Zoo-ming in on restoration

Pals, R.

Publication date:
2012

Zoo-ming in on Restoration

Physical features and restorativeness of environments

Roos Pals

Zoo-ming in on restoration

Physical features and restorativeness of environments

Roos Pals

This thesis was made possible through funding of Emmen Zoo.
Dit proefschrift is mede mogelijk gemaakt door subsidie van Dierenpark Emmen

Cover design: Roos Pals
Photo cover: Jim Nicholson
Illustration credits can be found on page 175

Printing: Ridderprint B.V.

ISBN: 978-90-367-5256-5 (Electronic version)
978-90-367-5240-4 (Paper version)

RIJKSUNIVERSITEIT GRONINGEN

Zoo-ming in on restoration

Physical features and restorativeness of environments

Proefschrift

ter verkrijging van het doctoraat in de
Gedrags- en Maatschappijwetenschappen
aan de Rijksuniversiteit Groningen
op gezag van de
Rector Magnificus, dr. E. Sterken,
in het openbaar te verdedigen op
maandag 9 januari 2012
om 16:15 uur

door

Rozemarijn Pals
geboren op 23 juli 1981
te Utrecht

Promotores:	Prof. dr. E. M. Steg Prof. dr. K. I. van Oudenhoven – van der Zee
Copromotor:	Dr. F. W. Siero
Beoordelingscommissie:	Prof. dr. A. E. van den Berg Prof. dr. M. Bonnes Prof. dr. G. de Roo

Contents

Chapter 1

General Introduction

Many people today suffer from chronically high stress levels. It is well known that continuous high levels of stress can lead to illness and even death (Cohen, Janicki-Deverts, & Miller, 2007). Therefore, it is important to know how we can recover from such elevated stress levels. Common sense suggests that a walk in the park or camping in the forest are helpful ways to recover from stress. Empirical findings support this idea that natural environments have beneficial effects on stress reduction and people's well-being. For example, people perform better on attention tasks, experience less physiological stress, and report more positive and less negative affect after a walk in nature compared to a walk in an urban setting (Hartig, Evans, Jamner, Davis, & Gärling, 2003). Interestingly, nature may even generate positive health effects. For example, Roger Ulrich (1984) showed that a patient's window-view was related to their recovery. Ulrich compared files of patients who underwent a gallbladder surgery over a period of nine years (from 1972 to 1981). He found that patients who had a room with a view on trees were released more quickly from the hospital and took fewer painkillers compared to those who viewed a brick wall.

Why does nature have these "restorative" effects on our well-being? The attention restoration theory (ART; Kaplan & Kaplan, 1989) attempts to explain why we can restore more quickly in one environment compared to another environment. The ART proposes that a stay in an environment with *restorative characteristics* will enhance the opportunity to restore from mental fatigue and stress. Before describing these restorative characteristics in more detail, I will first explain the core concepts of the ART. Two types of attention are distinguished, directed attention and effortless attention (James, 1892). Directed attention is used when something does not attract attention automatically, but one needs active effort to be able to focus on it. To stay focused one has to inhibit distractions. Directing attention and inhibiting distractions requires effort, and prolonged directed attention leads to a depletion of the necessary cognitive resources. For example, when you have been working intensively on a written report, you will most likely experience what Kaplan and Kaplan (1989) referred to as *directed attention fatigue*. Directed attention fatigue is equal to mental fatigue, and we will use the terms interchangeably.

The ART proposes that if you spend some time in an environment in which you do not need to direct your attention, you can instead rely on effortless attention, and be able to restore from directed attention fatigue. Especially natural environments require little effortful processing, and thus are often experienced as more restorative than urban settings. However, other environments can be restorative as well, such as monasteries and museums (Kaplan, Bardwell, & Slakter, 1993; Ouellette, Kaplan, & Kaplan, 2005).

Various *restorative characteristics* of environments appear to promote attention restoration (Kaplan, 2001; Kaplan & Kaplan, 1989; Laumann, Gärling, & Stormark, 2001). The first restorative characteristic, *fascination*, implies that your attention is drawn effortlessly by interesting things in the environment, for example a colorful butterfly. When you experience fascination, you do not need to actively direct your attention, allowing you to restore from mental fatigue. The second restorative characteristic, *being away*, implies that you are physically and mentally away from your usual surroundings. Empirical research has shown that this characteristic should be split in a physical component (novelty) and a psychological component (escape; Laumann et al., 2001). *Novelty* implies that you have the opportunity to recover if you are in a different setting than usual that allows you to be free from reminders of your daily obligations. *Escape*, the third restorative characteristic as distinguished in this thesis, refers to being able to free your mind from stressful thoughts. This distinction between *novelty* and *escape* is also theoretically meaningful because being away clearly has two components (i.e. a physical component and a psychological component) that may not always both be present (or absent) in a particular environment. The fourth restorative characteristic concerns the amount of *coherence* or harmony between all elements in the environment. Being in a highly coherent environment requires little cognitive effort, which will positively affect restoration. Coherence was originally referred to as *extent,* which was defined in terms of scope and connectedness. Scope refers to the scale of the environment, including the immediate surroundings and the areas that are out of sight or imagined. Connectedness refers to a degree of coherence of relatedness between perceived features or elements in the environment, and if these elements contribute to a larger whole. However, in a later publication Kaplan (2001) has suggested that both scope and connectedness rely to a large extent on the coherence of the environment. Therefore, in this thesis I will narrow down the definition of extent to coherence. Finally, a good match between the individual and the environment, or *compatibility,* will enhance restoration. The environment has to be compatible with an individual′s inclinations or expectations. Being in a highly compatible environment requires little effort, thus restoration is more likely to occur.

Several scholars have attempted to measure restorative characteristics of environments, and examined relationships between restorative characteristics and certain restorative outcomes (Hartig, Korpela, Evans, & Gärling, 1997a; Laumann et al., 2001). However, as yet there is not a measure available that captures the *five* components of the restorative experience described above that have emerged from research and theorizing in recent years. This thesis aims to develop and test an instrument to measure perceived restorative characteristics of environments.

There is growing evidence that restorative characteristics of environments are not only positively related to restoration from mental fatigue and stress and positive affective responses, but also to *preference* for these environments (Laumann et al. 2001; Purcell, Peron, & Berto, 2001). So, environments with restorative characteristics are likely to yield three types of outcomes that are indicative of the restorative quality of the relevant environment: 1) restoration from mental fatigue or stress, 2) positive affective responses (such as pleasure), and 3) positive evaluations of the environment (such as preference). I will refer to these outcomes (i.e. restoration, pleasure, and preference) as *restorative effects*. It should be noted that the interpretation of preference as a restorative effect goes against common conceptions of preference and restoration as two distinct components of human-environment relationships (e.g. Kaplan & Kaplan, 1989; Van den Berg et al., 2003). However, several studies have shown that perceived restoration is closely linked to environmental preference (Korpela & Hartig, 1996; Hartig, Maris, & Staats, 1998; Purcell, Peron, & Berto, 2001; Staats, Kieviet, & Hartig, 2003), and thus it seems justified to assume that both concepts seem to tap into the same underlying dimension reflecting the restorative quality of environments. Therefore, I consider all three restorative effects (restoration, pleasure, and preference) as important indicators of the restorative quality of environments.

Restorative characteristics (i.e. fascination, novelty, escape, coherence, and compatibility) are mental constructs, referring to an interaction between the individual and the environment. As such, they provide no clear guidelines on what physical features of environments are of key importance in the restorative process. Coherence, for example, reflects an individual's *perception* of the level of harmony in the environment, and does not indicate what environmental features make the environment more or less coherent. Therefore the restorative characteristics do not provide clear guidelines on how to improve an environment in order to enhance its restorative potential. For practitioners, it is highly important to understand which *physical characteristics* influence restorativeness of environments, because this reveals how the restorative quality of environments can be improved by changing particular physical features.

In this thesis I attempt to make some first steps towards integrating the Attention Restoration Theory, a prominent psychological approach, with the physical-perceptual approach (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, Daniel, & Schroeder, 1984) that examines relationships between physical characteristics of the environment and judgments of *preference* for landscapes. Typically, research that uses a physical-perceptual approach compares different types of environments, and analyses how physical environmental features are related to preference judgments for the environments (Daniel & Vining, 1983). For example the presence of water or vegetation may result in more positive evaluations of environments (Bell, Greene, Fisher, & Baum, 2001). An advantage of the physical-perceptual approach compared to the ART is that it does identify objective characteristics of the environment that positively affect environmental preferences. However, a theory on *why* people prefer certain physical characteristics is lacking. Furthermore, the physical-perceptual approach did not explicate relationships between physical features and other restorative effects, such as restoration and pleasure. As there appears to be a relationship between preference and the other restorative effects (restoration and pleasure; Laumann et al. 2001; Purcell, Peron, & Berto, 2001), I expect that certain physical environmental features will influence preference and the other restorative effects in a similar way. In this thesis I try to further develop a theoretical framework concerning restorative environments, by integrating the physical-perceptual approach and the ART. In particular, I will examine whether physical environmental features that are positively related to preference, one of the restorative effects, are also positively related to the two other restorative effects (i.e. restoration, and pleasure). Moreover, I will examine whether physical features influence the restorative effects via the perceived restorative characteristics of the particular environment. I will focus on one of the restorative characteristics: coherence. More specifically, I will examine the influence of specific physical features such as the presence of furniture on coherence, and on restorative effects (restoration, pleasure, and preference), as depicted in the Physical-Perceptual Restoration model (PPR model; see Figure 1). Furthermore, I will examine whether restorative characteristics, notably perceived coherence, mediates the relationship between physical features and restorative effects of environments. If this is indeed the case, this will provide a theoretical basis and practical insights on how to lift restorativeness of environments.

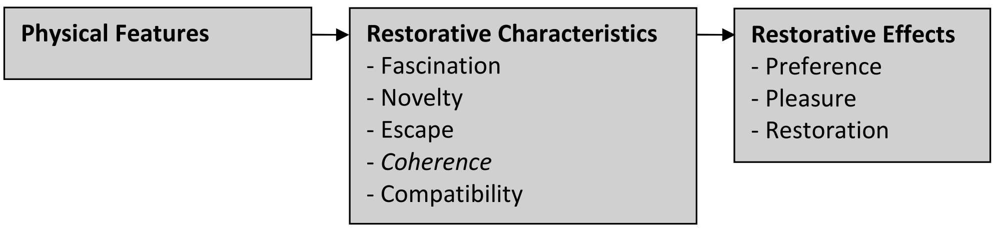


Figure 1. The Physical-Perceptual Restoration model

Aims of this thesis

To accurately examine the Physical-Perceptual Restoration Model, it is essential to have valid measures and tools. Therefore, the first aim of this thesis is to develop suitable measures and tools to accurately examine relationships between specific physical features, restorative characteristics, and restorative effects of environments. To achieve this aim, I will develop a questionnaire that accurately measures the *five* perceived restorative characteristics of environments on the basis of theoretical and empirical developments in the restorative environments literature (Kaplan & Kaplan, 1989; Laumann et al., 2001). I will test the reliability, validity and sensitivity of the scale. The scale will be administered in different natural and urban settings to its sensitivity to detect differences in the restorative quality of these environments. Also, I will test the extent to which the questionnaire is able to predict different restorative effects of environments.

Next, I will examine the validity of Virtual Reality (VR) as a tool to study relationships between physical characteristics, restorative characteristics and restorative effects. VR is an artificial environment generated by computer software, presented in such a way that the user is able to interact with the environment similar as with a real environment. Two major advantages of using VR in research on restorative environments are that in VR researchers can exert more control over the setting and more easily manipulate features of environments, compared to real settings. When conducting experiments in VR, it is important to examine whether experiences in virtual environments are similar to experiences in real environments. Because VR is a relatively new tool, research on its validity, especially in the field of environmental psychology, is scarce. Therefore a second step in developing measures and tools was to test the validity of VR as a tool to study restorative environment experiences. To find out if virtual reality can be used to examine relationships between physical features, restorative characteristics, and restorative effects, I will test if restorative characteristics and restorative effects of virtual environments are similar to comparable real environments. In this thesis, I will focus on zoo attractions (e.g. a butterfly garden, baboon attraction) as a particular example of natural environments, as zoo attractions are natural environments designed by humans, so findings can be directly translated into guidelines for design.

A second aim of this thesis is to use the newly developed measures and tools to provide a first step towards testing the Physical-Perceptual Restoration model (Figure 1). First, I will examine relations between perceived restorative characteristics (fascination, novelty, escape, coherence, and compatibility) and restorative effects in distinct settings: a butterfly garden, a baboon attraction, a shopping center, a virtual butterfly garden and a virtual urban neighborhood. I will study people's perceptions of restorative characteristics of the settings, and test whether these perceived restorative characteristics can predict the three different restorative outcomes: preference for the settings, and the extent to which people experience pleasure and restoration from mental fatigue while they are in the setting. Then, I will conduct first investigations on how physical features are related to restorative characteristics and restorative effects, by systematically manipulating certain physical features. In particular, I will focus on coherence as a key restorative characteristic with a strong physical component. First, I will examine the relationships between physical features, coherence, and restorative effects (restoration, pleasure, and preference) by manipulating specific objects in a virtual natural environment. Second, I will examine the relationship between physical features, coherence, and preference at a more abstract level. More specifically, I will examine how specific physical features (i.e. color, shape, and organization) of abstract pictures influence perceived coherence of and preference for these pictures. Additionally, I will examine the relative importance of each physical feature for evaluations of coherence and preference, to get more insight into the specific influence of each physical feature on coherence and preference individually.

Overview of the thesis

Chapter 2

Development of the PRCQ: A measure of perceived restorative characteristics of environments

Chapter 2 describes the development of the Perceived Restorative Characteristics Questionnaire (PRCQ), a new questionnaire that aims to measure perceptions of the five restorative characteristics (fascination, novelty, escape, coherence and compatibility) of environments. This questionnaire will be administered in two distinct settings (i.e. zoo attractions). The reliabilities of the subscales will be examined, as well as the underlying factor structure. I will examine whether the questionnaire indeed provides a reliable indicator of the five restorative characteristics.

Additionally, I will test the right part of the Physical-Perceptual Restoration model (Figure 1). I will examine the relations between perceptions of restorative characteristics and restorative effects, in particular experienced pleasure and preference for the settings. More specifically, I will examine whether the restorative characteristics as measured with the PRCQ are indeed able to *predict* experienced pleasure and preference for the settings.

Chapter 3

Is virtual reality a valid tool for restorative environments research?

Chapter 3 describes the validation of virtual reality as a tool for restorative environments research. At the same time in Chapter 3 the right part of the Physical-Perceptual Restoration model (Figure 1) will be examined. More specifically, I examined the validity of VR by examining perceptions of restorative characteristics of virtual settings and their real counterparts, and by examining the relations between restorative characteristics and restorative effects, that is, experienced pleasure, restoration, and preference for these settings, in both virtual settings and their real counterparts. If VR is indeed a valid tool the following four assumptions should be met. First, I should be able to replicate the finding that natural environments score higher on restorative characteristics and elicit stronger restorative effects (pleasure, preference, and restoration) than urban environments, both for virtual and for real environments. Second, if restorative characteristics can predict preference, pleasure, and restoration for real environments, restorative characteristics of *virtual* environments should also be able to predict preference, pleasure, and restoration for *virtual* environments. Third, the same restorative characteristics should be able to predict the restorative effects both in the real environments as in their virtual equivalents. Fourth, there should be no differences in perceived restorative characteristics of the real environment and its *virtual* equivalent. Finding support for these assumptions suggests that VR is a valid tool to further examine the relations between environmental features, restorative characteristics, and restorative effects.

Chapter 4

Physical features and restorativeness of environments: A virtual reality study

In Chapter 4 and 5 I will report the first tests of the full Physical-Perceptual Restoration model (Figure 1) and examine how physical features are related to restorative characteristics and restorative effects, by systematically manipulating certain physical features in a particular environment. Chapter 4 describes a study on the relationships between physical features, restorative characteristics, and restorative effects in a virtual natural environment, namely a virtual zoo attraction. More specifically, I studied how physical features affect *coherence* of an environment, a key restorative characteristic in the ART (Kaplan & Kaplan, 1989), and restorative effects. In VR I will examine how introducing objects (e.g. benches, fences, and garbage bins) that disharmonize or harmonize with a setting (i.e. a natural zoo environment) influence the perceived coherence of the setting, and restorative effects (restoration, pleasure, and preference). Furthermore, I will test the *mediating* role of coherence on the relationship between the physical features and restorative effects.

Chapter 5

The relationship between physical features, coherence, and preference for abstract stimuli

In Chapter 5 I will examine the relationship between physical features, coherence, and preference in more depth at a more abstract level. I will examine how specific physical features (i.e. color, shape, and organization) of abstract pictures influence perceived coherence of and preference for these pictures. The aim is to get more insight into the specific role of each physical feature individually. Additionally, I will examine the relative importance of each physical feature for evaluations of coherence and preference. Also, I will examine the *mediating* role of coherence on the relationship between perceived coherence and preference.

Chapter 6

General discussion

In the final chapter I will discuss the main findings of the studies I have presented in this thesis. I will discuss the instruments and tools I developed and tested in my studies, and discuss whether the methods used in this thesis can be useful for future research examining relationships between physical features and restorativeness of environments. Also, I will discuss the first evidence on the test of the Physical-Perceptual Restoration model. Furthermore, I will elaborate on the scientific and practical implications of the findings and indicate how urban planners, architects, and interior designers can use knowledge about relations between physical features and restorativeness to design "healthy" environments.

Chapter 2

Development of the PRCQ:

A measure of perceived restorative characteristics

of environments

Chapter 2 is based on Pals, R., Steg, L., Siero, F., & Van der Zee, K. I. (2009). Development of the PRCQ: A measure of perceived restorative characteristics of zoo attractions. *Journal of Environmental Psychology, 29*(4), 441-449.

Abstract

This study describes the development of the Perceived Restorative Characteristics Questionnaire (PRCQ), a measure of perceived restorative characteristics of zoo attractions. The questionnaire was administered in two zoo attractions. The hypothesized five factor structure of the PRCQ, and relations between perceived restorative characteristics and experienced pleasure in and preference for the attractions were examined. In Study 1, 137 visitors of a Dutch zoo evaluated perceived restorative characteristics of a butterfly garden. In Study 2, 158 visitors evaluated perceived restorative characteristics of a baboon attraction. In Study 1 three factors emerged (fascination, escape and coherence). In Study 2 four factors could be distinguished (fascination, novelty, escape, coherence). Compatibility did not appear as a separate factoring either study. Perceived fascination and escape were significant predictors of experienced pleasure and preference in both attractions. The implications of the findings are discussed.

Zoos strive to give their visitors a memorable experience. But what exactly makes attractions in zoos successful? Knowledge about which characteristics of the attraction positively influence visitor experience, and especially, being able to measure characteristics that can predict preference and experienced pleasure, would be very helpful for zoos.

Research on how characteristics of attractions in zoos influence visitor behavior is limited, and often observational methods are used. Observational studies typically include tracking visitors through an entire exhibition or exhibit area, conducting time sampling at specific areas, or doing observations of a single exhibit or exhibit area (Bitgood, 2002). For example, researchers have examined how characteristics of the animal and the attraction were related to visitors' movement through a zoo, and stopping time at specific attractions (Bitgood, Patterson, & Benefield, 1988). The characteristics of the animals and attractions were evaluated by the researcher and not by visitors themselves. Also, observational studies do not provide information about visitors underlying feelings and preferences. When a visitor lingers at the tigers for a certain time, it remains unclear whether this is because this visitor finds tigers fascinating creatures, or because the tigers are not visible. Also, we don't get to know if looking at the tiger is a pleasurable experience for this visitor. In order to get more insight in how visitors perceive characteristics of the attraction, and how this related to their feelings and preferences, questionnaire studies are needed.

Previous research has shown that there is a positive relationship between characteristics of restorative environments and preference for these environments

(Laumann, Gärling, & Stormark, 2001; Purcell, Peron, & Berto, 2001). In restorative environments places people can recover from stress and mental fatigue, and experience more positive and less negative affect (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Hartig, Mang, & Evans, 1991). We argue that people will have a preference for, and experience more pleasure at zoo attractions that incorporate characteristics of restorative environments. The goal of this study was to develop a measure of perceived restorative characteristics of attractions in zoos, and examine how perceived restorative characteristics are related to preference for the attraction and pleasurable experiences at the attraction.

Attention Restoration and Restorative Characteristics

An influential theory on restorative environments is the attention restoration theory (ART; Kaplan & Kaplan, 1989). Central to the ART is the concept of attention. Directed attention is used when a certain object does not attract attention automatically, but needs active effort to be able to focus on it. In order to be able to direct your attention it is necessary to inhibit all distractions. Directing attention and inhibiting distractions requires effort, and prolonged directed attention leads to directed attention fatigue. For example, when you have been working intensely on a task for considerable time, like writing a paper, this will lead to directed attention fatigue. Directed attention fatigue can lead to irritability, impatience, distractibility and an inclination to take unnecessary risks (Kaplan, Bardwell, & Slakter, 1993). An effective way to recover from directed attention fatigue is to spend some time in what Kaplan and Kaplan (1989) have called a restorative environment. So, what exactly makes an environment restorative? Kaplan and Kaplan identified four characteristics of restorative environments that enhance recovery from directed attention fatigue: fascination, being away, extent, and compatibility (Kaplan & Kaplan, 1989).

The first characteristic of a restorative environment, *fascination*, allows people to rely on effortless attention instead of directed attention. When your attention is drawn effortlessly by an interesting object in the environment, you do not need to direct your attention. This effortless attention is resistant to fatigue, and enables you to restore from directed attention fatigue.

Another important restorative characteristic refers to experiencing a sense of *being away*, either physically or psychologically, from your everyday environment. This means that you are in a different setting than usual, and are able to escape from unwanted distractions and reminders of your daily obligations. The component being away is closely related to fascination. When there are no undesirable distractions around you, because you are in a different setting than usual, it will require less effort to focus your attention, so fascination will more easily occur.

The third characteristic is *extent*. Hartig and colleagues explained that “Extent is treated by the Kaplans (1989) as a function of connectedness and scope” (Hartig, Kaiser, & Bowler, 1997b, p. 4). Connectedness refers to a degree of coherence of relatedness between perceived features or elements in the environment, and if these elements contribute to a larger whole. Scope refers to the scale of the environment, including the immediate surroundings and the areas that are out of sight or imagined. Kaplan (2001) clarified these concepts in terms of a cognitive map that an individual has of the environment. Having a cognitive map of a specific place or domain reduces the need to be vigilant or observant as you can anticipate what might happen and know how to deal with it. Situations in which one can rely on more extensive cognitive maps demand less directed attention. Kaplan (2001) wrote the following:

> *In a coherent environment, things follow each other in a relatively sensible, predictable and orderly way. Coherent environments make a cognitive map easier to build and easier to use. But even in a coherent environment, the boundary may come too soon. If the environment has insufficient scope, one must relinquish one's currently running cognitive maps and bring up a different one. This is true whether this deficiency is physical or conceptual. A garden in which one has many things to check out, care for, and wonder about can have vast scope although it is physically small. Extent thus calls on coherence and scope. Insufficient scope terminates the experience; insufficient coherence makes it difficult to experience the setting as a unified entity. From the point of view of restoration, running a single cognitive map for an extended period of time is ideal (p. 488).*

The fourth restorative characteristic defined by Kaplan and Kaplan (1989) is *compatibility,* and stands for a fit between the person and the environment. The idea is that being in a highly compatible environment will require little effort, so this helps to restore from directed attention fatigue. And the other way around: To rest directed attention you need to avoid situations where incompatibility may occur, because being in an incompatible situation demands directed attention. Kaplan (2001) defined four aspects of compatibility: information, motivation, (multiple) mental models, and competence. The first aspect of compatibility refers to the amount and kind of information available in the environment. Being in a situation where there is insufficient or inappropriate information to carry out what you want to do, requires effort (and directed attention). The second aspect of compatibility, motivational compatibility, has to do with the ability to do the things you are inclined or want to do in the environment. Incompatibility occurs when the environment forces one to do something that one does not want (for example you wish to go left, but you can only go straight). The third aspect of compatibility refers to the use of mental models. Incompatibility occurs when an individual is in a situation where it is necessary to run multiple mental models (Kaplan, 2001). A mental model will guide behavior in a particular setting. In a highly compatible situation using a single mental model will be sufficient. If what you are inclined to do is inappropriate in a situation, or if you have to check yourself constantly to be sure that what you are doing is acceptable, it is necessary to run multiple models at once. Running multiple models will increase the effort substantially, and hence directed attention cost (Kaplan, 2001). The fourth aspect of compatibility refers to level of competence. Incompatibility may occur when the action that one wants to do exceeds what one is capable of doing. An environment with all four types of compatibility satisfied will require little effort, and will help to restore from directed attention fatigue.

Fascination, being away, extent and compatibility can be experienced to various degrees in all kinds of environments, but these restorative characteristics are most likely to be experienced in natural environments. For most people who work and live in cities, nature is a place where they are away from their daily hassles. Nature has many sources of fascination (animals, flowers, water), natural settings are coherent (because it consists of related natural elements), and have scope. There is indeed evidence that people can recover faster in natural settings than in urban settings. People who were exposed natural setting (or to pictures of a natural setting) performed better on an attention task (Berto, 2005; Hartig et al., 2003), and showed more restoration in terms of skin conductance, blood pressure and heartbeat variability (De Kort, Meijnders, Sponselee, & IJsselsteijn, 2006; Hartig et al., 2003; Laumann, Gärling, & Stormark, 2003), than people who were exposed to an urban setting.

Most studies on restorative environments have focused on restorative experiences in natural environments. However, it is important to look at the restorative potential of other places as well. Some people may not have the opportunity to visit natural settings, and could benefit from the restorative potential of other environments that are more accessible. Kaplan, Bardwell and Slakter (1993) found some preliminary evidence that people can also have restorative experiences in museums. In addition, Ouelette, Kaplan and Kaplan (2005) examined the restorative value of a monastery. Zoos may also provide restorative experiences. This restorative experience could also be a motivation for many people to visit and enjoy zoos: They want to get away from their daily hassles, and have a great day to recover from a stressful week at work. The aim of this study is to measure perceived restorative characteristics of attractions in zoos, and to examine how these characteristics are related to visitor experience (i.e. preference ratings and experienced pleasure). To do this, we developed and tested a new instrument: the Perceived Restorative Characteristics Questionnaire.

Measuring Restorative Characteristics

Previous studies have aimed at developing measures for perceived restorative characteristics of urban and natural environments. Hartig and colleagues (Hartig, Korpela, Evans, Gärling, 1997a) developed the Perceived Restorativeness Scale (PRS) to measure the four restorative components as proposed by the ART (Kaplan & Kaplan, 1989). In several studies participants were asked to rate perceived restorative components of environments, either on site, using color slide presentations, or from memory or imagination. The results revealed that the four factors could not be distinguished empirically. Instead, two factors emerged, with the items designed to measure being away, fascination and compatibility loading on one empirical factor and the intended extent items loading on the other. It is likely that all extent items loaded on a separate factor because they were all negatively worded, whereas all other items were positively worded. This frequently occurring phenomenon that the valence of items defines a single factor is well described by Bentler and colleagues (Bentler, Jackson, & Messick, 1971) and Schmit and Stuits (1985). Also, the extent items of the PRS (Hartig et al., 1997a) did not seem to correspond entirely with the definition of extent (i.e. a function of coherence and scope). In the PRS, extent was measured using four items (there is too much going on, it is a confusing place, there is a great deal of distraction, and it is chaotic here). The items seem to measure how complex people find a specific environment rather than extent.

Following up on this work, Laumann and colleagues developed the Restorative Components Scale (RCS; Laumann et al., 2001). In two studies, participants had to rate urban and natural environments, in the first study by memory, and in the second study by watching videos of simulated walks in several different environments. Laumann et al. (2001) used four items to measure extent (the elements here go together, the surroundings are coherent, all the elements constitute a larger whole, and the existing elements belong here). Again, the extent items did not seem to fully reflect the theoretical construct as proposed in the ART (Kaplan & Kaplan, 1989). It seems that the extent items only captured the coherence aspect of extent, instead of reflecting both coherence and scope.

Laumann and colleagues (2001) found a five factor structure in their data gathered with the RCS, largely in line with the four factor structure as proposed by Kaplan and Kaplan (1989). However, the being away factor split into two factors: a physical component (referred to as *novelty*), and a psychological component (referred to as *escape*). This finding seems plausible, because Kaplan and Kaplan's definition of being away also has two components: a physical component (being in different setting than usual), and a psychological component (being able to escape from unwanted distractions and reminders of your daily obligations). So, the distinction between the two being away components is plausible both theoretically and empirically. Therefore, we argue that the two components should be measured separately.

Laumann also examined how restorative characteristics were related to preference evaluations of different environments. In one study, Laumann et al. (2001) found that fascination, novelty, escape, extent and compatibility could predict preferences for both a natural and a city environment which subjects recalled from memory. Compatibility was the most important predictor in both environments, fascination contributed significantly in the natural environment only. In another study, Laumann et al. (2001) found that evaluations of restorative characteristics were able to predict preference for five different environments (using videos of walks in a forest, park, sea area, city and snowy mountain). Again, compatibility was the most important predictor for all environments. Fascination made a significant contribution to the variance in preference for the forest, park and city.

In this study, we developed the Perceived Restorative Characteristics Questionnaire (PRCQ), a new questionnaire inspired on the PRS (Hartig et al., 1997a) and RCS (Laumann et al., 2001) that measures perceptions of five restorative characteristics (fascination, novelty, escape, coherence and compatibility) of attractions in zoos. Following Laumann (2001), *novelty* refers to the physical being away component, and *escape* to the psychological component as defined by Kaplan and Kaplan (1989). We narrowed down the definition of extent to *coherence*, referring to the degree of coherence between elements in the environment, and how well all elements go together. Fascination is defined as the degree to which attention is drawn effortlessly by objects in the environment. Compatibility was defined as the fit between the person and the environment, including four aspects of compatibility: information-fit (does the environment provide the information a person needs), motivation-fit (does the environment support activities a person wishes to perform), clear behavioral norms (does one know how to behave in a setting), and expectation-fit (does the environment confirm expectations). The latter two are related to the use of mental models. In a setting with clear behavioral norms, running a simple mental model will be sufficient, so the directed attention costs are low. A setting that matches with your expectation, and therefore matches with the mental model you have of the setting, will keep directed attention costs low as well. Competence, one of the compatibility aspects defined by Kaplan (2001), was excluded from our definition of compatibility because we think that competence is not relevant in a zoo context.

Only positively worded items were used in the PRCQ, because there is considerable evidence that including positively and negatively worded items within the same scale can lead to differential response patterns (Benson & Hocevar, 1985; Eys, Carron, Bray, & Brawley, 2007; Finney, 2001; QingKe, Dan, Zhao, & Kan, 2006; Weems, Onwuegbuzie, Schreiber, & Eggers, 2003).

The PRCQ was used to evaluate perceived restorative characteristics of two attractions in a Dutch zoo. Relationships between perceived restorative characteristics and visitor experience, that is, preference ratings and experienced pleasure were examined. We were interested in preference and pleasure because a successful zoo attraction will get high preference ratings and elicit pleasurable experiences for visitors. Also, the factor structure of the PRCQ was examined. In Study 1 the PRCQ was applied to a butterfly garden. In Study 2 improvements were made to the PRCQ and the PRCQ was applied to a baboon attraction. We hypothesize that high evaluations of perceived restorative characteristics of the attraction result in positive preference ratings for the attraction and a pleasurable experience when walking through (or by) the attraction. In addition, we hypothesize that among the perceived restorative characteristics, five separate restorative components can be found: novelty, escape, fascination, coherence, and compatibility.

Study 1

Environment

The tropical butterfly garden in Emmen Zoo (see Figure 1) is the largest in Europe. The butterfly garden is an immersive attraction: you can walk through, and be entirely surrounded by the attraction. The butterfly garden is located near the entrance of the zoo and is a tropical greenhouse of approximately 1200 square meters. During daytime, the temperature in the butterfly garden is around 25 degrees Celsius. In the garden there are several pathways, a bridge, a pond, a small waterfall, benches, tropical plants, and about 1600 butterflies in various colors and sizes. Some other animals in the butterfly garden are hummingbirds, quails and tree frogs. There are information boards describing the transformation of the butterfly, a glass display with cocoons, plastic flower shaped feeding platforms for the butterflies and signs telling visitors not to touch the butterflies.

Figure 1: Butterfly Garden in Emmen Zoo (the Netherlands)

Participants and Procedure

This study took place on clear days in spring and early summer 2007. Participants were 137 visitors of Emmen Zoo in the Netherlands (45 men, 89 women, 3 people did not fill out their sex). Mean age was 40.0 years (*SD* = 16.0). Among participants were 108 people who had been to Emmen Zoo before, of whom 50 people were season-ticket holders. Participants were recruited near the entrance of the butterfly garden, and filled out the questionnaire as they were walking through the butterfly garden. Participants could win a VIP treatment (i.e. free entrance, lunch, and a guided tour) in Emmen Zoo by filling out the questionnaire.

Because literature shows that familiarity and gender do not have a strong influence on perceived restorativeness and preference (Berto, 2007; Purcell, Peron, & Berto, 2001; Strumse, 1996), we did not control for these variables.

Measures

Restorative characteristics

The Perceived Restorative Characteristics Questionnaire (PRCQ) measures perceived restorative characteristics of attractions in zoos, and includes 24 items: 7 items to measure fascination, 3 items to measure novelty, 4 items to measure escape, 3 items to measure coherence, and 7 items to measure compatibility (see Table 2). All items were in Dutch, and were put in random order. Several items were based on the PRS (Hartig et al., 1997a), and the RCS (Laumann et al., 2001). The items focused on the butterfly garden. Participants indicated on a 7-point Likert Scale how much they agreed with the items, ranging from 1 ‘totally disagree’ to 7 ‘totally agree’.

Pleasure and Preference

Participants indicated on four (seven point) semantic differential items to what extent they experienced pleasure as they were walking through the butterfly garden: happy –

sad, pleasure – annoyance, satisfied – dissatisfied, content – bored[1] (Mehrabian & Russell, 1974; Russell, 2003). Reliability of the pleasure scale was good (α = .92, see Table 1). Items were mirrored, so a high score on the pleasure scale reflected more experienced pleasure (*M* = 5.33, *SD* = 1.39). Participants gave preference ratings of the butterfly garden by indicating (on a 7-point Likert scale) their level of agreement with three statements: “The butterfly garden is my favorite place in Emmen Zoo”, and “I like the butterfly garden”, and “The butterfly garden is a good place to relax”. Cronbach’s alpha for the preference scale was acceptable (α = .74, *M* = 5.29, *SD* = 1.19).

Table 1: Mean, Standard Deviation and Cronbach Alpha Scores for Restorative Characteristics, Pleasure, and Preference in the Butterfly Garden (Study 1) and the Baboon Attraction (Study 2).

	Butterfly garden			Baboon attraction		
	M	*SD*	α	*M*	*SD*	α
Fascination	5.92	.88	.87	5.11	1.20	.88
Novelty	5.48	1.05	.38	4.09	1.35	.85
Escape	5.33	1.14	.73	4.98	1.54	.90
Coherence	5.96	.91	.76	4.93	1.04	.78
Compatibility	6.00	1.00	.84	4.47	.94	.76
Pleasure	5.33	1.39	.92	5.01	1.01	.86
Preference	5.29	1.19	.74	4.77	1.31	.77

Results and Discussion

The multiple group method (MGM), a simple and effective type of confirmatory factor analysis (Guttman, 1952; Nunnally, 1978; Stuive, 2007; Ten Berge, 1986), was used to verify whether the data supported the grouping into the five restorative characteristics: novelty, escape, fascination, coherence and compatibility.

[1]We also measured arousal at the butterfly garden and at the baboon attraction. As the Cronbach’s alpha’s for the arousal scales were moderate (α = .68 and α = .62, respectively), we decided not to include arousal in the analyses. Information about the used scales to measure arousal is available upon request.

We calculated mean scores of the items that were supposed to measure each restorative characteristic. Next, correlations were computed between the items and the five restorative characteristics. Corrections for self-correlation and subscale-length were carried out. These corrections are necessary because an item will automatically correlate highly with scales in which it takes part, and correlations of items with a scale that consists of more items will also be higher (Stuive, 2007). Finally, we checked whether the items correlated highest with the restorative component scale they were a priori assigned to. It is assumed that the factor structure (i.e. the distinction of five restorative characteristics) is supported when items correlate highest with the subscale they are assigned to on theoretical grounds (see Nunnally, 1978).

Results from the MGM support the notion that fascination, coherence and escape are distinct components. Six out of seven fascination items correlated highest with the fascination scale and one fascination item correlated slightly higher (.01) with the coherence scale (see Table 2). As Cronbach's alpha of the fascination scale was high (α = .87, M = 5.92, SD = 0.88, see Table 1), and removing the item did not improve the reliability of the scale (α = .85), we decided to keep the specific item in the fascination scale. Three out of four escape items correlated highest with the escape scale (M = 5.33, SD = 1.14). One escape item correlated higher with the fascination scale (see Table 2). Because removing the item would make the Cronbach's alpha for the escape scale drop (from α = .73 to α = .68), it was decided to keep the item in the scale. All coherence items correlated highest with the coherence scale (r > .41), and the reliability of the coherence scale was good (α = .76, M = 5.96, SD = 0.91).

We did not find strong evidence that novelty and compatibility were distinct components. The novelty items correlated very low with all subscales (r < .21, see

Table 2). One of the three items correlated highest with the novelty scale, one item correlated highest with the escape scale, and another correlated highest with the fascination scale. Because the Cronbach's alpha for the novelty scale was low as well (α = .38, *M* = 5.48, *SD* = 1.05), we concluded that we did not adequately measure novelty, and decided not to include this construct in the remaining of the analyses. Although the Cronbach's alpha for the compatibility scale was high (α = .84, *M* = 6.00, *SD* = 1.00), we did not find strong support that compatibility is a distinct component. Only three out of seven compatibility items correlated highest with the compatibility scale (see Table 2). One compatibility item correlated higher with the fascination scale, and three other items correlated highest with the coherence scale. Looking at the content of the items, we could not find an explanation for these findings. For example "The butterfly garden matches with what I want to do at this moment" and "In the butterfly garden I can do things I like" should both measure compatibility between motivations of a person and the butterfly garden, but the first correlated highest with the coherence scale and the latter with the escape scale.

Because we found that fascination, escape and coherence were distinct components, we carried out further analyses with these three factors, leaving novelty and compatibility out of further analyses. Table 3 shows that fascination, escape and coherence are significantly positively related to pleasure and preference. Especially fascination appeared to correlate strongly with pleasure and preference. Correlations among the restorative characteristics were high. Especially fascination correlated strongly with the other restorative characteristics (escape and coherence).

Table 2: Corrected Correlations between Restorative Characteristic Items and Restorative Characteristics via Multiple Group Method (Butterfly Garden)

	Fas	Nov	Esc	Coh	Com
Fascination					
1. There are many interesting things to see in the butterfly garden.	**.50**	.23	.38	.41	.32
2. There are many beautiful things to see in the butterfly garden.	**.50**	.20	.34	.40	.42
3. Being in the butterfly garden makes me wonder about many things.	**.41**	.19	.32	.30	.27
4. There are many things in the butterfly garden that attract my attention effortlessly.	**.49**	.14	.38	.29	.30
5. There is much to discover in the butterfly garden.	**.47**	.18	.33	.40	.37
6. Butterflies are fascinating animals.	**.46**	.10	.26	.38	.30
7. I find behaviour of butterflies interesting.	.48	.14	.40	**.49**	.43
Novelty					
8. The butterfly garden is very different than my daily environment.	.14	**.21**	.08	.07	.06
9. In the butterfly garden I am engaged in activities that differ from my daily activities.	.16	.17	**.20**	.14	.17
10. There are many things to see in the butterfly garden that are new to me.	**.21**	.16	.19	.09	.09
Escape					
11. In the butterfly garden I can forget about my obligations.	.35	.10	**.45**	.38	.41
12. In the butterfly garden I feel that I am away from everything.	**.54**	.18	.42	.46	.50
13. When I am in the butterfly garden I don't have to worry about other peoples' expectations.	.18	.14	**.33**	.19	.29
14. When I am in the butterfly garden I feel free from my daily routine.	.31	.22	**.49**	.24	.36
Coherence					
15. Butterflies belong in this kind of environment	.31	.07	.18	**.41**	.32
16. Everything I see in the butterfly garden goes well together.	.48	.14	.36	**.59**	.42
17. Everything I see in the butterfly garden belongs there.	.36	.09	.40	**.58**	.42
Compatibility					
18. The butterfly garden matches with what I want to do at this moment.	.41	.07	.42	**.46**	.36
19. In the butterfly garden I can find the information I need.	.40	.10	.36	**.44**	.43
20. In the butterfly garden I can do things I like.	.30	.18	**.41**	.26	.39
21. I know what I can and can not do in the butterfly garden.	.25	.13	.26	.33	**.45**
22. I know how to behave in the butterfly garden.	.30	.11	.31	.29	**.43**
23. What I can see in the butterfly garden fits with my expectations.	.42	.06	.36	**.53**	.44
24. What I can do in the butterfly garden fits with my expectations.	.31	.08	.36	.38	**.44**

Note. For each item, the highest correlation is printed in bold. Correlations are corrected for subtest-length and self-correlation. Fas = Fascination; Nov = Novelty; Esc = Escape; Coh = Coherence; Com = Compatibility.

Tabel 3: Correlations between Restorative Characteristics with the Butterfly Garden Above the Diagonal and the Baboon Attraction Below the Diagonal

	Fascination	Novelty	Escape	Coherence	Preference	Pleasure
Fascination	-	-	.63	.66	.74	.51
Novelty	.62	-	-	-	-	-
Escape	.55	.34	-	.49	.57	.36
Coherence	.52	.63	.35	-	.58	.34
Preference	.69	.54	.66	.46	-	.52
Pleasure	.31	.19*	.29	.23	.36	-

Note. All correlations were significant at $p < .01$, except * $p < .05$

Regression analysis showed that fascination, escape and coherence explained 57% of the variance in preference (F (3, 114) = 51.21, $p < .001$, see Table 4). Fascination and escape appeared to be significant predictors of preference. Higher evaluations of fascination ($\beta = .54$, $t = 5.78$, $p < .001$, Table 4 provides confidence intervals), and higher evaluations of escape ($\beta = .16$, $t = 2.06$, $p < .05$) were associated with higher preference evaluations. Regression analysis showed that fascination, escape and coherence explained 27% of the variance in pleasure (F (3, 107) = 13.25, $p < .001$; see Table 4). Higher evaluations of fascination were associated with more experienced pleasure ($\beta = .53$, $t = 4.46$, $p < .001$).

Table 4: Simultaneous Regression Analyses for Restorative Characteristics of the Butterfly Garden Predicting Preference, and Experienced Pleasure (N = 137)

	ß	*t*		95% Confidence Interval for *ß* Lower Bound	Upper Bound	R^2	*df*	*F*	
Dependent Variable:									
Preference									
Fascination	.54	5.78	***	.36	.73				
Escape	.16	2.06	*	.01	.33				
Coherence	.14	1.62		-.03	.31				
						.57	3, 114	51.21	***
Dependent Variable:									
Pleasure									
Fascination	.53	4.46	***	.31	.80				
Escape	-.01	-.11		-.22	.20				
Coherence	.00	.01		-.22	.22				
						.27	3, 107	13.25	***

* p<.05. ** p<.01. *** p<.001

Study 2

In study two, the PRCQ was applied to the Hamadryas baboon attraction in Emmen Zoo (see Figure 2). The baboon attraction differs from the butterfly garden in many aspects: The baboon attraction has fewer plants, the baboon attraction is not an immersive attraction, and there are more distractions in the surroundings. The fact that the baboon attraction is very different from the butterfly garden enables us to test the robustness of the PRCQ scale. The factor structure of perceived restorative characteristics of very different attractions was expected to be similar. We improved the PRCQ, tested the hypothesized five factor structure and the hypothesis that high evaluations of restorative characteristics of the attraction will predict positive preference ratings for the attraction and experienced pleasure when walking by the baboon attraction.

Environment

The baboon attraction is an island of approximately 1450 square meters surrounded by a two meter wide moat, and a meter high brick wall. The baboon attraction is located in the middle of the park, and is surrounded by a few other attractions (kangaroos and ring tailed lemurs), a kiosk, and a terrace. The island is covered with sand, rocks, and some dead tree trunks. There is a small rocky hill with caves on the island, and there are a couple of oak trees. The oak trees are protected with electric fence to prevent the baboons from climbing them. There are about 120 Hamadryas baboons on the island including a few infants. Hamadryas baboons are very active animals.

Figure 2: Hamadryas Baboon Attraction in Emmen Zoo (the Netherlands)

Participants and procedure

In the second study, that took place on clear days in early summer 2007, 158 visitors of Emmen Zoo participated (62 men, 93 women, 3 did not fill out this question). Mean age was 40.5 years (*SD* = 13.89). Among participants were 118 people who had been to Emmen Zoo before, of whom 44 people were season-ticket holders. Participants were recruited near the baboon attraction. By filling out the questionnaire participants could win a VIP treatment in Emmen Zoo. Participants filled out the questionnaire as they were walking by the baboon attraction.

Measures

Restorative characteristics

All items of the RRCQ were rephrased focusing on the baboon attraction instead of the butterfly garden. Because reliability of the novelty scale we used in Study 1 was low, revision was needed. Items were formulated that more explicitly referred to novelty, originality, and uniqueness (see Table 5). From the escape scale we eliminated the item "In the butterfly garden I do not have to worry about what others expect me to do" as this item does not apply well to a zoo context, because many people visit the zoo with others who's needs they need to consider. We added two extra items to the coherence scale, namely "Baboon island looks well organized", and "Everything I see on baboons island fits there". The fascination and the compatibility scale remained unchanged. Although in Study 1 we did not find evidence that compatibility was a distinct component, we decided not to change the compatibility scale at this point. The reliability of the compatibility scale was very high, and removing any item would not affect the Cronbach's alpha of the scale significantly. We wanted to collect more data and examine whether compatibility could be distinguished as a distinct factor in Study 2 using the same scale.

Preference and Pleasure

The same scales from Study 1 were used to measure preference and pleasure. Again, participants had to indicate on four (seven point) semantic differential items to what extent they experienced pleasure as they were walking by the baboon attraction: happy – sad, pleasure – annoyance, satisfied – dissatisfied, content – bored. Reliability of the pleasure scale was good (α = .86, see Table 1). Items were mirrored, so a high score on the pleasure scale indicate more experienced pleasure (*M* = 5.01, *SD* = 1.01). Participants gave preference ratings of the baboon attraction by indicating their level of agreement with three statements: "Baboon island is my favorite place of Emmen Zoo", "I like the Baboon island", and "Baboon island is a good place to relax". Again a seven point Likert scale was used, varying from 1 (totally disagree) to 7 (totally agree). Cronbach's alpha for the preference scale was acceptable (α = .77, *M* = 4.77, *SD* = 1.31, see Table 1).

Results and Discussion

The multiple group method (MGM) was used to verify whether the data supported the grouping into the five restorative characteristics: novelty, escape, fascination, coherence and compatibility. Mean scores of the items that were supposed to measure each restorative component were calculated, correlations between the items and the five restorative characteristics were computed, and corrections for self-correlation and subscale-length were carried out.

Results of Study 2 support the notion that fascination, novelty, escape, and coherence are distinct components. All but two fascination items correlated strongest with the fascination scale (see Table 5). Two items correlated slightly higher with the escape scale than with the fascination scale. However, the content of these items "Being at Baboon island makes me wonder about many things", and "I find behaviour of baboons interesting", clearly refer to aspects of fascination. Moreover, the Cronbach's alpha of the fascination scale is high (α = .88, *M* = 5.11, *SD* = 1.20, see Table 1), and removing any item would not increase the Cronbach's alpha significantly, so we decided to keep all items in the fascination scale. The novelty scale improved significantly compared to results from Study 1. All novelty items correlated highest with the novelty scale (.45 < *r* < .62), and the reliability of the scale was high (α = .85, *M* = 4.09, *SD* = 1.35). Similar results were found for the escape scale. All escape items correlated strongest with the escape scale (.71 < *r* < .79), and Cronbach's alpha for the escape scale was high (α = .90, *M* = 4.98, *SD* = 1.54).

All but two coherence items correlated highest with the coherence scale (.24 < *r* < .47). One coherence item correlated equally high with the coherence scale (*r* = .49) as with the novelty (*r* = .49) scale. A second coherence item correlated slightly higher with the novelty scale (*r* = .45) than with the coherence scale (*r* = .42). Reliability of the coherence scale was good (α = .78, *M* = 4.93, *SD* = 1.04), and removing any item would not increase the Cronbach's alpha, so we decided to keep all items in the coherence scale. Although the reliability of the compatibility scale was high (α = .76, *M* = 4.74, *SD* = .94), the MGM did not support the notion that compatibility is a distinct component. All seven compatibility items correlated higher with other scales than with the compatibility scale. Because we found that fascination, novelty, escape and coherence were distinct components, we carried out further analyses with these four factors.

Table 3 shows that perceived restorative characteristics, preference, and pleasure were significantly related. Especially correlations between fascination and preference, and escape and preference were high.

Table 5: Corrected Correlations between Restorative Characteristic Items and Restorative Characteristics via Multiple Group Method (Baboon Island)

	Fas	Nov	Esc	Coh	Com
Fascination					
1. There are many beautiful things to see on Baboon island.	**.51**	.44	.30	.33	.31
2. There are many things on Baboon island that attract my attention effortlessly.	**.52**	.44	.35	.33	.35
3. There is much to discover at Baboon island.	**.55**	.42	.39	.27	.34
4. There are many interesting things to see on Baboon island.	**.51**	.46	.34	.28	.34
5. Being at Baboon island makes me wonder about many things.	.49	.41	**.55**	.34	.44
6. I find behaviour of baboons interesting.	.40	.22	**.41**	.20	.25
7. Baboons are fascinating animals.	**.35**	.24	.31	.20	.27
Novelty					
8. There are many new things to see on Baboon island.	.42	**.45**	.24	.30	.28
9. Baboon island is original.	.36	**.58**	.26	.40	.33
10. Baboon island is unique.	.39	**.62**	.33	.42	.35
11. Baboon island is novel.	.34	**.60**	.24	.43	.33
Escape					
11. At Baboon island I can forget about my obligations.	.38	.24	**.71**	.17	.32
12. At Baboon island I feel that I am away from everything.	.39	.30	**.75**	.28	.37
13. When I am at Baboon island I feel free from my daily routine.	.37	.25	**.79**	.20	.39
Coherence					
14. Baboon island is well organized.	.21	.20	.14	**.24**	.16
15. Baboons belong in this kind of habitat.	.28	**.45**	.24	.42	.33
16. Everything I see on Baboon island belongs there.	.28	.38	.23	**.43**	.30
17. Everything I see on Baboon island goes well together.	.31	.49	.24	**.49**	.34
18. Everything I see on baboons island fits there.	.30	.43	.23	**.47**	.36
Compatibility					
19. At Baboon island I can find the information I need.	.30	**.38**	.22	.32	.29
20. At Baboon island I can do things I like.	.40	.33	**.59**	.26	.35
21. I know what I can and can not do at Baboon island.	.25	.19	**.43**	.26	.28
22. I know how to behave at Baboon island.	.22	.07	**.46**	.16	.26
23. Baboon island matches with what I want to do at this moment.	**.33**	.31	.28	.20	.32
24. What I can see on Baboon island matches with my expectations.	.39	**.47**	.30	.41	.37
25. What I can do at Baboon island matches with my expectations.	.42	**.53**	.26	.45	.37

Note. For each item, the highest correlation is printed in bold. Correlations are corrected for subtest-length and self-correlation. Fas = Fascination; Nov = Novelty; Esc = Escape; Coh = Coherence; Com = Compatibility.

Regression analyses were carried out to examine how well fascination, novelty, escape and coherence could predict preference, and pleasure (see Table 6). Fascination, novelty, escape and coherence explained 60% of the variance in preference (F (4, 122) = 45.42, p < .001). Fascination and escape were significant predictors of preference. Higher evaluations of perceived fascination and escape went along with higher preference ratings (β = .41, t = 5.00, p < .001, and β = .34, t = 4.78, p < .05 respectively, Table 6 provides confidence intervals). Fascination, novelty, escape, and coherence explained 16% of the variance in pleasure (F (4, 120) = 5.76, p < .01). Only, escape appeared to be a significant predictor of pleasure (β = .25, t = 2.41, p < .05). Higher evaluations of perceived escape resulted in higher pleasure ratings.

Tabel 6: Simultaneous Regression Analyses for Restorative Characteristics of the Baboon Island Predicting Preference, and Experienced Pleasure (N = 158)

	β	t		95% Confidence Intervals for β Lower Bound	Upper Bound	R^2	df	F	
Dependent Variable:									
Preference									
Fascination	.41	5.00	***	.25	.58				
Novelty	.16	1.90		-.01	.31				
Escape	.34	4.78	***	.19	.47				
Coherence	.01	.16		-.14	.16				
						.60	4, 122	45.42	***
Dependent Variable:									
Pleasure									
Fascination	.17	1.41		-.07	.40				
Novelty	.01	.06		-.23	.24				
Escape	.25	2.41	*	.04	.44				
Coherence	.06	.58		-.15	.28				
						.16	4, 120	5.76	***

* p<.05. ** p<.01. *** p<.001

General Discussion

Knowledge about which characteristics of the attraction positively influence visitor experience, and especially, being able to measure characteristics that can predict preference and experienced pleasure, would be very helpful for zoos. This study aimed at developing a new instrument to measure perceived restorative characteristics of attractions in zoos. As a starting point for this study, we used the attention restoration theory (Kaplan & Kaplan, 1989), because previous research showed that perceived restorative characteristics are associated with preference for environments (Laumann et al., 2001; Purcell, et al., 2001), and positive affect (Hartig, et al., 2003; Hartig et al; 1991). Research on perceived restorativeness has focused mainly on natural and urban environments. We think that it is important to examine restorative potential of other environments through evaluation of perceived restorative characteristics. We hypothesized that the degree to which zoo attractions incorporate restorative characteristics can predict how much pleasure visitors will experience, and their preference for the attraction. To examine this hypothesis, we developed the Perceived Restorative Characteristics Questionnaire (PRCQ), a new instrument to evaluate perceived restorativeness of attractions in zoos. The PRCQ was applied to a butterfly garden (Study 1), and a baboon attraction (Study 2) in a Dutch zoo. The underlying factor structure of the PRCQ was examined. We expected a distinction of five separate restorative characteristics: novelty, escape, fascination, coherence, and compatibility. Also, we examined how perceived restorative characteristics were related to experienced pleasure and preference for the attractions.

The PRCQ was inspired on two existing instruments; the PRS (Hartig et al., 1997a) and the RCS (Laumann et al., 2001). The PRCQ includes only positively worded items and the items clearly represented the underlying theoretical constructs.

In two studies, we examined the hypothesized five factor structure of the PRCQ. In Study 1 three factors emerged: fascination, escape and coherence. Novelty and compatibility could not be distinguished as separate components. For novelty, this might be a measurement problem, as the reliability of the novelty scale used in Study 1 was low. We think that compatibility could not be distinguished as a separate factor due to a conceptual problem. Compatibility is a very broad concept, specifying four different aspects of compatibility. There might be situations where some aspects of compatibility are met, and others are not. In Study 2 four factors could be distinguished as separate factors: fascination, novelty, escape, coherence. We successfully improved the novelty scale as the scale appeared to be very reliable, and clearly distinguishable as a separate factor. In Study 2 compatibility could again not be distinguished as a separate factor. Previous research did find that compatibility could be distinguished as a separate factor (Laumann et al., 2001). However, the definition of compatibility that was used in the study by Laumann et al. was narrower than our definition. The definition of Laumann et al. (2001) did not entail all four compatibility aspects, but focused on the motivation-fit and a competence-fit between the person and environment. Future research should reconsider the concept of compatibility, and develop more accurate definitions and measures of this multidimensional concept.

The perceived restorative characteristics of the attractions examined in this study were successful in predicting pleasure and preference. In Study 1, we found that fascination, escape, and coherence could explain a large amount of variance in preference, and a reasonable proportion of the variance in experienced pleasure. In Study 2 we found that fascination, escape, coherence, and novelty could predict preference, and experienced pleasure. The results are encouraging, but more data are needed to further validate the questionnaire.

In both studies, we could predict preference better than pleasure. This might be due to the fact that perceived restorative characteristics and preference evaluations are both cognitive evaluations of the environment. These concepts may therefore be more closely related than perceived restorative characteristics and judgments about experienced pleasure, which is an affective evaluation. Preference was measured using three items (X is my favourite place in the zoo, I like X, X is a good place to relax). Although the reliability of the scale was good, the item "X is a good place to relax" might better reflect restorativeness than preference. Future research should consider separate scales for preference and restorativeness.

Fascination (in Study 1 and 2) and escape (in Study 2) appeared to be significant predictors of experienced pleasure and preference for the attraction. Laumann and colleagues (2001) also found that fascination was a significant predictor of preference for natural environments. The two factors, fascination and escape, describe a psychological evaluation of the interaction between a person and a environment (such as an attraction in a zoo). Coherence and novelty, on the other hand, are more related to characteristics of the environment (or attraction) itself. In Kaplan and Kaplan's model (1989) all perceived restorative characteristics are considered to be on the same hierarchical level. But it is possible that perceived characteristics of the environment influence the psychological evaluation of the person-environment interaction. In other words, coherence and novelty might influence fascination and escape, which in turn influence preference. Future research should examine the causal relationships among perceived restorative characteristics.

A possible limitation of the present study is that with on-site data collection, it remains difficult to control for factors that might influence the data, like for example weather conditions. In order to minimize weather influences, both studies were conducted on clear days. There are important benefits of on-site data collection. First, participants do not have to rely on memory or imagination, rather they can evaluate the environment directly as they experience it. Second, external validity is high because actual visitors of Emmen Zoo participated in this study, instead of university students.

Another issue is that evaluating one single attraction might be difficult, because the experience might be affected by surrounding attractions or previous experiences. Immersive attractions, like the butterfly garden, might be easier to evaluate, because there are no distractions from surrounding attractions. However, we found similar results for both the butterfly garden and the baboon attraction. This suggests that people are still able to focus on one single attraction despite possible distractions.

This research is very valuable both for zoos and for research on restorative environments. Most studies on restorative environments are restricted to natural or urban environments. This is the first study that has applied the attention restoration theory to a zoo context. We have developed an instrument to measure perceived restorative characteristics of zoo attractions, and gained more knowledge about the positive relationship between perceived restorative characteristics, experienced pleasure, and preference for these attractions. Knowledge about which factors positively influence visitor experience and being able to measure these factors, could ultimately provide useful guidelines for designing new attractions or improving existing attractions in zoos. This is particularly relevant because competition between zoos and other attraction parks is growing. Zoos seek new ways to distinguish themselves from other zoos and attraction parks. The PRCQ can be easily adapted and applied to different fields in order to assess perceived restorative characteristics. Restorative characteristics can, for example, also be relevant for museum designers, city planners, and any other person involved in designing environments.

Chapter 3

Is virtual reality a valid tool for restorative environments research?

Chapter 3 is based on Pals, R., Steg, L., Siero, F., & Van der Zee, K. I. (submitted).Is virtual reality a valid tool for restorative environments research?

Abstract

This study examines the validity of virtual reality for assessing the restorative quality of environments. In Study 1 we found that perceived restorative characteristics, preference ratings, experienced pleasure and self-reported restoration were higher in a real (human-made) natural environment compared to a real urban environment. Perceived restorative characteristics could predict preference, pleasure, and restoration for the *real* natural environment, and perceived restorative characteristics could predict pleasure and restoration for the *real* urban environment. Study 2 showed that *virtual* simulations of a natural and urban environment elicit similar effects. Perceived restorative characteristics, preference, pleasure and restoration were higher in a *virtual* natural environment compared to a *virtual* urban environment. Perceived restorative characteristics could predict preference, pleasure, and restoration for the *virtual* natural environment, and perceived restorative characteristics could predict pleasure and restoration for the *virtual* urban environment. Our results did not indicate that there were differences in perceived restorative characteristics, preference, pleasure and restoration between the real and the virtual natural environment. These findings suggest that virtual reality is a valid tool for restorative environments research.

Our environment has a great impact on how we feel and behave. It is likely that a walk in a forest on a sunny autumn day will have a different effect than a walk in a crowded urban neighborhood. Insight in how people experience different environments, what kind of environments people prefer, and what kind of environments are experienced positively, can be very useful when designing or modifying environments.

Previous research has shown that if we experience mental fatigue or stress, we benefit more from a walk in a natural environment compared to a walk in an urban environment. Nature provides opportunities for people to restore from mental fatigue (Hartig, Evans, Jamner, Davis, & Gärling, 2003) and psychological and physiological stress (Kaplan & Kaplan, 1989; Ulrich, 1984; Ulrich, Simons, Losito, & Fiorito, 1991). People tend to experience more positive and less negative affect in nature compared to urban environments (Hartig, Mang, & Evans, 1991; Hartig et al., 2003). Furthermore, people tend to have a strong preference for natural environments over built environments (Laumann, Gärling, & Stormark, 2001; Purcell, Peron, & Berto, 2001). So, being in nature has three important positive outcomes: 1) restoration from stress or mental fatigue, 2) positive cognitive evaluations of the environment (preference), and 3) positive affective responses (pleasure). In the current paper we will refer to these outcomes (restoration, preference, and pleasure) as *restorative effects*. We will focus on the extent to which environments are able to elicit restorative effects, referred to as the restorative *quality* or simply *restorativeness* of environments.

The attention restoration theory (ART; Kaplan & Kaplan, 1989) proposes that natural environments score higher on restorative characteristics (described in more detail below), which may explain why nature elicits stronger restorative effects than urban environments. However, the definitions of restorative characteristics are still quite abstract (Ivarsson & Hagerhall, 2008) and therefore they provide no clear guidelines on how to improve environments in order to enhance its restorative effects. After all, evaluations of restorative characteristics are cognitive constructs, based on the interaction between the individual and physical characteristics of the particular environment. An obvious next question is: why does nature score higher on restorative characteristics than urban settings? And, related to this, how are specific physical features related to the restorative characteristics and restorative effects of an environment? For practitioners, it is highly important to understand which physical characteristics influence restorativeness of environments, because this reveals how the restorative quality of environments can be improved by changing particular physical characteristics.

To get insight into causal relationships between specific physical characteristics of environments, (perceived) restorative characteristics and restorative effects (restoration, preference, and pleasure), researchers have to systematically manipulate one characteristic in the environment while keeping the environment and all other factors constant. To conduct experiments to examine these causal relationships researchers need suitable tools. In this paper, we aim to show that virtual reality can be a very useful and valid tool for conducting controlled experiments in restorative environments research. We will first describe restorative characteristics in more detail, and then explain what virtual reality is and why virtual reality can be useful for restorative environments research.

Restorative Characteristics

Based on pioneering research by Kaplan and Kaplan (1989) and more recent work by Laumann et al. (2001), Pals and colleagues distinguish five characteristics (reflecting interactions between the individual and an environment) that may contribute to restorative experiences: fascination, novelty, escape, coherence, and compatibility (Pals, Steg, Siero, & Van der Zee, 2009). Although it has not (yet) been tested empirically, Kaplan (1995) suggests that all restorative characteristics must be present in an environment to a certain extent for it to be restorative. These so-called restorative characteristics are cognitive representations resulting from the interaction between features of the environment and features of the individual.

Fascination is defined as the degree to which one's attention is drawn effortlessly by objects in the environment. It is speculated that elements like flowers, animals, or waterfalls might elicit fascination (Kaplan, 1995). Because fascination requires no effort, one can restore from mental fatigue. The second characteristic, *novelty*, means that the environment is new to someone or different than one's daily environment. For example, when you live and work in a city, a forest will be a relatively novel environment to you. The third characteristic, *escape*, implies being able to take your mind of unwanted distractions and reminders of your daily hassles and obligations. Inhibiting distractions requires effort, so being free from distractions will enhance restoration from mental fatigue. Escape and novelty are closely related: When you are in a novel environment, there are less things that will remind you of your daily obligations, so you will be able to let go of stressful thoughts. *Coherence*, the fourth characteristic, refers to the degree of coherence or harmony between all elements in the environment. Being in a harmonious and coherent environment is easy on the mind, hence restoration will more easily occur. The final characteristic, *compatibility*, is defined as the fit between the person and the environment. The setting "must fit what one is trying to do and what one would like to do. Compatibility is a two-way street. On the one hand, a compatible environment is one where one's purposes fit what the environment demands. At the same time the environment must provide the information needed to meet one's purposes. Thus in a compatible environment one carries out one's activities smoothly and without struggle." (Kaplan, 1995, p. 173). Although restorative characteristics are more prevalent in natural settings than urban settings, fascination, novelty, escape, coherence, and compatibility can be experienced to various degrees in all kinds of environments (e.g. monastries, museums, or zoos; Kaplan, Bardwell, & Slakter, 1993; Ouellette, Kaplan, & Kaplan, 2005; Pals et al., 2009).

A number of instruments have been developed to assess restorative characteristics of environments (Hartig et al., 1997a; Laumann et al., 2001; Pals et al., 2009). The Perceived Restorativeness Scale (PRS; Hartig et al., 1997a) has been used and validated in a number of studies (Hartig et al., 1997a; Ivarsson & Hagerhall, 2008; Korpela & Hartig, 1996; Purcell et al., 2001). Based on the PRS and the Restorative Components Scale (Laumann et al., 2001) Pals and colleagues developed the Perceived Restorative Characteristics Questionnaire (PRCQ; Pals et al., 2009) with further adaptations and enhancements to better suit restorative environments research. The first results based on the PRCQ look promising.

Most studies on restorative environments compare environments that differ from one another on a great number of aspects. Typically, a natural area is compared to an urban area. Because no controlled experiments have been conducted to date, we can only speculate what specific physical features account for differences in the restorative quality of environments. To get insight into causal relationships between specific characteristics of environments, perceived restorative characteristics and the occurrence of restorative effects, researchers have to systematically manipulate one characteristic in the environment while keeping the environment and all other factors constant. Due to recent technological developments, a new research tool to examine restorative environments in a controlled way has become available: virtual reality.

Virtual reality

Virtual reality (VR) is an artificial environment generated by computer software, presented in such a way that the user is able to interact with the environment similar as with a real environment. Virtual reality can be experienced in different ways. There are, for example, variations in presentation modes (e.g. personal computer, head-mounted displays, wrap-around screens, virtual reality rooms) and variations in the number of senses that are stimulated (sight, sound, touch, and smell).

We argue that virtual reality could potentially be very useful for restorative environments research. Two major advantages are that in virtual reality researchers can exert more control than in real settings and easily manipulate features of environments. When conducting experiments in virtual reality, it is important to know how valid research in virtual reality is. Do virtual environments elicit similar responses as would the real environments they represent?

Validity of virtual reality

For an environmental simulation to be considered valid, it should evoke similar responses as would a direct experience of the same (real) environment (Bishop & Rohrmann, 2003). Because virtual reality is a relatively new tool, research on its validity (especially in the field of environmental psychology) is still very scarce.

Some studies have shown that (static) computer simulations generally evoke similar responses as photographs (for an overview see Bishop & Rohrmann, 2003). However, research (on landscape preference) has shown that experiences of real environments (Kroh & Gimblett, 1992) and dynamic environmental simulations (Heft & Nasar, 2000) differ from experiences of static simulations. This indicates that, as VR is dynamic, often three-dimensional and interactive, the experience of VR is likely to be more similar to experience of real environments. But few studies have actually compared experience of virtual environments with direct experience of real environments, and these studies did not look at either perceived restorative characteristics or restorative effects (Bishop & Rohrmann, 2003; De Kort, IJsselsteijn, Kooijman, & Schuurmans, 2003). To our knowledge the current study is the first to examine the validity of virtual reality for assessing perceived restorative characteristics and the restorative quality of environments.

Current study

In the current study we examine if we can use virtual reality to examine the restorative quality of environments by measuring perceived restorative characteristics of virtual and real environments as well as restorative effects. As restorative characteristics of environments appear to be related to restorative effects (i.e. preference, pleasure, and restoration), by evaluating perceived restorative characteristics of environments, we might be able to predict preference for, experienced pleasure and restoration in these environments. Several scholars have measured restorative effects of environments. Some have measured physiological (Hartig et al., 2003; Laumann, Gärling, & Stormark, 2003; Ulrich, 1984; Ulrich et al., 1991) or cognitive restoration (Hartig et al., 2003; Laumann et al., 2003). Others have measured subjective restorative effects, among which environmental preference (Laumann et al., 2001; Pals et al., 2009; Peron, Purcell, Staats, Falchero, & Lamb, 1998; Purcell et al., 2001), experienced pleasure or positive affect (Hartig et al., 2003; Pals et al., 2009; Staats, Gatersleben, & Hartig, 1997), and self-reported restorative outcomes (Staats, Kieviet, & Hartig, 2003; Staats & Hartig, 2004). In the current study we will focus on three subjective restorative effects: environmental preference, experienced pleasure, and self-reported restoration (i.e. how restored people *feel* after being exposed to a restorative environment). These restorative effects may be causally related, for example, if restoration occurs in a certain environment this may lead to a higher preference for this environment. However, these causal relationships among restorative effects have not been systematically studies thus far. Importantly, all three restorative effects are important indicators of the restorative quality of environments. By including multiple indicators of restorativeness, we will gain more insight into the robustness of the results.

The aim of the current study is to test the validity of virtual reality for assessing the restorative characteristics and the restorative quality of environments. If the following four assumptions are met, we conclude that VR is a valid tool to study restorative environments. First, we reason that if research shows that if *real* natural environments score higher on restorative characteristics and elicit stronger restorative effects (pleasure, preference, and restoration) than urban environments, we should find that *virtual* natural environments score higher on restorative characteristics and elicit stronger restorative effects than virtual urban environments. Second, one would expect that if restorative characteristics can predict preference, pleasure, and restoration for real environments, restorative characteristics of *virtual* environments should also be able to predict preference, pleasure, and restoration for *virtual* environments. The third assumption is that the same predictors will be able to predict preference, pleasure, and restoration for both the real environments and their virtual equivalents. And, fourth, there should be no differences in perceived restorative characteristics of the real environment and its *virtual* equivalent.

We tested these four assumptions in two studies. In Study 1, we examined whether perceived restorative characteristics, preference, pleasure and restoration are higher in a real natural environment compared to a real urban environment. Second, we examined how the perceived restorative characteristics of both *real* environments are related to preference for these environments, pleasure, and restoration.

In Study 2 we examined whether perceived restorative characteristics, preference, pleasure and restoration in a *virtual* natural environment are higher than those of a *virtual* urban environment. Second, we examined how the perceived restorative characteristics of both *virtual* environments are related to preference for these environments, and pleasure and restoration in these environments. We expected to find similar effects as in Study 1. More specifically, we expected that in Study 2 the same restorative characteristics will emerge as significant predictors of the restorative effects of the environments as in Study 1.

Finally we compared the real natural environment we used in Study 1 with its virtual equivalent we used in Study 2. We expected to find no significant differences between the perceived restorative characteristics of the real environment and the virtual environment. Confirming the four assumptions would give us reasons to believe that virtual reality is a valid tool for restorative environments research.

Study 1

Method

Participants and Design

Twenty-three students participated in Study 1 (9 men, 14 women; mean age 20.39; range 17-27 years). Monetary compensation was provided. The experiment had a within-subjects design with two environmental conditions: a butterfly garden and a shopping center. Because of the within-subjects design of the study, participants had to come to Emmen Zoo for two sessions. The time scheduled between two sessions varied from 1 to 12 days. We counterbalanced whether participants first went for a walk in the butterfly garden or the shopping center, and participants were randomly assigned to each order condition. Fourteen participants first went to the butterfly garden, 9 participants saw the shopping center first. Because literature shows that gender does not have a strong influence on perceived restorativeness and preference (Purcell et al., 2001), we did not control for gender in Study 1 as well as Study 2.

Environments

The study took place in Emmen, a medium sized city in one of the Northern provinces of the Netherlands. The natural environment was a human-made natural environment, namely the butterfly garden in Emmen Zoo (Figure 1). The butterfly garden is a tropical greenhouse of approximately 1200 square meters. In the garden there are several pathways, a bridge, a pond, a small waterfall, benches, tropical plants, and about 1600 butterflies in various colors and sizes. Some other animals in the butterfly garden are hummingbirds, quails and tree frogs. A previous study found that a butterfly garden indeed scored high on perceived restorative characteristics (Pals et al., 2009). We compared perceived restorative characteristics, preference, pleasure, and restoration of the butterfly garden with an urban setting. For the urban setting we used an indoor shopping center (see Figure 2), to keep weather conditions between the two environmental conditions constant. The shopping center is wind- and water-proof, giving it a comfortable temperature. There are 65 shops in the shopping center and a square with benches in the middle of the center.

Figure 1.The Butterfly Garden in Emmen Zoo (Study 1)

Figure 2. Shopping Center "de Weiert" in Emmen (Study 1)

Procedure

The participants were welcomed in an office building of Emmen Zoo. Participants were told that we were interested in people's experiences of different environments. We did not tell participants anything about our expectations or the goal of the study, in order to avoid demand characteristics, social desirability, and experimenter expectancies. Upon arrival participants filled out an informed consent form. To make sure that all participants had comparable levels of mental fatigue, and therefore, an equal need for restoration (Hartig & Staats, 2006), we induced mental fatigue in all participants with a Sudoku task. The participants were told that they had to solve as many Sudoku puzzles as possible within 50 minutes. Eight puzzles with four difficulty levels were available. Participants could choose which puzzle they wanted to try to solve. For every solved puzzle the participants could earn points; 1 point for easy puzzles, 3 points for medium puzzles, and 5 points for hard puzzles. After the Sudoku task, the participants were taken to the butterfly garden or the shopping center.

To get from the starting position to the shopping center, participants had to walk approximately 200 meters. They crossed a cycle path and walked through a pedestrian area. To get to from the starting position to the butterfly garden, participants had to walk approximately 100 meters, passing through a pedestrian area as well as the zoo entrance. The butterfly garden is located near the zoo entrance, so the participants did not see any other exhibits on their walk to the butterfly garden. The participants were asked to walk through the environment (butterfly garden or shopping center) at their own pace, and were asked to sit down and look at the surroundings at specific moments. The total time they spent in each environment was

50 minutes. After the walk the participants were taken back to the office where they filled out a questionnaire.

Measures

Perceived Restorative Characteristics

The Perceived Restorative Characteristics Questionnaire (Pals et al., 2009) was used to measure four perceived restorative characteristics (fascination, novelty, escape, and coherence) of the butterfly garden and the shopping center. We excluded compatibility both in Study 1 and Study 2, as compatibility involves individuals' motivations and inclinations (what one would like or is trying to do) in a certain environment. In a real environment there are more possibilities for different kinds of behavior compared to a virtual environment. In a real environment for example a person would be able to pick flowers, which would not be possible in a virtual environment. For this reason we argued that a comparison between compatibility in a real environment and a virtual simulation of that environment is difficult to make. All perceived restorative characteristics items were put in random order and directly referred to either the butterfly garden or the shopping center. The reliabilities of the fascination, novelty, and escape scales were good ($\alpha > .71$, see Table 1). The reliability of the coherence scale was acceptable for the evaluations of the butterfly garden, but the reliability was low when assessing coherence of the shopping center ($\alpha = .54$). As the coherence scale was reliable in Study 2, as well as in earlier research (Pals et al., 2009), we decided to maintain the scale for further analyses.

Restorative effects: Preference, pleasure and restoration

We measured preference for the environments using four seven-point semantic differentials: "I find the butterfly garden" or "I find the shopping center": unattractive – attractive, unpleasant – pleasant, negative – positive, and not enjoyable – enjoyable.

Participants indicated on four seven-point semantic differential items to what extent they experienced pleasure as they were walking through the environment: sad - happy, annoyance - pleasure, dissatisfied - satisfied, bored – content (Mehrabian & Russell, 1974). Restoration was measured using self-report measures, based on work by Staats and colleagues (2003). The scale included 5 items, like “Being in the butterfly garden/ shopping center was relaxing”, “Being in the butterfly garden/ shopping center renewed my energy level”, and “After walking in the butterfly garden/ shopping center I was able to concentrate better”. All three scales were reliable for both environments ($\alpha > .71$, see Table 1).

Results

Butterfly garden versus shopping center

Repeated measures analyses[1] (ANOVA) confirmed our expectation that all perceived restorative characteristics were higher for the butterfly garden than for the shopping center. Also, as we expected, stronger restorative effects occurred after the walk in the butterfly garden, compared to the walk in the shopping center. Preference was higher for the butterfly garden compared to the shopping center. Participants experienced more pleasure in the butterfly garden compared to the shopping center, and self-reported restoration was also higher in the butterfly garden compared to the shopping center (see Table 1).

Butterfly Garden: Predicting preference, pleasure and restoration.

For the butterfly garden, all restorative characteristics (fascination, novelty, escape, and coherence) correlated positively with preference[2] (see Table 2). Regression analysis showed that 74% of the variance in preference for the butterfly garden could be explained by the perceived restorative characteristics ($F(4, 18)$ =

[1] Both in Study 1 and Study 2 we included order as a between subjects variable to rule out order effects. Order was not significant, so we will only discuss the main effects of the environmental conditions.
[2] All correlations we discuss are statistically significant at $p < .05$.

Table 1: Estimated Means, Standard Deviation and Cronbach's Alpha Scores for Restorative Characteristics and Restorative Effects for the Butterfly Garden and the Shopping Center (Study 1), and F-values for the Differences in Restorative Characteristics and Restorative Effects between the Butterfly Garden and the Shopping Center (N = 23)

		Real Environments								
		Butterfly Garden			Shopping Center					
	n items	α	*M*	*SD*	α	*M*	*SD*	$F(1,21)$		η_p^2
Fascination	5	.87	5.20	1.26	.78	4.13	1.10	10.83	**	.34
Novelty	4	.71	4.74	1.30	.71	3.08	1.01	44.68	***	.68
Escape	3	.79	4.61	1.39	.87	3.49	1.37	10.79	**	.34
Coherence	3	.70	5.42	.91	.54	4.69	.92	6.56	*	.24
Preference	4	.89	5.83	.83	.71	4.98	.67	11.12	**	.35
Pleasure	4	.82	5.32	.78	.91	4.43	1.00	13.11	***	.38
Restoration	5	.81	4.74	1.01	.86	3.71	1.18	14.82	***	.41

* $p < .05$ ** $p < .01$ *** $p < .001$

Note Restorative Characteristics, Preference, Pleasure, and Restoration were rated on seven-point scales with high numbers indicating higher levels of the specific variable.

12.95, $p < .001$; see Table 3). Higher escape ratings ($\beta = .36$, $t = 2.27$, $p < .05$) and higher coherence ratings ($\beta = .37$, $t = 2.81$, $p < .01$) were associated with higher preference ratings (see Table 3, which also provides confidence intervals).

Escape correlated positively with pleasure ($r = .55$, $p < .05$). Regression analysis showed that 38% of the variance in pleasure was accounted for by the perceived restorative characteristics of the butterfly garden, this model was marginally significant ($F(4, 18) = 2.78$, $p = .06$). Higher escape ratings were associated with higher experienced pleasure ($\beta = .50$, $t = 2.07$, $p < .05$).

Fascination correlated positively with restoration ($r = .51$, $p < .01$). Also the correlation between escape and restoration was highly positive ($r = .85$, $p < .05$). Regression analysis showed that perceived restorative characteristics of the butterfly garden could predict 80% of the variance in restoration ($F(4, 18) = 18.10$, $p < .001$). Higher escape ratings were associated with more restoration after walking in the butterfly garden ($\beta = .93$, $t = 6.74$, $p < .001$).

Shopping Center: Predicting preference, pleasure, and restoration.

As for the shopping center, fascination correlated positively with preference ($r = .44$, $p < .01$; see Table 2). Regression analysis revealed that, although fascination was positively related to preference for the shopping center ($\beta = .48$, $t = 2.22$, $p < .05$, Table 4 also provides confidence intervals), the overall model including all perceived restorative characteristics could not explain a significant proportion of the variance in preference for the shopping center ($R^2 = .33$, $F(4, 18) = 2.20$, $p = .11$; see Table 4).

Escape correlated positively with pleasure ($r = .63$, $p < .05$). Regression analysis showed that 43% percent of the variance in pleasure experienced in the shopping center could be explained by perceived restorative characteristics ($F(4, 18)$

= 3.41, *p* = .03). Higher escape ratings were associated with more experienced pleasure (β = .65, *t* = 3.50, *p* < .01).

Escape correlated positively with restoration (*r* = .74, *p* < .05). Regression analysis showed that perceived restorative characteristics of the shopping center could predict 68% of the variance in restoration (*F*(4, 18) = 9.56, *p* < .001). Higher fascination ratings (β = .36, *t* = 2.42, *p* < .05) and higher escape ratings were associated with more restoration (β = .76, *t* = 5.41, *p* < .001).

Table 2: Correlations between Restorative Characteristics and Preference, Pleasure, and Restoration, with the Butterfly Garden above the diagonal and the Shopping Center below the diagonal (Study 1)

	Fas	Nov	Esc	Coh	Pref	Plsr	Rest
Fascination	-	.72**	.62**	.40	.75**	.39	.51*
Novelty	.42*	-	.30	.31	.57**	.21	.37
Escape	.00	.27	-	.23	.65**	.55**	.85**
Coherence	.04	-.22	-.07	-	.61**	.41	.38
Preference	.44*	.08	.17	.31	-	.70**	.58**
Pleasure	-.12	.06	.63**	.08	.42*	-	.61**
Restoration	.35	.32	.74**	.01	.22	.46*	-

* correlation is significant at the .05 level

** correlation is significant at the .01 level

Note. Fas = Fascination; Nov = Novelty; Esc = Escape; Coh = Coherence; Pref = Preference; Plsr = Pleasure; Rest = Restoration.

Table 3. Regression Analyses for Restorative Characteristics on Preference, Pleasure, and Restoration (N = 23) for of the Real Butterfly Garden (Study 1)

				95% Confidence Interval for ß					
	ß	*t*		Lower Bound	Upper Bound	R^2	*df*	*F*	*p*
Dependent Variable: Preference									
Fascination	.26	1.16		-.21	.72				
Novelty	.17	.93		-.21	.54				
Escape	.36	2.27	*	.03	.69				
Coherence	.37	2.81	**	.09	.64				
						.74	4, 18	12.95	< .001
Dependent Variable: Pleasure									
Fascination	-.05	-.14		-.77	.67				
Novelty	.00	.00		-.58	.58				
Escape	.50	2.07	*	-.01	1.02				
Coherence	.31	1.52		-.12	.74				
						.38	4, 18	2.78	.06
Dependent Variable: Self reported Restoration									
Fascination	-.35	-1.77		-.75	.07				
Novelty	.26	1.67		-.07	.59				
Escape	.93	6.74	***	.64	1.22				
Coherence	.22	1.95		-.02	.47				
						.80	4, 18	18.10	< .001

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 4. Regression Analyses for Restorative Characteristics on Preference, Pleasure, and Restoration (N = 23) of the Shopping Center (Study 1)

				95% Confidence Interval for ß					
	ß	*t*		Lower Bound	Upper Bound	R^2	*df*	*F*	*p*
Dependent Variable: Preference									
Fascination	.48	2.22	*	.03	.94				
Novelty	-.13	-.55		-.61	.36				
Escape	.23	1.13		-.20	.65				
Coherence	.28	1.40		-.14	.70				
						.33	4, 18	2.20	.11
Dependent Variable: Pleasure									
Fascination	-.11	-.53		-.53	.32				
Novelty	-.04	-.19		-.49	.41				
Escape	.65	3.50	**	.26	1.04				
Coherence	.13	.68		-.26	.51				
						.43	4, 18	3.41	.03
Dependent Variable: Self-reported Restoration									
Fascination	.36	2.42	*	.05	.68				
Novelty	-.03	-.20		-.37	.30				
Escape	.76	5.41	***	.46	1.05				
Coherence	.04	.31		-.25	.33				
						.68	4, 18	9.56	< .001

* $p < .05$ ** $p < .01$ *** $p < .001$

Conclusion

In Study 1 we found that perceived restorative characteristics (fascination, novelty, escape, and coherence) were indeed higher in the natural environment (the butterfly garden) than in the urban environment (the shopping center). Furthermore, the restorative effects (preference, pleasure, and restoration) were higher after walking in the natural environment, compared to the urban environment. The perceived restorative characteristics of the natural environment were good predictors of preference, experienced pleasure, and restoration in the natural environment. Also, the perceived restorative characteristics of the *urban* environment could predict experienced pleasure and restoration in that environment. Especially escape appeared to be a good predictor of restoration in both environments.

Study 2

In Study 2 we aimed to examine whether we can replicate these findings of Study 1 in the virtual environments. First we examined whether perceived restorative characteristics and restorative effects (preference, pleasure and restoration) are higher in a *virtual* natural environment compared to a *virtual* urban environment. Second, we examined how the perceived restorative characteristics of both *virtual* environments are related to preference for the environments, pleasure, and restoration. Third, we compared perceived restorative characteristics and restorative effects of the real butterfly garden (Study 1) with perceived restorative characteristics and restorative effects of the virtual butterfly garden (Study 2).

Method

Participants and Design

Twenty-six students (9 men, 17 women; mean age 19.54; range 18-23 years) participated in this study in exchange for course credits. The experiment had a within-subjects design with two environmental conditions: a virtual butterfly garden and a virtual urban neighborhood. Because of the within-subjects design of the study, participants had to come to the virtual reality center for two sessions. The time scheduled between two sessions varied from 1 to 12 days. We counterbalanced the order in which participants were exposed to either the virtual butterfly garden or to the virtual urban neighborhood, and participants were randomly assigned to each order condition. Fifteen participants first saw the virtual butterfly garden, 11 participants first saw the urban neighborhood.

The CAVE Automatic Virtual Environment

Study 2 took place in a Cave Automatic Virtual Environment or CAVE (for a detailed description of the CAVE see Cruz-Neira, Sandin, DeFanti, Kenyon, & Hart, 1992; Cruz-Neira, Sandin, & DeFanti, 1993). The CAVE is a half-open cube with 2.5 m long edges. Three dimensional images were projected on 3 sides (rear-projection) and the floor. Shutter glasses allowed the participant to see depth in the virtual environment and a head tracking device (a sensor that determines the position of the user within the cubicle) allowed the participants to see the virtual environment from their own perspective. The objects in the virtual environment appeared to be stationary, and the participants were able to look underneath objects or around virtual street corners or trees. Participants could walk in the cubicle and navigate through the virtual space using a joystick. Although the physical movement of participants through the virtual environment is more restricted compared to their movement in a real environment, exploring the virtual environment is still quite similar to exploring a real environment because the physical movement of participants in the CAVE is combined with "virtual" movement (navigation with the joystick).

Virtual Environments

In the virtual "natural" condition we used a three dimensional virtual representation of the real butterfly garden we used in Study 1 (see Figure 3). The virtual butterfly garden contained tropical plants, flowers, a paved footpath, a pond with water plants, and a wooden bridge. Animation was used to simulate flying virtual butterflies and some butterflies were placed on leaves. For the background audio we used bird sounds. The virtual urban neighborhood (see Figure 4) contained streets, terraced houses, apartments, parked cars and bicycles, a number of moving cars in the distance, parking meters, a bus stop, street lanterns, and glass collection bins. As background sounds distant car sounds were audible.

De Kort and colleagues (De Kort, Meijnders, Sponselee, & IJsselsteijn, 2006) suggest that the individual's experience of *presence* or 'being there' in the mediated environment may influence the restorative effectiveness of simulated nature. This feeling of presence becomes stronger as the media technology becomes more immersive and perceptually realistic (De Kort et al., 2006). By including many details, movement (butterflies, clouds, and cars), and sounds (birds and car sounds) we created highly immersive virtual environments that elicit strong feelings of presence. The head tracking device may also enhance feelings of presence, as the virtual environment responds to the participant's position in the CAVE.

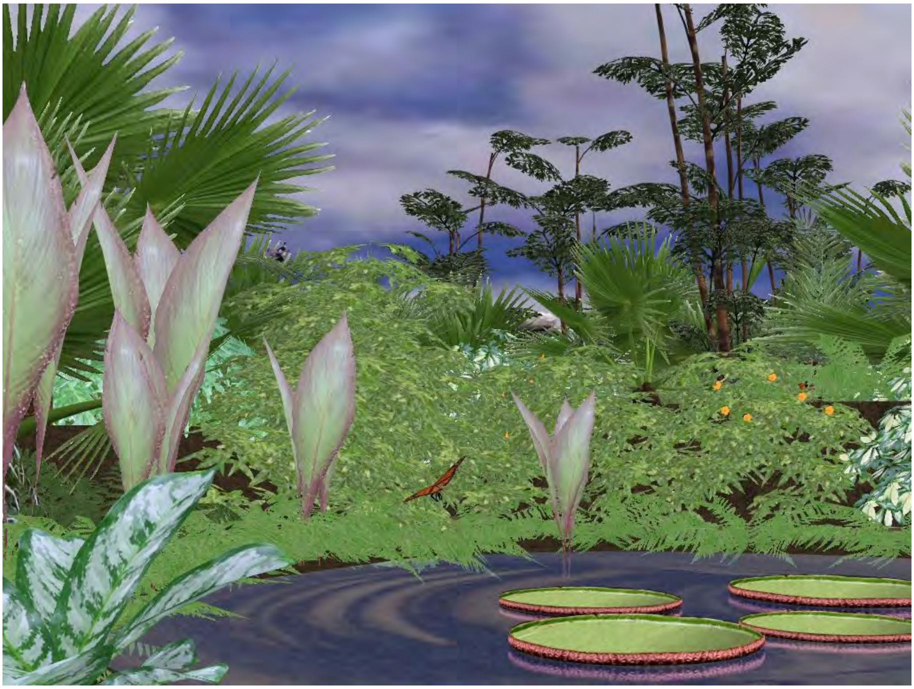


Figure 3. The Virtual Butterfly Garden (Study 2)

Figure 4. The Virtual Urban Neighborhood (Study 2)

Procedure

The participants were welcomed at the virtual reality center. Participants were told that we were interested in people's experiences of different virtual environments. We did not tell participants anything about our expectations or the goal of the study, in order to avoid demand characteristics, social desirability, and experimenter expectancies. Upon arrival participants filled out an informed consent form. To make sure that all participants had comparable levels of mental fatigue, we induced mental fatigue in all participants with the same Sudoku task as used in Study 1. The participants were again told that they had to solve as many Sudoku puzzles as possible within 50 minutes. The participant with the highest score would win a VIP treatment in Zoo Emmen. After the Sudoku task, participants were taken to the CAVE in a different room. Participants could explore the virtual environment (the virtual butterfly garden or the virtual urban neighborhood) for 20 minutes. After exposure to the virtual environment, participants filled out the questionnaire on a table near the CAVE.

Measures

Perceived Restorative characteristics.

The PRCQ (Pals et al., 2009) was used to measure four perceived restorative characteristics (fascination, novelty, escape, and coherence) of the virtual environments. As explained earlier, we excluded compatibility both in Study 1 and Study 2. All items were put in random order and focused on either the virtual butterfly garden or the virtual urban neighborhood. We explicitly asked the participants to evaluate the virtual environment and not the physical environment they were in (i.e. the CAVE itself). The reliabilities of all scales were acceptable for both environments ($\alpha > .70$, see Table 5).

Restorative effects: Preference, pleasure, and restoration.

We used the same scales to measure preference, pleasure and restoration in the virtual environments as used in Study 1. All three scales were reliable for both environments (α > .90, see Table 5).

Table 5. Estimated Means, Standard Deviation and Cronbach's Alpha Scores for Restorative Characteristics and Restorative Effects for the Virtual Butterfly Garden and the Virtual Urban Neighborhood (Study 2), and F-values for the Differences in Restorative Characteristics and Restorative Effects between the Virtual Butterfly Garden and the Virtual Urban Neighborhood (N = 26)

		Virtual Environments								
		Butterfly Garden			Urban Neighborhood					
	n items	*M*	*SD*	α	*M*	*SD*	α	*F*(1,24)		η_p^2
Fascination	5	5.31	1.08	.88	3.36	1.29	.89	53.65	***	.69
Novelty	4	4.61	1.24	.76	2.76	1.06	.83	45.13	***	.65
Escape	3	4.91	1.32	.90	3.31	1.32	.91	38.90	***	.62
Coherence	3	5.70	.78	.70	5.01	1.31	.84	25.30	***	.51
Preference	4	5.98	.80	.90	4.50	1.32	.93	21.16	***	.47
Pleasure	4	5.27	1.11	.94	4.28	1.26	.92	18.84	***	.44
Restoration	5	4.89	1.15	.91	3.53	1.26	.90	26.54	***	.53

*** $p < .001$

Note Restorative Characteristics, Preference, Pleasure, and Restoration were rated on seven-point scales with high numbers indicating higher levels of the specific variable.

Results

Virtual butterfly garden versus virtual urban neighborhood

Repeated measures analyses[1] confirmed our expectation that all perceived restorative characteristics were significantly higher in the virtual butterfly garden than in the virtual urban neighborhood (see Table 5). Furthermore, stronger restorative effects occurred after the walk in the virtual butterfly garden, compared to the walk in the virtual urban neighborhood. Preference ratings were higher for the virtual butterfly garden than the virtual urban neighborhood. Participants experienced more pleasure after exposure to the virtual butterfly garden, compared to the urban neighborhood. Also, restoration was higher after walking in the virtual butterfly garden compared to walking in the virtual urban neighborhood.

Butterfly Garden: Predicting preference, pleasure, and restoration

All restorative characteristics, except novelty, correlated positively with preference for the butterfly garden (see Table 6). Regression analysis showed that the perceived characteristics of the virtual butterfly garden (fascination, novelty, escape, and coherence) explained 50% of the variance in preference for the butterfly garden ($F(4, 21) = 5.17$, $p < .01$, see Table 7). Higher evaluations of escape ($\beta = .42$, $t = 2.11$, $p < .05$), and higher evaluations of coherence ($\beta = .44$, $t = 2.50$, $p < .05$) were associated with higher preference ratings (Table 7 also provides confidence intervals).

Escape and coherence correlated positively with experienced pleasure. The restorative characteristics explained a significant proportion of the variance in pleasure ($R^2 = .45$, $F(4, 21) = 2.51$, $p = .01$; see Table 7). Higher escape ratings were associated with higher ratings of experienced pleasure ($\beta = .63$, $t = 3.07$, $p < .01$).

All perceived restorative characteristics correlated positively with restoration in the butterfly garden. Especially escape correlated highly positive with restoration (r = .91). Perceived restorative characteristics of the virtual butterfly garden could explain 88% of the variance in restoration (F(4, 21) = 39.43, p < .001). We found that higher escape ratings were associated with more restoration (β = .74, t = 7.81, p < .001).

Urban Neighborhood: Predicting preference, pleasure, and restoration

As for the virtual urban neighborhood, fascination, and novelty correlated positively with preference (see Table 6). Restorative characteristics were not able to explain a significant proportion of the variance in preference for the urban environment (R^2 = .26, F(4, 21) = 1.87, p = .15; see Table 8).

Fascination, novelty, and escape correlated positively with experienced pleasure. Regression analysis showed that perceived restorative characteristics of the virtual urban neighborhood could explain 48% of the variance in pleasure (F(4, 21) = 4.92, p = .01; see Table 8). Higher escape ratings were associated with more experienced pleasure (β = .49, t = 2.74, p < .01, Table 8 also provides confidence intervals).

Fascination and escape correlated positively with restoration. Perceived restorative characteristics could explain 75% of the variance in restoration (F(4, 21) = 15.36, p < .001). Both fascination and escape were significant predictors of restoration. Higher fascination and higher escape were associated with higher levels of restoration (β = .34, t = 2.14, p < .05, and β = .72, t = 5.69, p < .001).

Comparing the Real Butterfly Garden with the Virtual Butterfly Garden

Because the virtual butterfly garden was based on the real butterfly garden in Emmen Zoo, we were able to make a direct comparison between these two environments. We examined whether people perceived the restorative characteristics of a virtual butterfly garden similarly as the restorative characteristics of its real equivalent. The data from Study 1 and Study 2 were combined. Next we conducted a between subjects analysis (N = 49) with two environmental conditions (virtual butterfly garden versus real butterfly garden). Results from the t-test showed that there were no significant differences in the perceived restorative characteristics and restorative effects (preference, pleasure, and restoration) between the virtual butterfly garden and the real butterfly garden (see Table 9).

We examined whether the same predictors that explain preference, pleasure and restoration in the real butterfly garden could also explain preference, pleasure and restoration in the virtual butterfly garden. Overall the restorative characteristics predicted a significant proportion of the variance in preference, pleasure and restoration for both the real butterfly garden (see Table 3) and the virtual butterfly garden (see Table 7). Especially escape appeared to be a good predictor for preference and restoration in both environments.

Tabel 6. Correlations between Restorative Characteristics, Preference, Pleasure, and Restoration, with the Virtual Butterfly Garden above diagonal and the Virtual Urban Neighborhood (Study 2) below diagonal

	Fas	Nov	Esc	Coh	Pref	Plsr	Rest
Fascination	-	.69**	.61**	.47*	.45*	.37	.71**
Novelty	.60**	-	.45*	.26	.19	.20	.56**
Escape	.38	.27	-	.33	.55**	.63*	.91**
Coherence	.30	-.10	-.18	-	.58**	.40*	.46*
Preference	.49*	.48*	.29	.13	-	.76**	.66**
Pleasure	.53**	.43*	.54**	.23	.73**	-	.63**
Restoration	.52**	.25	.83**	-.08	.38	.56**	-

* correlation is significant at the .05 level

** correlation is significant at the .01 level

Note. Fas = Fascination; Nov = Novelty; Esc = Escape; Coh = Coherence; Pref = Preference; Plsr = Pleasure; Rest = Restoration.

Table 7. Regression Analyses for Restorative Characteristics on Preference, Pleasure, and Restoration (N = 26) of the Virtual Butterfly Garden (Study 2)

	ß	*t*		95% Confidence Interval for ß Lower Bound	Upper Bound	R^2	*df*	*F*	*p*
Dependent Variable: Preference									
Fascination	.12	.47		-.42	.66				
Novelty	-.19	-.84		-.65	.27				
Escape	.42	2.11	*	.01	.83				
Coherence	.44	2.50	*	.07	.81				
						.50	4, 21	5.17	.01
Dependent Variable: Pleasure									
Fascination	-.04	-.13		-.60	.53				
Novelty	-.15	-.64		-.62	.33				
Escape	.63	3.07	**	.20	1.06				
Coherence	.25	1.37		-.13	.63				
						.45	4,21	4.34	.01
Dependent Variable: Self reported Restoration									
Fascination	.13	1.03		-.13	.39				
Novelty	.11	1.00		-.12	.33				
Escape	.74	7.81	***	.54	.94				
Coherence	.12	1.39		-.06	.30				
						.88	5,20	39.43	<.001

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 8. Regression Analyses for Restorative Characteristics on Preference, Pleasure, and Restoration (N = 26) of the Virtual Urban Neighborhood (Study 2)

				95% Confidence Interval for ß					
				Lower	Upper				
	ß	*t*		Bound	Bound	R^2	*df*	*F*	*p*
Dependent Variable: Preference									
Fascination	.36	1.32		-.21	.92				
Novelty	.12	.50		-.38	.61				
Escape	.14	.64		-.31	.58				
Coherence	.05	.23		-.41	.51				
						.26	4,21	1.87	.15
Dependent Variable: Pleasure									
Fascination	.14	.63		-.33	.62				
Novelty	.19	.98		-.22	.61				
Escape	.49	2.74	*	.12	.87				
Coherence	.29	1.59		-.09	.67				
						.48	4,21	4.92	.01
Dependent Variable: Self-reported Restoration									
Fascination	.34	2.14	*	.01	.67				
Novelty	-.13	-.93		-.42	.16				
Escape	.72	5.69	***	.46	.98				
Coherence	-.06	-.49		-.33	.21				
						.75	4,21	15.36	<.001

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 9. Mean Scores of Restorative Characteristics, Preference, Pleasure, and Restoration for the Real Butterfly Garden (Study 1) and the Virtual Butterfly Garden (Study 2). Results of t-test Analysis of the Differences between the Means (N = 49)

	Butterfly Gardens				
	Real	Virtual	95% CI of the Difference		
	M	*M*	Lower Bound	Upper Bound	
Fascination	5.11	5.22	-.57	.78	.31
Novelty	4.67	4.52	-.88	.58	-.42
Escape	4.54	4.83	-.48	1.08	.77
Coherence	5.43	5.69	-.20	.72	1.13
Preference	5.83	5.97	-.32	.61	.62
Pleasure	5.30	5.24	-.62	.50	-.23
Restoration	4.65	4.80	-.48	.77	.48

** $p < .01$

Note Restorative Characteristics, Preference, Pleasure, and Restoration were rated on seven-point scales with high numbers indicating higher levels of the specific variable.

Conclusion

Study 2 showed similar results as Study 1. First, the results confirmed our expectation that perceived restorative characteristics of and the restorative effects (preference, pleasure, and restoration) elicited by a virtual “natural” environment are higher than the perceived restorative characteristics of and restorative effects elicited by a virtual urban environment. Second, the results confirmed our expectation that the perceived restorative characteristics of the virtual “natural” environment are good predictors of preference, pleasure, and restoration in this environment. Also, the perceived restorative characteristics of the virtual urban environment could predict pleasure and restoration in that environment. Again, especially escape appeared to be a good predictor of restoration in both virtual environments. Third, our results did not indicate that there were differences in perceived restorative characteristics, and restorative effects (preference, pleasure and restoration) between the real and the virtual butterfly garden. The effects we found in the virtual environments were highly comparable to the effects we found in the real environments.

General Discussion

Compared to urban environments, natural environments have a strong potential to elicit restorative effects. After exposure to a natural environment people restore more quickly from mental fatigue and stress (Hartig et al., 2003; Ulrich, 1984), experience more positive affect (Hartig et al., 2003), and evaluate the environment more positively (i.e. preference; Laumann et al., 2001; Purcell et al., 2001). The Attention Restoration Theory (Kaplan & Kaplan, 1989) suggests that these restorative effects are more likely to occur in environments with restorative characteristics. The ART, however, does not explain what specific physical characteristics influence perceived restorative characteristics and restorative effects. To further examine the underlying processes involved in restorative experiences it is important to conduct controlled experiments. Due to recent technological developments, a new research tool to examine restorative environments in a controlled way has become available: virtual reality. In this chapter we show that virtual reality can be a very useful and valid tool for conducting controlled experiments in restorative environments research.

The aim of this study was to examine the validity of virtual reality to assess the restorative quality of environments. In three steps we examined whether virtual environments elicit similar responses as real environments. First, we reasoned that if *real* natural environments score higher on restorative characteristics and elicit stronger restorative effects (preference, pleasure, and restoration) than urban environments, we should also find that *virtual* natural environments score higher on restorative characteristics and elicit stronger restorative effects than virtual urban environments. We indeed found that people perceived both the virtual “natural” environment and the real natural environment as more restorative than the two urban environments (virtual and real). Additionally, preference ratings, experienced pleasure, and restoration were also higher in both virtual and real natural environments.

Second, one would expect that if restorative characteristics can predict preference, pleasure, and restoration for real environments, restorative characteristics of *virtual* environments should also be able to predict preference, pleasure, and restoration for *virtual* environments. Indeed we found that perceived restorative characteristics predicted restorative effects (preference, pleasure, and restoration) for real environments, as well as for *virtual* environments. Especially escape appeared to be a good predictor for restoration in all environments. The perceived restorative characteristics, however, could neither explain preference for the real urban environment, nor for the virtual urban environment.

Third, we reasoned that there should be no differences in perceived restorative characteristics of the real environment and its *virtual* equivalent. As expected, we did not find evidence for differences between the virtual natural environment and real environment it represented in terms of perceived restorative characteristics, preference, and restoration.

Despite the relatively small number of participants and the fact that the duration of the walk differed somewhat between the virtual and the real settings, we found support for our hypothesis that virtual environments elicit similar effects as real environments. These findings support the notion that virtual reality may be a valid tool to examine restorative experiences in simulated environments that can be generalized to real environments.

In this study we focused on subjective experiences (perceived restorative characteristics, pleasure, preference and restoration) of virtual and real environments. The self-report measures used in this study have great practical value. Practitioners (for example landscape architects or urban planners) can use these questionnaires to evaluate the restorative quality of environments they have designed. To further validate virtual reality, future research could be aimed at examining whether physiological or mental restoration also occurs in virtual (restorative) environments, and whether these experiences are similar to experiences of the real environments they represent. In addition to this, our results need to be replicated for other types of (natural as well as urban) environments.

The present findings offer great opportunities for research as well as practice. An important practical implication of our study is that designers and urban planners can use virtual reality to find out how people experience their designs before they are actually built. In virtual environments it is easier to spot possible shortcomings in the design, allowing designers to optimize their design before commissioning construction companies to execute the project enabling more cost- and time-efficient investments. Although the initial costs of creating a virtual environment are considerable, and programming virtual environment calls for individuals with considerable skill in programming and interfacing (Blascovich, Loomis, Beall, Swinth, Hoyt, & Bailenson, 2002), once a basic environment is programmed, it can be used as a starting point to conduct numerous experiments, making only slight changes in that virtual environment for each subsequent experiment.

Scientific implications are that virtual reality can be used for theory testing and to gain insight into causal relationships between key variables of interest. Previous research mainly compared urban environments with natural environments. These environments differ on a great number of aspects, which makes it hard to conclude why any differences in restoration actually occur. To get more insight into which features are of key importance for restorative experiences researchers should take one environment as a starting point and change features of this environment one by one. Virtual reality can serve this purpose, especially now we have obtained first evidence that virtual reality is a valid tool for research on restorative environments. Using virtual reality we can take this next step and examine with controlled experiments how specific physical features of environments influence perceived restorative characteristics, and thereby the restorative quality of environments.

Chapter 4

The relationship between physical features and restorativeness of environments: A virtual reality study

Chapter 3 is based on Pals, R., J. Dontje, Steg, L., Siero, F., & Van der Zee, K. I. (under review). The relationships between physical features, restorative characteristics and restorative effects: A virtual reality study.

Abstract

In this study we examined how physical features of a natural setting influenced perceived coherence of this environment and restorative effects (i.e. preference, restoration and pleasure). Additionally, we examined whether coherence mediated the relationship between physical features and restorative effects. One hundred thirty-one students evaluated three (virtual) natural environments: an environment with metal furniture, an environment with wooden furniture, and an environment without furniture. Results showed that metal furniture negatively influenced perceived coherence and restorative effects, compared to the environment with wooden furniture and the environment without furniture. Perceived coherence of a natural environment with wooden furniture was significantly lower than a natural environment without furniture. We did not find support that restorative effects of the environment with wooden furniture differed from the environment without furniture. Furthermore, we found strong support for the mediating role of perceived coherence on the effect of furniture on the three restorative effects: preference, pleasure, and restoration.

Imagine that you have been working intensively on a difficult project for a considerable time. You experience a lot of stress and you find it hard to stay focused. You feel the urgent need to restore your energy level. Where would you go? Previous research has shown that individuals who experience stress or mental fatigue benefit more from a stay in a natural setting than an urban setting. Compared to urban environments, nature allows people to restore quicker from (psychological and physiological) stress or mental fatigue (Berman, Jonides, & Kaplan, 2008; Berto, 2005; Kaplan & Kaplan, 1989; Laumann, Gärling, & Stormark, 2003; Ulrich, 1984; Ulrich, Simons, Losito, & Fiorito, 1991), and to experience more positive and less negative affect (Hartig, Mang, & Evans, 1991; Hartig, Evans, Jamner, Davis, & Gärling, 2003). Also, people tend to have a preference for natural settings over urban settings (Laumann, Gärling, & Stormark, 2001; Pals, Steg, Siero, & Van der Zee, 2009; Purcell, Peron, & Berto, 2001). So, being in a restorative environment (e.g. nature) has three important positive outcomes: 1) restoration from stress or mental fatigue, 2) positive cognitive evaluations of the environment (preference), and 3) positive affective responses (such as pleasure). In the current paper we will refer to these outcomes (i.e. restoration, preference, and pleasure) as *restorative effects*. The extent to which environments are able to elicit restorative effects will be referred to as the *restorativeness* of environments.

But what makes a natural environment more restorative than an urban environment? The current study aims to examine the relationship between physical features of the environment, cognitive evaluations of the environment (i.e. restorative characteristics), and restorative effects.

The Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) proposes that natural environments score higher on so-called restorative characteristics, which may explain why nature elicits stronger restorative effects than urban environments. Based on pioneering research by Kaplan and Kaplan (1989) and more recent literature (Hartig, Korpela, Evans, & Gärling, 1997a; Laumann et al., 2001; Van den Berg, Koole, & Van der Wulp, 2003), Pals and colleagues (2009) distinguish five restorative characteristics that may affect restorative effects. Restorative effects will be stronger when you experience harmony between all elements in the environment (coherence), and see things that attract your attention effortlessly (fascination). Also, restorative effects are stronger when you are in a different environment than your daily environment (novelty), and be able to free your mind from everyday hassles (escape)[1]. Finally, a good match between what you *can* do and *want* to do in a certain environment (compatibility) enhances restorative effects (Pals et al., 2009).

These five restorative characteristics are cognitive constructs that are based on the interaction between physical characteristics of the particular environment and the observer. As such, they do not stipulate which specific physical features influence the restorativeness of a particular environment. Therefore these restorative characteristics do not provide clear and straightforward guidelines on how to change environments in order to enhance its restorativeness. Furthermore, most studies on restorativeness of environments compared natural environments with urban environments. Obviously, the physical features of these environments differ greatly. As a consequence, we can only speculate what specific physical characteristics account for differences in restorativeness between these environments.

The current study attempts to integrate the Attention Restoration Theory, a prominent psychological approach, with the physical-perceptual approach.

[1] The restorative characteristic *being away*, was originally described as either physically or psychologically being away from your everyday environment (Kaplan & Kaplan, 1989). Being away was later split into two components: novelty, which refers to the physical component, and escape, which refers to the psychological component of being away (Laumann et al., 2001; Pals et al., 2009).

The physical-perceptual approach examines relationships between physical characteristics of the environment and judgments of preference for landscapes (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, Daniel, & Schroeder, 1984). For example the presence of water or vegetation are physical landscape characteristics that may predict negative or positive evaluations of environments (Bell, Greene, Fisher, & Baum, 2001). An advantage of the physical-perceptual approach compared to the ART is that it does identify objective characteristics of the environment that positively affect aesthetic judgments. However, a theory on *why* people prefer certain physical characteristics is lacking. The aim of the study is to combine both approaches and examine the relationship between specific physical features of the environment, restorative effects, and underlying cognitive constructs as described in the ART.

Based on the ART, we would expect physical features to influence restorativeness *via* restorative characteristics. After all, restorative characteristics are based on the interaction between the observer and the environment. Therefore physical characteristics of the environment may influence the perceived restorative characteristics of the environment, in turn influencing restorative effects (preference, pleasure, and restoration). There is some initial evidence that restorative characteristics (i.e. being away and fascination) mediate the relationship between physical components and restorativeness. Nordh and colleagues (Nordh, Hartig, Hagerhall, & Fry, 2009). found that certain *natural* components in small parks (such as lower ground vegetation, bushes, grass, water and trees) increased the restoration likelihood, and these effects were (partially or fully) mediated by being away and fascination. Fascination appeared to be strongly associated with the presence of water and the size of the park, whereas being away appeared to be strongly associated with the presence of grass, bushes, trees, and with the size of the park (Nordh,et al., 2009).

They, however, did not systematically manipulate the physical components of the parks (Nordh et al. 2009). Therefore the individual influence of each (physical) component on restorativeness remains unclear.

In the current study we are interested in the effect of physical characteristics on restorative characteristics and restorative effects. As a first step we will focus on coherence, one key restorative characteristic of the ART. We will manipulate coherence by systematically changing physical properties of an environment, and examine how this influences restorative effects. Previous research has shown that natural scenes (i.e., a forest, a sea area, and mountain scene), where only natural elements are visible, were perceived as more coherent, compared to an urban setting (Laumann et al., 2001). Although it has not been tested empirically, one may argue that the natural scenes are more coherent, *because* all natural elements (trees, plants, grass, mountains, water) go well together. If this is indeed the case, it would be advisable to design environments where only natural elements are visible and let existing natural settings as they are. However, in many instances planners also want to meet the needs and wishes of people visiting natural areas, often leading to the placement of human-made objects such as park benches and garbage bins. It is quite imaginable that the introduction of these human made objects may have a negative impact on the coherence of the setting, leading to a decrease of its restorative potential. But what if the objects (for example the benches in the park) are designed in a way to harmonize optimally with the environment? Will this preserve the coherence and restorativeness of the environment? The first aim of the current study is to examine the effect of the presence and the design of street furniture in a natural setting on perceived coherence and restorative effects. The second aim is to examine the mediating role of perceived coherence on the effect of these human-made objects on the restorativeness of natural environments.

To examine causal relationships between physical features, restorative characteristics, and restorative effects, ideally, researchers have to systematically manipulate aspects of the environment, while keeping the environment and all other factors constant. We argue that virtual reality is a very useful tool to conduct these kinds of experiments for restorative environments research. Virtual reality (VR) is an artificial environment generated by computer software, presented in such a way that the user is able to interact with the environment similar as with a real environment. Virtual reality has two major advantages. First, researchers can exert more control in virtual reality than in real settings. Second, it allows researchers to systematically manipulate some features of environments while keeping all other factors constant. Moreover, due to recent technological developments, virtual reality can simulate highly realistic environments, so experiences in virtual environments can be generalized to real environments. Indeed, previous research showed that virtual reality is a *valid* tool for restorative environments research, as it elicits similar effects on perceived restorative characteristics and self-reported restorative effects as comparable real environments (Bishop & Rohrmann, 2003; De Kort, IJsselstijn, Kooijman, & Schuurmans, 2003; Pals, Steg, Siero, & Van der Zee, under review).

In the current study we will use virtual reality to examine how the presence and the design of street furniture (fences, benches, and garbage bins) in a natural setting influences perceived coherence of this environment and restorative effects (preference, restoration and pleasure). We will compare three (virtual) environments: a natural environment with furniture that disharmonizes with the environment (metal furniture), a natural environment with furniture that harmonizes with the environment (wooden furniture), and a natural environment without furniture. We expected that perceived coherence, and in turn restorative effects (preference, restoration, and pleasure) are highest in the natural environment without furniture, lowest in the environment with metal furniture, and expect that the natural environment with wooden furniture will take a midpoint position (hypothesis 1). Additionally, we expect that the effect of the physical features we manipulated in the environments (i.e. the street furniture) on the restorative effects (preference, restoration, and pleasure) will be *mediated* by perceived coherence (hypothesis 2).

Method

Participants and Design

A total of 131 students participated in this study (48 men, 83 women; mean age 21.06; range 18-29 years) in exchange for course credits. The experiment had a within-subjects design with three virtual environmental conditions: an environment with metal furniture, a natural environment with wooden furniture, and a natural environment without furniture. We counterbalanced the order in which participants were exposed to the environments, in a way that each environment was once presented first, once second, and once last. In this way there were three order conditions: Wood – Metal – Control, Metal – Control – Wood, and Control – Wood – Metal. Participants were randomly assigned to the order conditions.

Virtual environment

We conducted this study in a Virtual Reality Theatre. A virtual natural environment was used as a starting point for this study (see Figure 1). The environment contained grass, plants, bushes, trees, and water. A soil path circled through the area. To make the environment more dynamic, we included some (moving) virtual animals visible (e.g. butterflies) and bird sounds were audible.

Three-dimensional images of the virtual environments were projected onto a wide cylindrical screen. The transparent screen was approximately ten meters wide and 2.80 meters high, and surrounded participants with a 135 degree field-of-view. Shutter glasses created a three-dimensional life-like experience of the virtual environments.

Figure 1. Natural environment without furniture

Manipulation of physical features: Furniture

Three (virtual) environments were programmed: a natural environment with furniture that harmonizes with the environment, a natural environment with disharmonious furniture, and a natural environment without furniture. We argued that furniture that is perceived as unnatural is more likely to be disharmonious with a natural setting, and furniture that is perceived as natural is more likely to harmonize with a natural setting. We used three types of furniture in each condition: benches, fences, and garbage cans. We manipulated the naturalness of the shape and the naturalness of the texture of the furniture. For the unnatural furniture we used shiny metal textures, smooth surfaces, and regular shapes (see Figure 2). For the natural furniture we used raw wooden textures, uneven surfaces, and irregular shapes (see Figure 3).

Figure 2. Natural environment with metal furniture

Figure 3. Natural environment with wooden furniture

Procedure

Upon arrival participants filled out an informed consent form. Participants were seated on a 3-row stage in front of the screen. Participants got a 12 minute virtual tour in each environment. After each tour participants filled out questions about perceived coherence and restorative effects. Finally participants filled out the manipulation check items and some items on demographics (i.e. age, gender).

Measures

Perceived coherence

We used three items from the Perceived Restorative Characteristics Questionnaire (PRCQ; Pals et al., 2009) to measure perceived coherence of the environments. The items were adapted slightly so they referred directly to the virtual environments. Participants rated on a Likert scale, ranging from 1 (totally disagree) to 7 (totally agree), their level of agreement with the following items: “Everything I saw in the virtual environment went well together”, “Everything I saw in the virtual environment fits there”, and “Everything I saw in the virtual environment belonged there”.

Restorative Effects: Preference, Pleasure, and Restoration

Preference for the environments was measured using three seven-point semantic differentials: (I find the virtual environment) unattractive – attractive, negative – positive, and not enjoyable – enjoyable. The preference scale was reliable for all three environments ($\alpha > .85$, see Table 1).

Participants indicated on four seven-point semantic differential items to what extent they experienced pleasure when they saw the virtual environment: sad - happy, annoyed - pleased, dissatisfied - satisfied, bored – content (Mehrabian & Russell, 1974). The pleasure scale was reliable for all three environments (α > .83, see Table 1).

Restoration was measured using a self-report measure, based on work by Staats and colleagues (Staats, Kieviet, & Hartig, 2003). Participants rated on a seven-point Likert scale their level of agreement with the following five items: “In the virtual environment I was able to concentrate well”, “In the virtual environment I was able to focus on myself”, “In the virtual environment I was able to release all tension”, “In the virtual environment I was able to relax”, and “In the virtual environment my energy level got renewed”. The restoration scale was reliable for all three environments (α > .77, see Table 1).

Table 1. Mean, Standard Deviation and Cronbach’s Alpha Scores for Perceived Coherence and Restorative Effects for the environments with wooden furniture, metal furniture, and no furniture (N = 131).

		Environmental Conditions								
		Wooden furniture			Metal Furniture			No Furniture		
	n items	*M*	*SD*	α	*M*	*SD*	α	*M*	*SD*	α
Coherence	3	4.73	1.31	.88	3.98	1.54	.90	5.20	1.22	.89
Preference	3	5.20	1.22	.85	4.75	1.38	.89	5.23	1.22	.87
Pleasure	4	4.57	1.15	.84	4.23	1.15	.85	4.45	1.12	.83
Restoration	5	4.36	1.03	.79	4.21	1.05	.79	4.41	1.03	.77

Manipulation checks

At the end of the experiment participants evaluated the naturalness of the furniture, and how well the furniture harmonizes with the virtual environment (both on a single item seven-point Likert scale). Participants evaluated the wooden and metal furniture (the benches, the garbage bins, and the fences) separately. We calculated mean scores for naturalness and harmonizing for the wooden furniture by taking together the scores for the wooden benches, the wooden garbage bins, and the wooden fences. In a similar way we computed mean scores for naturalness and harmonizing of the metal furniture. Both scales were reliable for both types of furniture ($\alpha > .79$). The wooden furniture was indeed perceived as more natural ($M = 5.53$) compared to the metal furniture ($M = 2.38$, $F(1, 129) = 378.38$, $p < .001$), and participants stated that the wooden furniture harmonized better with the virtual natural environment ($M = 5.66$) than the metal furniture ($M = 2.28$, $F(1,129) = 469.65$, $p < .001$).

Statistical analyses

Repeated measures analyses were conducted in SPSS to examine the main effects of furniture on perceived coherence and the restorative effects (preference, pleasure, and restoration). To examine the specific differences between all environmental conditions and to examine whether coherence mediated the effects on preference, pleasure and restoration we conducted multilevel analyses using MLwin. First we tested whether the three contrast effects (wood - control, metal - control, and wood - metal) were significant. Second we tested whether coherence mediated these effects. Following Baron and Kenny (Baron & Kenny, 1986), we tested whether the three assumptions for conducting mediation analyses were met: a) there has to be an effect of furniture on the mediator variable (i.e. coherence), b) there has to be an effect of furniture on the dependent variable (i.e. preference, pleasure, or restoration), and c) there has to be an effect of the mediator variable on the dependent variable. When these preconditions were met, we tested whether coherence indeed caries the influence of furniture on the restorative effects. We will only report those cases that meet all three assumptions.

We first we examined the influence of furniture on coherence. Second, we examined the influence of furniture on the three restorative variables (preference, pleasure, and restoration). For those cases that met the three assumptions for establishing mediation effects, we added coherence to these models, to test whether coherence indeed mediated the effects of furniture features on restorative effects. To test the significance of the mediation effects we inspected the test outcomes in two steps: (A) is the difference in the model fit (represented by the deviance scores) significant? These differences in model fit follow a chi-square distribution. (B) In the case of differences in model fit, is the reduction of the effects of the three contrasts from the model without the mediating variable coherence to the model including the mediating variable coherence on the three restorative variables substantial?

Results

Perceived Coherence

Repeated measures analysis[2] showed that there was a difference in perceived coherence between the three conditions ($F(2, 127) = 50.19$, $p < .001$). The multilevel analysis showed that all contrasts (wood – control, metal – control, and metal – wood) were significant (see Table 2). In line with our first hypothesis, the environment with wooden furniture scored significantly lower on perceived coherence than the environment without furniture (control condition). Perceived coherence wassignificantly lower in the environment with metal furniture compared to the control condition and compared to the environment with wooden furniture.

[2] We included order as a variable in our model to test for order effects. We found significant main effects for order, and significant interaction effects between order and environment. The same pattern occurred for perceived coherence and the restorative effects (pleasure, preference, and restoration). The first environment that was evaluated by the participants scored higher on perceived coherence and restorative effects compared to the second or third environment. We interpreted this as a “wow” effect, as most participants never saw a virtual environment before. Despite this order effect, we still found a main effect for environment.

Restorative Effects: Preference, Pleasure, and Restoration

Repeated measures analyses[2] revealed that there were significant differences in preference ($F(2,128) = 23.38$, $p < .001$), pleasure ($F(2, 127) = 7.14$, $p < .001$), and restoration (F(2, 128) = 4.86, $p < .01$) between the three environments. As can be seen in Table 2, we did not find statistically significant differences in preference, pleasure, and restoration between the environment with wooden furniture, compared to the environment without furniture. Participants scored the environment with metal furniture significantly lower on preference, pleasure, and restoration than the environment without furniture. The environment with metal furniture also scored significantly lower on preference and pleasure than the environment to wooden furniture. We did not find statistically significant differences in restoration between the environment with metal furniture, compared to the environment with wooden furniture.

Perceived Coherence as a Mediator

As explained above, we found an effect of furniture on coherence, which means that the first assumption to establish mediation is met. Furthermore, we found that, compared to the condition without furniture, *metal* furniture influenced preference, pleasure, and restoration, which means that the second assumption to establish mediation is met for all three dependent variables. As a next step we added coherence to each model to check if the third assumption is met for all the dependent variables, and test whether coherence mediates the effect of metal furniture on the restorative effects. As can be seen in Table 2, there is a significant effect of coherence on preference, pleasure, and restoration, which means that the third assumption for establishing meditation effects is met. As all three assumptions are met for all three dependent variables, we can now look whether coherence mediated the effects of furniture on preference, pleasure and restoration. We looked at those contrasts that were significant without the mediating variable coherence. If an effect that appeared significant is no longer significant when the mediating variable coherence is added to the model, we concluded that coherence mediated the effect of metal furniture on restorative effects.

We first looked at the contrast between the environment with metal furniture and the control condition (no furniture). We found that when coherence was added to the model, the negative effects of metal furniture (compared with the condition without furniture) on all three dependent variables (preference, pleasure, and restoration) were no longer significant. This implies that coherence fully mediated the negative effect of metal furniture (compared with the condition without furniture) on preference, pleasure, and restoration. The contrast effects between the environment with metal furniture and the environment with wooden furniture on preference and pleasure were still significant when the mediator variable coherence was added to the model, but the effects were less profound. This suggests that coherence partially mediated these effects of metal furniture on preference and pleasure.

Table 2. Multilevel models of the effects of furniture type on coherence and restorative effects, and the effects of furniture on restorative effects with coherence as mediator variable

		Without Mediator				Mediation Model				
		B	*SE*	*t*		*B*	*SE*	*t*		χ^2(df=2)
Coherence										
	Wood – Control	-0.45	0.14	-3.27	*					
	Metal- Control	-1.78	0.14	-12.99	*					
	Metal - Wood	-.073	0.14	-5.33	*					
	Deviance	1296.87								
Preference										
	Wood – Control	-0.06	0.10	-0.59		0.13	0.08	1.65		
	Metal- Control	-0.51	0.10	-5.38	*	-0.06	0.09	-0.72		
	Metal - Wood	-0.46	0.10	-4.79	*	-0.20	0.08	-2.39	*	
	Coherence					0.38	0.04	9.85	*	
	Deviance	1124.66				1013.57				111.10*
Pleasure										
	Wood – Control	0.12	0.09	1.33		0.20	0.09	2.28	*	
	Metal- Control	-0.22	0.09	-2.49	*	-.01	0.10	-0.05		
	Metal - Wood	-0.34	0.09	-3.82	*	-0.20	0.09	-2.27	*	
	Coherence					0.18	0.04	5.17	*	
	Deviance	1071.15				1045.60				84.08*
Restoration										
	Wood – Control	-0.05	0.08	-0.56		0.08	0.07	1.15		
	Metal- Control	-0.21	0.08	-2.44	*	0.14	0.08	1.70		
	Metal - Wood	-0.16	0.08	-1.87		0.05	0.08	0.68		
	Coherence					0.28	0.04	8.11	*	
	Deviance	1010.38				926.31				25.55*

Note: *Significant at p<.05, N = 131.

Discussion

The aim of this study was to get more insight into how specific physical features influence restorative characteristics as described in the ART (Kaplan & Kaplan, 1989), and restorative effects (experienced pleasure, preference for the environment, and restoration). Most studies on restorative environments compared urban environments with natural environments. These environments differ on a great number of aspects, which makes it hard to conclude which environmental features cause differences in restoration. In the current study we used a new way to examine restorativeness of environments. We used one (virtual) environment as a starting point and systematically manipulated features of the environment. This makes it possible to draw conclusions about causality and identify what specific features influence restorativeness.

As a first step in examining the relationship between physical characteristics, restorative characteristics, and restorative effects, we focussed on perceived coherence, one of the key restorative characteristics described in the ART (Kaplan & Kaplan, 1989). We examined whether the perceived coherence and restorative effects of a natural environment were influenced when we introduced two styles of furniture, reflecting a natural and unnatural design. We argued that introducing elements that disharmonize with the natural setting might weaken the perceived coherence of the setting, while introducing elements that harmonize with the natural setting might less affect the perceived coherence of the setting. We expected that the diminished perceived coherence would, in turn, lead to diminished restorative effects. The second aim of the study was to examine whether coherence mediated the relationship between physical features and restorative effects. We argued that physical features of an environment influence restorativeness *via* perceived coherence. More specifically, the presence of unnatural or disharmonizing elements in a natural setting may negatively influence coherence and thereby diminish the occurrence of restorative effects.

The results of the study confirmed our hypotheses. We found that placing furniture (either wooden or metal) in a natural environment diminishes the perceived coherence of the environment. Introducing metal furniture in a natural environment not only reduced coherence, but also negatively influenced the restorative quality of the environment: self-reported restoration, experienced pleasure, and preference evaluations were lower in a natural environment with metal furniture compared to a natural environment without or with wooden furniture. However, when wooden furniture was introduced in a natural setting, perceived coherence was significantly higher than a natural environment with metal furniture, but significantly lower than a natural environment without furniture. The restorative quality, however, remained intact: There were no differences in restoration, pleasure and preference between the environment with wooden furniture and the environment without furniture. An explanation for this finding could be that the object itself (i.e. the furniture) may be perceived as unnatural because it is still a man-made and thus less harmonizing with a natural setting compared to a setting without man-made objects. The wooden furniture may be perceived as more natural compared to the metal furniture, due to the naturalness of the material and shape. It seems that the wooden furniture did not sufficiently disrupt the coherence of the environment to diminish the restorative quality of the environment, as we did not find support that restorative effects of the environment with the natural design furniture (i.e. wooden furniture) differed from the environment without furniture. Thus, from this study we can conclude that placing unnatural (metal) furniture in a natural environment, negatively influences perceived coherence and the restorative quality of the environment. Placing natural (wooden) furniture does influence perceived coherence but preserves the restorative quality of the environment.

We also found support for the mediating role of perceived coherence on the effect of metal furniture on three restorative effects: preference, pleasure, and restoration. Therefore we found support for our hypothesis that the introduction of unnatural elements in a natural setting negatively affects preference, pleasure, and restoration *via* perceived coherence.

This study has important theoretical and practical implications. This study gives insight on the causal relationship between specific physical features, restorative characteristics, and the restorative quality of environments, and thereby contributes to the theoretical development regarding restorative environments. The current study provides initial evidence that the presence of unnatural objects in a natural setting diminishes perceived coherence, and thereby negatively influencing the restorative quality of the environment. In this study we focused on one restorative characteristic. To further develop the Attention Restoration Theory and understand how physical features relate to restorative characteristics and restorative effects, the influence of other restorative characteristics should be examined as well. Nordh et al. (2009) found initial evidence that fascination and being away mediated the effect of physical components on restorative quality, however, they did not systematically manipulate physical components. So it is not clear which physical component caused effects on the restorative quality of the environment.

In this study we manipulated both the shape and the texture of the furniture. Therefore it remains unclear whether the effect of the furniture on perceived coherence and restorativeness was caused by the material or the shape, or the combination of both. Future research could be aimed at examining the effect of textures and shape of furniture on perceived coherence and restorativeness of the environment separately.

We found that the presence of unnatural elements (i.e. furniture) in a natural setting can *diminish* perceived coherence and thus restorativeness. This is an important finding, because it can help us understand how we can protect or design restorative environments. It is also interesting to explore how the restorativeness of environments can be *enhanced*. For example, previous research shows that urban settings are less restorative than natural settings. Nowadays, the majority of people live in cities, so it is important to find out how the restorativeness of peoples most immediate settings can be enhanced. To find out how this can be accomplished, future research could focus on urban settings and other types of environments, and attempt to examine how systematically manipulating physical elements affect restorativeness of these environments.

In this study we found that introducing unnatural elements in a natural setting negatively influences perceived coherence and restorativeness. This however, does not imply that the opposite is true for urban settings. Hernandez and Hidalgo (2005) found that the presence of natural elements in urban environments positively influenced general restorativeness. They, however, did not measure the separate restorative characteristics, so it remains unclear how for example the natural elements influenced perceived coherence or other restorative characteristics of the urban settings. It could be that introducing natural elements in an urban setting negatively influences coherence, but positively influences other restorative characteristics, for example escape and fascination, which in turn could lead to an enhancement of restorative effects. Future research could examine whether this is indeed the case.

Practical implications of this study are that practitioners involved in designing environments should pay special attention to factors that influence perceived coherence and restorativeness. This study demonstrates how restorativeness of an environment can deteriorate when elements that disharmonize with the environment are introduced. An obvious implication is that landscape architects or urban planners should especially be aware of the diminishing effect of placing elements in a surrounding where they become disharmonious (e.g. unnatural design furniture in parks), but the current findings may also be relevant for interior designers, as perceived coherence and other restorative characteristics is likely to also play an important role in indoor places.

In this study we took a first step in systematically examining how physical features are related to restorative characteristics and restorative effects. We found preliminary evidence that certain physical features of environments can influence the restorative effects via restorative characteristics (i.e. coherence). Knowledge about what specific features of environments positively influence restorative experiences is very valuable as it can be used to design healthy environments.

.

Chapter 5

Physical features, perceived coherence, and preference for abstract stimuli

Chapter 5 is based on Pals, R., Steg, L., Siero, F., & Van der Zee, K. I. (submitted). Physical features, perceived coherence, and preference for abstract stimuli.

Abstract

Research showed that there is a relationship between perceived coherence of environments and preference for these environments. We aimed to examine how specific physical features influence coherence and preference, and to get more insight into the specific role of each physical feature individually. Seventy participants evaluated perceived coherence of and preference for 24 pictures with geometrical shapes of which we manipulated the variety of colors (one or six), the variety of shapes (one or six), and way the shapes were organized on the paper (orderly versus chaotic). Unity in color and shapes, and an orderly organization resulted in higher ratings of perceived coherence. Unity in shapes also resulted in higher preference ratings, whereas, *variety* in colors resulted in higher preference ratings. There was no significant effect of organization on preference. Organization appeared to contribute most to the coherence judgments, followed by shape and color. As for the preference judgments, color contributed most strongly, closely followed by shape. In contrast to our expectation we did not find support that the effects of physical features on preference were mediated by coherence. These findings show that more coherent stimuli are not necessarily more preferred. Scientific and practical implications are discussed.

People often prefer a hotel room with a view on the ocean over a hotel room with an urban view, and rather go the forest instead of the city center when they feel the need to relax. What do these preferences tell us? Environmental preferences seem to reflect a functional aesthetic: they signal conditions relevant to well-being (Hartig et al., 2010). Indeed, individuals seem to have a strong preference for natural environments (Kaplan, Kaplan, & Wendt, 1972; Purcell, Peron, & Berto, 2001; Ulrich, 1983). Nature is also found to have a positive influence on stress reduction (Ulrich, Simons, Losito, & Fiorito, 1991), restoration from mental fatigue, and the experience of positive emotions (Hartig, Mang, & Evans, 1991; Hartig, Evans, Jamner, Davis, & Gärling, 2003). Thus, people seem to prefer environments that elicit positive health effects, or so called *restorative* effects. An important next question is: What physical features cause these preferences? Insight on the relationship between physical features and preference could be useful when designing "healthy" environments.

There is a large body of literature on the relationship between environmental features and preference for environments (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, Daniel, & Schroeder, 1984). This physical-perceptual approach identifies various specific characteristics of the environment that positively affect aesthetic judgments and preference. For example physical landscape characteristics such as the presence of water or vegetation appear to predict preferences for environments (Bell, Greene, Fisher, & Baum, 2001). However, a theory on *why* people prefer certain physical characteristics is lacking in the physical perceptual approach. In this study we try to further develop a theoretical framework regarding restorative environments, by integrating the physical-perceptual approach and the Attention Restoration Theory.

The Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) identifies certain restorative characteristics that appear to be positively related to preference for environments. These restorative characteristics are: coherence, fascination, novelty, escape, and compatibility (Kaplan & Kaplan, 1989; Laumann, Gärling, & Stormark, 2001; Pals, Steg, Siero, & Van der Zee, 2009). The ART (Kaplan & Kaplan, 1989) proposes that natural environments score higher on these restorative characteristics which may explain why people have a strong preference for natural environments. An important next question is, how are physical features related to restorative characteristics and preference? As most studies on restorative environments compare natural environments with urban environments, whose physical features differ greatly, we can only speculate what specific physical characteristics account for differences in restorativeness between these environments.

In the current study we will examine how physical features influence coherence and preference. C*oherence,* one of the key restorative characteristics described in the ART, refers to the degree of harmony between all elements in the environment. In a coherent environment all elements go well together and contribute to a larger whole or theme. We propose that coherence is especially relevant for practitioners (e.g. urban planners or architects) as we expect that coherence can relatively easily be enhanced or deteriorated by the design of environments. For example, Pals and colleagues (Pals, Steg, Siero, & Van der Zee, under review) have examined how introducing elements in an environment that disharmonize or harmonize with the setting influence coherence and preference for the setting. They found that introducing metal modern design street furniture (e.g. benches, fences, and garbage bins) in a natural setting diminished the perceived coherence of as well as the preference for the setting. In addition, self-reported restoration and experienced pleasure were lower in the setting with metal furniture, compared to an environment without furniture. Introducing wooden natural design furniture in a natural environment also slightly diminished the perceived coherence of the setting, but less compared to metal furniture. Interestingly, there was no significant difference in preference for the setting with wooden furniture and the setting without furniture.

Why does metal furniture in a natural setting negatively influence coherence and preference while wooden furniture in a natural setting does not reduce preference? It is likely that the sharp shapes of the mental benches created a contrast with the natural shapes that were visible in the environment, thereby deteriorating the coherence of the environment. Another explanation might be that the color of the metal benches disharmonized with the colors in the natural environment. As Pals and colleagues (under review) manipulated both the shape and the material (which differs in color and texture) of the furniture simultaneously, it remains unclear whether the effect of the furniture on perceived coherence and preference was caused by the shape or the material of the furniture, or the combination of both. To better understand how specific features (such as color, shape and regularity) influence coherence and preference, and to get more insight into the specific role of each physical feature individually, we wanted to examine this systematically on a more abstract level. The aim of the current study is to examine how physical features of abstract stimuli influence perceived coherence of and preference for these stimuli.

What physical features will we focus on? We reason that nature might be more coherent, because in nature there is typically a strong degree of harmony of colors and (natural) shapes, and in nature all elements are organized in a predictable way. That is why we will to examine three specific features of abstract stimuli: color (one or six), shape (one or six), and organization (systematic versus chaotic). We expect that perceived coherence and preference for stimuli will be highest when the shapes in the picture are similar and all have the same color, and when these shapes are neatly organized. Additionally, we will examine the relative contribution of each physical attribute for judgments of coherence and preference. In other words, what physical feature influences coherence and preference most strongly?

Furthermore, based on the ART, we expect physical features to influence preference *via* coherence. After all, restorative characteristics are based on the interaction between the observer and the environment. Physical features may influence coherence, in turn influencing preference. Pals et al. (under review) found some initial evidence that perceived coherence mediates the relationship of physical attributes on preference for environments. In the current study we examine whether the effect of physical features on preference for abstract stimuli is also *mediated* by perceived coherence. We expect to find a positive relationship between perceived coherence and preference, and we expect that perceived coherence will mediate the relationship between physical features and preference.

Method

Participants, design, and procedure

Seventy Psychology students (57 female, 13 male; mean age 21.21; age range 19 – 26 years) participated in this study in exchange for course credits. The experiment had a 2 (color: one versus six different colors) x 2 (shapes: one versus six different shapes) x 2 (organization: orderly versus chaotically organized) within-subjects design[1].

We designed eight types of abstract pictures (6 by 6 cm). In each picture were 36 geometrical shapes of which we manipulated the color, the shapes, and way the shapes were organized on the paper (see Table 1). Of each stimulus type we designed three versions, leading to a total of 24 pictures. For example stimulus type A consisted of 36 orderly organized small squares (6 rows of 6 squares), all in the same color (yellow, red, or blue). Stimulus type B consisted of 36 similar colored squares, scattered around the paper. Stimulus type H consisted of 36 different geometrical shapes (squares, triangles, circles, lightning bolts, stars, and stones), six different colors (yellow, red, blue, orange, purple, and green), scattered around the paper.

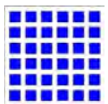
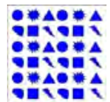
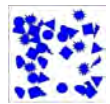
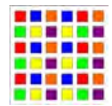
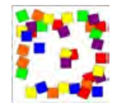
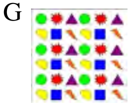
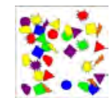
Upon arrival participants filled out an informed consent form. Then participants evaluated the coherence of and their preference for all 24 pictures in a random order. After evaluating all pictures, participants filled out their gender and age.

Measures

The coherence of each stimulus was measured using the following 7-point single item Likert scale “I find this picture coherent” (1 = totally disagree, 7 = totally agree). Preference for each stimulus was measured using a single item seven-point Likert scale “I find this picture attractive”. Mean scores were calculated for the evaluations of coherence and preference of the three versions of each stimulus type. The reliabilities of the scales were acceptable to good (see Table 1).

[1] In this study we also manipulated novelty. Before participants were asked to evaluate coherence and preference for the target stimuli, all participants were asked to categorize a number of pictures. Half of the participants had to categorize the target stimuli, the other half of the participants had to categorize unrelated pictures (bicycles, cars, flowers, and birds). As we did not find significant main effects for the novelty manipulation, we concluded that the manipulation failed. Therefore these results will not be reported. However, in all analyses we controlled for the novelty manipulation.

Table 1. Mean and Chronbach Alpha Scores (in brackets) for Coherence and Preference, for the Eight Stimuli Types.

	1 color				6 colors			
	1 shape		6 shapes		1 shape		6 shapes	
	orderly	chaotically	orderly	chaotically	orderly	chaotically	orderly	chaotically
Stimulus	A 	B 	C 	D 	E 	F 	G 	H 
Coherence	5.63 (.91)	3.63 (.79)	4.19 (.81)	2.75 (.82)	4.75 (.64)	3.27 (.76)	3.85 (.80)	2.51 (.80)
Preference	3.12 (.80)	3.16 (.62)	2.66 (.88)	2.62 (.69)	4.06 (.70)	3.58 (.73)	3.09 (.85)	3.25 (.82)

Statistical Analyses

First, repeated measures analyses were conducted to examine if the coherence and preference judgments, respectively, were influenced by the three physical features (color, shape, and organization). Second, we conducted two conjoint analyses to examine to what extent each physical feature (color, shape, and organization) contributed to the coherence and preference judgments, respectively. Conjoint analysis is a decompositional method that estimates the structure of individual preferences in an indirect way (Green & Srinivasan, 1990; Louvriere, 1988). The basic idea of conjoint analysis is that evaluations of a particular stimulus (in the current study: the perceived coherence of and preference for abstract stimuli) are built up by the independent contributions of different attributes (in this case: the three physical features of the abstract stimuli), each with a limited number of levels (in the current study each physical feature had two levels) that are systematically varied in the stimuli provided to respondents (Steg, Dreijerink, & Abrahamse, 2006). Third, we conducted a multilevel mediation analysis (Baron & Kenny, 1986) using MLwin to examine whether the effect of physical features on preference was mediated by coherence.

Results

Effects of Color, Shape and Organization on Coherence and Preference

Repeated measures analysis confirmed our hypothesis and revealed significant main effects of color ($F(3,65) = 22.16$, $p < .001$, $\eta_p^2 = .26$), shape ($F(3,65) = 102.17$, $p < .001$, $\eta_p^2 = .60$), and organization ($F(3,65) = 107.85$, $p < .001$, $\eta_p^2 = .62$) on perceived coherence. Unity in color as well as unity in shapes resulted in higher ratings of perceived coherence, and an orderly organization resulted in higher ratings of perceived coherence.

Repeated measures analysis showed that there were significant main effects of color ($F(3,66) = 24.19$, $p < .001$, $\eta_p^2 = .26$) and shape ($F(3,66) = 27.23$, $p < .001$, $\eta_p^2 = .29$) on preference for the abstract stimuli. Opposite to what we found for perceived coherence, *more* colors resulted in higher preference ratings. In line with our hypothesis, shape influenced preference in the same direction as what we found for perceived coherence: Unity in shapes resulted in higher preference ratings. There was no significant effect of organization on preference.

Relative Contributions of Color, Shape, and Organization on Coherence and Preference Judgments

First, we examined the extent to which each physical feature contributed to the coherence judgments. The conjoint analysis showed that organization contributed most to the coherence judgments, as it had the highest importance value (46.99), followed by shape (30.17), and then color (22.84; See Table 2). Perceived coherence ratings were highest when the stimulus had one color, one shape, and when the figures were organized in an orderly way (see Table 3 for utility estimates). The model fit was good (Pearson's $r = .99$, $p < .001$; Kendall's tau = 1.00, $p < .001$)[2].

Second, we examined the relative importance of each physical feature on preference evaluations. This time color had the highest importance value (36.58), closely followed by shape (33.67), and organization (29.76; See Table 3). The model fit was good (Pearson's $r = .96$, $p < .001$; Kendall's tau = .64, $p < .01$). Preference ratings were highest when the stimulus had six different colors and one shape. The way the shapes were organized hardly affected preference judgments (see Table 3 for utility estimates).

[2] Pearson's *r* and Kendall's tau indicate the fit of the conjoint model and reflect the relationships between the observed and estimated judgments (in this case: perceived coherence and preference, respectively). Judgments are estimated as follows. First, utility estimates (or part-worth scores) are multiplied with 1 if the stimulus has a specific characteristic, and with 0 if the stimulus does not have the specific characteristic. Second, these product scores are added to the constant (also printed in Tables 2 and 3). For example, the perceived coherence judgment of stimulus A (one color, one shape, orderly organized, see Tables 1 and 2) is estimated as follows: 3.82 + (.23 x 1) + (-.23 x0) + (.50 x 1) + (–.50 x0) + (.78 x1) + (-.78 x 0) = 5.33.

Table 2. Utilities and Average Important Scores of Physical Features for Perceived Coherence of Abstract Stimuli

Physical Feature and Level		Utility Estimates	Average Importance
1. Color	one color	.23	22.84
	six colors	-.23	
2. Shape	one shape	.50	30.17
	six shapes	-.50	
3. Organization	orderly	.78	46.99
	chaotically	-.78	
Constant		3.82	

Table 3. Utilities Estimates and Average Important Scores of Physical Features for Preference for Abstract Stimuli

Physical Feature and Level		Utility Estimates	Average Importance
1. Color	one color	-.30	36.58
	six colors	.30	
2. Shape	one shape	.29	33.67
	six shapes	-.29	
3. Organization	orderly	.04	29.76
	chaotically	-.04	
Constant		3.19	

Mediation

For organization mediation could not be established, because organization appeared to be not significantly related to preference (see above). Multilevel analyses showed that the effects of shape and color on preference for the abstract pictures were not mediated by coherence.

Discussion

The aim of the current study was to get more insight into relations between specific physical features, coherence, one of the key components of the ART (Kaplan & Kaplan, 1989), and preference. By examining how physical features influence restorative characteristics and preference, we could ultimately gain more knowledge about how to enhance the restorative quality of stimuli, as there is a strong link between preference for and the restorative quality of environments (Hartig et al., 2010). Most studies on restorative environments compared urban environments with natural environments. These environments differ on a great number of aspects, which makes it difficult to conclude which environmental features cause differences in restoration. To understand how specific physical features influence restorative characteristics and preference, researchers have to systematically manipulate these physical features in a controlled setting. In the current study we have examined relationships between physical features, restorative characteristics, and preference, focusing on coherence.

Pals and colleagues (under review) used virtual reality to examine relations between physical features, coherence, and restoration. They found that placing metal modern design furniture (e.g. benches) in a natural setting diminishes perceived coherence and the restorative quality of the setting. In their study, however, both the shape, the color and texture of the furniture were manipulated. To get more insight into how each physical feature influences perceived coherence and preference individually, we have examined this at a more abstract level. The aim of the current study was to examine how specific physical features influence perceived coherence and preference for abstract stimuli. Three physical features were examined: color (one or six), shape (one or six), and organization (orderly versus chaotic).

The results of this study showed that the use of a single color and similar shapes had a positive influence on perceived coherence. Additionally, when the shapes were organized in an orderly fashion perceived coherence was higher than when the shapes in the pictures were scattered chaotically. Thus, as expected, perceived coherence ratings were highest when the stimulus had one color, one shape, and when the figures were organized in an orderly way. The organization of the geometrical shapes in the picture contributed most to the coherence judgments, followed by shape, and then color.

For preference we found a different pattern of results. In line with our hypothesis, we found that people preferred pictures with similar shapes. Most interestingly, the effect of color on preference was opposite to the effect of color on perceived coherence. Whereas unity in color resulted in higher coherence ratings, a *variety* of colors resulted in higher preference ratings. So, preference ratings were highest when the stimulus had six different colors and one shape. Color appeared to contribute most to the preference judgments, closely followed by shape. The way the shapes were organized did not significantly influence preference for the abstract stimuli.

Apparently, more coherence does not necessarily result in higher preference. That is, when there was no variation in color these pictures were evaluated as more coherent, but preference for these pictures was lower. Possibly, variation in color influenced other restorative characteristics that may have influenced preference as well. For example, it might be that although variation in color reduced coherence, it may have enhanced fascination, resulting in an increase in preference. In this study we focused on one restorative characteristic in particular (i.e. coherence), as we expected that the physical features we manipulated would especially affect coherence. However, it is likely that manipulations of physical features affect different restorative characteristics simultaneously. Even though there are often strong relationships among the restorative characteristics (Pals et al., 2009), certain manipulations of physical features of a stimulus (or environment) may not always influence every restorative characteristic in the same direction. This issue needs to be addressed in future research where effects of physical features on all restorative characteristics are included.

The results from this study suggest that people prefer coherence, but only up to a certain extent. When a stimulus (or environment) is too coherent, people may find it less attractive or even boring. In other words more coherence is not always better. Our findings seem to contradict earlier findings of Pals et al. (under review) that showed that more coherent (natural) environments are also more strongly preferred. The natural environments that Pals and colleagues (under review) used in their study were perceived as highly coherent, but nevertheless these environments had more variation than the abstract pictures used in the study described here. It is likely people preferred the natural environments because these environments were sufficiently coherent but still had enough variation to keep them interested. This would suggest that people prefer moderately coherent stimuli with an optimal level of variation.

The idea that individuals prefer moderately coherent stimuli is in line with a study by Hagerhall and colleagues (Hagerhall, Purcell, & Taylor, 2004) who found that there is a relationship between preference and the fractal dimension of landscapes. In a fractal structure similar shapes recur at different scales of magnitude (i.e. scale invariance). Zooming in on a fractal, at each scale level a structure appears that is more or less similar to the global form of the fractal (i.e. self-similarity). For example, a side branch of a tree is similar to the whole tree. A smaller branch is again more or less a copy of the side branch, and so on. These fractal structures are organized in an orderly and predictable way, which may positively influence coherence, but there is still variation in the fractal structures due to the variation in scale levels. There is initial evidence that people prefer moderately complex (or coherent) fractal structures (Hagerhall et al., 2008; Joye, 2007). This suggests that an fractal structure with an optimal level of variation is most preferred. Similarly, Berlyne (1971) proposed that preferences for stimuli with certain arousal evoking characteristics follow an inverted U-pattern. This would suggest that highly coherent and highly incoherent stimuli are least preferred, and moderately coherent stimuli are most preferred.

In the current study we did not find support for our hypothesis that the effect of physical features (color and shape) on preference were mediated by coherence. For color it was less likely that its effect was mediated by coherence, as color had an opposite effect on coherence compared to preference. Shape influenced coherence and preference in the same direction, but we did not find a significant mediation effect.

This is in contrast with results of the study by Pals and colleagues (under review) who did find that coherence mediated the effect physical features (i.e. furniture type) on preference of a natural environment. A possible explanation is that the range in perceived coherence of the different environmental conditions in the study by Pals et al. (under review) was smaller compared to the range in perceived coherence of the abstract stimuli used in the current study. In the study by Pals and colleagues all three environments scored moderately high on coherence, with scores ranging from 4 to 5.2 on a scale from 1 to 7. The range in perceived coherence of the abstract stimuli used in the current study was much broader: ranging from very incoherent to very coherent (2.5 and 5.6 respectively, on a scale from 1 to 7). It is likely that there is a linear relationship between physical features (color, shape, and organization) and coherence, with less variation in color, shapes and an orderly organization leading to higher coherence ratings, but a curve-linear relationship between physical features and preference, with too little as well as too much variation leading to lower preference ratings. This is in line with Berlyne's proposal (1971) that preferences for stimuli follow an inverted U-pattern, as explained above. The broad range in coherence of the abstract stimuli used in the current study could lead to a weakened relationship between coherence and preference. So, the broad range in coherence may explain why in the current study we did not find that coherence mediated the relationship between physical features and preference, whereas Pals and colleagues (under review) did find a mediation of coherence the relationship between physical features and preference.

In the current study we have systematically examined how color, shapes, and regularity influenced perceived coherence and preference for abstract pictures. Unity in shapes and colors, and an orderly organization enhanced coherence, whereas unity in shapes and *variety* in color enhanced preference. To examine whether the results we have found in this study can be generalized to real environments, future research could examine the effects of specific physical features, such as color, shape, and regularity on restorative characteristics and preference in (real or virtual) environments. Researchers could, for example, manipulate the shapes, colors, and patterns of wallpaper and furniture in a room and examine how this affects perceived coherence and preference for the setting. Also researchers could examine how variation in color and shapes, and organization of environmental features influence perceived coherence preference for landscapes or urban settings.

In this study we have developed a theoretical framework on environmental preferences that integrated the physical-perceptual approach with the Attention Restoration Theory. We showed how physical features can influence perceived coherence and preference. To our knowledge we are one of the first that have experimentally examined causal relationships between physical features, restorative characteristics (i.e. coherence), and preference or other indicators of restorativeness (for exceptions see Herzog, Hayes, Applin, & Weatherly, 2011; Pals, et al. under review). As we have focused on one of the five restorative characteristics (i.e. coherence), more studies are needed to further develop and test the theoretical framework. Future research should study how physical features influence other restorative characteristics (i.e. fascination, novelty, escape, and compatibility) and preference. To further establish the relationship between preference and the restorative quality of environments (Hartig et al., 2010; Van den Berg, Koole, & Van der Wulp, 2003), also the relationships between other indicators of restorative quality such as positive affect and restoration from mental fatigue should be taken into account.

The results of this study have important practical implications, in particular for designers, urban planners and architects. In order to increase the perceived coherence and preference of settings, designers should attempt to find an optimal level of harmony and diversity, for example by using similar shapes, orderly organization and variation in color. Insight into the causal relationships between specific physical features, restorative characteristics and preference is very valuable. as there appears to be a strong link between restorative characteristics of and preferences for environments and positive health effects (Hartig et al., 2010). Therefore knowledge about what physical features can enhance restorative characteristics and preferences could ultimately help to design "healthy" environments.

.

Chapter 6

General Discussion

Our environment has a great impact on our well-being. Especially nature appears to have a positive influence on restoration from stress and mental fatigue, and our emotional well-being (Hartig, Evans, Jamner, Davis, & Gärling, 2003; Ulrich, 1984; Ulrich, Simons, Losito, & Fiorito, 1991). Moreover, people tend to have a preference for environments that enhance well-being, such as nature. Why does nature have these restorative effects, such as restoration from stress and mental fatigue, pleasurable experiences, and preferences for the environment? And what characteristics of environments contribute to these *restorative* effects? Knowledge about what kinds of environmental features positively influence our well-being and why they do so is valuable, as it can be used to design "healthy" environments.

The ART proposes that restorative effects are more likely to occur in environments that score higher on so-called restorative characteristics. Kaplan and Kaplan (1989) proposed that various *restorative characteristics* of environments promote attention restoration (Kaplan & Kaplan, 1989). Based on work by Kaplan and Kaplan and Laumann and colleagues (Kaplan & Kaplan, 1989; Laumann, Gärling, & Stormark, 2001), I have distinguished the following five restorative characteristics:

1. *Coherence:* there is a high degree of harmony between all elements in the environment,
2. *Fascination:* there are elements present that attract your attention effortlessly,
3. *Novelty:* the environment differs from your daily environment,
4. *Escape:* the environment allows you to free your mind from everyday hassles,

5. *Compatibility:* there is a match between what you *can* do and what you *want* to do in the environment.

In an environment that incorporates these restorative characteristics, people do not have to rely on *directed attention*, which requires effort. Instead, attention is drawn and held effortlessly. Therefore restorative effects (i.e. restoration from mental fatigue, positive affect and preference for the environment) will more easily occur. Several scholars have attempted to measure restorative characteristics of environments, and examined relationships between restorative characteristics and certain restorative outcomes (Hartig, Korpela, Evans, Gärling, 1997a; Laumann et al., 2001). However, there was not a measure available that captures the *five* restorative characteristics as they have emerged from research and theorizing in recent years (Laumann et al., 2001). This thesis aimed to develop and test an instrument to measure perceived restorative characteristics of environments.

Restorative characteristics (i.e. fascination, novelty, escape, coherence, and compatibility) are mental constructs, referring to an interaction between the individual and the environment. As such, they provide no clear guidelines on what physical features of environments are of key importance in the restorative process. Coherence, for example, reflects an individual's *perception* of the level of harmony in the environment, and does not indicate what environmental features make the environment more or less coherent. Therefore the restorative characteristics do not provide clear guidelines on how to improve an environment in order to enhance its restorative potential. For practitioners, it is highly important to understand which *physical characteristics* influence restorativeness of environments, because this reveals how the restorative quality of environments can be improved by changing particular physical features.

The physical-perceptual approach examines relationships between physical features of environments and *preference* judgments for environments. Typically, research that uses a physical-perceptual approach compares different types of environments, and analyses how physical environmental features are related to preference judgments for the environments (Daniel & Vining, 1983). An advantage of the physical-perceptual approach compared to the ART is that it does identify objective characteristics of the environment that positively affect environmental preferences. However, a theory on *why* people prefer certain physical characteristics is lacking. Furthermore, the physical-perceptual approach only focuses on preference and not on the other restorative effects (i.e. restoration and pleasure). As there appears to be a relationship between preference and the other restorative effects (restoration and pleasure; Laumann et al. 2001; Purcell, Peron, & Berto, 2001), I expected that certain physical environmental features will influence preference and the other restorative effects in a similar way.

In this thesis I have made some first steps towards integrating the Attention Restoration Theory, with the physical-perceptual approach (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, Daniel, & Schroeder, 1984). More specifically, I proposed that physical features influence the cognitive constructs described in the ART (i.e. the restorative characteristics: fascination, novelty, escape, coherence, and compatibility) which in turn influence restorative effects (restoration, pleasure, and preference), depicted in the Physical-Perceptual Restoration model (PPR; see Figure 1). I have tested parts of the Physical-Perceptual Restoration model in Chapter 2 and 3. In Chapter 4 and 5 I tested entire model focusing on a key restorative characteristic, namely coherence. In Chapter 4 I focused on how physical features influence coherence, preference, pleasure and restoration. In Chapter 4 I focused on the relationship between physical features, coherence, and preference.

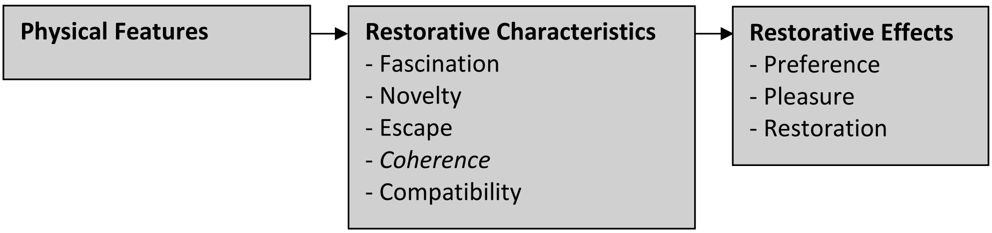


Figure 1. The Physical-Perceptual Restoration Model

Additionally, I have examined whether restorative characteristics mediate the relationship between physical features and restorative effects of environments. Based on the ART, one would expect physical features to influence restorativeness (preference, pleasure, restoration) *via* restorative characteristics. After all, restorative characteristics are based on the interaction between the observer and the environment. Therefore I argue that physical characteristics of the environment are likely to influence the perceived restorative characteristics of the environment, in turn influencing restorative effects (preference, pleasure, and restoration). If this is indeed the case, this will provide a theoretical basis and practical insights on how to lift restorativeness of environments.

Aims of this thesis

The first aim of this thesis is to develop suitable measures and tools to accurately examine relationships between specific physical features, restorative characteristics, and restorative effects of environments. To achieve this aim, I have first developed and tested a questionnaire that aims to measure the *five* perceived restorative characteristics of environments on the basis of current theoretical and empirical developments in the restorative environments literature (Kaplan & Kaplan, 1989; Laumann et al., 2001).

Next, I have examined the validity of Virtual Reality (VR) as a tool to study relationships between physical characteristics, restorative characteristics and restorative effects. VR is an artificial environment generated by computer software, presented in such a way that the user is able to interact with the environment similar as with a real environment. There are two major advantages of using VR in research on restorative environment, compared to field experiments in real environments. First, in VR researchers can exert more control over other factors that might influence the results, and second, researchers can more easily manipulate physical features of the environments. When conducting experiments in VR, it is important to examine whether experiences in virtual environments are similar to experiences in real environments. Because VR is a relatively new tool, research on its validity, especially in the field of environmental psychology, is scarce. As a second step in developing measures and tools I have tested the validity of VR as a tool to study restorative environment experiences. In this thesis, I have focused on zoo attractions (e.g. a butterfly garden, baboon attraction) as a particular example of natural environments. As zoo attractions are natural environments designed by humans, findings can be directly translated into guidelines for design.

The second aim of this thesis was to use the newly developed measures and tools to provide a first test of the Physical-Perceptual Restoration model (Figure 1). More specifically, I focused on the influence of physical features on one of the restorative characteristics: coherence. I have examined how physical features (such as the presence and the design of street furniture) influence coherence, and restorative effects (restoration, pleasure, and preference). To examine the relationships between specific physical features and restorativeness more in depth, I have examined how physical features (such as color, shape, and organization) influence coherence and preference for abstract pictures. I will now discuss the main findings of this thesis.

The development of the PRCQ

A first requirement for accurately examining relationships between physical features, restorative characteristics, and restorative effects is to have an instrument that accurately measures the five restorative characteristics of environments. Chapter 2 describes the development of the Perceived Restorative Characteristics Questionnaire (PRCQ) that aims to measure perceptions of five restorative characteristics (fascination, novelty, escape, coherence and compatibility) of environments. This questionnaire was administered in two studies in two distinct settings (zoo attractions). To examine whether the questionnaire indeed provides reliable indicators of the five restorative characteristics, I explored the reliabilities of the subscales, as well as the underlying factor structure. Moreover, I examined whether the scales were able to predict the three restorative outcomes: pleasure, preference, and restoration.

In both settings in which the PRCQ was administered, the five subscales aimed to measure the five restorative characteristics appeared to be reliable. Furthermore, four out of five factors (fascination, novelty, escape, and coherence) could clearly be distinguished empirically. Although the reliability of the compatibility scale was good, compatibility could not be empirically distinguished as a separate restorative characteristic in either study. This might be due to conceptual problems. In Chapter 2 compatibility was defined as the fit between the person and the environment, including four aspects of compatibility (i.e. information-fit, motivation-fit, clear behavioral norms, and expectation-fit). Although these four aspects reflect different aspects of compatibility, they may not all be present in a given situation. For example, an environment may score high on information-fit, while at the same time behavioral norms are not clear. Future research should reconsider the concept of compatibility, examine which dimensions of compatibility are of key importance for restorativeness, and develop more accurate definitions and measures of this multidimensional concept. This may result, for example, in narrowing down the definition of compatibility, or by developing four different subscales to measure each aspect of compatibility separately.

In the following chapters I found additional support for the reliability and the validity of the PRCQ. In Chapter 3 the PRCQ was applied to evaluate the restorative characteristics of four environments: a butterfly garden, a shopping center, a virtual butterfly garden and a virtual urban neighborhood. The subscales of the PRCQ appeared to be reliable measures to evaluate the perceived restorative characteristics of all four environments. In chapter 3, however, I excluded compatibility from the analyses, as compatibility was expected to be irrelevant in virtual environments because the ways in which one can interact with virtual environments are still limited. For example, it is not (yet) possible to touch, pick or smell virtual flowers, something that one might like to do in a real environment. So, in a virtual environment you are not (yet) able to do all the things you could do in a real environment. In Chapter 4 I focused on one key component of the ART (coherence). I used the coherence subscale of the PRCQ to measure perceived coherence of three natural environments. Again I found that the reliability of the scale was high.

Additionally I examined whether the PRCQ was a valid tool to predict restorative effects of environments. Results from Chapter 2 and Chapter 3 revealed that the PRCQ was able to predict experienced pleasure and restoration in, and preference for various settings, suggesting that the PRCQ is a suitable tool to evaluate the restorative potential of environments. The predictive value of the restorative characteristics will be discussed in more detail below.

In sum, the PRCQ appeared to be a reliable and valid instrument that can be used to evaluate restorative characteristics of environments. I employed the PRCQ in the studies reported in Chapter 2, 3, and 4.

Validating Virtual Reality

As a next step in developing valid measures and tools for restorative environments research, in Chapter 3 I have tested the validity of Virtual Reality (VR) as a tool to examine relations between physical features, restorative characteristics and restorative effects of environments. In VR researchers can exert more control and they can manipulate features of environments more easily compared to real settings. That is why VR may be an ideal tool for research on restorative environments, especially for testing the effect of physical features on restorativeness. However, before we can draw conclusions that VR is an ideal tool for conducting experiments on restorative environments, it is important to examine whether findings derived from virtual environments can be generalized to real environments. To find out if virtual reality can be used for restorative environments research I have compared perceived restorative characteristics and restorative effects of a *real* natural environment (a butterfly garden) and urban environment (shopping center) with a *virtual* natural environment (a butterfly garden) and urban environment (residential area).

I was able to show that virtual environments elicit similar effects as real environments. First, I found that the restorative characteristics ratings were higher for the real natural environment than the urban environment. Additionally, preference ratings, experienced pleasure, and restoration were also higher in the real natural environment compared to the urban environment. As expected, these findings were replicated for the virtual natural and urban setting. Restorative characteristics ratings were higher for the *virtual* natural environment than the *virtual* urban environment, and preference ratings, experienced pleasure, and restoration were also higher in the *virtual* natural environment than the *virtual* urban environment. This suggests that the differences we found in restorative quality between virtual natural and urban environments could be generalized to similar real environments.

Second, I found that perceived restorative characteristics generally predicted restorative effects (preference, pleasure, and restoration) for real environments, as well as for *virtual* environments. Third, I found that the same predictors that explained restorative effects in virtual environments appeared to explain restorative effects in real environments. Fourth, I reasoned that perceived restorative characteristics and restorative effects of the real environment should resemble the perceived restorative characteristics and restorative effects of its *virtual* equivalent. As the virtual butterfly garden was inspired on the real virtual butterfly garden, we were able to make a direct comparison of the restorative characteristics and restorative effects between these two environments. As expected, we did not find evidence for differences between the virtual natural environment and the real environment it represented in terms of perceived restorative characteristics, preference, pleasure, and restoration. This indicates that the perception of restorative quality of virtual environments was similar to the perception of the restorative quality of the real environments it represented.

In conclusion, this study provided support for the notion that virtual reality is a valid tool for restorative environments research. Relying on the PRCQ and VR I was able to accurately examine relationships between physical features, restorative characteristics, and restorative effects in the next studies.

Testing the Physical-Perceptual Restoration model

The relationship between restorative characteristics and restorative effects

First, I examined relations between perceived restorative characteristics (fascination, novelty, escape, coherence, and compatibility) and restorative effects. With the PRCQ I assessed people's perceptions of restorative characteristics of different settings and tested whether these perceived restorative characteristics could predict preference for the particular setting, and the extent to which people experienced pleasure and restoration from mental fatigue while they were in the setting. To test the robustness of the findings these relations were examined in different settings (e.g. a butterfly garden, a shopping center, a virtual butterfly garden, and a virtual residential area).

The data provided strong support for my hypothesis that restorative characteristics are good predictors of restorative effects in diverse settings. Overall, environments that scored highly on restorative characteristics were more strongly preferred. Additionally, people stated that they experienced more pleasure and were better able to restore in settings that scored high on restorative characteristics. However, the restorative characteristics of the two urban settings (the shopping center and the virtual residential area) were unable to predict preference for these two settings. It is imaginable that people prefer urban settings for other reasons than they prefer natural settings, suggesting that the strength of the relationship between restorative characteristics and preference might depend on the specific setting. For example, people (especially those people with a high need for restoration; Hartig & Staats, 2006) may prefer natural environments that score high on restorative characteristics *because* it offers the opportunity for restoration. People might prefer urban settings because those settings fulfill other needs than restoration, for example more functional needs related to shopping and living.

Interestingly, the PRCQ could predict more variance in preference and restoration than in pleasure. This might be due to the fact that perceived restorative characteristics, preference and restoration ratings are all cognitive evaluations while pleasure is an affective evaluation. It is likely that cognitive evaluations are more strongly inter-related than cognitive and affective evaluations. Other factors could also affect affective responses, such as mood or previous experiences that day.

Especially escape, and to a lesser extent fascination, appeared to be a good predictor of preference, pleasure and restoration. One could argue that fascination and escape describe the psychological experience of an individual in the environment, while coherence and novelty, on the other hand, are more strongly based on the evaluations of physical characteristics of the environment. This could explain why escape and fascination might be more predictive for preference, pleasure and restoration than the other restorative characteristics. For example, when you are in an environment that is very different from your daily environment (novelty) you might be able to let go of unwanted thoughts (escape), allowing you to restore from mental fatigue (restoration). This suggests that the restorative characteristics should not be considered at the same hierarchical level, as proposed in the ART (Kaplan & Kaplan, 1989). Rather, it is possible that the evaluation of physical characteristics of the environment (coherence and novelty) influence the experience of the environment (escape and fascination) in turn influencing restorative effects. Future research should examine this assumption and explore the causal relationships *among* perceived restorative characteristics, and investigate the hierarchical structure of the model.

Earlier studies mainly examined relationships between restorative characteristics and restorative effects of natural and urban environments (Hartig, Korpela, Evans, & Gärling, 1997a; Hartig et al., 2003; Laumann et al., 2001; Laumann, Gärling, & Stormark, 2003; Ulrich et al., 1991). The results in Chapter 2 and 3 showed that the restorative characteristics can also successfully predict the restorative quality of zoo settings and virtual environments. Furthermore, Chapter 2 and 3 show that restorative characteristics influence preference in a similar way as pleasure and restoration.

Manipulating physical features

To further examine the full Physical-Perceptual Restoration model, I have systematically manipulated physical features and examined how these physical features influenced restorative characteristics and restorative effects. I also tested whether the effects of physical features on restorative effects were indeed mediated by restorative characteristics. I focused on coherence, one of the key restorative characteristics. First I have examined the relationships between physical features, perceived coherence, and restorative effects (preference, pleasure, and restoration) by manipulating specific objects in a virtual natural environment. Next, I examined the relationships between physical features, perceived coherence and preference at a more abstract level, using pictures with geometrical shapes.

Manipulating physical features in a natural virtual environment

In Chapter 4 I examined how physical features (i.e. the presence and design of street furniture) of a *natural* setting influenced the perceived coherence of this environment and the occurrence of restorative effects (preference, restoration and pleasure). Additionally, I examined the *mediating* role of coherence on the relationship between physical features and restorative effects. Nordh and colleagues (Nordh, Hartig, Hagerhall, & Fry, 2009) found initial evidence that restorative characteristics mediate the effect of physical environmental features on restorative outcomes. They, however, did not systematically manipulate the physical components of the environments. Therefore the individual influence of each (physical) component on restorativeness remained unclear. By systematically manipulating physical features of the environment, I have tried to overcome this problem and was able to draw conclusions about the causal relationships between the specific physical features, perceived coherence, and restorative effects.

This study revealed, as expected, that the presence of disharmonizing furniture (i.e. metal benches, fences, and garbage-bins) in a natural setting appeared to negatively influence perceived coherence, compared to a natural setting without furniture. Additionally, I found that in comparison with a natural setting without furtniture, the presence of metal furniture diminished preference for the environment, as well as experienced pleasure and restoration. Furthermore, we found support for the mediating role of perceived coherence on the effect of *metal* furniture on the three restorative effects (preference, pleasure, and restoration), suggesting that physical features of environments indeed influence the restorative quality of environments *via* coherence. Interestingly, when the design of the furniture harmonized with the natural environment (i.e. wooden furniture), the perceived coherence of the environment slightly diminished, but there were no statistically significant effects of the wooden benches on preference, pleasure, and restoration compared to a natural environment without furniture.

Chapter 4 demonstrated how the perceived coherence and thereby the restorative quality of an environment can deteriorate when elements that disharmonize with the environment are introduced. Hereby I have found that physical features in the environment can indeed influence the restorative quality of the environment *via* restorative characteristics (i.e. coherence). Chapter 4 provides first evidence for the Physical-Perceptual Restoration model and provided clear evidence for the proposed causal relationships between physical features, coherence and restorative effects.

Manipulating physical features of abstract stimuli

Which specific physical features of the metal furniture that was placed in the natural setting negatively influenced coherence and restorativeness in Chapter 4? It is likely that the sharp shapes of the mental benches created a contrast with the natural shapes that were visible in the environment. Another explanation might be that the color of the metal benches disharmonized with the colors in the natural environment. As in Chapter 4 the shape, the color and the texture of the furniture was manipulated simultaneously it remains unclear whether the effect of the furniture on perceived coherence and preference was caused by the shape or the material (color and texture) of the furniture, or the combination of these physical features.

To better understand which specific features influence perceived coherence and preference, I examined this systematically on a more abstract level. More specifically, in Chapter 5 I examined how specific physical features of abstract pictures influenced perceived coherence of and preference for these pictures. Three features were examined: color (one or six), shape (one or six), and organization (systematic versus chaotic). To get more insight into the specific influence of the physical features on coherence and preference individually, I examined the relative contribution of each physical feature on evaluations of coherence and preference. Additionally, I examined whether perceived coherence mediated the effects of physical features on preference.

The results of Chapter 5 showed that the use of a single color and similar shapes had a positive influence on perceived coherence. Furthermore, when the shapes were organized in an orderly fashion perceived coherence was higher than when the shapes in the pictures were scattered chaotically. Thus, in line with my expectation, perceived coherence ratings were highest when the stimulus had one color, one shape, and when the figures were organized in an orderly way. The organization of the geometrical shapes in the picture contributed most to the coherence judgments, followed by shape, and then color.

For preference I found a different pattern of results. In line with my hypothesis, I found that people preferred pictures with similar shapes. Interestingly, the effect of color on preference was opposite to the effect of color on perceived coherence. Whereas unity in color resulted in higher coherence ratings, a *variety* of colors resulted in higher preference ratings. So, preference ratings were highest when the stimulus had six different colors and one shape. Color appeared to contribute most to the preference judgments, closely followed by shape. The way the shapes were organized did not significantly influence preference for the abstract stimuli.

Chapter 5 showed that more coherence does not necessarily result in a higher preference. There are several explanations for this finding. First, it is likely that manipulations of physical features affect different restorative characteristics simultaneously. Even though Chapter 2 showed that there is a strong positive relationship among the restorative characteristics, certain manipulations of physical features of a stimulus (or environment) may not always influence every restorative characteristic in the same direction. For example, variation of a specific physical feature, such as color, can negatively influence perceived coherence, while it positively influences fascination. This issue needs to be addressed in future research where effects of physical features on all restorative characteristics are examined simultaneously.

Second, the results from Chapter 5 suggest that people prefer coherence, but only up to a certain extent. This suggests that when a stimulus (or environment) is too coherent, people may find it less attractive or even boring. In other words, more coherence might not always be better. These findings seem to contradict the findings of Chapter 4 showing that more coherent (natural) environments were also more strongly preferred. The natural environments that were used in Chapter 4 were perceived as highly coherent, but nevertheless these environments had more variation than the abstract pictures used in the study described here. It is likely people found the natural environments preferable because these environments were sufficiently coherent but still had enough variation to keep them interested, whereas the abstract stimuli were highly coherent but lacked variation resulting in lower preference ratings. This would suggest that people prefer moderately coherent stimuli with an optimal level of variation.

The idea that people prefer moderately coherent stimuli is in line with studies on preference for fractal structures. In a fractal structure similar shapes recur at different scales of magnitude. Zooming in on a fractal, at each scale level a structure appears that is more or less similar to the global form of the fractal (i.e. self-similarity). For example, a side branch of a tree is similar to the whole tree, and a smaller branch is again more or less a copy of the side branch. So, in a fractal structure similar shapes recur in an orderly and predictable way, yet the scale of magnitude varies (i.e. scale invariance). It is likely that the similar shapes in the fractal structure positively influence coherence, and that the different sizes of the shapes create variation. An optimal combination of self-similarity (coherence) and scale invariance (variation) of the fractal structure may in turn enhance preference. There is evidence that people prefer moderately complex fractal patterns (Hagerhal et al., 2008; Joye, 2007). This supports the idea that a fractal structure with a low number of scale levels (for example a tree with side-branches, but without smaller side-branches) may be perceived as too coherent and therefore as boring, leading to low preference evaluations. A fractal with many different scale levels may be perceived as too incoherent and therefore as unpleasant, leading to low preference ratings. A similar line of argument was put forward by Berlyne (1971) who proposed that preferences for stimuli with certain arousal evoking characteristics follow an inverted U-pattern. This also suggests that highly coherent as well as very incoherent stimuli should be least appealing, whereas the moderately coherent stimuli should be the most appealing.

In Chapter 5 I did not find support for our hypothesis that the effect of physical features (color and shape) on preference were mediated by coherence. This is in contrast with the results of Chapter 4 revealing that coherence mediated the effect physical features (i.e. furniture type) on preference of a natural environment. A possible explanation is that the range in perceived coherence of the different environmental conditions in Chapter 4 was smaller compared to the range in perceived coherence of the abstract stimuli used in Chapter 5. In Chapter 4 all three environments scored moderately high on coherence. The range in perceived coherence of the abstract stimuli used in Chapter 5 was much broader, ranging from very incoherent to very coherent. It is likely that there is a linear relationship between physical features (color, shape, and organization) and coherence, with less variation in color, shapes and an orderly organization leading to higher coherence ratings, but a curve-linear relationship between physical features and preference, with too little as well as too much variation leading to lower preference ratings. The broad range in coherence of the abstract stimuli used in Chapter 5 could lead to a weakened relationship between coherence and preference. This could explain why in the Chapter 5 I did not find that coherence mediated the relationship between physical features and preference, whereas in Chapter 4 I did find that coherence mediated the relationship between physical features and preference.

In Chapters 4 and 5 I have further developed and tested the theoretical framework, the Physical-Perceptual Restoration model, on restorative environments. The Physical-Perceptual Restoration model integrates the physical-perceptual approach with the Attention Restoration Theory. I showed how physical features can influence restorative characteristics (i.e. perceived coherence) and indicators of restorativeness (i.e. preference, pleasure, and restoration). As I have focused on one of the five restorative characteristics (i.e. coherence), more studies are needed to further test the theoretical framework. Future research should study how physical features influence other restorative characteristics (i.e. fascination, novelty, escape, and compatibility) and restorative effects (restoration, pleasure, and preference), and attempt to further establish the relationship between preference and the restorative quality of environments (Hartig et al., 2010; Van den Berg, Koole, & Van der Wulp, 2003).

Implications of this thesis

The findings from this thesis offer great opportunities for research as well as practice. An important finding of this thesis is that restorative characteristics of environments are good predictors of the restorative quality of environments. I have developed a reliable questionnaire to evaluate restorative characteristics and thus, the restorative quality of environments. Furthermore, I have found support that VR is a valid tool to assess the restorative quality of environments.

VR together with the PRCQ enable solid theory testing and can be used to gain insight into causal relationships between key variables of interest, such as physical features of environments and restorativeness. Previous research on restorative environments mainly compared urban environments with natural environments. These environments differ on a great number of aspects, which makes it hard to conclude why any differences in restoration actually occur. To get more insight into which features are of key importance for restorative experiences researchers should take one environment as a starting point and change features of this environment one by one. Virtual reality can be a valuable tool to study restorative environments in more detail, especially now we have obtained first evidence that virtual reality is a valid tool for research on restorative environments.

In this thesis I have integrated the physical perceptual approach with the ART and found that it is possible to influence restorative characteristics and restorative effects (pleasure, preference, and restoration) by manipulating physical features of environments. To my knowledge I was one of the first to experimentally examine causal relationships between physical features, restorative characteristics and restorative effects (pleasure, preference, and restoration). The methodologies used in this thesis can be used to further examine these relationships and further test the Physical-Perceptual Restoration model.

The PRCQ together with VR also have great practical value: designers and urban planners can use these instruments to evaluate the restorative potential of their designs before they are actually built. In virtual environments it is easier to spot possible shortcomings in the design, allowing designers to optimize their design before commissioning construction companies to execute the project enabling more cost- and time-efficient investments.

Furthermore, the results presented in this thesis offer clear guidelines for designers, urban planners and architects on how to enhance or preserve the restorative quality of environments. Chapter 4 demonstrated how the perceived coherence and thereby the restorative quality of an environment can deteriorate when elements that disharmonize with the environment are introduced. Chapter 5 showed that in order to increase the perceived coherence of and preference for settings, designers should attempt to find an optimal level of harmony and diversity, for example by using similar shapes, orderly organization and variation in color. The results of this thesis are already been used by Emmen Zoo, as guidelines for the design of a new zoo. Insight into relationships between specific physical features, restorative characteristics and restorative effects (pleasure, preference, and restoration) is very valuable, as knowledge about what physical features can enhance the restorative quality of environments can ultimately help to design "healthy" environments.

Dutch summary/

Nederlandse samenvatting

Stress is niet meer weg te denken is uit de hedendaagse westerse samenleving. Aangezien stress nadelige gevolgen kan hebben voor onze fysieke en geestelijke gezondheid is het van belang om te onderzoeken hoe mensen optimaal kunnen herstellen van stress. Onze omgeving blijkt een grote invloed te hebben op menselijk welbevinden. Zo bleek uit eerder onderzoek dat natuur in vergelijking tot stedelijke omgevingen een positieve invloed heeft op herstel van mentale vermoeidheid, stress en emotioneel welbevinden (Hartig, Mang, & Evans, 1991; Hartig, Evans, Jamner, Davis, & Gärling, 2003). Daarnaast blijkt dat mensen natuurlijke omgevingen aantrekkelijker vinden dan stedelijke omgevingen (Laumann, Gärling, & Stormark, 2001). Er lijkt dus een verband te zijn tussen welke omgevingen mensen aantrekkelijk vinden (voorkeur) en de herstellende effecten die in deze omgevingen optreden. Maar waarom heeft natuur deze herstellende (of *restoratieve*) werking? En welke kenmerken in de omgeving beïnvloeden zogenaamde *restoratieve uitkomsten*, zoals herstel van stress en mentale vermoeidheid, emotioneel herstel en voorkeuren voor de omgeving? Kennis over welke specifieke kenmerken van omgevingen een positieve invloed hebben op ons welzijn, kan zeer zinvol zijn bij het ontwerpen van gezonde leefomgevingen.

De Attention Restoration Theory (Kaplan & Kaplan, 1989) stelt dat herstel eerder optreedt in omgevingen met zogenaamde *restoratieve kenmerken*. In eerste instantie werden er vier restoratieve kenmerken onderscheiden (Kaplan en Kaplan, 1989). Onderzoek heeft echter aangetoond dat er beter vijf kenmerken kunnen worden onderscheiden (Laumann et al., 2001). In dit proefschrift heb ik mij daarom gericht op *vijf* restoratieve kenmerken. Het eerste kenmerk, *fascinatie*, houdt in dat je aandacht moeiteloos wordt getrokken en vastgehouden door elementen in de omgeving, bijvoorbeeld bij het zien van een mooi gekleurde vlinder. Je hoeft dus geen moeite te doen om je aandacht actief te richten. *Nieuwigheid,* het tweede restoratieve kenmerk, houdt in dat je je fysiek in een andere omgeving bevindt waar geen (of minder) dingen te zien die je herinneren aan je dagelijkse beslommeringen, waardoor je beter in staat bent om te herstellen. *Ontsnappen*, het derde restoratieve kenmerk dat wordt onderscheiden in dit proefschrift, houdt in dat je in staat bent stressvolle gedachten los te laten, en je niet bezig hoeft te houden met verplichtingen en verwachtingen. Het vierde kenmerk, *samenhang*, houdt in dat alle elementen in de omgeving bij elkaar passen en de omgeving een harmonieus geheel vormt. Wanneer alle kenmerken in de omgeving goed bij elkaar aansluiten is het mentaal minder belastend om in de omgeving te zijn. En het vijfde en laatste kenmerk, *compatibiliteit,* houdt in dat er sprake is van een match tussen de persoon en de omgeving, dat wil zeggen dat de omgeving aansluit bij de behoeften en verwachtingen van het individu. Deze restoratieve kenmerken zorgen ervoor dat het weinig mentale inspanning kost om in de omgeving te zijn, waardoor je beter in staat bent om te herstellen van stress en mentale vermoeidheid.

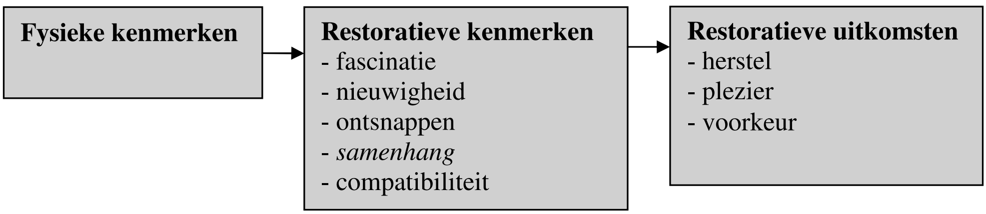
Verschillende onderzoekers hebben geprobeerd om restoratieve kenmerken van omgevingen te meten en relaties te onderzoeken met bepaalde restoratieve uitkomsten (Hartig, Korpela, Evans, Gärling, 1997a; Laumann et al., 2001). Er is echter nog geen instrument beschikbaar om de *vijf* restoratieve kenmerken te meten die in meer recent onderzoek aan het licht zijn gekomen (Laumann et al., 2001). Een van de doelen van dit proefschrift is dan ook het ontwikkelen van een valide vragenlijst die de vijf restoratieve kenmerken meet (fascinatie, nieuwigheid, ontsnappen, samenhang, en compatibiliteit).

Er is steeds meer bewijs dat restoratieve kenmerken niet alleen positief gerelateerd zijn aan herstel van mentale vermoeidheid en stress en positieve affectieve reacties, maar ook aan *voorkeur* voor deze omgevingen (Laumann et al. 2001; Purcell, Peron, & Berto, 2001). In dit proefschrift heb ik mij gericht op deze drie restoratieve uitkomsten: 1) de mate waarin mensen kunnen herstellen van stress en mentale vermoeidheid (herstel), 2) de mate waarin mensen plezier ervaren (plezier) en 3) hoe aantrekkelijk men de omgeving vindt (voorkeur). Omdat een aantal onderzoeken heeft aangetoond dat waargenomen restorativiteit en voorkeur voor omgevingen sterk aan elkaar gerelateerd zijn (Korpela & Hartig, 1996; Hartig, Maris, & Staats, 1998; Purcell, Peron, & Berto, 2001; Staats, Kieviet, & Hartig, 2003), lijkt het aannemelijk aan deze twee concepten eenzelfde dimensie (de restoratieve kwaliteit van de omgeving) ten grondslag ligt. Om die reden heb ik in dit proefschrift alle drie restoratieve kenmerken beschouwd als belangrijke indicatoren voor de restoratieve waarde van omgevingen.

Restoratieve kenmerken zijn mentale constructen, die betrekking hebben op een interactie tussen het individu en de omgeving. Hierdoor blijft het onduidelijk welke fysieke kenmerken in omgevingen invloed hebben op restoratieve kenmerken. Wat maakt een omgeving bijvoorbeeld samenhangend? Omdat er in voorgaand onderzoek omgevingen met elkaar zijn vergeleken die op meerdere factoren van elkaar verschillen (vooral natuurlijke versus stedelijke omgevingen), kunnen er geen conclusies worden getrokken over welke specifieke kenmerken van omgevingen van doorslaggevend belang zijn voor de herstellende waarde van de omgeving. Een doel van dit proefschrift was daarom om meer inzicht te krijgen in hoe specifieke kenmerken van de omgeving invloed hebben op restoratieve kenmerken en daarmee op de restoratieve waarde van de omgeving.

De fysieke-perceptuele benadering (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, et al., 1984) richt zich op de relatie tussen fysieke omgevingskenmerken en *voorkeuren* voor omgevingen. In dit type onderzoek worden er in tegenstelling tot de ART (Kaplan & Kaplan, 1989) wel specifieke omgevingskenmerken gedefinieerd die de aantrekkelijkheid van landschappen positief beïnvloeden, bijvoorbeeld de aanwezigheid van water. Het grote nadeel is echter dat de theoretische onderbouwing voor de effecten van omgevingskenmerken op voorkeuren bij de fysieke-perceptuele benadering ontbreekt. Het blijft onduidelijk waarom mensen voorkeuren voor bepaalde landschapskenmerken hebben en welke onderliggende processen daarbij een rol spelen. Ook doet de fysieke-perceptuele benadering geen uitspraken hoe fysieke omgevingskenmerken invloed hebben op de andere restoratieve uitkomsten (herstel en plezier).

In dit proefschrift heb ik de Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) geïntegreerd met de fysieke perceptuele benadering (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, Daniel, & Schroeder, 1984). Ik heb de ART en de fysieke-perceptuele benadering samengebracht in het "Physical-Perceptual Restoration" model (Figuur 1), die stelt dat fysieke omgevingskenmerken invloed hebben op de restoratieve kenmerken (fascinatie, nieuwigheid, ontsnappen, samenhang, en compatibiliteit), die op hun beurt invloed hebben op de drie indicatoren van de herstellende waarde van de omgeving: herstel van stress en mentale vermoeidheid, ervaren plezier en voorkeur voor de omgeving. In dit proefschrift heb ik de eerste stappen genomen om het Physical-Perceptual Restoration Model empirisch te toetsen. Meer specifiek, heb ik onderzocht hoe bepaalde fysieke kenmerken (zoals het ontwerp en de aanwezigheid van bankjes) invloed hebben op de samenhang van de omgeving (een van de restoratieve kenmerken) en op restoratieve uitkomsten (herstel, plezier en voorkeur). Daarnaast heb ik onderzocht of waargenomen samenhang de relatie tussen fysieke kenmerken en restoratieve uitkomsten *medieert*.



Figuur 1 "Physical-Perceptual Restoration" model

Doelen van dit proefschrift

Om het "Physical-Perceptual Restoration" model te toetsen zijn geschikte methoden en meetinstrumenten nodig. Daarom was het eerste doel van dit proefschrift het ontwikkelen van valide instrumenten om nauwkeurig relaties tussen fysieke kenmerken, restoratieve kenmerken, en restoratieve uitkomsten te onderzoeken. Hiertoe heb ik eerst een vragenlijst ontwikkeld die *vijf* restoratieve kenmerken van omgevingen meet.

Vervolgens heb ik onderzocht of Virtual Reality een valide instrument is om relaties tussen fysieke omgevingskenmerken, restoratieve kenmerken en restoratieve uitkomsten te onderzoeken. Virtual reality (VR) is een artificiële omgeving gegenereerd door computer software. Deze virtuele omgevingen kunnen zo worden gepresenteerd dat gebruikers in staat zijn om met deze omgeving te interacteren alsof het een echte omgeving is. Twee voordelen van het gebruik van VR voor onderzoek naar restoratieve omgevingen is dat onderzoekers meer controle kunnen uitoefenen over de onderzoekssituatie en daarnaast gemakkelijker elementen in de virtuele omgevingen kunnen manipuleren dan in echte omgevingen. Wanneer er onderzoek wordt gedaan in VR is het belangrijk om te onderzoeken of ervaringen in virtuele omgevingen vergelijkbaar zijn met ervaringen in echte omgevingen. VR is nog een relatief nieuw onderzoeksinstrument, in het bijzonder in het domein van de omgevingspsychologie. Om die reden onderzoek is naar de validiteit van VR nog schaars.

Ik heb mij in dit proefschrift in het bijzonder gericht op dierentuinattracties als voorbeeld van natuurlijke omgevingen, omdat dit bij uitstek omgevingen zijn die door mensen worden ontworpen. De bevindingen uit dit proefschrift kunnen daarom rechtstreeks teruggekoppeld kunnen worden naar concrete ontwerprichtlijnen voor de praktijk.

Een tweede doel van dit proefschrift was om de nieuwe instrumenten te gebruiken om eerste stappen te nemen om het "Physical-Perceptual Restoration" model te toetsen. Eerst heb ik relaties tussen restoratieve kenmerken (fascinatie, nieuwigheid, ontsnappen, samenhang en compatibiliteit) enerzijds en restoratieve uitkomsten (herstel, plezier en voorkeur) anderzijds onderzocht. Vervolgens heb ik twee onderzoeken gedaan naar de relatie tussen fysieke omgevingskenmerken, restoratieve kenmerken en restoratieve uitkomsten. Hieronder zal ik de belangrijkste resultaten bespreken.

Het ontwikkelen van betrouwbare en valide instrumenten

Allereerst heb ik de Perceived Restorative Characteristics Questionnaire ontwikkeld (PRCQ; zie hoofdstuk 2) waarmee de *vijf* restoratieve kenmerken van omgevingen gemeten kunnen worden. De PRCQ heb ik toegepast op verschillende omgevingen: een vlindertuin, een winkelcentrum, een virtuele vlindertuin en een virtuele stadswijk. De subschalen die de vijf restoratieve kenmerken meten bleken betrouwbaar. Confirmatieve factoranalyses lieten zien dat de restoratieve kenmerken over het algemeen (met uitzondering van compatibiliteit) ook conceptueel te onderscheiden waren. Daarnaast bleken de restoratieve kenmerken goede voorspellers van herstel, voorkeur en plezier in verscheidene omgevingen. Hiermee heb ik sterke aanwijzingen gevonden dat de PRCQ een betrouwbaar en valide instrument is om de restoratieve waarde van omgevingen in kaart te brengen.

Vervolgens heb ik onderzocht of virtual reality (VR) een geschikt instrument is om onderzoek te doen naar relaties tussen fysieke kenmerken, restoratieve kenmerken en restoratieve uitkomsten (zie hoofdstuk 3). Om te onderzoeken of VR een valide instrument is voor onderzoek naar restoratieve omgevingen heb ik de restoratieve waarde van een echte vlindertuin en een echte stadsomgeving vergeleken met de restoratieve waarde van een virtuele vlindertuin en een virtuele stadsomgeving. Verwacht werd dat in virtuele omgevingen vergelijkbare effecten gevonden worden als in echte omgevingen, bijvoorbeeld dat natuurlijke virtuele omgevingen hoger scoren op restoratieve kenmerken dan stedelijke virtuele omgevingen. Ik heb vier aanwijzingen gevonden dat VR een geschikt instrument is voor onderzoek naar restoratieve omgevingen. Allereerst bleken restoratieve kenmerken en restoratieve uitkomsten zowel in de echte als in de virtuele vlindertuin hoger te zijn dan in de echte en virtuele stedelijke omgevingen. Ten tweede bleken restoratieve kenmerken van zowel de virtuele als de echte omgevingen in staat om restoratieve uitkomsten in de betreffende omgeving te voorspellen. Ten derde bleken in de echte en virtuele omgevingen dezelfde restoratieve kenmerken significante voorspellers van restoratieve uitkomsten te zijn. Bijvoorbeeld het kenmerk ontsnappen bleek zowel in de echte vlindertuin als in de virtuele vlindertuin een significante voorspeller van hoe goed men kon herstellen in de betreffende omgeving. Ten vierde heb ik geen bewijs kunnen vinden dat er verschillen waren in restoratieve kenmerken en restoratieve uitkomsten tussen de echte omgeving en haar virtuele equivalent. Deze resultaten bieden ondersteuning dat VR een valide instrument is om onderzoek te doen naar restoratieve omgevingen. Met de PRCQ en VR was ik in staat om de relatie tussen fysieke kenmerken, restoratieve kenmerken en restoratieve uitkomsten nauwkeurig te onderzoeken.

Het onderzoeken van relaties tussen fysieke kenmerken en restoratieve waarde van omgevingen.

In een aantal onderzoeken heb ik de verschillende segmenten van het Physical-Perceptual Restoration model getest. Eerst heb ik de relatie tussen restoratieve kenmerken (fascinatie, nieuwigheid, ontsnappen, samenhang en compatibiliteit) en restoratieve uitkomsten (herstel, plezier en voorkeur) onderzocht. Met de PRCQ heb ik mensen restoratieve kenmerken van verschillende omgevingen laten beoordelen. Vervolgens heb ik onderzocht of de waargenomen restoratieve kenmerken konden voorspellen hoe goed men kon herstellen in de betreffende omgeving, hoeveel plezier men ervoer en hoe aantrekkelijk men de omgeving vond. De resultaten lieten zien dat de restoratieve kenmerken goede voorspellers zijn van restoratieve uitkomsten in uiteenlopende omgevingen. Over het algemeen hadden mensen een sterke voorkeur voor omgevingen die hoog scoorden op restoratieve kenmerken. Daarnaast bleken mensen beter in staat om te herstellen van stress en mentale vermoeidheid en ervoeren mensen meer plezier in omgevingen die hoog scoorden op restoratieve kenmerken. De restoratieve kenmerken bleken echter niet in staat om voorkeur voor de twee stedelijke omgevingen te voorspellen. Een mogelijke verklaring hiervoor is dat de sterkte van de relatie tussen restoratieve kenmerken en voorkeur afhangt van de functie van een omgeving. Het is bijvoorbeeld aannemelijk dat in een omgeving waar mensen graag naar toe gaan om te herstellen van stress, de relatie tussen voorkeur en restoratieve kenmerken sterker is dan in een omgeving waar mensen graag naar toe gaan om te winkelen.

Om het Physical-Perceptual Restoration model verder te testen heb ik twee onderzoeken uitgevoerd waarbij ik systematisch fysieke kenmerken heb gemanipuleerd en heb onderzocht hoe dit restoratieve uitkomsten beïnvloedt. Hierbij heb ik me gericht op samenhang, een van de restoratieve kenmerken. Eerst heb ik in een virtuele natuurlijke omgeving de relaties tussen fysieke kenmerken, samenhang en restoratieve uitkomsten onderzocht. Vervolgens heb ik de relaties tussen fysieke kenmerken, samenhang en voorkeur op een abstracter niveau onderzocht waarbij ik gebruik heb gemaakt van abstracte afbeeldingen met geometrische vormen.

Manipulatie van fysieke kenmerken in een virtuele omgeving

In hoofdstuk 4 heb ik onderzocht hoe fysieke kenmerken (in dit geval de aanwezigheid en het ontwerp van straatmeubilair) in een natuurlijke omgeving invloed hebben op hoe samenhangend de omgeving wordt gevonden, en de restoratieve uitkomsten die er optreden. Daarnaast heb ik onderzocht of fysieke kenmerken invloed hebben op restoratieve uitkomsten *via* samenhang, oftewel of samenhang het effect van fysieke kenmerken op restoratieve kenmerken *medieert*. De resultaten lieten, in overeenstemming met mijn verwachtingen, zien dat wanneer het straatmeubilair niet harmonieerde met de omgeving (in dit geval metalen bankjes, hekken en vuilnisbakken) de waargenomen samenhang van de omgeving verslechterde. Ook vond ik dat vergeleken met een natuurlijke omgeving zonder straatmeubilair, de omgeving met metalen straatmeubilair lagen scoorde op voorkeur, zelf-gerapporteerd herstel en plezier. Daarnaast heb ik aanwijzingen gevonden dat waargenomen samenhang de invloed van metalen meubilair op alle drie restoratieve uitkomsten medieerde. Dit betekent dat fysieke kenmerken inderdaad invloed hebben op de restoratieve kenmerken van een omgeving, en dat deze vervolgens invloed hebben op restoratieve uitkomsten. Opvallend was dat wanneer het straatmeubilair wel harmonieerde met de omgeving (in dit geval houten meubilair) waargenomen samenhang wel iets verslechterde, maar er geen verschillen waren in restoratieve uitkomsten tussen de omgeving met houten meubilair en de omgeving zonder meubilair. Het lijkt er dus op dat natuurlijk vormgegeven meubilair de restoratieve waarde van de omgeving intact laat.

Manipulatie van fysieke kenmerken van abstracte stimuli

Welke specifieke fysieke kenmerken van het metalen meubilair hebben samenhang en restoratieve waarde van de omgeving negatief beïnvloed? Het is mogelijk dat de vorm en de kleur van de bankjes een contrast creëerden met natuurlijke vormen en kleuren in de omgeving wat vervolgens de samenhang en de restoratieve uitkomsten negatief heeft beïnvloed. Om meer inzicht te krijgen welke afzonderlijke fysieke kenmerken samenhang en restoratieve uitkomsten beïnvloeden heb ik dit onderzocht op een abstracter niveau. In hoofdstuk 5 heb ik aan de hand van afbeeldingen met geometrische vormen onderzocht hoe variatie in kleur, variatie in vorm en de manier waarop vormen zijn georganiseerd invloed hebben op samenhang en voorkeur voor de afbeeldingen. De resultaten van hoofdstuk 5 lieten zien dat het gebruik van één kleur en dezelfde vormen een positieve invloed heeft op hoe samenhangend een afbeelding wordt gevonden. Tevens werden de afbeeldingen waarbij de vormen netjes waren geordend hoger beoordeeld op samenhang dan wanneer de vormen chaotisch waren geordend. De manier waarop de vormen waren geordend bleek het zwaarst mee te wegen in de beoordelingen van samenhang.

Voorkeur voor de afbeeldingen liet een ander patroon zien. In overeenstemming met de verwachting bleken mensen de afbeeldingen met dezelfde vormen het meest aantrekkelijk te vinden. Het effect van kleur op voorkeur was echter tegengesteld aan het effect van kleur op samenhang. Eenheid in kleuren werd meer samenhangend gevonden, maar *variatie* in kleuren werd aantrekkelijker gevonden. Kleur bleek het zwaarst mee te wegen bij de beoordelingen van aantrekkelijkheid. De manier waarop de vormen waren georganiseerd bleek geen invloed te hebben op hoe aantrekkelijk de afbeeldingen werden gevonden.

In tegenstelling tot hoofdstuk 4 heb ik in hoofdstuk 5 geen bewijs kunnen vinden dat samenhang de effecten van de fysieke kenmerken op voorkeur medieerde. Het is mogelijk dat er een lineaire relatie is tussen bepaalde fysieke kenmerken (zoals kleur) en samenhang, waarbij minder variatie in kleuren leidt tot meer samenhang, en een curve-lineaire relatie tussen fysieke kenmerken en voorkeur, waarbij te weinig en teveel variatie minder aantrekkelijk wordt gevonden en een gemiddelde hoeveelheid variatie het meest aantrekkelijke wordt gevonden. De natuurlijke omgevingen in hoofdstuk 4 scoorden allemaal redelijk hoog op samenhang maar hadden waarschijnlijk genoeg variatie om aantrekkelijk gevonden te worden. Om die reden was de relatie tussen samenhang en voorkeur daar sterker dan in hoofdstuk 5. De afbeeldingen die in hoofdstuk 5 zijn gebruikt varieerden van heel laag tot heel hoog samenhangend. Het is aannemelijk dat deze brede range van samenhang ervoor heeft gezorgd dat de relatie tussen samenhang en voorkeur minder eenduidig is en er geen mediatie effect is gevonden voor samenhang.

Theoretische en praktische implicaties van dit proefschrift

De bevindingen uit dit proefschrift hebben belangrijke praktische en wetenschappelijke implicaties. Een belangrijke bevinding is dat restoratieve kenmerken van omgevingen goede voorspellers zijn van de restoratieve waarde van omgevingen. Ik heb een betrouwbare en valide vragenlijst ontwikkeld (de PRCQ) om restoratieve kenmerken, en daarmee de restoratieve waarde van omgevingen in kaart te brengen. Daarnaast heb ik bewijs gevonden dat VR een valide instrument is om onderzoek mee te doen naar restoratieve omgevingen. VR kan samen met de PRCQ worden gebruikt om theorieën te testen en inzicht te krijgen in causale verbanden tussen fysieke kenmerken en restoratieve uitkomsten. Maar ook de relaties tussen omgevingskenmerken, restoratieve kenmerken en andere uitkomstvariabelen kan goed worden onderzocht met behulp van de PRCQ en VR.

In dit proefschrift heb ik twee onderzoekslijnen geïntegreerd: de ART (Kaplan & Kaplan, 1989) en de fysieke-perceptuele benadering (Im, 1984; Shafer, Hamilton, & Schmidt, 1969; Vining, et al., 1984). Ik ben erin geslaagd om restoratieve kenmerken (in dit geval samenhang) en restoratieve uitkomsten te beïnvloeden door fysieke omgevingskenmerken te manipuleren. Naar mijn weten ben ik een van de eersten die door middel van experimenten causale verbanden tussen fysieke kenmerken, restoratieve kenmerken en restoratieve uitkomsten heeft onderzocht. De methoden die ik in dit proefschrift heb gebruikt kunnen worden gebruikt om deze relaties verder te onderzoeken en het Physical-Perceptual Restoration model verder te ontwikkelen en te testen.

Het gebruik van VR in combinatie met de PRCQ heeft potentieel ook een grote praktische waarde. Vormgevers, architecten en planologen kunnen deze instrumenten gebruiken om de restoratieve waarde van hun ontwerpen te evalueren voordat ze daadwerkelijk worden gebouwd. In VR en met de PRCQ kunnen tekortkomingen gemakkelijk worden ontdekt zodat het ontwerp geoptimaliseerd kan worden., Dit kan leiden tot grote kostenbesparingen.

Verder biedt dit proefschrift richtlijnen voor vormgevers, architecten en planologen over hoe de restoratieve waarde van omgevingen verhoogd of beschermd kan worden. Hoofdstuk 4 laat zien dat waargenomen samenhang en daarmee de restoratieve waarde van omgevingen kan verslechteren wanneer er objecten in de omgeving worden geplaatst die niet harmoniëren met de omgeving. Daarentegen laten objecten die wel in harmonie zijn met de omgeving de restoratieve waarde van de omgeving intact. Hoofdstuk 5 laat zien dat eenheid in vormen een positieve invloed heeft op samenhang en dat juist variatie in kleuren de aantrekkelijkheid van de omgeving kan bevorderen. Vormgevers zouden op zoek kunnen gaan naar een optimale balans tussen harmonie en variatie. Inzicht in relaties tussen specifieke fysieke kenmerken, restoratieve kenmerken en restoratieve uitkomsten is zeer waardevol, omdat deze kennis kan worden gebruikt om gezondere leefomgevingen te ontwerpen waarin we optimaal kunnen herstellen.

Bedankt!

Zonder de hulp en steun van mijn lieve vriend, vrienden, mijn zus Carina, ouders (Nico en Lia, maar ook Aaf, Dirk, Truus en Kees), begeleiders en collega's was dit proefschrift een stuk minder voorspoedig en aangenaam tot stand gekomen. Graag wil ik de volgende mensen nog even expliciet bedanken. Mijn begeleiders Linda Steg, Frans Siero, Karen van Oudenhoven – van der Zee, bedankt voor al jullie feedback en de prettige samenwerking. Ook wil ik de leescommissie bedanken voor het beoordelen van mijn proefschrift. Verder wil ik Henk Hiddingh, Cathalijne Elings, Katinka Brink, Jan Kempe en Jan Fuhler van Dierenpark Emmen bedanken voor de leuke samenwerking en de financiering van het promotieproject. Ik vind het geweldig om te zien hoe de resultaten van mijn onderzoek écht worden gebruikt bij de ontwikkeling van het nieuwe dierenpark. Mijn lieve vriend (super-)Mendel, heeft mij vooral in de laatste en misschien wel lastigste fase van het promotietraject enorm gesteund. Lieve Mendel, ik heb het gevoel dat ik meer aan kan met jou naast me. Mijn vrienden, Carla, Marlies, David, Machteld, Anne, Fiona, Ingrid, Lemke, Hilde, Serinde, bedankt dat jullie er zijn. Carla en Marlies, extra bedankt, jullie zijn/waren geweldige paranimfen! Ook heb ik veel gehad aan de relativerende en wijze woorden van mijn (eerste) kamergenootje Geertje. Bedankt! Marret Noordewier, van wie ik dit mooie project heb overgenomen, bedankt voor de tips, de leuke gesprekken en de leuke uitstapjes die we samen hebben gemaakt naar de dierentuin. Mijn collega's Ellen, Jan Willem, Janet, Kees, Martijn, Goda, Berfu, Ebru, Ernst, Danny, Anne, Leonie, en ook Anne Fetsje en Thecla voor de gezellige koffiepauzes, lunchwandelingen, spelletjes avonden en de feedback jullie me hebben gegeven op

mijn onderzoek. En natuurlijk ook alle andere collega's van Experimentele Psychologie, Sociale en Organisatie Psychologie en het Instituut voor Integratie en Sociale Weerbaarheid: Bedankt! Ook wil ik José Heesink bedanken voor de prettige gesprekken die we hebben gehad op momenten waarop ik dat nodig had. Agnes van den Berg en Yannick Joye, bedankt voor de inspirerende gesprekken die we hebben gevoerd en de leuke samenwerkingen, onder andere tijdens de Summer School on Theories in Environmental Psychology (STEP 2009). Ben Mulder, bedankt voor de leuke samenwerking bij het (virtuele) vlindertuin onderzoek. Mijn studenten, Amanda Lautenbach, Wilto Gerritsma, Hilde Bruins, Bertine de Vries, Eelco Dijkstra, Annemieke van Ravenzwaay, Anne-Marije Houtjes, Jos Dontje, wil ik bedanken voor het mooie werk dat zij hebben verricht bij verschillende studies. Frans van Hoesel, Jeroen Meijer en Bart Campman van het Donald Smits Centrum voor Informatie Technologie van de RUG, bedankt voor het realiseren van de virtuele vlindertuin en de virtuele dierentuin en alle technische ondersteuning tijdens het uitvoeren van de experimenten in virtual reality. En last but not least: bedankt Ans, Kina, Anita, Femke en Barbara, voor de secretariële ondersteuning.

References

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.

Bell, P. A., Greene, T. C., Fisher, J., & Baum, A. (2001). *Environmental psychology* (5th ed.). Fort Worth: Harcourt College Publishing.

Benson, J., & Hocevar, D. (1985). The impact of item phrasing on the validity of attitudes scales for elementary school children. *Journal of Educational Measurement, 22,* 231-240.

Bentler, P. M., Jackson, D. N., & Messick, S. (1971). Identification of content and style: A two-dimensional interpretation of acquiescence. *Psychological Bulletin, 76,* 186-204.

Berlyne, D. E. (1971). *Aesthetics and psychobiology*. East Norwalk, CT US: Appleton-Century-Crofts.

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19*(12), 1207-1212.

Berto, R. (2005). Exposure to restorative environments helps restore attentional capacity. *Journal of Environmental Psychology, 25,* 249-259.

Berto, R. (2007). Assessing the restorative value of the environment: A study on the elderly in comparison with young adults and adolescents. *International Journal of Psychology, 42,* 331-341.

Bishop, I. D., & Rohrmann, B. (2003). Subjective responses to simulated and real environments: A comparison. *Landscape and Urban Planning, 65*, 261-277.

Bitgood, S. C., Patterson, D., & Benefield, A. (1988). Exhibit design and visitor behavior: Empirical relationships. *Environment and Behavior, 20,* 474-491.

Bitgood, S. C. (2002). Environmental psychology in museums, zoos, and other exhibition centers. In R. B. Bechtel & A. Churchman (Eds.), *Handbook of environmental psychology* (pp. 461-480). Hoboken, NY, US: John Wiley & Sons, Inc.

Blascovich, J., Loomis, J., Beall, A. C., Swinth, K. R., Hoyt, C. L., & Bailenson, J. N. (2002). Target Article: Immersive virtual environment technology as a methodological tool for social psychology. *Psychological Inquiry, 13*(2), 103-124.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *JAMA: The Journal of the American Medical Association, 298*(14), 1685-1687.

Cruz-Neira, C., Sandin, D. J., DeFanti, T. A., Kenyon, R. V., and Hart, J. C. (1992). The CAVE: audio visual experience automatic virtual environment. *Communications of the ACM*, 35 (6), 64-72.

Cruz-Neira, C., Sandin, D. J., and DeFanti, T. A. (1993). Surround-screen projection-based virtual reality: the design and implementation of the CAVE. *Proceedings of the 20th Annual Conference on Computer Graphics and interactive Techniques*, 135-142.

Daniel, T. C., & Vining, J. (1983). Methodological issues in the assessment of landscape quality. *Human Behavior & Environment: Advances in Theory & Research, 6*, 39-84.

De Kort, Y. A. W., IJsselsteijn, W. A., Kooijman, J., & Schuurmans, Y. (2003). Virtual laboratories: Comparability of real and virtual environments for environmental psychology. *Presence, 12*(4), 360.

De Kort, Y. A. W., Meijnders, A. L., Sponselee, A. A. G., & IJsselsteijn, W. A. (2006). What's wrong with virtual trees? restoring from stress in a mediated environment. *Journal of Environmental Psychology, 26*(4), 309-320.

Eys, M. A., Carron, A. V., Bray, S. R., & Brawley, L. R. (2007). Item wording and internal consistency of a measure of cohesion: The Group Environment Questionnaire. *Journal of Sport & Exercise Psychology, 29,* 395-402.

Finney, S. J. (2001). *A comparison of the psychometric properties of negatively and positively worded questionnaire items.* ProQuest Information & Learning, US.

Green, P. E., & Srinivasan, V. (1990). Conjoint analysis in marketing: New developments with implications for research and practice. *The Journal of Marketing, 54*(4), pp. 3-19.

Guttman, L. (1952). Multiple group methods for common-factor analysis: Their basis, computation, and interpretation. *Psychometrika, 17,* 209-222.

Hagerhall, C. M., Laike, T., Taylor, R. P., Küller, M., Küller, R., & Martin, T. P. (2008). Investigations of human EEG response to viewing fractal patterns. *Perception, 37*(10), 1488-1494.

Hagerhall, C. M., Purcell, T., & Taylor, R. (2004). Fractal dimension of landscape silhouette outlines as a predictor of landscape preference. *Journal of Environmental Psychology, 24*(2), 247-255.

Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology,* , 109-123.

Hartig, T., Kaiser, F. G., & Bowler, P. A. (1997b). *Further developments of a* *measure of perceived environmental restorativeness (Working paper no. 5).* Gävle, Sweden: Uppsala University, Institute for Housing Research.

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997a). A measure of restorative quality in environments. *Housing, Theory, and Society, 14*(4), 175.

Hartig, T., Mang, M., & Evans, G. W. (1991). Restorative effects of natural environment experiences. *Environment and Behavior, 23*(1), 3-26.

Hartig, T., & Staats, H. (2006). The need for psychological restoration as a determinant of environmental preferences. *Journal of Environmental Psychology, 26*(3), 215-226.

Hartig, T., Van den Berg, A. E., Hagerhall, C. M., Tomalak, M., Bauer, N., Hansmann, R., et al. (2010). Health benefits of nature experience: Psychological, social and cultural processes. In K. Nilsson, et al. (Eds.), *Forest, trees and human health.* (pp. 127-167). Dordrecht: Springer Science Business and Media.

Heft, H., & Nasar, J. L. (2000). Evaluating environmental scenes using dynamic versus static displays. *Environment and Behavior, 32*(3), 301.

Hernandez, B., & Hidalgo, M. C. (2005). Effect of urban vegetation on psychological restorativeness. *Psychological Reports, 96*, 1025-1028.

Herzog, T. R., Hayes, L. J., Applin, R. C., & Weatherly, A. M. (2011). Compatibility: An experimental demonstration. *Environment and Behavior, 43*(1), 90-105.

Joye, Y. (2007). Architectural lessons from environmental psychology: The case of biophilic architecture. *Review of General Psychology, 11*(4), 305-328.

Im, S. B. (1984). Visual preferences in enclosed urban spaces. *Environment and Behavior, 16*(2), 235-262.

Ivarsson, C. T., & Hagerhall, C. M. (2008). The perceived restorativeness of gardens-assessing the restorativeness of a mixed built and natural scene type. *Urban Forestry & Urban Greening, 7*(2), 107.

James, W. (1892). Psychology. NY US: Henry Holt and Company.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*(3), 169-182.

Kaplan, S. (2001). Meditation, restoration, and the management of mental fatigue. *Environment & Behavior, 33,* 480-506.

Kaplan, S., Bardwell, L. V., & Slakter, D. B. (1993). The museum as a restorative environment. *Environment & Behavior, 25*(6), 725-742.

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

Kaplan, S., Kaplan, R., & Wendt, J. S. (1972). Rated preference and complexity for natural and urban visual material. *Perception & Psychophysics, 12*(4), 354-356.

Korpela, K., & Hartig, T. (1996). Restorative qualities of favorite places. *Journal of Environmental Psychology, 16*(3), 221-233.

Kroh, D. P., & Gimblett, R. H. (1992). Comparing live experience with pictures in articulating landscape preference. *Landscape Research, 17*(2), 58.

Laumann, K., Gärling, T., & Stormark, K. M. (2001). Rating scale measures of restorative components of environments. *Journal of Environmental Psychology, 21,* 44.

Laumann, K., Gärling, T., & Stormark, K. M. (2003). Selective attention and heart rate responses to natural and urban environments. *Journal of Environmental Psychology, 23,* 125-134.

Louvriere, J. J. (1988). *Analyzing decision making: Metric conjoint analysis.* Beverly Hills, CA: Sage.

Ouellette, P., Kaplan, R., & Kaplan, S. (2005). The monastery as a restorative environment. Journal of Environmental Psychology, 25(2), 175-188.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. Cambridge, MA: MIT Press.

Nasar, J. L. (1987) Effects of signscape complexity and coherence on the perceived visual quality of retail scenes. *Journal of the American Planning Association, 53,* 499-509.

Nordh, H., Hartig, T., Hagerhall, C. M., & Fry, G. (2009). Components of small urban parks that predict the possibility for restoration. *Urban Forestry & Urban Greening, 8*(4), 225-235.

Nunnally, J. C. (1978). *Psychometric theory*. (2nd ed.) New York: McGraw-Hill.

Ouellette, P., Kaplan, R., & Kaplan, S. (2005). The monastery as a restorative environment. *Journal of Environmental Psychology, 25,* 175-188.

Pals, R., Dontje, J., Steg, L., Siero, F., & Van der Zee, K. I. (under review) The relationships between physical features of environments, restorative characteristics, and restorative effects: A virtual reality study.

Pals, R., Steg, L., Siero, F., & Van der Zee, K. I. (2009). Development of the PRCQ: A measure of perceived restorative characteristics of zoo attractions. *Journal of Environmental Psychology, 29*(4), 441.

Pals, R., Steg, L., Siero, F., & Van der Zee, K. I. (submitted). Is virtual reality a valid tool for restorative environments research?

Pals, R., Steg, L., Siero, F., & Van der Zee, K. I. (submitted). The relationship between physical features, perceived coherence, and preference for abstract stimuli.

Peron, E., Purcell, A. T., Staats, H., Falchero, S., & Lamb, R. J. (1998). Models of preference for outdoor scenes: Some experimental evidence. *Environment and Behavior, 30*(3), 282-305.

Purcell, T., Peron, E., & Berto, R. (2001). Why do preferences differ between scene types? *Environment and Behavior, 33*(1), 93-106.

QingKe, G., Dan, H., Zhao, W., & Kan, S. (2006). Effects of positively and negatively worded items in personality measurement. *Acta Psychologica Sinica, 38,* 626-632.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110,* 145-172.

Schmitt, N., & Stuits, D. M. (1985). Factors defined by negatively keyed items: The result of careless respondents? *Applied Psychological Measurement, 9,* 367-373.

Shafer, E. L., Hamilton, J. F., & Schmidt, E. A. (1969). Natural landscape preferences: A predictive model. *Journal of Leisure Research, 1*(1), 1-19.

Staats, H., Gatersleben, B., & Hartig, T. (1997). Change in mood as a function of environmental design: Arousal and pleasure on a simulated forest hike. *Journal of Environmental Psychology, 17*, 283-300.

Staats, H., & Hartig, T. (2004). Alone or with a friend: A social context for psychological restoration and environmental preferences. *Journal of Environmental Psychology, 24*(2), 199-211.

Staats, H., Kieviet, A., & Hartig, T. (2003). Where to recover from attentional fatigue: An expectancy-value analysis of environmental preference. *Journal of Environmental Psychology, 23*(2), 147-157.

Strumse, Einar (1996). Demographic differences in the visual preferences for agrarian landscapes in western Norway. *Journal of Environmental Psychology, 16,* 17-31.

Silvia, P. J. (2005). Emotional responses to art: From collation and arousal to cognition and emotion. *Review of General Psychology, 9*(4), 342-357.

Steg, L., Dreijerink, L., & Abrahamse, W. (2006). Why are energy policies acceptable and effective? *Environment and Behavior, 38*(1), 92-111.

Stuive, I. (2007). *A comparison of confirmatory factor analysis methods: Oblique multiple group method versus confirmatory common factor method.* Groningen: University of Groningen (dissertation).

Ten Berge, J. M. (1986). Rotation to perfect congruence and the cross-validation of component weights across populations. *Multivariate Behavioral Research, 21,* 41-64.

Ulrich, R. S. (1983). Aesthetic and affective response to natural environment. In I. Altman, & J. F. Wohlwill (Eds.), *Behavior and the natural environment* (pp. 85-125). New York: Plenum Press.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420.

Ulrich, R. S., Simons, R. F., Losito, B. D., & Fiorito, E. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201-230.

Van den Berg, A. E., Koole, S. L., & Van der Wulp, N. Y. (2003). Environmental preference and restoration:(how) are they related? *Journal of Environmental Psychology, 23*(2), 135.

Vining, J., Daniel, T. C., & Schroeder, H. W. (1984). Predicting scenic values in forested residential landscapes. *Journal of Leisure Research, 16*(2), 124-135.

Weems, G. H., Onwuegbuzie, A. J., Schreiber, J. B., & Eggers, S. J. (2003). Characteristics of respondents who respond differently to positively and negatively worded items on rating scales. *Assessment & Evaluation in Higher Education, 28,* 587-607.

Wohlwill, J. F. (1976). Environmental aesthetics: The environment as a source of affect. In I. Altman & J. F. Wohlwill (Eds.), *Human behavior and the environment: Advances in theory and research: Vol 1* (pp. 37-86). New York: Plenum.

KLI Dissertation Series

The "Kurt Lewin Institute Dissertation Series" started in 1997. Since 2009 the following dissertations have been published

2009-1: Marijke Leliveld: *Ethics in Economic Decision-Making*
2009-2: Monique Pollmann: *Accuracy and Bias in Person Perception*
2009-3: Krispijn Faddegon: *Regulatory Focus in Group Contexts*
2009-4: Lieven Brebels: *Mirror, mirror on the wall… Procedural fairness as an evaluative and regulatory looking-glass self*
2009-5: Daphne Wiersema: *Taking it personally: Self-esteem and the protection of self related attitudes*
2009-6: Judith D.M. Grob: *Dial E for Emotion: Context and Consequences of Emotion Regulation*
2009-7: Katherine Stroebe: *Is this about me? Responding to subtle discrimination – beyond an individual versus group perspective*
2009-8: Menno Vos: *Identity patterns in diverse work groups: Improving social integration outcomes through relational identities*
2009-9: Lennart Renkema: *Facing Death Together: Understanding The Consequences of Mortality Threats*
2009-10: Michael Vliek: *Group-based social comparison processes: An intragroup level of analysis*
2009-11: Karlijn Massar: *Unconscious rivals: The automatic evaluation of rivals in jealousy-evoking situations*
2009-12: Bart Terwel: *Origins and consequences of public trust: Towards an understanding of public acceptance of carbon dioxide capture and storage*
2009-13: Emma ter Mors: *Dealing with information about complex issues: The role of source perceptions*
2009-14: Martijn Veltkamp: *On the Instigation of Implicit Motivation: How Deprivation and Positive Affect Cause Motivated Behavior*
2009-15: Marret K. Noordewier: *Consistency and the unexpected*
2009-16: Sytske van der Velde: *Imitation of Emotion: How meaning affects the link between imitation and liking*
2009-17: Jacomijn Hofstra: *Attaching Cultures: The role of attachment styles in explaining majority members' acculturation attitudes*
2009-18: Jacqueline Tanghe: *Affect in Groups: Convergence, Conditions and Consequences*
2009-19: Anne Marike Lokhorst: *Using Commitment to Improve Environmental Quality*
2009-20: Jonathan van 't Riet: *Framing Health Communication Messages*
2009-21: Suzanne Pietersma: *Persuasive Health Communication: A Self-Perspective*
2009-22: Remco Wijn: *A functional perspective on the justice judgment process and its consequences*
2009-23: Niels van de Ven: *The bright side of a deadly sin: The psychology of envy*
2009-24: Anthon Klapwijk: *The Power of Interpersonal Generosity*
2010-1: Maarten Wubben: *Social Functions of Emotions in Social Dilemmas*
2010-2: Joyce Rupert: *Diversity faultlines and team learning*
2010-3: Daniel Lakens: *Abstract Concepts in Grounded Cognition*
2010-4: Luuk Albers: *Double You? Function and Form of Implicit and Explicit Self-Esteem*
2010-5: Matthijs Baas: *The Psychology of Creativity: Moods, Minds, and Motives*
2010-6: Elanor Kamans: *When the Weak Hit back: Studies on the Role of Power in Intergroup Conflict*
2010-7: Skyler Hawk: *Changing Channels: Flexibility in Empathic Emotion Processes*

2010-8: Nailah Ayub: *National Diversity and Conflict: The Role of Social Attitudes and Beliefs*
2010-9: Job van der Schalk: *Echoing Emotions: Reactions to Emotional Displays in Intergroup Context*
2010-10: Nevra Cem: *Organizational citizenship behavior and counterproductive work behavior: Cross-cultural comparisons between Turkey and the Netherlands*
2010-11: Ron Broeders: *On Situated and Embodied Knowledge Regarding Moral Issues*
2010-12: Margriet Braun: *Dealing with a deviant group member*
2010-13: Dennis Bleeker: *Representing or defecting? The pursuit of individual upward mobility in low status groups*
2010-14: Petra Hopman: *Group Members Reflecting on Intergroup Relations*
2010-15: Janneke Oostrom: *New Technology in Personnel Selection: The Validity and Acceptability of Multimedia Tests*
2010-16: Annefloor Klep: *The Sharing of Affect: Pathways, Processes, and Performance*
2010-17: Geertje Schuitema: *Priceless policies. Factors influencing the acceptability of transport pricing policies*
2010-18: Femke van Horen: *Breaking the mould on copycats: What makes product imitation strategies successful?*
2010-19: Niek van Ulzen: *Exploring affective perception and social action*
2010-20: Simon Dalley: *Women's body dissatisfaction and restrictive eating behaviour: A tyranny of a thin-ideal or a fear of fat?*
2010-21: Paul Preenen: *Challenge at Work: A matter of give and take*
2010-22: Katarzyna Ewa Kubacka: *The Rules of Attraction: Trust, Anxiety and Gratitude*
2010-23: Loes Kessels: *May I have your attention please? A neuroscientific study into message attention for health information*
2011-1: Elze Ufkes: *Neighbor-to-neighbor conflicts in multicultural neighborhoods*
2011-2: Kim van Erp: *When worlds collide. The role of justice, conflict and personality for expatriate couples' adjustment*
2011-3: Yana Avramova: *How the mind moods*
2011-4: Jan Willem Bolderdijk: *Buying people: The persuasive power of money*
2011-5: Nina Regenberg: *Sensible Moves*
2011-6: Sonja Schinkel: *Applicant reactions to selection events: Interactive effects of fairness, feedback and attributions*
2011-7: Suzanne Oosterwijk: *Moving the Mind: Embodied Emotion Concepts and their Consequences*
2011-8: Ilona McNeill: *Why We Choose, How We Choose, What We Choose: The Influence of Decision Initiation Motives on Decision Making*
2011-9: Shaul Shalvi: *Ethical Decision Making: On Balancing Right and Wrong*
2011-10: Joel Vuolevi: *Incomplete Information in Social Interactions*
2011-11: Lukas Koning: *An instrumental approach to deception in bargaining*
2011-12: Petra Tenbült: *Understanding consumers' attitudes toward novel food technologies*
2011-13: Ashley Hoben: *An Evolutionary Investigation of Consanguineous Marriages*
2011-14: Barbora Nevicka: *Narcissistic Leaders: The Appearance of Success*
2011-15: Annemarie Loseman: *Me, Myself, Fairness, and I: On the Self-Related Processes of Fairness Reactions*
2011-17: Francesca Righetti: *Self-regulation in interpersonal interactions: Two regulatory selves at work*
2012-1: Roos Pals: *Zoo-ming in on restoration: Physical features and restorativeness of environments*

Illustration Credits

Chapter 2

Figure 1, p. 33. Rob Doolaard © Dierenpark Emmen

Figure 2, p. 41. Rob Doolaard © Dierenpark Emmen

Chapter 3

Figure 1, p. 64. Rob Doolaard © Dierenpark Emmen

Figure 2, p. 64. Mendel Bouman

Figure 3, Figure 4, p. 76. Donald Smits Centrum voor Informatie Technologie, RUG

Chapter 4

Figure 1, p. 97. Donald Smits Centrum voor Informatie Technologie, RUG

Figure 2, Figure 3 p. 98. Donald Smits Centrum voor Informatie Technologie, RUG

kurtle
winins
tituut

Dissertation series Kurt Lewin Institute
Reeksnummer 2012-1