and mobility, are more likely to find a feature that affords sitting-on. Stated inversely, because built settings more obviously conform to design standards, affordance possibilities may be fewer there for some individuals. That point emphasizes the relational nature of affordances. Moreover, natural settings may offer more affordance possibilities because, unlike built settings, there are fewer normative social practices in place to limit the ways features may be engaged. In built environments, some uses of those affordances are more likely to be normatively proscribed.

The preceding properties constitute just a preliminary list to direct thinking toward *the perceptible features and properties* that might lead one to distinguish "natural" as compared to "built" environments in everyday experience. It is the *appearances of things*—how the environment looks (or sounds, smells, and feels) that is "the first-order of business" for living organisms. With that in mind, we can employ Wohlwill (1983) as a starting point for identifying the *perceptual qualities that are typically used to distinguish between* the natural and built environments.

8.5.3 Affordances, Motivation, and Psychological Well-Being

Wohlwill was initially drawn to Berlyne's (1960, 1971) framework, in part, because it linked visual characteristics of stimulus patterns such as complexity to arousal, thereby providing an account of preference on motivational grounds. But we raised the question above whether those properties are somewhat abstract and, for that reason, too detached from actions in the world. That is not the case with affordances, which are perceived as offering action possibilities. What might we say about the relationship between perceiving affordances and motivation, and most critical for our purposes here, preference and even psychological well-being? *Can an affordance perspective offer any additional insight into why certain environmental features are preferred over others, and what bearing they have for well-being?*

The concept of affordance grows out of a phenomenological tradition in perceptual psychology where the emphasis is on how the features of the world appear to a perceiver. In that vein consider the following commonplace observation: Imagine walking with a small child along a path, such as a sidewalk, while parallel to that path is a slightly elevated surface, such as ledge. As parents well know, the child will invariably attempt to step up on the ledge and to walk along it. Its affordance seems nearly irresistible to the child; she appears to be *drawn* to walk along it. In Lewinian terms, the ledge is experienced as having a positive valence, a motivational quality (Lewin, 1943). Why is that?

Because affordances are functional properties of the environment taken relative to an individual, from a first-person perspective, the ledge from the child's point of view affords stepping-up-on "for me." Importantly, doing so—stepping-up on it—is typically intrinsically satisfying. This is because engaging an affordance, especially one toward the limits of one's current action possibilities, offers the opportunity for experiencing *self-efficacy* (e.g., Bandura, 1982) through that engagement. The experience of self-efficacy can be attributed to an individual's developing awareness that *they themselves can effect change in the environment and a change in their relation to its features* (Chawla & Heft, 2002).

White (1959) marshaled decades of evidence demonstrating that animals commonly engage in sustained and focused action directed toward certain features of the environment seemingly for the sake of the action itself. Their reason for doing so in many cases seems to be because the actions "provide changing and interesting feedback in connection with the effort expended" (White, 1959, p. 329). The experience of self-efficacy can be attributed to an individual's awareness *that they themselves are the source of the change*. White refers to the "drive" that propels these actions as effectance motivation. "Effectance motivation must be conceived to involve satisfaction—a feeling of efficacy—in transactions in which behavior has an exploratory, varying, experimental character. . . . " (p. 329).

These observations have an obvious bearing on psychological well-being. That they do can be brought into sharp relief when contrasted with feelings of helplessness and hopelessness that arise when an individual finds herself chronically in stressful circumstances that are unalterable and uncontrollable. The continuing development of an awareness of self-efficacy is indicative of advancing psychological well-being.

With these brief considerations, we have broadened our discussion of affordances to encompass, if only in a preliminary way, matters concerning psychological well-being. To perceive an affordance is to perceive the action possibilities of features of the environment, and engaging those affordances may enhance and extend one's self-awareness of his or her own capabilities. This is a path to health and flourishing at a psychological level of analysis.

8.5.4 Why Are Natural Environments Preferred? A Pragmatic Proposal

With these considerations of affordances from a motivational point of view in mind, let us return to an earlier question: Why are environments that are perceived to be natural preferred to those that are perceived to be built? There are a variety of suggestions that could be offered, but we limit our attention here to what affordances can contribute to this question.

It would seem that the prevailing affordances in built environments can be engaged usually with ease, but in only limited ways. For example, while paved

surfaces are more easily walked on than surfaces that are not smooth and are cluttered with features, this affordance of walk-ability also results in these surfaces being relatively impervious to changes brought about by human action. Likewise, other features of built environments, such as building facades, tend not to be amenable to actions of the individual beyond what they have been intended for. It takes much effort to gouge or fracture most sidewalks or facades. That said, children delight in drawing on such surfaces, e.g., with chalk, indicative of expressions of self-efficacy.

In contrast, trees in park settings or in forests can be climbed on and sometimes used for swinging. Branches that are removed or have fallen can be used for building temporary shelters and hiding places. Even rock faces can be clambered up on owing to their rough, irregular textures; and smaller rocks can be stacked, rolled, and even thrown if they are light enough. These considerations suggest that particular environments may be preferred *because of the kinds of actions that they afford* along with the experiences of self-efficacy they make possible.

In short, we can add to the preceding list of criteria that might differentiate what are perceived to be natural versus built environments a pragmatic one: the kinds of affordances that are available in each and the opportunities for experiencing self-efficacy they make possible.

8.6 The Chapters in Relation to the Three Approaches to Environment–Person Relations

Most of the chapters in this volume can be classified with respect to the approaches discussed earlier. I will justify this organization in more detail below. Here at the outset, I propose that the chapters by Berman, Cardenas-Iniguez, and Meidenbauer; by Sullivan and Li; and by Hartig fit into an "S" or stimulus approach with their emphases on *the effects of* particular environmental circumstances on experience, preference, and well-being. To varying degrees in each case, their communality in this regard is traceable to the influence on all three of Attention Restoration Theory (ART) developed by Kaplan (1995), which itself has its roots in an information-processing approach to cognition (Kaplan, 1972), and as applied to stress and coping. Berman et al. and Hartig go well beyond this starting point, but clearly ART and particularly its assumptions about perception have shaped their thinking. van den Berg's chapter also fits in here because her assessment of research is limited mostly to findings shaped by approach.

None of the chapters in this volume fit neatly into Wohlwill's designation "R" or response approaches, and that marks a notable shift in theoretical commitments in this domain of research over recent decades. Throughout the 1970s and 1980s, one can point to a number of influential contributions offered from a Piagetian perspective, particularly concerning the relationship between environments and psychological development (e.g., Hart, 1978; Liben, Patterson, & Newcombe, 1981;

Moore, 1976). This shift away from organismic thinking in environmental psychology over the past few decades is attributable to the dominance of mechanistic thinking in the area of environmental perception and restoration beginning in the 1990s and fewer instances of adopting a developmental perspective.

Chawla's developmental contributions over the years are a notable exception, and her chapter reveals a shift on her part toward a transactional approach. Wells' chapter is somewhat atheoretical from a psychological standpoint, and in large measure this is due to her primary focus on analyses at the group rather than individual level. Still, her chapter can be located within the ecological framework developed by Bronfenbrenner (1979), which ultimately has more to do with the scope of inquiry rather than a way of conceptualizing psychological processes. Bronfenbrenner urged researchers to examine the role that macro-level societal factors play in processes operating at the individual level—a macro-systems perspective.

8.6.1 The Environment as a Source of Sensory Stimulation

The chapters by Berman et al., Sullivan and Li, and Hartig adopt the meta-theoretical stance of an "S" approach, which treats the individual as essentially a receiver of sensory stimulation ("input") from environmental sources. Bodily actions of the individual are treated largely as "output" of the system, and as a consequence do not play a constitutive role in perception. The emphasis by Hartig on social cognition distinguishes it from the others. (Except where it is noted, quoted passages below come from the respective chapters.)

8.6.1.1 A Program of Environmental Neuroscience

In their chapter, Berman et al. staked out a relatively new multidisciplinary field that they call "environmental neuroscience." Judging from the research that they cite, we might locate its beginnings in the early 2000s, and more distantly, in the seminal contributions by Hebb (1949). Broadly speaking, the aim of environmental neuroscience is, as they put it, the study of environmental factors that "produce behavior." While that goal can be traced to the earliest decades of behaviorism up through environmental psychology in the 1970s, what makes environmental neuroscience distinctive are matters of scale, levels of analysis, and disciplinary breadth. They intend to examine environmental factors operating at multiple levels of size, from molecules to cities, and across multiple time scales, from milliseconds to centuries; and its multidisciplinary breadth includes the fields of genetics, neuroscience, psychology, and the social sciences among others. As a template, this vision is ambitious. As a research program, time will tell how it might be realized.

Because the primary focus of environmental neuroscience seems mostly to concern the effects of exposure to environmental conditions, particularly natural environments, on the individual or groups of individuals, it appears to fall under the

heading of an S or stimulus approach. That said, sometimes the relationship between environment and outcomes is described as an interaction. But because interaction in a causal rather than statistical sense suggests reciprocal effects, and because few instances of individuals' actions on the environment are offered here, the clear emphasis is on how the environment affects the person(s), and not the other way around.

Perhaps owing to the scope of the program, there are instances of vagueness in the terminology employed. For example, while a goal of the field is "to bring to the forefront the physical and social environment," it would be useful to clarify what the physical and social environment refer to with some specificity. The authors also see value in examining human and non-human research in order to find comparable brain measures across species for examining *environmental effects*. However, it is important to recognize that the *ecological niches* occupied by different species are not likely to be comparable in numerous ways. Ecological niches are best characterized relationally with respect to organisms' activities (Walsh, 2015). For this reason and others, comparative psychologists have long cautioned that generalizations across species, and even within-species groups, are not straightforward (e.g., Boesch, 2007).

8.6.1.1.1 Perceiving Naturalness

Research efforts led by Berman have attempted identify in the perceptual domain the so-called low-level features of the environment that are posited to dominate natural environments. The rationale for doing so is mostly rooted in Attention Restoration Theory (ART) developed by Kaplan (1995; also see Kaplan & Berman, 2010). It is assumed that the stressful circumstances of everyday life place considerable demands on the cognitive system as the individual attempts to cope with them. For example, chaotic and unpredictable circumstances would demand, it is assumed, sustained "directed attention" on the part of the individual. Deployment of directed attention over sufficient periods of time will result, according to ART, in the depletion of mental resources which are assumed to be limited. In the face of that, exposure to environments that place few attentional demands on the individual would provide opportunities for depleted mental resources to replenish. Individuals are said to prefer natural environments in relation to other types of environments partially for restorative reasons.

8.6.1.1.2 Selected Research

In an effort to identify stimulus properties that would demand little in the way of directed attention, Berman et al. (2014) considered some "low level" perceptual properties or features that may distinguish natural from built environments. Such properties or features would be comparatively simple rather than complex and are assumed to be taken up in the initial phases of a bottom-up visual processing stream.

Those properties they have studied are hue, saturation, and brightness with respect to color and edges. Notably, edges have long been posited by neuroscientists to be an early component of perceiving in the processing stream (e.g., Marr, 1982).

In their research, edges were defined as changes in brightness or color in some direction in photographic images of environments. The relative density in a photograph of straight and non-straight edges was indexed by a quantitative analysis of the number of pixels that fell on each type of edge in the display. Photographs with relatively higher densities of non-straight edges were found to be positively related to perceivers’ ratings of the degree of “naturalness” of the environments represented. As a further test of the predictive value of these low-level variables, Berman et al. (2014) found that a machine-learning classification algorithm applied to the photographs to index the presence of these low-level properties was correlated with naturalness ratings of the photographs. In a subsequent study (Schertz et al., 2018), participants selected topic words that these same photographic images brought to mind. Those images possessing a high density of non-straight edges, which again correlated with naturalness ratings, also correlated with words relating to spirituality.

Likewise, Karden et al. (2015) found an inverse relationship between response latency of preference judgments and ratings of naturalness. This finding was taken to indicate that low-level features assumed to be processed early in the visual processing stream were determinants of environmental preference. It may be worth noting, however, that the images in this experiment were made available for viewing only for 1 and 1.5 s for the preference and naturalness ratings, respectively, with 4 and 1.5 s allowed for rating them. Under such experimental constraints, perceivers are primed to respond quickly, which arguably is not only a departure from everyday encounters but perhaps even more critically, may predispose extraction of low-level features given the time limitations. In this case, theoretical assumptions and methodology would seem to be entangled, as they often are in research. Earlier I proposed that one’s theoretical stance *on the nature of perceiving directly affects what we take to be the environmental basis for perceiving*; and here we may see that playing out in the variables selected and the methodology employed. Researchers make theoretical choices that in turn drive research.

With this in mind, one could also ask whether the dominance of non-straight edges is a determining *perceptual* variable here, or whether that variable is a correlate of something else experientially more immediate rather than abstract (see above) in the ecological niche? An examination of the areas of high non-straight edge density in the images provided in Schertz et al. (2018) indicates that these properties are typically found in areas with foliage and plant life in the image, as compared to straight edges characteristic of architectural structures. This raises the possibility that the presence of high non-straight edge density is merely one way of indexing the presence of “green features” that is amenable to quantification. If so, the justification for treating that variable as a low-level input suitable for bottom-up processing might have been driven mostly by the model of visual processing that is adopted and the analytical techniques available.

Also, let us reflect on the time course of perceiving a bit more. In his extension of Berlyne's (1960) framework, Wohlwill (1976) proposed a distinction between *specific* and *diversive* exploration. With regard to the former, when stimulus conditions, owing to their uncertainty, generate arousal, the individual may be prompted to examine those stimuli quickly in an effort to resolve that uncertainty. Diversive exploration, however, comes into play when an individual explores the visual field in order to establish some level of arousal, which is a correlate of affect. For example, at times of boredom one may seek out more stimulating conditions. The time course in the case of diversive exploration is by comparison open-ended. Wohlwill argued that between these two modes of exploration only diversive exploration might characterize situations relating to aesthetic preference.

8.6.1.1.3 Dynamic Properties of Environment: Limits of Using Photographs

Returning to other distinctive visual qualities of natural environments, there is a set of qualities that has yet to be explored because so much of the extant research has relied on photographs of environments. I refer to qualities attributable to *movements* in the field of view, due to either actions of the perceiver or events in the environment or both. Because of their static quality, photographs by their very nature exclude those salient qualities of environmental experience. Two of the most prominent of these types of perceivable qualities are *motion parallax* and *dynamic occlusion*. The perceivable effects of motion parallax and dynamic occlusion occur almost continuously with even a slight shift in the point of observation all over most landscapes, except those barren of features (Heft, 2019, 2020).

Research in environmental perception and restoration has employed photographs of environments based on the premise that they are adequate facsimiles of environments as experienced first-hand through activity. Empirical evidence and conceptual considerations exist for challenging that claim (see Heft, 2019). More broadly, the study of vision in psychology shows a long history of conflating the workings of a camera with how the visual system functions (Joyce, 1988); and owing to that, it is often taken for granted that photographs are faithful facsimiles of visual experience. A close comparison of both shows that this conventional belief is highly suspect (Snyder & Allen, 1975).

8.6.1.1.4 Nature and Restoration

Berman, Jonides, and Kaplan (2008; Experiment 1) is one of a handful of studies of psychological restoration where photographs were not employed. The researchers assessed performance on working memory (using a backward digit-span task) before and after participants either walked through a nearby arboretum or a commercial district. The former walk was described as being along tree-lined paths "secluded from traffic and other people," while the walk through the commercial district was on a "traffic-heavy" street "lined with university and office buildings"

(p. 1208). Performance improved only after walking in the arboretum. This is a noteworthy study in that it considered first-hand and action-related exposure to environments rather than using static photographic facsimiles.

The results are interpreted as evidence for the restorative value of exposure to green environments. That may well be, but it is important also to recognize that these two settings differed in other ways as well. Referring to the descriptions provided by the authors, these settings also differed in terms of activity levels within each, which would have produced differing patterns and degrees of visual change as well as differences in the sheer complexity and intensity of sounds. A descriptive comparison of these two settings would have been invaluable. Detailed descriptions of environments that individuals encounter in daily life would be enormously beneficial for future research in environmental psychology.

8.6.1.1.5 Affordances and the Natural Environment

Berman et al. propose that perhaps natural environments are beneficial because they afford more action possibilities than those typically available in built environments. The reasons why that may be the case beyond the sheer numbers of relevant features present warrant some attention. First, as discussed above, typically there are greater constraints operating in built environments owing both to intentional design choices, which, e.g., reduce the availability of certain affordances for some individuals, and to social norms that operate in those settings. For example, the authors point out that a tree branch can be engaged in multiple ways, such as climbing on it and swinging from it. That is true of many features in built environments as well, such as railings and fences, but those actions in built environments are more likely to be socially proscribed. Moreover, actions such as climbing and swinging on tree branches in built areas, e.g., city parks, tend to be proscribed as well. Here, we find ourselves again forced to recognize that the separation of the so-called natural environments and the social dimensions of human life is porous. Second, what we call natural environments are more readily modified by individuals in order to create new affordances. Lerstrup (2015) offers many wonderful examples in her study of children in forest schools, for example, children moving a log over a stream in order to create a bridge (Lerstrup & Moller, 2016).

The authors propose that the tools of neuroscience may aid in the study of affordances, and toward this end, they cite evidence for "a large overlap between actions taken and those imagined"—presumably overlap refers to cortical areas. And yet the studies offered in support of this claim (Barsalou et al., 2003; Hauk, Johnsrude, & Pulvermuller, 2004; Kossyln, Ganis, & Thompson, 2001) have little to do with action taken in the sense of motor behavior, but rather with, respectively, the use of action words; the production of action imagery; and conceptualizing action. A more fruitful line of research might be based on the claim that the perception of affordances involves *anticipated action* possibilities (Rietveld, 2008; Rietveld, Denys, & van Westen, 2020). Most of the imaging technology currently being employed to record measures of brain activity do not allow for much bodily movement on the

part of the individual. New technologies are beginning to appear that seem to eliminate those constraints (e.g., Jungnickel & Gramman, 2016), and Berman et al. point to newer mobile imaging devices that may allow for the study brain processes during activity in everyday environments.

8.6.1.1.6 Long-Term Effects of Exposure to Environmental Properties

There is much of potential value in their call for the inclusion of multiple time scales in the study of environment-psychology relations, from the brief periods of time of experiments to effects that may be manifested throughout the life span. With regard to the latter, they could profitably make contact with developmental considerations such as those of Chawla (1993, 1994, 2015; Chawla & Derr, 2012) who has attempted to trace the long-term effects of early experiences in natural environments on environmental attitudes and activism in adulthood. Further, there is an extensive literature available on the short and long-term effects of early environments on human development (e.g., Evans, 2004; Wachs, 2000; Wachs & Gruen, 1982). An examination of this body of work may prompt new research directions for this environmental neuroscience program.

8.6.1.2 Assessing the Predictions of Attention Restoration Theory

The chapter by Sullivan and Li focuses primarily on Attention Restoration Theory (ART). After examining the primary claims of this theory in a clear and accessible way, they set out to determine the extent to which research findings in the literature support ART. In order to do so, they conducted a literature review with the goal of identifying all studies since 1995 that explicitly examined claims that bear on ART. They included in their search only papers that cited Kaplan (1995)—the publication that introduced ART—among other criteria.

The authors reported that two-thirds of the publications examined participants who were directly exposed to a "green" environment by either being present in it or through visual contact (e.g., through a window), while the remaining third used some form of simulation (e.g., photographs). They found that more than half of the studies demonstrated positive effects of exposure to "green" features on some measure of attention. Another 27% reported positive effects for a portion of their sample, or for at least one attentional measure; while 12% reported no effect and one study reported inverse effects. They reported that there were, however, no differences between direct exposure and simulated exposure regarding the percentage of positive outcomes. Sullivan and Li concluded that there is considerable evidence to show that visual access to a green landscape is "likely to reduce symptoms of mental fatigue"—a conclusion consistent with a central prediction from ART.

Although the choice to include only studies that cited Kaplan (1995) likely captured the lion's share of research relevant to this topic, the decision to do so may have restricted consideration of evidence that might have been brought to bear on

the claims of ART. It might be valuable for the purpose of assessing *this theory itself* to examine at some point its claims in relation to the attention literature more broadly (but see, Kaplan & Berman, 2010). Because the study of attentional processes from an information-processing perspective has been an active research area for many decades, it is not surprising that features of the various attentional models have been the subject of debate (e.g., Egeth, Leonard, & Leber, 2010; Pashler, Johnston, & Ruthruff, 2001; Posner & Petersen, 1990). How well does ART stack up in the context of these wider debates in the attentional literature? This is not to question its potential value for research in environmental effects on cognitive restoration, but only that many researchers who have adopted ART rarely evaluate it in relation to other models of attention. Perhaps the time is ripe now 25 years after ART was first introduced to reexamine the theory in light of subsequent developments in attentional research. For example, there is recent evidence to indicate that performance deficits previously attributed to mental fatigue may be better explained by shifts in motivation (Hopstaken, van der Linden, Kompier, & Bakker, 2016).

Finally, among the features of ART as developed by Kaplan (1995) is the adoption of a distinction very briefly raised by William James (1890, 1892) between involuntary attention and directed attention. Owing to this, researchers of the environmental effects on perception and cognitive restoration often link ART to a tradition of Jamesian psychology. And yet it should be noted that several features of ART are inconsistent with James' psychology overall. For example, a critical feature of ART is the claim that directed attention is a limited resource. That assumption would have been entirely foreign to William James (Meyers, 1986; also see, Spelke, Hirst, & Neisser, 1976). More broadly, the overall approach adopted by ART would conflict with James' long-standing critique of mechanistic (or S) approaches to mind (James, 1878; also see James, 1890, Chapter 5).

In addition, James argued strenuously against accounts of knowing that assume that perceptual experiences arise from elemental sensations (see James, 1890, Chapter XVII). A sensation-driven approach to perception would have been an anathema to James. Indeed, he rejected claims that elementary sensations are components of perceiving, as later would James Gibson (1966, 1979).

8.6.1.3 Experiencing Nature with Others

The chapter by Hartig, like the preceding ones, follows the line of thinking developed in Attention Restoration Theory (ART; Kaplan, 1995), and to a lesser degree Stress Reduction Theory (SRT; Ulrich, 1983). In these respects, this chapter also adopts an "S" or stimulus approach, which assumes that the effects of the environment on the individual are due to the result of sheer exposure to environmental conditions. For example, Hartig summarizes much of the relevant research literature by stating that "*repeated contacts* with nature can cumulatively engender significant health benefits" (Chap. 5, p. 92) (emphasis added)—a phrasing that connotes relatively passive encounters rather than active engagement. Hartig's chapter differs from the others above, however, with its emphasis on social cognition.

At the outset, Hartig follows the standard account we find in Kaplan's ART model with its claim that an individual can find psychological restoration following periods of stress with exposure to "green" environments. He lays particular emphasis in this chapter on the claim that exposure to natural environments serves as an opportunity to "get away" from the settings of everyday life. As the chapter proceeds, Hartig refers to research based on ART and SRT as following the "conventional narrative." Later, he modifies the conventional narrative in several respects, while continuing to work within that framework. One of these modifications has implications for how natural environments are defined.

8.6.1.3.1 "Natural Environments" Redefined?

A principal concern of most chapters in this volume is to clarify "what is distinctive about so-called natural environments"? This is a crucial question because to the extent that the so-called natural environments are found to be psychologically restorative, identifying what is distinctive about them points to those qualities or properties that can promote psychological well-being, even as it suggests some possible psychological mechanisms at work. Practically speaking, it points to some ways that environments can be modified to promote psychological health and well-being. While most of the authors in this volume propose various candidate properties that are intrinsic to the so-called natural environments that make them distinctive—with "intrinsic" in this context meaning that the environmental properties in question exist independently of any individual's experience of it—Hartig takes a different approach.

Adopting a social ecological approach, Hartig distinguishes natural environments from those that are not with respect to the activities individuals engage in. He writes "much of what now gets viewed as 'nature' *came to be regarded* less as the environmental settings in which people performed ordinary work and more as settings that support recreational and restorative activities" (Chap. 5, p. 94) (emphasis added). It is the *activities* occurring in certain locales such as work or recreation that appear to demarcate the natural environment from the settings of the workaday world. What matters primarily is how these differing locales are *conceptualized*: "conceptions of 'nature' got shaped in opposition to conceptions of the 'urban' . . . for a growing proportion of the population" (Chap. 5, p. 94). Although Hartig acknowledges that the settings "support" the activities in question, the particular intrinsic characteristics of the locales where activities occur seem to be nearly an incidental consideration (see, Wohlwill, 1973b).

Adopting a socio-historical stance, Hartig posits that "an increasingly prevalent pattern of movement involves leaving the built settings where the ordinary demands of life are situated for *seemingly* natural settings where people can gain distance from everyday tasks and worries, engage with positive aspects and affordances of the environment, and so satisfy needs for restoration" (Chap. 5, p. 95) (emphasis

added). He proposes that "conceptions of 'nature' have increasingly become *linked* with restoration motives, memories, and meanings while conceptions of the 'urban' have gotten grounded in the demands that increasing numbers of people face in their everyday life" (emphasis added). The use of "linked" is telling, connoting associative (external) relationships. In external relations, the intrinsic characteristics of the entities being connected tend to be incidental.

On these grounds, it is striking that rather than discussing "the experience of nature," as if nature itself has a particular character, Hartig employs the expression "nature experience." In this vein, he writes: "The 'nature' of concern in such situations is not only some set of objectively measurable biological, physical, visual, or other attributes of the environment…" (Chap. 5, p. 95). Nature would seem to be in large part a semantic label that individuals employ when conceptualizing those settings where individuals go to escape the stressors of their workaday lives. Hartig describes nature as a setting or context into which people go in order to restore resources that have been depleted by built/urban settings. But what it is about those settings that is restorative other than they are not where the ordinary demands of life occur is not explored.

This general point of view suggests that what we take to be the natural environment is based on how we cognitively construe areas of the environment. What is emphasized is conceptions of "nature." He writes, "The various settings in such a social ecological system . . . accordingly acquire meanings, individual and shared, that reflect on the *activities* and *experiences* they normally and predictably support" (Chap. 5, p. 95) (emphasis added). The character of that environment as such matters; and yet it is the activities that occur in those settings that receive most emphasis here. Intended or not, this is a major shift in how one might regard natural environments in relation to psychological restoration (also see below). It is the socially derived categories that we cognitively impose on the world that receives the emphasis.

For those who adopt a *social constructivist approach* to knowing, this kind of stance may be just what is called for when faced with the vexing question "what is the natural environment?" However, it may be less than satisfying for those who seek to identify which properties of the environment as such matter for psychologically restorative experiences. Taking "the activities individuals engage in" as a criterion for differentiating natural environments from those that are not would seem to relegate to the sidelines any distinctive properties that are intrinsic to those settings themselves.

How does this social cognition approach relate to the point offered earlier that the way visual perception is conceptualized directly influences the way the environment is in turn conceptualized from a psychological standpoint? In this type of approach little attention is paid to perceptual processes, and at most, whatever "information" is perceived is taken to be highly malleable, capable of being shaped by "top-down" concepts such as "nature" and "urban." Perception has become fully folded into conceptual processes—it is an *interpretation* of what is detected though sensory processes.

8.6.1.3.2 Expanding the "Conventional Narrative"

Hartig construes much of the research literature in environmental psychology on restorative effects as offering a "narrative structure" which takes as its foundation Kaplan's ART and Ulrich's SRT. As mentioned above, he characterizes this body of work as the "conventional narrative." Describing the research literature as a *narrative* is revealing. This is not the terminology that one typically finds in the experimental psychology tradition, which tends to refer to empirically grounded theory rather than a narrative as a basis of explanation. However, it is not uncommon among social constructivists to do so. They invoke as a metaphor for explanation the "stories" we tell ourselves in order to make sense of the world around us (Crossley, 2000; Sarbin, 1986), with the origins of those stories residing in social discourses. Hartig prefers "narrative" to "theory" out of concern that some take theory to be "a settled matter." Instead, he wants to situate "theory within an on-going discourse or exchange . . . [such that] theory can remain 'unsettled' as the discourse continues." While this motive is understandable, it is already well understood that theory is *always* unsettled in the sense that it remains open for revision as inquiry continues.

With that in mind, what is to be gained by referring to a relatively coherent body of research as a narrative? For one thing, it reinforces the approach Hartig seems to be advancing here that what we take to be the natural environment is a result of subjective cognitive processes, such as *attributing* the property of "natural" to those settings where recreational rather than workaday activities occur. Characterizing research based on theories of environmental perception (which is at bottom what ART and SRT are) as narratives prompts a shift in thinking away from the intrinsic properties of environments and toward grounding the concept of natural environment in social discourse. There is value in doing so, and yet it minimizes the role of perceiving as a ground for knowing and theory building, or even more problematically, it can take perception to be entirely a socially constructed process.

What likely motivates Hartig to take this position is his very laudable attempt to integrate social processes into an account of environmental perception. However, rather than doing so by overriding perceiving by placing the weight of explanation on subjective cognitive processes, we may be better served considering how perceptual and social processes become intertwined over the course of ontogenesis (Heft, 2007, 2018).

8.6.1.3.3 Relational Restoration Theory and Collective Restoration Theory

Hartig's effort to go beyond what he calls the conventional narrative is an important step forward conceptually. With his "post-conventional" narratives, he rightly recognizes that relationships with other people can also be psychologically restorative. On these grounds, he expands the conventional approach to include consideration of nature experience when in a dyad (Relational Restoration Theory—RRT) as well as among relationships in larger groups or at units of scale within a population level of analysis (Collective Restoration Theory—CRT). With these moves he picks up a

line of thought that initially began to appear in the stress literature research in the 1970s and 1980s showing that social support as well as social capital in communities can serve to buffer stress and to promote recovery from illness. Today, the research literature on the role of social factors as buffers to stress is vast.

And yet, these social considerations have rarely made their way into the environmental restoration literature, and here Hartig makes a place for them in his chapter. He proposes that these considerations can be folded into the existing conventional narrative without altering its basic premises. His proposals are surely valuable, and yet they prompt a few questions. One is why has it been the case that if the significance of social relationships for the buffering of and recovery from stress has been well known for decades that few attempts to integrate these insights into the so-called conventional narrative have not been made until now? This is partially explainable because the origins of ART and SRT do not lay in the stress literature, but instead in inquiry about environmental perception. When the focus shifted from environmental perception to psychological restoration and stress in the 1990s, it seems that little attention was given to the already extensive literature on stress and its buffers. Doing so would have necessarily led to considerations of social factors. Belatedly, but notably, Hartig has now started to shift the conversation in those directions.

Second, how well can this expansion of the conventional approach be integrated into the existing literature on environmental restoration effects? Unfortunately, that question cannot be answered as yet because here, as we saw above in the treatment of natural environments, intrinsic properties of the environment continue to play a negligible role in the presentation of RRT and CRT. Even as Hartig writes concerning a dyadic focus, "[i]t is not only a matter of the two getting away, but also where they get to; *how the environment promotes restoration* of the depleted relational resources needs consideration" (emphasis added), still how the environment as such plays this role goes unexamined. Hartig states that a restorative environment should provide opportunities for people to enjoy time relaxing and having fun together, and yet the properties of an environment that would support these outcomes are not identified. The environment seems to have slipped from our focus here.

Moving beyond the dyad, Hartig proposes even a broader analytical scope to include "relationships among people who do not know one another but have some common bonds, even if weak, for example from living in the same community …" (p. 119). These helpful suggestions resonate with Bronfenbrenner's (1979) emphasis on the significance of what he calls macro-systems and exosystems.

Also, like Bronfenbrenner, Hartig aptly draws attention to the temporal dimensions of relevant circumstances. He proposes that stress-restoration cycles are regulated by activity cycles, by which he means that patterns of daily life have a degree of regularity, such as differences between weekday and weekend routines. In this regard, he points out that often activity cycles are regulated and shaped by "economic, political, social, technological, and other higher-level processes." He illustrates the role of such higher order processes with reference to government policies, such as those concerning "national vacation legislation" that create opportunities for restorative activities within a population. And yet, when discussing a study of

the positive psychological effects of such policies (Hartig, Catalano, Ong, & Syme, 2013), he laments that where people choose to vacation was not considered. Adopting a dyadic or a collective unit of analysis should not preclude consideration of the properties of the environments where restorative activities occur.

8.6.1.4 A Critical Assessment of the Restoration Literature

The chapter by van den Berg offers a careful and systematic review of the research literature on environmental restoration, mostly undertaken from the stance of what we have called here an S or stimulus approach. She structures her chapter somewhat chronologically, providing an account of her own engagement in this research area over several decades. In the process, she shares some of the changes in her thinking during this time.

Reflecting on the past several decades of research, she rightly points out that a question which was at the forefront of environmental perception research at its outset has subsequently come to be somewhat side-lined. That question is "[w]hat is it exactly in or about natural environments that make these environments more aesthetically and affectively appealing than human made environments?" van den Berg attributes the relatively recent neglect of this question to a shift in the focus of research "from visual preferences to restorative effects and health benefits of green space." I agree with this assessment (see above). When research concerning the potentially restorative significance of natural environments began to appear, the more fundamental question on which the restorative work ultimately depends—namely, what is distinctive about natural environments?—often seems set aside. (For exceptions, see e.g., Berman et al., 2014; Purcell, Peron, & Berto, 2001; van den Berg, Joye, & Koole, 2016.)

8.6.1.4.1 Preference, Restoration, Evolution, and Development

van den Berg's skepticism about an evolutionary basis for restoration effects is a welcomed opportunity for a healthy reassessment of some cherished assumptions among environmental psychologists about the biophilic foundations of psychological restoration. Biophilia posits a pre-existing predisposition toward animate life and natural features in the landscape that is "represented in the human gene pool [and assumes] . . . that certain types of positive response were adaptive for early humans and increased fitness for chances for survival" (Ulrich, 2008, p. 89). Over time, claims for biophilia have softened such that it is now characterized as "a 'weak' biological tendency that is reliant on adequate learning, experience, and sociocultural support for it to become functionally robust" (Kellert, 2008, p. 4). Still, Kellert claims that "if our biophilic tendencies are insufficiently stimulated and nurtured, they will remain latent, atrophied, and dysfunctional" (p. 4).

The biophilia hypothesis is consistent with the point of view offered in *evolutionary developmental psychology* (e.g., Bjorklund & Ellis, 2005; Bjorklund &

Pellegrini, 2002). This view rooted in *population biology*—which focuses on the distribution of phenotypic "traits" in a population—posits that "evolved psychological cognitive mechanisms" are conveyed across generations through genetic transmission; and that these mechanisms are biased toward processing some information that contribute to the development of species-typical behavior (Bjorklund, 2015). It is assumed that these genetically based predispositions were selected within populations owing to their functional value in ancestral environments. Biophilia, for example, is one such predisposition, and as such *pre-exists* its expression, as Kellert states above.

Over the past several decades, an alternative approach has emerged that rejects the notion of such pre-existing tendencies in the genome. *Developmental systems theory*, which has its roots in *developmental biology*—the origins of which are in the study of embryology rather than population biology—adopts a *relational, emergent* perspective when considering the nature of ontogenesis. Its unit of analysis is "the developing individual in a dynamic environment"—that is, "a developmental system." From this perspective, developmental outcomes are not viewed as being attributable to the expression of latent genetic predispositions residing in the organism, but rather as emergent structures, functions, and patterns of organization that arise out of the constructive processes of a dynamic organism-environment system. Developmental systems theory stems, in recent decades from the work of, among others, Oyama (1985); Gottlieb (1987); Griffiths and Gray (1994); Keller (2010); Lickliter (2008), and Thelen and Smith (1994), while its psychological roots can be found in Dewey (1925) and Lewin (1943).

This point of view is aligned with the ever-burgeoning study of self-organizing, nonlinear dynamical systems in biology and psychology (DiPaolo, Buhrmann, & Barandiaran, 2017; Juarrero, 1999; Kelso, 1995; Rosen, 2000). In the developmental systems approach, "the key to the developmental emergence of structure and function is not in preexistent information, privileged levels of analysis, or processes of transmission but rather *in the constructive activity of developmental processes themselves*" (Witherington & Lickliter, 2017, p. 206).

Developmental systems theory emphasizes "transaction" in favor of "interaction." With interaction, two or more distinguishable factors combine to produce an outcome which is a joint product of the two; and the essential qualities of each factor "pre-exists"—perhaps only in latent form—prior to their combination (Oyama, 1985). Transactions refer to dynamic, reciprocal processes between factors out of which emergent and sometimes novel outcomes can arise. These outcomes are not reducible to any individual contributing component alone.

Would the adoption of the developmental systems approach make any positive contribution to the issue of psychological restoration? In my estimation, it raises an interesting and perhaps even novel possibility. Stress has been characterized as the disruption of functional stability of an organism by a dysregulation of its biological systems (McEwen, 2009). From a dynamical systems perspective, we might consider restoration as a transition from such a state of biological dysregulation to one of relative functional stability. In light of recent discussions of environment and organism as *coupled dynamical systems* (e.g., Chemero, 2014; Rietveld et al., 2020),

perhaps engagement with environments that are structured and organized in particular ways will facilitate the restoration of functional stability of an active organism. Rather than assuming, along the lines of the biophilia hypothesis, that the present-day environments necessary for human well-being need to match some pre-existing ancestral standard, we could ask what contemporary patterns of environmental structure and events would allow for an individual to establish some dynamic functional stability *in relation to them*?

An alternative hypothesis that van den Berg advances in the chapter to explain natural environment preferences and restoration draws on an associative learning model along the lines of context-dependent learning. Drawing on a thesis by Egner (2016), she proposes that leisure-time activities, by virtue of the positive affect they produce, become associated with the context within which they occur. And it just so happens that many of these leisure-time activities in contemporary modern life happen to occur in natural environments. We saw above that Hartig makes a similar claim. Although she doesn't mention it, this associative model is congruent with a large research literature in learning theory that demonstrates the role that context can play in classical conditioning (e.g., Bouton & Nelson, 1998).

8.6.1.4.2 Meta-Analyses of Restoration Effects

Perhaps the center piece of van den Berg's chapter is the discussion of several meta-analyses that have been carried out recently to assess the possible restorative potential of natural environments. Her conclusions run counter to what has mostly seemed to be unqualified positive assessments in the literature: "[T]he evidence for greater restorative effects of natural compared to built settings varies between outcome measures . . . [and] the strongest support is found for *self-reported* improvements in mood, while the evidence for improved cognitive and physiological functioning is weak and inconsistent" (Chap. 3, p. 43) (emphasis added). It is well understood that self-reports are among the least valued measures that researchers can obtain because they are so susceptible to factors such as the demand characteristics of an experiment. Further, she concludes that the evidence for the positive effects on cognitive functioning specifically, which is fundamental to the psychological restoration argument, is "weak and only found for a limited number of measures." van den Berg is also critical of the frequent practice of comparing one instance of a natural setting to one instance of a built setting. She calls for studies that include multiple natural settings that "would seem a necessary requirement for identifying the components of natural settings that are responsible for their restorative potential."

8.6.1.4.3 Other Considerations

Finally, van den Berg casts a very wide net, considering a number of variables that might shed light on environmental effects for restoration, all of which call for further investigation. These include variables she has examined in her own research

suggesting that preference for natural environments over built environments might be partially attributable to a higher degree of visual redundancy, describable as fractal patterns (e.g., Joye & van den Berg, 2011). She and others (e.g., Berman et al., 2014) characterize such patterns as low-level visual components from the perspective of bottom-up processing, and their impact is particularly evident when participants are given only brief exposures to representations of the environment, tyically photographs. She also reviews studies that point to the restorative potential of sounds common to natural environments; and she raises the possibility that phytoncides stemming from plant life in natural areas, and negative ions in the air especially in proximity of flowing water, may have restorative benefits. More investigations into these latter possibilities in situ are needed. van den Berg's most recent thinking has been directed toward considering how exposure to the environment over the course of development may have an impact on the immune system to the benefit of health resiliency.

Those possibilities notwithstanding, van den Berg calls for a greater appreciation of the role of social processes (what she refers to as "top-down" influences) in environmental preference and restoration. After her decades of research, she now expresses concern about the narrowness of the stimulus-based approach in capturing human experience.

8.6.2 The Environment as a Source of Opportunities for Action and Development

From the very outset of Chawla's chapter, it is evident that we are in quite different meta-theoretical terrain from that of the four chapters just discussed. With her declared emphasis on "young people's agency," Chawla reveals that her conceptualization of organismic functioning will not be that of a passive recipient of environmental stimulation, but instead of an active organism engaging its surround. Moreover, her focus on experiences during childhood and adolescence indicates more than an interest in those periods of life as such, but rather reflects a concern with the formative role that early experiences play in human development over the life span. Chawla brings the perspective of a developmental psychologist to her research and writing. In this respect, her chapter differs from the others in this volume.

An emphasis on human agency stands in contrast to what she calls "studies that seek to determine the 'dose' of nature needed for measureable benefits for human health and well-being" (Chap. 6, p. 156). Dose–response relationships are commonly invoked in the medical literature, as well as in stress research, referring to the level of some exogenous factor such as a drug or the physical parameters of a stressor (e.g., noise) that will produce some discernible effect on an individual. As applied to the topic of nature and psychological well-being, this way of thinking suggests a view that the natural environment brings to a passive individual a certain

level of palliative properties. To this Chawla notes critically: "Through its sole focus on what people receive from nature, this approach neglects what they *do in nature*, and what these relationships may contribute to wellbeing" (Chap. 6, p. 156) (emphasis added).

Her emphasis is on "nature-based learning" by an *active individual* who makes direct contact with nature. In this regard, she distinguishes direct engagement with nature from adopting the stance of an on-looker and a spectator—a position that follows as a matter of course when pictorial representations of natural environments are used in research. Chawla has had a long-standing interest in the ways in which early active experiences in nature may prepare individuals to appreciate the complexities and interdependencies of the biosphere, and even become activists on behalf of ecological causes. As we continue to be faced with the enormous challenges of a rapidly changing environment, this developmental question becomes a matter of vital practical significance.

Moreover, she focuses on the early experiences of young people, not solely as isolated individuals, but in relation to others such as parents and family members, as well as in the context of cultural-ethical traditions. From this wider focus beyond individual actions, she urges that we consider the ways that different cultures value the natural environment. Among these alternatives are those traditions that view humans as having a responsibility to care for nature. This relational value can be contrasted with *both* a conservationist ethic with an eye toward resource management, as well as with what seems to be its antithesis, a tendency to value nature primarily as a source of individual fulfillment. Instead, a stance of caring assumes a place in nature that recognizes the interdependencies of an ecosystem.

Chawla draws here on the writings of Sen (1985) and Nussbaum (2011) who have written about the development of those human "capabilities" that are essential for biological and psychological well-being, while also contributing to maintaining conditions for all life to flourish. This stance of responsibility and caring is inspired by the Aristotelian notion of eudaimonia, a state of living well grounded in moral virtue and caring. It is this ethical commitment that motivates much of Chawla's work. Because of its compatibility with an ecosystem's perspective, she finds common cause between this largely philosophical stance and James Gibson's ecological psychology, especially as it has been extended by Edward Reed (1996a, 1996b).

Chawla identifies affordances as especially suitable as a relational concept for characterizing the opportunities the environment offers the individual agent. For example, if our focus is on children's experiences, the relevant affordances in natural and built environment are those features that are scaled relative to a child's body and that offer action possibilities within the range of that child's perceptual-motor competencies. Affordances' relational qualities also highlight the claim that they are discoverable in the environment, not imposed on it through acts of mental construction.

With this point of view in mind, Chawla proposes that natural settings may be distinctive because the "multitude of affordances in nature enable [children] to find the right level of challenge" (Chap. 6, p. 174). This is a very insightful way to distinguish between natural and built environments with respect to children's actions.

It is not so much that there are more affordances in natural environments than there are in built environments, but that there is a greater range of affordance possibilities among features for children at different points of development (for evidence supporting this claim, see, Lerstrup, 2015). Because children are creative and inventive in their play, they can discover novel affordance possibilities even in built settings that go beyond the intentions of designers.

Further, when an individual perceives an affordance, such as that an object affords grasping, she is concurrently aware of her action capabilities, e.g., that the object in question is graspable "for me." For this reason, engagement with affordances may contribute to a developing sense of self-efficacy and competence for a child (see above). Chawla ties such experiences to "joy in understanding how things are connected, just as there is joy in being a cause" (Chap. 6, p. 175). That such affective experiences can accompany the process of engaging affordances is evident among some of the narrative descriptions of children's activity that Chawla includes in her chapter. Chawla has a keen eye for insights to be gleaned from research employing qualitative methodologies. Notably, in those instances when children seem to be spontaneously and intensively engaged in prolonged examination of natural features, she finds evidence that runs contrary to those views claiming that attentional fatigue results from extended periods of directed attention. She writes that attention in such instances "was simultaneously directed and fascinated."

Chawla draws on the writings of Reed and others to consider how individuals in the community participate in the child's engagement with the environment. She notes that in contemporary society, "other people determine how much nature infants' experience. They construct worlds where nature is nearby in farms, parks and gardens, or entirely built over. When nature is nearby, they control access to it." In this regard, we can distinguish among fields of "promoted action," when nature is accessible and children receive encouragement to engage with it; and fields of "constrained action," where exploration is limited often due to caregiver's anticipation of dangers and their judgments about what actions are "proper" (Heft, 2018). Others also play a role in influencing children's engagement with nature in less intentional ways, as when children participate in acts of joint attention and when they rely on social referencing. By considering children's action toward features of the natural environment in relation to others around them, Chawla considers how competencies develop not only as solo actions, but also as "apprenticeships in nature" (Rogoff, 1990).

Finally and importantly, Chawla sees in the ecological perspective of children as agents in the environment the possibilities for fostering *hope* among young people in the face of daunting, and even seemingly insurmountable challenges (also see, Reed, 1996b). To the extent that acts of agency are group efforts, they can promote social trust and feelings of collective efficacy. She quotes Reed (1996b) as follows: "Hope is neither subjective nor private. It is an aspect of public experience and public action" (p. 153). This is a quintessential Jamesian-like insight. The ways in which experience in natural settings may promote agency, public engagement, and hope is in need of further study. Chawla's chapter can serve as an inspiration for that endeavor.

8.6.3 *Nature and Psychological Outcomes from a Macro-Systems Level of Analysis*

The chapter by Wells importantly bridges two bodies of research that are typically considered separately: resiliency in human development and the effects of proximity and access to nature on well-being. Significantly, rather than reviewing evidence that speaks to possible direct effects of nature, Wells examines the possibility that access to nature can function as a moderator of stressors that vulnerable populations, in particular, are confronted within everyday life.

Unlike most of the studies discussed by the other contributors, much of the research that Wells reviews has a demographic focus, with data collected outside of the laboratory and at the level of some selected population. This level of analysis is characteristic of the kind of ecosystems approach advocated by Bronfenbrenner at Cornell, and productively continued by Evans (2004) and now Wells at this same institution.

Bronfenbrenner (1979) argued that it is critical to recognize that individual bio-psychological processes are not only affected by immediate proximal conditions, but they are also embedded within a set of higher order interpersonal and sociocultural nested systems that operate beyond the reach of the individual. In this respect, availability and access to the natural environment for individuals typically stems from circumstances and decision-making outside the scope of individual choice—such as the location of a child's home or school in relation to a natural area.

Because these circumstances originate in processes operating beyond that of the psychological domain, and because their effects are assessed at a population level, research of this sort remains mostly agnostic about the specific psychological processes involved. Even so, Wells does propose some possible psychological "pathways" through which availability of natural areas may operate. Still, the value of this macro-system approach has less to do with a particular model of environment–person relations than with the sheer scope of its analysis. Simply put, in the absence of the kind of nested systems approach utilized here, circumstances operating in the society at large that are critical to bio-psychological well-being might not receive the attention that they deserve. This is especially the case for those portions of the population that are poor and under-served in a society, as Wells shows empirically.

The range of risk factors that Wells considers is vast, and yet her focus in this chapter is somewhat narrow. For those reasons, this chapter has considerable value. She examines "the potential for nature [functioning as a moderator] to interact with a risk factor(s) and to thereby dampen the impact of risk or adversity" (Chap. 7, p. 205). This goal is immensely practical. Although there is no doubt that risk factors such as poverty, homelessness, and poor housing can be best addressed head-on through, e.g., governmental policy, "moderators provide additional leverage points for intervention." If the provision of nearby green space, or even the planting of trees near residences and schools, can function as moderators of stress from other sources, their influence could be widespread, and in many cases, at a comparatively low cost.

With that in mind, Wells reviews studies that on balance show a moderating effect of the natural environment on the effects of adversity on physical and mental health, as well as on infant birth weight, particularly among individuals living in low-income areas. Its potential moderating effects on academic achievement, however, are a bit mixed. It would be useful to know more about how availability of and access to nature was measured in some of these studies. For example, references to "perceived nature" and "perception of near school nature" suggest solely individual's estimates, if we take "perceived" to mean subjective assessments. Needless to say, that is not the way in which "perceived" is employed in this chapter. It could be argued that what individuals believe to be the case is what matters primarily, but that is a contestable claim.

As for proximal mechanisms or "pathways" through which access to nature may operate, Wells singles out two in particular, providing supporting evidence in each case. One is executive functioning skills which may best serve individuals in their utilization of information and resources that could off-set effects of environmental adversity. The other is social support, which as already noted has long been known to play a positive role in recovery from illness and in contributing to resilience in the face of adverse conditions. Several studies have found a positive relationship between neighborhood green space and social capital (Arnberger & Eder, 2012; Holton, Dieterlen, & Sullivan, 2015; Hong et al., 2018). The linkages between access to nature and these pathways need to be elucidated, but Wells offers a promising start.

What is particularly significant about this chapter stems mostly from one of the conclusions a macro-system level of analysis brings to the forefront: I refer to Well's concerns about *environmental justice*. Inequities become most readily apparent when looking across categories of income distribution as well as race, gender, and ethnicity. Wells writes: "If nature access is associated with risk factors, inequitable distribution of nature must be remedied before nature can be effectively leveraged as an equigenic tool" (Chap. 7, p. 222). It would certainly be remiss if a collection of chapters about the relationship between experience in nature and psychological well-being did not call attention to such inequities, especially in those societies like our own where the gap between the well-off and the poor has been growing. The inclusion of this topic is not only significant in its own right, but taken in relation to the other chapters collected here, it also points to the value of examining psychological issues at multiple levels of analysis.

8.7 Postscript

The chapters in this volume attest to the ongoing vitality of inquiry into the relationship between the natural environment and psychological functioning/well-being. Since the beginnings of this area of study in the early 1970s, demonstrable gains have been made on both empirical and conceptual fronts. What has been revealed is not merely that exposure to and engagement with particular environmental

conditions seem to promote psychological development over time and remediate the stressors of everyday affairs in the short run—informally those possibilities have been supposed for centuries—but more critically, empirical inquiry has started to reveal some of the properties of environments that contribute to those outcomes. In recent decades, the so-called natural environments have been singled out as perhaps having special significance in this regard, and the chapters here review that possibility from different theoretical perspectives. Still, more work is needed to clarify what is meant by natural environments from a psychological perspective -- an effort that will return this area of research back to some basic problems that were left unresolved decades ago.

The health of this area of research can be gauged by the tangible gains that have been made in shedding light on these relationships, as modest as those gains are so far. It can also be gauged by the diversity of theoretical approaches that collectively provide alternative directions from which to approach these important matters. Each of these approaches is built on a prior history of psychological inquiry, and as we look ahead to the new insights that seem likely to accrue, there remains much to be gained by attending to the conversations of previous generations and occasionally to look beyond disciplinary boundaries. From there, we should expect to uncover fruitful and practical conceptual tools for revealing the psychologically significant qualities of the environments in which we carry out our daily lives.

Acknowledgments I am grateful to the editors of this volume, Anne Schutte, Jeffrey Stevens, and Julia Torquati, for inviting me to participate in the long-esteemed Nebraska Symposium Series, and for their helpful feedback and suggestions on earlier versions of this chapter. I also thank Louise Chawla and Agnes van den Berg for their comments on some sections. Finally, the influence of Jack Wohlwill on my initial thinking about environmental perception and environmental psychology generally should be apparent here, and I dedicate this chapter to his memory.

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A. R. Schutte et al. (eds.), *Nature and Psychology*, Nebraska Symposium on Motivation 67, https://doi.org/10.1007/978-3-030-69020-5