

MASTER

What makes nature restorative? an exploration using associations

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What makes nature restorative?
An exploration using associations

Bianca van der Ha

September 2011

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Preface

Although, the preface is the first chapter of the report, it is the last one I completed. Writing my thesis was not always easy and writing this preface has not made it easier: What do I want to say? Who do I want to thank and why? But most of all how am I going to say it without sounding cliché?

One of the most used clichés in the preface (as far as I know) discusses the hard work that was necessary to complete the thesis. I can tell you, I could say the same thing. Especially the last months filled with data-analyses and writing were very busy and stressful. I was lucky to have a restorative holiday with six friends in between; thank you girls for the wonderful time!

Before these two stressful months, I spend seven months mainly reading literature and conducting experiments. During the experiment-days I sat by myself in a windowless room. My supervisors joked that I should watch nature photographs to improve my mood. Although I believe in the restorative effect of nature, friends who came by to have a chat, drink tea and eat chocolate muffins with improved my mood better. I would like to thank everyone who took the time and the effort to participate in my experiments; I was moved by how willing everybody was to help me.

When I was not spending my time in the lab, I worked in the graduation room. Although, my other graduation students and I worked hard, there was always time for singing along with songs by the Lonely Island to release stress and regain energy. The last months, Niels accompanied me in the graduation room while the others worked at home. When I was having a tough time, he told me “Everything is going to be alright.” And although I know that it was going to be alright—especially now that I am finished—it motivated me to work harder and believe in myself.

Throughout my graduation period, I felt much supported by my supervisors Yvonne de Kort and Femke Beute. Although, they are both busy women, I always felt welcome to ask for advice and to share my progress and stories. During our weekly meeting Yvonne, Femke, and I had a lot of fun; I think you could hear us laugh at the end of the hallway. Of course they also helped me a lot by sharing their knowledge and giving me advice. I truly appreciate their enthusiasm and dedication.

This graduation thesis means the end of my student life: an amazing time. These eight years my parents believed in me and were always there for me. Thank you mum and dad for your unconditional support during my graduation, but mostly during my eight years of studying!

Now that my preface comes to an end, you can almost flip the page and start reading my final master thesis, which was an exploration of the restorative effect of nature using associations. You can find out what this means, how I did this, and what I have concluded in my report. And although writing my thesis, including this preface, was not always easy, I enjoyed it very much.

Bianca van der Ha
Eindhoven, September 2011

Summary

More than half of the world population lives in cities (United Nations Population Fund, 2007). Urban life can be very stressful, and a nice walk through a forest can help to reduce this stress as indicated by many studies. However, relatively little is known about what it is that makes nature restorative. Therefore, this research aimed at improving the knowledge on the restorative effect of natural surroundings.

Three theories can help to provide an insight in this restorative effect: the psycho-evolutionary theory by Ulrich, the attention restoration theory (ART) by Kaplan and Kaplan, and ego-depletion theory. Together, these theories imply that nature restores affect and cognitive capacities consciously and unconsciously. Furthermore, it has been suggested that our behavior and emotions drain a limited resource.

When looking at restoration into more detail, several aspects of nature or being in nature are related with restoration. Based on the literature these are aesthetics, positive affect, social interaction and physical activity. Literature also suggests that we give meaning to places based on earlier use and experiences in those (types of) environments. In the current research we wanted to explore whether indeed the experiences we associate with environments by looking at them can somehow explain their restorative potential.

Both theories by Ulrich, and Kaplan and Kaplan hint into the direction of associations as an underlying mechanism of the restorative effect of nature. Learned positive associations with nature have been suggested in relation to restoration by Ulrich, and ART's components can be linked to associations. In our research, associations were used to explore the restorative effects of nature

In the first study the difference between the associations with nature and urban settings are explored. Moreover, the effect of these associations on the restorative potential of nature was studied. The second study was based on the results of study one. The restorative effects of nature vs. urban settings and of the production of positive vs. negative associations after a stress-induction were investigated. In addition, the mediating effect by the valence of associations was examined.

As a conclusion it can be said that both studies indicated that nature settings were perceived as more restorative, more beautiful, and people showed stronger preferences for spending time in nature as opposed to urban settings. Furthermore, nature and urban environments elicited different associations. Mainly, nature elicited more positive and urban settings elicited less positive associations. However, while producing associations with the environments, nature had a very limited restorative effect. In contrast, producing positive associations showed restorative benefits, and influenced perceived restorativeness and preferences for nature. Based on our findings, our research hints that previous experiences with nature can play a role in the restorative potential of nature.

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General Introduction

The restorative potential of natural environments is an extensively studied subject in the field of environmental psychology (e.g. Kaplan, 1995; Ulrich, Simons, Losito, Fiorito, Miles, & Michael, 1991). Many studies have shown that nature is perceived as a restorative environment, meaning that it “can help to restore depleted emotional and functional resources and capabilities” (p. 464; Kjellgren & Buhrkall, 2010). Many other studies underline this by claiming that natural environments can help restore mental fatigue and/or reduce stress (e.g. Hartig, Mang, & Evans, 1991; Berman, Jonides, & Kaplan, 2008). In addition, viewing nature can increase focus (Hartig, et al., 1991), positive affect (Hartig, et al., 1991; Valtchanov, Barton, & Ellard, 2010), confidence (Kaplan R. , 1974), self-sufficiency (Kaplan R. , 1974), realistic self-evaluations (Kaplan R. , 1974), vitality (Ryan, Weinstein, Bernstein, Brown, Mastella, & Gagné, 2010), and performance (Berman, et al., 2008). At the same time, natural environments reduce cognitive fatigue (Hartig, et al., 1991), anger (Kweon, Ulrich, Walker, & Tassinary, 2008), negative affect (Hartig, et al., 1991), stress (Valtchanov, et al., 2010), and sympathetic nervous system activity (Hartig, et al., 1991). Taken together, these different studies indicate that exposure to nature has positive effects both cognitively and affectively. Although, these studies found evidence for the benefits of nature, they do not clarify what it is about nature that makes it restorative.

The aim of this research is therefore to gain more knowledge about what makes nature restorative. In the introduction we will discuss three theories which can give more insight into the restorative processes of nature. These theories are the psycho-evolutionary theory by Ulrich (e.g. Ulrich, 1983; Ulrich, Dimberg, & Driver, 1991), attention restoration theory by Kaplan and Kaplan (e.g. Kaplan & Kaplan, 1989; Kaplan, 1995), and ego-depletion theory (e.g. Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister, 2002).

Furthermore, we will look at restoration into more detail by aiming to relate nature and being in nature with restorative aspects: aesthetics and positive affect, and social connection and physical activity. We will explore these aspects as an explanation for what it is about nature that makes it more restorative than urban settings.

And finally, this report will introduce a—to our knowledge—possible new explanatory mechanism for the restorative effect, which are associations. In two studies, associations will be used to obtain more insight in the restorative potential of nature. In study one, the differences between the associations with nature and urban settings and their influence on perceived restorativeness will be explored. The second study will be based on the results of study one. The main difference will be manipulated to investigate its effect on the restorative benefits of nature.

Three Relevant Theories for the Restorative Potential of Nature

Psycho-evolutionary theory. In his theory, Ulrich proposed that, from an evolutionary perspective, generations of humans that had a preference for unthreatening natural environments managed to survive and reproduce (Ulrich, 1983). As a consequence, today's humans are physiologically and psychologically adapted to natural, as opposed to urban, settings and their responses to these environments are immediate, unconsciously triggered, and initially affective. In this view, Ulrich et al. (1991) claim that unthreatening natural environments are aesthetically pleasing and free from potential stressors, making it easier for humans to sustain attention, stimulate feelings of pleasure, reduce negative affect, and regulate states of emotional and physiological arousal. To conclude it can be said that according to Ulrich, humans react to natural environments with positive affect, and unthreatening nature works stress reducing.

Attention restoration theory. Kaplan and Kaplan have another perspective on the restorative potential of nature with their attention restoration theory (ART). According to ART, humans are using voluntary attention or directed attention to be effective in their daily lives (Kaplan, 1995). This form of attention requires cognitive-controlled processes and effort, which are fatiguing, leading to directed attention fatigue. To overcome this directed attention fatigue, involuntary attention is needed. This is captured automatically by inherently intriguing incentives or stimuli that are important for a person or for a person's activity, and which require no effort. Kaplan and Kaplan (1989) state that natural environments are characterized as environments rich with inherently fascinating stimuli, which invoke involuntary attention moderately in a bottom-up fashion, allowing directed-attention mechanisms a chance to replenish, reducing mental fatigue, and enhancing self-regulation and cognitive inhibition. Urban environments, on the other hand, contain top-down stimulation that captures attention dramatically and therefore requires directed attention to overcome that stimulation (Valtchanov, et al., 2010). Thus, based on Kaplan's theory it can be said that focusing attention is the cognitive mechanism that is restored by interactions with nature.

Ego-depletion theory. Kaplan (1995) speaks of a limited source that is depleted by a cognitive-controlled process, namely focusing attention. Ego-depletion theory also speaks of a capacity, which—according to Kaplan and Berman (2010)—depends on the same resource as ART, which is directed attention: the need one has to direct attention on certain stimuli while suppressing other stimuli. According to Baumeister, et al. (1998), self-regulation depletes this resource. Self-regulation, or self-control, involves the ability humans have to control one's own responses, thoughts, emotions, and actions, like restraining impulses (e.g. having a spontaneous drink in a pub when one has to write one's thesis) and resisting temptations (e.g. eating cookies when on a diet), and it is necessary to achieve long term goals (Baumeister, 2002). In sum it can be said that self-regulation causes ego-depletion.

Another important concept within ego-depletion is vitality, which can be defined as physical and mental energy, and is experienced as a sense of enthusiasm, energy, and aliveness (Ryan & Deci, 2008). Ego-depletion can result in a diminished sense of vitality; and—as we have seen in the previous paragraph—the act of self-regulation can cause ego-depletion. Therefore, ego-depletion describes “the condition that arises when the self’s resources have been expended and the self is temporarily operating at less than full power” (p. 133; Baumeister, 2002). This means that self-regulation causes ego-depletion which diminishes vitality.

According to Kaplan and Berman (2010) humans’ capacities depend on the same resource. Moreover, they add to this that intervention with nature restores this finite resource. However, there is hardly any evidence for this statement. What has been shown to replenish the self’s stock of energy is social connectedness, which refers to a short-term experience of belonging (van Bel, In Press). The results of the study by Ryan and Deci (2008) underlined this: social connectedness increased vitality. In addition, a series of studies by Stillman (2007) found that social connectedness increased self-regulation. This restorative effect of social interaction will be further elaborated when exploring restoration into more detail. In sum it can be said that both attention restoration theory and ego-depletion theory speak of a limited resource that can become depleted. There are some suggestions that exposure to nature can restore this recourse. However, social interaction has been shown to have a restorative potential.

To conclude, natural environments restore affect and cognitive capacities unconsciously as well as on a more conscious level (Kaplan & Kaplan, 1989; Ulrich, 1983). Both ART and ego-depletion speak of a similar finite resource that determines our cognitive capacities and behavior, more explicitly our ability to exert self-control (Kaplan & Berman, 2010). According to Kaplan & Berman (2010) this limited resource can be restored by interaction with natural environments. However, there is very limited evidence for this statement. Nevertheless, social interaction has been shown to have restorative benefits. In our research we will use these three theories complementary to gain more knowledge about the restorative effect of nature.

What Is It That Makes Nature Restorative?

The theories discussed earlier provide an insight in the restorative potential of nature on a broader level. Now we will look at restoration in more detail. Kaplan (1995) already provided some insight by mentioning four characteristics of an environment that can enhance restoration. Fascination is the central component of a restorative experience, and is equal to involuntary attention. Second, the environment needs to provide the feeling of being away. This is a conceptual transformation out of one’s daily life, physically or mentally. Third, there must be compatibility between the activities one is doing in a setting and the activities one wants to do. Lastly, the surroundings must be rich and coherent enough that they constitute a whole other world; this is called extent. Kaplan (1995) states that natural environments are rich in these four characteristics.

Other studies mentioned additional aspects of environments—mostly nature and urban—that are related to their restorative potential, for instance aesthetics (e.g. van den Berg, Koole, & van der Wulp, 2003; Stamps, 1996) and positive feelings and appreciation (e.g. van den Berg, et al., 2003; Hietanen, Klemettilä, Kettunen, & Korpela, 2006). Additionally, literature on favorite places can provide an explanation for restorative environments (e.g. Korpela & Hartig, 1996), since they state that visiting one's favorite places works restorative and that the majority of favorite places consist of natural settings. In addition, ego-depletion studies show that social interaction and physical activity *ansich* have restorative benefits (e.g. Baumeister, et al., 1998; Smith & Baum, 2003). These studies and literature will be further elaborated on as possible explanations for the restorative potential of nature.

Restoration and aesthetics: What is the role of aesthetics in the restorative effect of nature?

Many studies have shown that nature is shown to be perceived as more positive and more beautiful than urban environments. This accounts for exposure to real nature as well as to photographs of nature settings (e.g. van den Berg, et al., 2003; Berman & Jonides, 2008; Hietanen, et al., 2006; Kaplan, Kaplan, & Wendt, 1972; Purcell, Lamb, Mainardi Peron, & Falchero, 1994; Staats, Kievit, & Hartig, 2003; Stamps, 1996; Ulrich, 1983). In addition, in a study by Verges and Duffy (2010) nature elements elicited a positive connotation whereas urban elements elicited a negative connotation. Using the Implicit Attitudes Test (IAT) they have found that participants connected nature (e.g. trees) and self (e.g. me) items faster than built (e.g. factory) and other (e.g. them) items. According to Verges and Duffy this was caused by humans' preferences of themselves over others, and humans' positive associations with nature. So, as they state, people have an unconscious connection between themselves, positivity, and nature. In sum it can be said that these studies showed that natural environments are considered to be more beautiful—consciously as well as unconsciously—than urban environments.

This preference of nature can play a role in the restorative effect of an environment as indicated by a study by Gal, de Kort, Staats, and Midden (2004). Their results showed that a high preference for an environment was related to a high restorative potential. On the other hand, the results of the study by van den Berg, et al. (2003) implicated that due to the restorative effect of nature, people prefer nature over built settings. However, in their discussion they point out that the direction of causality can also go the other way. Both studies do point out that although there is not yet evidence for the effect of aesthetics on restoration, they do show that positive liking and the restorative effect of natural settings are related. In our current research we attempted to explore if aesthetics of nature influences its restorative effect.

Is it the positive feeling elicited by nature that is responsible for restoration?

Not only is nature perceived as more positive and beautiful, people also report an increase in positive affect, like happiness and joyfulness, and a decrease in negative affect, like fear and sadness, when viewing nature (e.g. van den Berg, et al., 2003; Ulrich, et al., 1991). On the contrary, when viewing urban scenes without vegetation people report an increase in negative affect and a decrease or no change in positive affect. These results showed an explicit positive affect with nature; Hietanen, et

al. (2006) also found an implicit connection between positive feelings and nature. In their study, participants recognized happy faces earlier after viewing natural environments as opposed to urban environments. Together, these studies indicate that natural environments elicit positive feelings implicitly and explicitly.

These positive emotions can also have a restorative effect on people, as indicated by a series of ego-depletion studies by Tice, Dale, and Baumeister (2000) which assessed the influence of positive affect on the depleted self. All their studies had a similar design in which participants engaged in two consecutive, seemingly unrelated acts of self-control. The purpose of the first act was to induce ego-depletion; the performance on the second act was a measure for self-control. In between the two tasks, participants received an induction of positive or negative mood. The participants who were put into a positive mood (e.g. by showing a funny movie clip or by surprising them with a small gift) showed no reduction of self-control, suggesting that the good emotional state helped to counteract the depleting effect of the first task. In sum it can be said that nature elicits a positive affect and that positive affect works restorative. When combining these two findings, an assumption can be made that the positive affect elicited by nature can play a role in its restorative effect. This implies for our research that the relation between nature's restorative benefits and positive affect is interesting to explore.

The restorative effect of favorite places

Favorite places also elicit positive emotional states as can be concluded from favorite places literature (e.g. Korpela & Hartig, 1996; Korpela, Hartig, Kaiser, & Fuhrer, 2001). For instance, in a study by Korpela and Hartig (1996) participants associated higher positive affect, lower aggression, and lower fear with their favorite places as compared to the town square.

Furthermore, a couple of studies suggest that favorite places were perceived as more restorative than other places. In a study by Korpela, et al. (2001) the answers of the participants indicated a connection between favorite places and restorative experiences, because they mentioned being away, being relaxed, forgetting worries, and reflecting on personal matters. The results of the study by Korpela and Hartig (1996) underline this: The scores for the four components mentioned by Kaplan (1995), which characterize a restorative environment (being away, fascination, coherence, and compatibility) were higher for the favorite places than for the neutral place (i.e. the central square), which were in turn higher for those of unpleasant places. In addition, Korpela and Ylén (2009) found that people visiting their favorite places on a daily basis experienced significantly stronger restorative experiences compared to people who were not visiting their favorite places and people in the control group. In sum, favorite places are perceived and experienced as more restorative.

Nature also plays a role in the favorite places literature, since a majority of the favorite places consists of natural settings. This is indicated by the results of a study by Korpela, et al. (2001) which stated that "natural settings were overrepresented among favorite places and underrepresented among the unpleasant places" (p. 572). In addition, the results of a study by Korpela, Ylén, Tyrväinen, and Silvennoinen (2010) revealed that restorative experiences in favorite nature settings were higher than

those in favorite urban settings. Together, these findings suggest that nature is often seen as a favorite place, eliciting positive feelings, and providing a restorative effect. It would be interesting to explore that when an environment elicits an association about a favorite place, this association enhances its restorative effect.

Giving meaning to places

Naming a place a favorite place can be interpreted as giving meaning to a place. Genereux, Ward, and Russell (1983) found another way in which people give meaning to places; according to them activities and behavior form an important part of place meaning. They described places based on behavior, and meaning of places is to a large extent based on behavior associated with that place. Genereux, et al. (1983) came to this conclusion with a study in which the activities associated with different places were explored. Participants considered the various behaviors or activities associated with places shown on twenty slides. The investigators found that there were some overlapping activities which held for more places, like walking, but every environment elicited very specific associations as well, like skiing for snow-covered mountains. Furthermore, as indicated by Staats, et al. (2003), associations with an environment can be a reflection of prior use of this environment or this type of environment. Taking these two studies together it can be said that places can gain meaning through previous activities undertaken in or associated with that (type of) environment.

This recollection of past experiences can influence the current feelings, as shown by the studies by Tarrant, Manfredo, and Driver (1994) and Tarrant (1996), in which arousal decreased during remembrance, and mood and subjective health states improved immediately after the remembrance of past recreation experiences compared to the remembrance of an exam event. An explanation for this restorative effect of the remembrance of previous recreation can be found in an article by Ulrich, Dimberg, and Driver (1991). They state that mental escape from daily lives can cause restoration, which is one of the four characteristics of a restorative environment according to Kaplan (1995). In sum, these studies indicate that activities and experiences associated with environments can benefit the restorative effect of that environment, not only while being in that environment, but also when thinking about that (type of) environment (so, mentally being away). In the current study we will explore if indeed previous experiences in a (type of) environment influence its restorative benefits.

The restorative benefits of social interaction

Previously we have mentioned that nature elicits positive affect (e.g. van den Berg, et al., 2003; Ulrich, et al., 1991). Ego-depletion theory indicated that positive affect can work restoratively (Tice, et al., 2000). In addition, ego-depletion literature indicated that social connectedness can work restorative by diminishing ego-depletion (e.g. Baumeister, DeWall, Ciarocco, & Twenge, 2005; Stillman, 2007), since people have a natural need to belong to and relate with other people (Baumeister, Brewer, Tice, & Twenge, 2007). According to the original paradigm of ego-depletion, social exclusion causes ego-depletion, and ego-depletion decreases self-regulation (Baumeister, et al., 1998). This implies that social exclusion has an indirect negative effect on self-regulation.

Baumeister, et al. (2005) illustrated this indirect effect in a series of studies where social exclusion was induced. Results showed that when participants were socially excluded, their self-regulation capacity (measured with persistence and performance) diminished. The studies show that social exclusion causes ego-depletion, which decreases self-regulation.

In addition, there also appears to be evidence for a positive effect of inducing social connectedness on stress-reduction, health, self-regulation, and vitality (Maas, 2008; Ryan & Deci, 2008; Smith & Baum, 2003), which can be defined as ego-replenishment. Smith and Baum (2003) state that social encounters and potential social support are a way to restore from stress. Maas (2008) adds to this that an increase in the number of social interactions has been linked to a positive effect on physical and mental health. In addition, in a study by Stillman (2007) participants performed better and demonstrated more self-control after being subliminally primed with names or a visual cue of their family and after writing an essay about a family member. A series of studies by Ryan, et al. (2010) showed that social activities enhance vitality after reading vignettes describing a setting, a social interaction, and a physical activity or after reporting their activities and corresponding places in a diary. Based on these studies it can be said that social interaction or a simulation of social interaction can have a restorative influence on humans. Based on these findings it is interesting to explore if social interaction benefits the restorative effect of nature.

The restorative effect of physical activities

What holds for social interaction, holds for physical activity as well: Being physically active has shown to have a positive effect on wellbeing and subjective vitality (e.g. Frederick & Ryan, 1995; Plante & Rodin, 1990; Ryan & Deci, 2008; Thayer, 1996). The vignette and diary studies by Ryan, et al. (2010), which were mentioned earlier to illustrate the restorative influence of social interaction, underline these findings: Their results showed that, next to outdoor experience and social interaction, physical activities have the potential to work restorative.

Evidence substantiating this suggestion, the paper by Plante and Rodin (1990) reviewed over forty studies that investigated the enhancing effect of physical exercise on psychological health and wellbeing. Their overall conclusion was that these studies indicate that being physically active improves mood and wellbeing and reduces stress, depression, and anxiety. This holds for changes in mood and wellbeing right after the exercise and after long-term maintaining of an exercise-regime. For instance the study by Lichtman and Posner (1983) investigated the short-term effects of physical activity on the mood of people from an exercise class and from a hobby class. Results revealed that although both pastimes were associated with mood improvement, physical activity improved mood better. In addition, the study by Blumenthal, Williams, Needels, and Wallace (1982) looked at the more long-term effects of being physically active on the mood of community volunteers (control group) and people who registered for a ten-week exercise program. Their results showed that the exercisers felt less depressed, tense, anxious, and fatigued than the volunteers. These studies suggest that an increase in physical activity can have restorative benefits.

An Exploration Using Associations

We have seen that nature has a restorative influence on human beings. Several theories try to explain this effect; in sum these state that nature restores affect and cognitive capacities both on a conscious and on an unconscious level. Furthermore, we have discussed a series of possible explanations for this restorative potential of nature. In the literature we found that nature or being in nature is closely related to appreciation of aesthetics and positive affect, and experiences of social interaction and physical activity.

Literature also suggests that we give meaning to places based on earlier use and experiences with those environments or types of environments. In the current study we wanted to explore whether indeed the appreciations and experiences we associate with environments just by looking at them can somehow explain their restorative potential.

Both theories by Ulrich and Kaplan hint into the direction of associations as an underlying mechanism of the restorative effect of nature. Associations can be defined as a connection between ideas, thoughts, concepts, stimuli, or items in one's head, which can be caused by experience, memory, generalization, or prejudice (Encyclo.nl, 2011). Firstly, Ulrich (1991) suggested associations in relation to restoration, since people can learn positive associations with natural environments, for instance during vacations. Secondly, ART's components fascination, being away, extent, and compatibility can be linked to associations. For instance, the feeling of being away could be induced by associations with activities like holidays or afternoon walks. This recollection of prior experiences can influence one's current feelings as mentioned earlier (Tarrant, et al., 1994; Tarrant, 1996). Furthermore, fascination implies that people's thoughts are captured by the stimulus, but why and in what way is yet unknown.

The Current Studies

In two studies we are exploring associations as an explanatory mechanism for the restorative potential of natural environments, since we want to gain more insight in what makes natural settings restorative (as compared to urban settings). The first study is an exploration of the spontaneous associations with natural and urban environments. With this exploration we want to see if there are differences between the associations with natural settings and with urban settings, if these differences in associations can be linked to restorative aspects (e.g. preference, positive feelings, social interaction, and physically active), and if the associations influence the restorative potential of nature.

For study one we hypothesize that nature photographs are rated higher on preference and perceived restorativeness than urban photographs (hypothesis 1a). Furthermore, we expect that nature pictures elicit more associations with social experiences, physical activity, positive affect, and an activating character (hypothesis 1b). In addition, we hypothesize that (the characteristics of) these associations are related to the perceived restorativeness of nature (hypothesis 1c).

In a second study we subsequently explored the causality of association type on restoration by inducing either positively or negatively valenced associations with both natural and urban settings, and by investigating their effect on restoration after stress-induction. For study two we expect that exposure to nature photographs will restore more than exposure to urban photographs (hypothesis 2a). Furthermore, we hypothesize that producing positive associations will result in better restoration than producing negative associations (hypothesis 2b). Moreover, we expect that the valence of the associations will mediate nature's restorative benefits (hypothesis 2c).

Introduction Study 1

With the first study, people's associations with nature and urban settings were explored. Mainly the differences between the produced associations were looked upon. To achieve this, participants freely mentioned their associations with nature and urban photographs. To gain more insight in these associations, participants also reported their mood, their backgrounds, and they rated the valence of their associations. Furthermore, we explored the relation between participants' associations and the perceived restorative potential of natural environments.

In study 1 we expected to find that natural settings were judged as more positive, more pleasurable, and more restorative compared to urban settings. Furthermore, we expected to find that participants would rate their associations with nature as more positive than their associations with urban settings, and that participants would mention more social and physical associations for nature and more activating associations for urban settings. Finally, we expected that associations would mediate the restorative potential of natural settings.

Method Study 1

Design

Study 1 used a within-subjects design. The main independent variable was Environment (with two levels: nature and urban). The main dependent variables were perceived restorativeness, aesthetics, attitude, and the number, valence, and type of associations.

Participants

Data were collected in individual sessions from thirty-eight young adults (eighteen men, 47%). The average age of participants was twenty-three years old, with a range of nineteen to twenty-seven. Participants were recruited mostly via e-mail and social media or by asking them personally.

Setting

The experiment took place in the Game Lab of the Eindhoven University of Technology. One room was used in which participants were seated behind a table with a laptop. The whole experiment was conducted on a Dell Latitude E6500 laptop, with a screen size of 15.4 inch and 1280 x 800 pixels, a color quality of 32 bits, and a screen refresh rate of 60 Hertz. On this laptop, the pictures were displayed and the participants answered the questionnaires.

Stimuli

Participants viewed, associated with, and rated twelve pictures on the laptop. All photographs were taken by the experimenters. Four nature pictures were taken in the ‘Strabregtse Heide’, woodland in the south of The Netherlands. These pictures mainly contained heath land and trees. Four urban pictures were taken in the city centre of Eindhoven and mainly contained squares, roads, and high buildings. The four filler pictures respectively contained a beach with people, parasols, and palm trees, a park with a lantern and a man-made path, a park with a man-made pond and sky scrapers in the background, and the tops of snow covered mountains. See Picture 1 and Picture 2 for an example of the nature and urban photographs respectively; all photographs can be found in Appendix A.



Picture 1: nature photograph



Picture 2: urban photograph

Measures

Mood. Participants' mood was measured with the mood questionnaire by Beute, Smolders, and de Kort (In Preparation). Participants answered 'how do you feel right now?' for forty-three items; answers could be indicated on five-point scales ranging from *not at all* to *very much*. Mood was measured along five dimensions, namely happy (e.g. satisfied, enthusiastic), sad (e.g. angry, dejected), calm (e.g. calm, composed), tense (e.g. irritable, composed), and tired (e.g. sleepy, listless). Internal consistency was respectively $\alpha = 0.947$, $\alpha = 0.923$, $\alpha = 0.880$, $\alpha = 0.855$, and $\alpha = 0.940$.

State self-control. A short version of the state self-control capacity scale (SSCCS) by Ciarocco, Twenge, Muraven, and Tice (2007) was used to measure state self-control. Ten items described how one could feel right now, like 'I feel mentally exhausted', 'I need something pleasant to make me feel better', and 'I have lots of energy'. Participants responded to these statements on seven-point scales ranging from not true to very true. The scale measured one dimension with an internal consistence of $\alpha = 0.87$.

Associations. For all twelve pictures, participants produced minimally five and maximally ten associations. This method is comparable to the method used by White and Abrams (2004), Kirchler (1998), and Lovelace and Cooley (1982); in their studies participants reported their spontaneous reactions to homophones (words that share phonology but differ in meaning and spelling), to the word 'tax', or to one word or a triad of words.

After the production of the associations, participants evaluated all of their associations on seven-point scales ranging from *very negative* to *very positive*. This method was based on the study by Kirchler (1998), in which participants had to indicate whether their association was negative, neutral, or positive.

An independent rater¹, blind to the conditions, categorized all associations on four characteristics: Whether they (1) involved a social or nonsocial experience, like chatting or alone, (2) were physically active or passive, like jogging or sitting, (3) were activating or not, like busy or

¹ The categorization by the second rater was not finished in to time to be used for this report.

rest, and (4) had a positive or negative content, like beautiful or ugly. These values were used to calculate the level of social/physically active/activating/positive associations per photograph. For instance, we rated an association with a 1 when it had a social meaning (for instance chatting) or with a 0 when the meaning was nonsocial (for instance by myself). Ambiguous or nonrelated associations were recoded as missing value and not taken into further account. Furthermore, we computed the level of associations with a social character by calculating the mean of these ratings. A value of 0 would therefore mean no socially related associations; a value of 1 would mean that all associations had a social character. The same calculations were made for associations of a physically active, an activating, and a positive character per photograph. These variables were named *sociality*, *physically active*, *activation*, and *positivity*.

Evaluations of environments. Participants rated all twelve pictures on ‘familiarity’ and on ‘comforting’, ‘energizing’, ‘fascinating’, ‘extent’, ‘being away’, and ‘compatibility’. These last six form one dimension, namely perceived restorativeness with an internal consistency of $\alpha = 0.879$. Furthermore, participants assessed all photographs on aesthetics (i.e. ‘How (beautiful, nice, pleasant) is this environment?’) and on attitude (i.e. ‘How (attractive, pleasant, positive) would it be to walk in this environment for one hour?’; Staats, Kieviet, & Hartig, 2003). All these ratings could be indicated on seven-point scales ranging from *not at all* to *to a large extent*. The internal consistency of aesthetics was $\alpha = 0.934$ and of attitude $\alpha = 0.963$.

Need for Restoration. Need for restoration was measured with a revised version of the Attitude towards being Mentally Fit Scale (AMFS; Beute, de Kort, Haans, & Kaiser, 2010). Thirty-six questions asked how often participants performed certain behaviors (e.g. ‘On a regular day at school I take an extra break’, ‘When I have the day off I go to bed early’, ‘As soon as I arrive home after work I take off my shoes’), and these could be answered with *never*, *occasionally*, *now and then*, *often*, *always*, and *no answer possible*. Six additional evaluative statements were to be answered on five-point scales ranging from *completely disagree* to *completely agree*. (e.g. ‘My performance is optimal when I am under pressure’, ‘It is important for me to avoid feeling mentally tired.’) Need for restoration measured one dimension; item reliability was 0.98 and person reliability was 0.57.

Connectedness with nature. To measure connectedness with nature, two scales were used. First, in an adjusted version of the Inclusion of Nature in Self Scale (INS; Schultz, 2001), participants dragged a circle labeled ‘self’ over a circle labeled ‘nature’ indicating how related they feel with nature. Second, a Dutch translation of the Disposition to Connect with Nature Scale (DCN) asked for nature related behaviors (Brügger, Kaiser, & Roczen, In Press). Out of forty items, fourteen contained evaluative statements (e.g. ‘Nature is my favorite place’, ‘Pets are part of the family’) that were to be answered with *yes* or *no*. The other twenty-six items included behavioral self-reports from which nine were to be answered with *yes* or *no* (e.g. ‘I prefer sporting outdoors over sporting indoors’, ‘I collect natural objects, like stones, butterflies, and insects’), and seventeen (e.g. ‘I spend time in a park’, ‘I prefer living in a city’) on five-point frequency scales ranging from 1 (*never*) to 5 (*very often*). One dimension measured connectedness with nature; item reliability was 0.91 and person reliability was 0.61.

Nature in life. Several questions asked for the level of nature/urban in participants' lives. Participants answered 'To what extent are (the place where you were born, the environment where you grew up in, the environment you visited during child holidays, the environment you visited during your last holidays, the place where you live now) mainly urban/natural?' These were indicated on seven-point scales ranging from *urban* to *natural*. Furthermore, participants indicated how much they like to spend time in a natural and in an urban environment on seven-point scales ranging from *not at all* to *a large extent*. Lastly, participants described their favorite places overall, to relax, and to gain energy.

Procedure

Upon arrival participants filled out a consent form. After this, the experiment started with the measurement of mood and state self-control. Second, participants produced a minimum of five and a maximum of ten associations for the twelve pictures which were displayed in a random order (four nature, four urban, and four filler). Third, participants evaluated the valence of all of their produced associations. And fourthly, participants rated the pictures on perceived restorativeness, aesthetics, and attitude. Closing questionnaires probed need for restoration, connectedness with nature, nature in life, favorite places, and demographic variables. The whole experiment took approximately forty-five minutes, mainly depending on the time it took to produce the associations. Afterwards, participants received their monetary reward (€10 for students from Eindhoven University of Technology and €12 for participants from outside the university), were debriefed, and were thanked for their participation.

Data Analysis

We used Linear Mixed Models, because our data was hierarchical data. This means that some variables are clustered or nested within other variables (Field, 2005). For example each participant produced five associations per photograph. This means that the data on the associations was clustered within the variable photograph. Equally, the data on the four nature (urban) photographs were nested within the category natural (urban) environment. We analyzed our data, using separate analyses, on two different levels, namely photo-level and category-level. In the results section we will explain why we used a certain level.

Results Study 1

The results section of study 1 consists of two parts: the preparatory and the main analyses. The preparatory analyses first investigated gender differences in the evaluations of and the associations with the natural and urban photographs. The aim of these preliminary analyses was to see if there is a difference between men and women which could influence the main analyses.

The main analyses investigated the restorative potential of natural versus urban environments and participants' aesthetics and preference ratings of these environments. Furthermore, they examined the differences in associations with these environments. Subsequently, the main analyses explored the potential mediation of the restorative potential, aesthetics, and attitude by associations.

In the additional analyses, we examined the effect of connectedness with nature and need for restoration on the evaluations of and the associations with the nature and urban photographs. The results can be found in Appendix D.

Preparatory Analyses

Gender differences in ratings of and associations with environments

We used Linear Mixed Models to explore gender differences on all of the dependent variables: perceived restorativeness, aesthetics, attitude, valence of associations, and characteristics of the associations. These analyses were conducted on the category-level (natural vs. urban environments). The only significant main effect of Gender was on sociality, $F(1, 62) = 7.872$, $p = 0.007$. Means indicated that women produced more associations of a social character ($M_{\text{women}} = 0.465$, $SE_{\text{women}} = 0.063$) than men did ($M_{\text{men}} = 0.212$, $SE_{\text{men}} = 0.064$). There were no other significant main effects of Gender ($ps > 0.125$) or interaction effects of Gender and Environment ($ps > 0.230$). Statistical data are summarized in Table 19 in Appendix B.

Main Analyses

Mediation of associations

Our primary interest of this study was to determine whether associations mediate the restorative potential of nature and the positive ratings of nature on attitude and aesthetics. To show mediation (see Figure 1), (step 1: c) the independent variable (IV, in our case Environment) must have a significant influence on the dependent variable (DV, in our case perceived restorativeness, aesthetics, and attitude), (step 2: a) the IV must also have a significant effect on the mediator (M, here valence and characteristics of the associations), (step 3: b) the mediator must significantly influence the DV, and (step 4: c') the relation between the IV and DV should disappear (full mediation) or weaken (partial mediation) when the mediator is controlled for (Baron & Kenny, 1986). We used a series of Linear Mixed Model-analyses and the Sobel test to assess mediation (MacKinnon, 2008).

The complete mediation-analysis was conducted on photo-level. This means that averages were computed per photograph per participant. We choose to analyze on photo-level, since for each photograph at least five associations were produced, a sufficient number of data-points remained per participant (namely eight: four nature, four urban), and this number of data-points was equal for each participant.

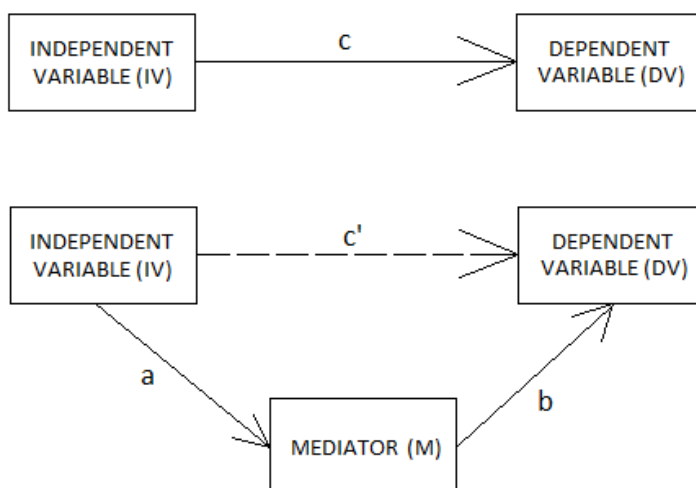


Figure 1: mediation analysis

Step one: environmental effects on perceived restorativeness, aesthetics, and attitude

Linear Mixed Models assessed the differences between natural and urban photographs (IV) for the ratings on perceived restorativeness, aesthetics, and attitude (DV's). The results revealed that nature pictures were rated higher on perceived restorativeness, aesthetics, and attitude than urban pictures. Statistics can be found in Table 1. These significant values demonstrate that the criterion for the first step ('c' as indicated in Figure 1) of the mediation analysis was met.

Table 1: *environmental effects on perceived restorativeness, aesthetics, and attitude*

	Nature		Urban		F(1, 266)	p
	M	SE	M	SE		
Perceived restorativeness	4.924	0.086	2.719	0.086	628.460	0.000
Aesthetics	4.947	0.104	3.058	0.104	249.465	0.000
Attitude	4.932	0.112	2.923	0.112	223.343	0.000

Step two: environmental effects on associations

Linear Mixed Models explored the differences between Environments (IV) for the associations. The dependent variables were the number of associations, the valence of the associations (rated by the participants), and sociality, physically active, activation, and positivity (rated by an experimenter). All associations were categorized by the experimenters on these last four characteristics. The values range from 0 to 1: Zero means that no associations were related; one means that all associations were related. (See the method section for a detailed explanation.)

The results revealed that participants rated their associations with nature pictures as more positive, and they produced more associations of a physically active and positive character as compared to urban pictures. No differences were found for associations of an activating and social character and the number of produced associations. Statistical values can be found in Table 2. These results indicated that step 2 ('a' as indicated in Figure 1) of the mediation analysis (the significant influence of the IV on the M) holds for valence of associations and physically active and positivity. Therefore, further mediation analyses will be reported only for these three possible mediators.

Table 2: *environmental differences for the produced associations. PR means participant rated, ER means experimenter rated.*

	Nature		Urban		F	p
	M	SE	M	SE		
Valence of associations (PR)	4.954	0.102	3.980	0.102	F(1,226) = 62.062	0.000
Sociality (ER)	0.326	0.061	0.285	0.052	F(1, 140.719) = 0.322	0.572
Physically active (ER)	0.709	0.045	0.543	0.047	F(1, 189.316) = 9.188	0.003
Activation (ER)	0.210	0.049	0.332	0.040	F(1, 165.970) = 3.736	0.055
Positivity (ER)	0.485	0.064	0.304	0.057	F(1, 119.022) = 4.846	0.030
Number of associations	5.316	0.064	5.355	0.064	F(1, 266) = 0.292	0.589

Step three: influence of associations on perceived restorativeness, aesthetics, and attitude

Step one of the mediation analysis indicated significant environmental effects on all three dependent variables: perceived restorativeness, aesthetics, and attitude. Step two demonstrated environmental effects on the valence of the associations and on the associations with a physically active and positive character (which are the possible mediators). In this third step we tested correlations between these potential mediators and the three dependent variables.

Linear Mixed Models investigated the influence of the Associations on the ratings of the environments. The independent variables were Valence of Associations (PR), Physically Active (ER), and Positivity (ER); the dependent variables were perceived restorativeness, aesthetics, and attitude.

The results showed that the Valence of Associations and Positivity significantly influenced the three dependent variables. Physically Active had a significant influence on aesthetics and attitude, but not on perceived restorativeness. A summary of the statistics can be found in Table 3, Table 4, and Table 5. (The statics of the influences of Sociality and Activation on the three dependent variables are reported in Table 20 and Table 21 in Appendix C.)

The results of step 1, step 2, and step 3 of the mediation analysis implied that mediation is possible for the valence of the produced associations and the associations with a positive character for all three dependent variables. And mediation is possible for the association with a physically active character for aesthetics and attitude. Therefore, further analyses of mediation will only be reported for these eight possible mediations.

Table 3: *influence of Valence of Associations (participants rated) on perceived restorativeness, aesthetics, and attitude*

	Estimate	SE	F	p
Perceived restorativeness	0.692355	0.052341	F(1, 303.957) = 174.976	0.000
Aesthetics	0.819503	0.049991	F(1, 302.690) = 268.731	0.000
Attitude	0.808676	0.058839	F(1, 302.234) = 188.896	0.000

Table 4: *influence of Physically Active (experimenter rated) on perceived restorativeness, aesthetics, and attitude*

	Estimate	SE	F	p
Perceived restorativeness	0.388999	0.221340	F(1, 215) = 3.089	0.080
Aesthetics	0.561318	0.230947	F(1, 209.216) = 5.907	0.016
Attitude	0.606769	0.252180	F(1, 209.122) = 5.789	0.017

Table 5: *influence of Positivity (experimenter rated) on perceived restorativeness, aesthetics, and attitude*

	Estimate	SE	F	p
Perceived restorativeness	1.325778	0.277175	F(1, 120.184) = 22.879	0.000
Aesthetics	1.613168	0.260448	F(1, 121.652) = 38.363	0.000
Attitude	1.656826	0.278985	F(1, 121.999) = 35.268	0.000

Step four: environmental effects when controlling for the associations

Step 4 of the mediation analysis includes that the relation between the IV and DV should disappear (full mediation) or weaken (partial mediation) when the mediator is controlled for. Linear Mixed Models was used to analyze this last step of mediation analysis. The independent variable is Environment, the dependent variables are perceived restorativeness, aesthetics, and attitude (using separate analyses), and the mediators (which are controlled for) are valence of associations (PR) and associations of a physically active (ER) and positive (ER) character (again using separate analyses).

The results indicated that all main effects of Environment remained significant when controlling for valence of associations, associations of a physically active character, or positive associations. The mediators, Valence of Associations and Associations with a Positive Character had a significant effect on all dependent variables; the mediator Associations of a Physically Active Character did not have a significant effect on the dependent variables. These statistics can be found in Table 6, Table 7, and Table 8.

Sobel tests were used to assess partial mediations. The estimates of Environment (a) and the estimates of the associations (b) were used in these tests. The results indicated that valence of associations and positivity partially mediated the environmental effects on perceived restorativeness, aesthetics, and attitude. A summary of the statistical values of the Sobel tests can be found in Table 9.

Table 6: *environmental effects when controlling for valence of association. PR means participant rated, ER means experimenter rated.*

		Estimate	SE	F	p
Effect environment	Perceived restorativeness	1.830464	0.081279	F(1, 272.040) = 507.180	0.000
Effect valence of associations (ER)		0.384507	0.035303	F(1, 294.398) = 118.628	0.000
Effect environment	Aesthetics	1.310883	0.103187	F(1, 274.036) = 161.392	0.000
Effect valence of associations (ER)		0.593699	0.044332	F(1, 300.576) = 179.345	0.000
Effect environment	Attitude	1.465502	0.125050	F(1, 274.300) = 137.343	0.000
Effect valence of associations (ER)		0.557667	0.053578	F(1, 301.622) = 108.336	0.000

Table 7: *environmental effects when controlling for physically active. PR means participant rated, ER means experimenter rated.*

		Estimate	SE	F	p
Effect environment	Aesthetics	1.932125	0.144508	F(1, 190.304) = 178.766	0.000
Effect physicality (ER)		0.143989	0.177845	F(1, 214.227) = 0.656	0.419
Effect environment	Attitude	2.090749	0.159228	F(1, 190.009) = 172.411	0.000
Effect physicality (ER)		0.156490	0.195317	F(1, 214.593) = 0.642	0.424

Table 8: *environmental effects when controlling for positivity. PR means participant rated, ER means experimenter rated.*

		Estimate	SE	F	p
Effect environment	Perceived	2.369962	0.134583	F(1, 103.565) = 310.099	0.000
Effect positivity (ER)	restorativeness	0.846127	0.148953	F(1, 108.522) = 32.268	0.000
Effect environment	Aesthetics	1.802715	0.178578	F(1, 107.187) = 101.905	0.000
Effect positivity (ER)		1.251532	0.196351	F(1, 113.001) = 40.627	0.000
Effect environment	Attitude	1.976140	0.190096	F(1, 107.115) = 108.066	0.000
Effect positivity (ER)		1.260965	0.208834	F(1, 113.212) = 36.459	0.000

Table 9: *data of the Sobel test for analysis of the partial mediation of the associations. PR means participant rated, ER means experimenter rated.*

		Sobel					
		a	SE _a	b	SE _b	Z	p
Perceived restorativeness	Valence of associations (PR)	0.974	0.124	0.692	0.052	6.769	0.000
	Positivity (ER)	0.181	0.082	1.326	0.277	2.000	0.046
Aesthetics	Valence of associations (PR)	0.974	0.124	0.820	0.050	7.101	0.000
	Physically active (ER)	0.166	0.055	0.561	0.231	1.896	0.058
	Positivity (ER)	0.181	0.082	1.613	0.260	2.074	0.038
Attitude	Valence of associations (PR)	0.974	0.124	0.809	0.0599	6.835	0.000
	Physically active (ER)	0.166	0.055	0.607	0.252	1.885	0.059
	Positivity (ER)	0.181	0.082	1.657	0.279	2.064	0.039

Additional Analyses

We also wanted to gain more insight in the produced associations for and the differences in ratings of the natural and urban photographs. Therefore, we examined the influences of connectedness with nature and need for restoration on these two. The results showed no significant effect of Need for Restoration or a significant interaction effect with Environment x Need for Restoration on the ratings of and the associations with the environments. Furthermore, the results revealed an effect of INS on perceived restorativeness, associations with an activating and positive character. Moreover, significant interaction effects of both connectedness with nature scales with Environment on attitude were found. The analyses and results can be found in Appendix D.

Conclusion Study 1

Study 1 aimed at finding differences between associations with nature and urban photographs and at analyzing the influence of these associations on the evaluations of the photographs. Therefore, participants freely produced associations with nature and urban pictures, and rated these photographs on perceived restorativeness, aesthetics, and attitude.

Clear effects of environment on perceived restorativeness, aesthetics, and attitude were found: Natural settings had a higher restorative potential and were rated higher on aesthetics and attitude as compared to urban settings. Furthermore, a clear difference between nature and urban environments was found for the produced associations: People rated their associations with natural environments as more positive than their associations with urban environments. In addition, nature settings elicited more associations with a physically active and positive character. No differences were found between nature and urban surroundings for associations with a social and activating character.

These findings are partly in line with our hypotheses which stated that natural settings are judged as more positive, more pleasurable, and more restorative compared to urban settings, and that natural settings are linked to other restorative aspects, e.g. physical activity and positive ratings. Furthermore, these findings are in line with previous research, which indicated that nature is rated as more positive and more beautiful (e.g. Berman, et al., 2008; Hietanen, et al., 2006; Staats, et al., 2003; Ulrich, et al., 1991). The found relation between nature settings and associations with a physical character is in line with the results of a diary study by Ryan, et al. (2010) which indicated that physical activities and nature are correlated when predicting vitality.

An absence of a link between nature settings and associations with a social and activating character could be due to the fact that the nature and urban pictures contained very few to no people. Therefore, participants were not confronted with and did not or less think of other people. Subsequently, the link with the activating characteristic could be absent since the photographs were very static. Furthermore, activating was a somewhat ambiguous and hard to define characteristic, based on the very few positive ratings for this variable.

The mediation analyses looked at the influence of the produced associations on the evaluations of the environments. The results of these analyses revealed partial mediation of the valence of the associations and the associations with a positive character on perceived restorativeness, aesthetics, and attitude. This means that positive associations influenced the restorative potential of and the preference for natural settings.

As a conclusion of study 1 can be said that the main difference between the associations was found in the valence: Nature elicited more positive associations as compared to urban settings. Moreover, valence partially influenced the positive perceived effect and evaluation of nature. We found this both for the valence scores given by the participants themselves and the independent rater. In study 2 this main finding will be further elaborated on. Therefore, to see if the same holds for real restoration, stress was induced. Furthermore, participants produced associations solely for natural or urban photographs and the valence of the production of the associations was directed.

Introduction Study 2

From study 1 we learned that there is a difference between the associations elicited by natural and urban environments. Nature photographs elicited more positive associations and more associations with a physically active and positive character. Moreover, positive associations (participants and experimenter rated) partially mediated the higher restorative potential of and preference for nature. Therefore, the most important difference between the associations lies in valence.

In study 2, we will further explore this mediation by attempting to manipulate the valence of the associations for both natural and urban environments. Furthermore, the effect of this valence-instruction was measured. Thus, participants produced associations with natural or urban photographs, and they produced associations negatively, freely, or positively. Before the production of the associations with the environments, stress was induced, as a result of which restorativeness instead of perceived restorativeness was measured.

We expected to find that exposure to nature photographs would provide a better restoration as compared to exposure to urban photographs. Furthermore, we expected that producing positive associations would result in a better restoration and producing negative associations would result in a worse restoration as compared to no direction of valence. Furthermore, we hypothesized that the valence of the associations would mediate the restorative effect of nature.

Method Study 2

Design

Study 2 used a 2x3-between-design: There were two independent variables, Environment (nature vs. urban) and Valence-instruction (positive vs. negative vs. free). The main dependent variables were attention capacity, defined as the number of pattern reversals of the Necker Cube, and mood.

Participants

There were a hundred and twenty participants, from which seventy-five were men (62.5%). Their average age was twenty-three years old, with a range of eighteen to thirty-eight. Distribution of the participants over the conditions can be found in Table 10. Participants were recruited via e-mail, via social media, by asking them personally, or via the university participant-database.

Table 10: *distribution of the participants over the six conditions, specified per gender*

			Association-instruction		
			Negative	Free	Positive
Environment	Nature	Male	13	13	13
		Female	7	7	7
	Urban	Male	12	12	12
		Female	8	8	8

Setting

The experiment took place in the Game Lab of the Eindhoven University of Technology. Two rooms were used in which individual participants were seated behind a table with a laptop. The experiment was conducted on a Dell Latitude E6500 laptop, with a screen size of 15.4 inch and 1280 x 800 pixels, a color quality of 32 bits, and a screen refresh rate of 60 Hertz. Participants viewed the pictures and answered the questions on this laptop. Associations with the photographs and their valence ratings were to be written down on the associations-form. (See Figure 8 in Appendix E for this form.)

Stimuli

Stressor task. The Markus & Peters Arithmetic Test (MPA-test; Peters, et al., 1998) was used to induce stress prior to the making of the associations. This stressor task consists of a mental arithmetic task in combination with uncontrollable industrial noise (65, 70, or 80 dB) presented through an over-the-ear headphone. The stressor task took between eighteen and thirty-two minutes, depending on the time participants needed to read the instructions, and on the performance on the first exercises of the task, as the actual task only started after three correct answers (de Kort, Meijnders, Sponselee, & IJsselsteijn, 2006). The actual stressor took sixteen minutes, consisting of sixteen trials of one minute.

All questions consisted of three steps and were shown on succeeding screens. Participants calculated a difficult operation (e.g. $27 * 14$) and two easy operations (e.g. $+ 2$). After the last operation, participants chose one out of four multiple choice solutions. During each trial, participants had to correctly solve a specified number of sums (the criterion). Constant feedback on the criterion, of the time left and the number of sums solved correctly per trial were provided, enhancing the credibility of the task and the motivation of the participants (Markus, Olivier, Panhuysen, van der Gugten, Alles, & Tuiten, 2000). If participants met the criterion or if they were out of time, a new trial began.

Participants were told that their performance influenced the intensity of the noise. If they met the criterion, they could choose the noise level for the next trial; however, they could not choose when they had not met the criterion. Many multiple choice solutions did not contain the correct answers and all criteria were set at one sum above what participants could handle, which was calculated from the average time per sum needed on the previous trial. This made it impossible to meet a criterion, as a result of which participants could not choose the noise intensity for the next trial.

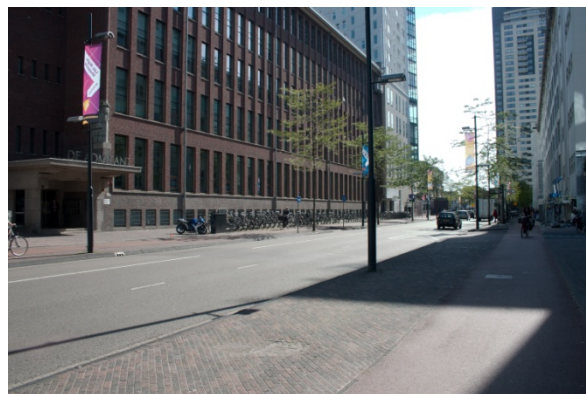
Previous research has confirmed the effectiveness of this stressor task, showing a heightened heart rate (Peters, et al., 1998), an increased skin conductance and a negative mood (de Kort, et al., 2006; Markus, et al., 2000; Markus, Panhuysen, Tuiten, Koppeschaar, Fekkes, & Peters, 1998), a decreased inter beat interval and a decreased positive affect (de Kort, et al., 2006). Furthermore, it has been perceived as highly uncontrollable (Peters, et al., 1998).

We conducted a pilot study to test the efficiency of the stressor with fifteen participants (ten male, 66.7%) with a mean age of twenty-three. Results showed that the MPA-task had a negative effect on all five dimensions of the mood questionnaire; there was no effect on Neckercube-performance, however the means indicated that performance decreased after the stressor.

Photographs. Participants viewed and rated four (nature or urban) pictures on the laptop. All photographs were taken by the experimenters. Four nature pictures were taken in the ‘Strabregtse Heide’, woodland in the south of The Netherlands. These pictures mainly contained grass, heath land, and trees. Four urban pictures were taken in the city centre of Eindhoven and mainly contained squares, roads, and high buildings. All pictures were different from those in study 1, but picture sizes remained the same, since these can influence the restorative effect (de Kort, et al., 2006). Two examples can be found in Picture 3 and Picture 4; all photographs can be found in Appendix F.



Picture 3: nature photograph



Picture 4: urban photograph

Measures

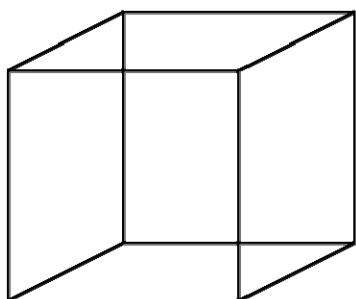
Since restoration processes are of a complex nature (van den Berg, et al., 2003), we measured restoration using a multi-method strategy that included affective measures (i.e. a mood questionnaire), a cognitive measure (i.e. the Necker cube-task), and psychophysiological measures (i.e. skin conductance and ECG)².

Mood. Participants’ mood was measured with a short version of the mood questionnaire by Beute, et al. (In Preparation). Participants answered ‘how do you feel right now?’ for sixteen items; answers could be indicated on five-point scales ranging from *not at all* to *very much*. Mood was measured along five dimensions, namely energized (e.g. sleepy, alert), relaxed (e.g. tense, nervous), happy (e.g. satisfied, enthusiastic), sad (e.g. sad, dejected), and calm (e.g. calm, composed). Internal consistency was respectively $\alpha = 0.868$, $\alpha = 0.829$, $\alpha = 0.816$, $\alpha = 0.736$, and $\alpha = 0.554$.

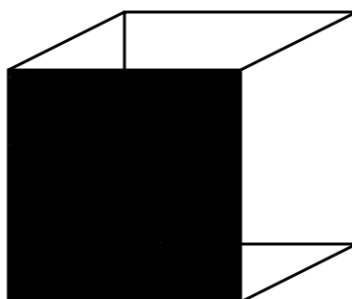
Attention. To measure attention, the Necker Cube Pattern Control Task (NCPCT) was used, which has shown to be a good indicator of restorative environments (Cimprich, 1993; Gal, et al., 2004; Hartig, Evans, Jamner, Davis, & Gärling, 2003; Tennessen & Cimprich, 1995). A Necker cube is a picture of a wire frame cube and forms an optical illusion (see Picture 5). This cube can be

² The analyses of the physiological measures are not part of this report.

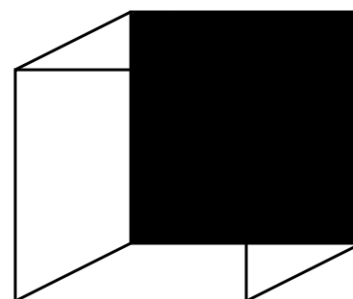
perceived in two ways; with the lower-left face as being in front (see Picture 6) or with the right-up face being in front (see Picture 7). Participants were instructed to focus on one pattern for thirty seconds. Reversals occurring despite the effort to hold are considered to happen due to attention fatigue (Kaplan, 1995).



Picture 5: *Necker cube*



Picture 6: *Necker cube with the lower-left face in front*



Picture 7: *Necker cube with the upper-right face in front*

Associations. For all four (nature or urban) photographs, participants produced maximally ten (positive, negative, or free) associations per photograph in one minute. So, participants saw four pictures in four minutes, making the time of restoration equal for all participants. Afterwards, participants evaluated the valence of their associations on seven-point scales ranging from *very negative* to *very positive*.

Complexity. To measure how complex participants found the task of producing associations, they answered three questions. The first question asked for difficulty (How difficult/easy was producing associations for you?), answers could be indicated on a seven-point scale ranging from *very difficult* to *very easy*. The second question measured effort (How much effort did you put into making the associations?), answers were to be indicated on a seven-point scale ranging from *very little* to *a lot*. The third question asked for suppression: how often they suppressed positive or negative associations (in the negative or positive condition respectively). The question ‘How often did you have to suppress a negative/positive association?’ could be answered on a seven-point scale ranging from *never* to *very often*.

Evaluations of environments. As in study 1, participants evaluated all four (nature or urban) pictures. The dimension perceived restorativeness had an internal consistency of $\alpha = 0.861$, aesthetics had an internal consistency of $\alpha = 0.908$ and attitude of $\alpha = 0.959$. (See the method section of study 1 for the questions and items).

Connectedness with nature. Connectedness with nature was measured with an adjusted version of the Inclusion of Nature in Self scale (Schultz, 2001). Participants dragged a circle labeled ‘self’ over a circle labeled ‘nature’ indicating how related they feel with nature.

Procedure

Practice of the Necker cube-task. Upon arrival participants read and signed an informed consent form, and the electrodes for the psychophysiological measures were attached. Before participants started with the experiment, the experimenter practiced the Necker cube-task with them. (See Appendix G for the instruction sheet.) The experimenter explained and showed the two perspectives of the cube, and asked them if they were able to see both perspectives and the pattern reversal. When it was clear that participants could see these, the task was practiced in two rounds. In the first round, participants viewed the cube and indicated how many times the faces reversed position by tapping on the table. In the second round, participants were instructed to focus on one pattern. If the perspective changed nevertheless, they tapped the table, and focused on the other perspective. It was made clear to participants that this focusing on one pattern was equal to the real task. During the experiment, the Necker cube-task was conducted on the laptop.

Main study. After the practice of the Necker cube-task, participants were asked to relax for five minutes, while the baseline recordings were taken. Participants then started the experiment with a pre-measurement ($t = 1$) of mood (Beute, et al., In Preparation) and Necker cube-performance. This was followed by a stress-induction: the MPA-test (Peters, et al., 1998). Then the between-measurement ($t = 2$) of mood and Necker cube-performance took place. Subsequently, participants associated (freely, positively, or negatively) with four nature or four urban pictures. Participants saw each picture one minute, and in this minute they wrote down a maximum of ten associations on the associations-form. In between each photograph, participants heard a beeping sound, which notified them about the next picture. The production of associations was followed by the post-measurement ($t = 3$) of mood and Necker cube-performance. After the production of their associations, participants indicated difficulty, effort, and suppression. For all their associations participants indicated the valence on the same sheet of paper, and for all pictures participants indicated their aesthetics, attitude, and perceived restorativeness on the laptop (Staats, et al., 2003). The experiment concluded with a closing questionnaire which probed connectedness with nature (Schultz, 2001) and demographic variables. The whole experiment took between forty-five and sixty minutes, mainly depending on the time it took for participants to start with the stressor and to answer the questions. The schedule of the experiment can be seen in Figure 2. When finished with the experiment, participants received their monetary reward (€10 for student from the Eindhoven University of Technology or €12 for participants from outside the university), were debriefed, and thanked for their participation.

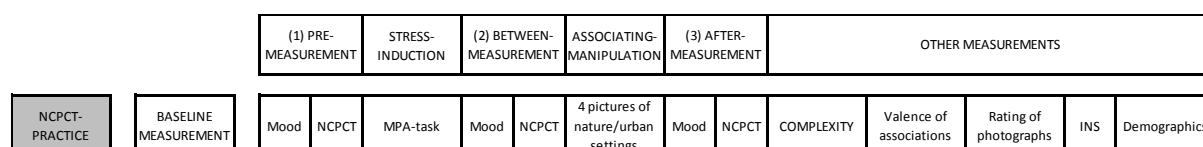


Figure 2: *schedule of the experiment*

Results Study 2

The results section of study 2 consists of three parts: the preparatory and the main analyses. The preparatory analyses examined the baseline effects before and after the stress-induction and the effect of the stress-induction. These were conducted to see if there were no baseline differences between the conditions which could influence the main analyses. Furthermore, the influence of Environment and the Valence-instruction on the valence of the associations was investigated. In addition, the differences between the conditions for number of produced associations and difficulty were analyzed. And finally, gender differences were explored.

After the preparatory analyses, the main analyses investigated the influence of Environment and Valence-instruction on restoration, which was measured twofold: with the Necker cube-task (Hartig, et al., 2003) and with the mood questionnaire (Beute, et al., In Preparation). Moreover, the main analyses explored the influence of the valence of the produced associations on these potential effects.

Additional analyses studied the environmental and valence-instruction effects on perceived restoration, attitude, and aesthetics. Furthermore, the potential mediation of the effect of environment on perceived restoration, aesthetics, and attitude by the valence of associations were explored.

Preparatory Analyses

Baseline effects before and after the stressor

We used Two-Way Analyses of Variance to examine the baseline effects before (t1) and after (t2) the stressor. The dependent variables were the measurement before (t1) and after the stressor (t2) of Necker cube-performance and the five mood dimensions: energized, relaxed, happiness, sadness, and calm. The fixed factors were Environment, Valence-instruction and the interaction between those two.

The results revealed that Environment and Valence-instruction did not significantly influence all the dependent variables. This means that all conditions were equal at the start of the experiment (t1), and all conditions were equal after the stressor (t2). Statistical values can be found in Table 11 and Table 12.

Table 11: *baseline effect before the stressor (t1)*

	Environment		Valence-instruction		Environment x Valence-instruction	
	F(1, 109)	p	F(2, 109)	p	F(2, 109)	p
Necker cube	0.373	0.542	1.178	0.312	0.169	0.845
Energized	0.745	0.390	1.855	0.161	0.176	0.839
Relaxed	1.467	0.228	0.135	0.874	0.307	0.736
Happiness	0.136	0.713	0.101	0.904	1.319	0.272
Sadness	0.023	0.881	0.330	0.720	0.003	0.997
Calm	0.542	0.463	0.158	0.854	1.201	0.305

Table 12: *baseline effect after the stressor (t2)*

	Environment		Valence-instruction		Environment x Valence-instruction	
	F(1, 103)	p	F(2, 103)	p	F(2, 103)	p
Necker cube	0.060	0.807	0.046	0.955	2.047	0.134
Energized	1.671	0.199	1.656	0.196	0.120	0.887
Relaxed	0.062	0.803	0.022	0.979	1.048	0.354
Happiness	0.442	0.508	1.672	0.193	1.207	0.303
Sadness	0.320	0.573	0.230	0.795	0.910	0.406
Calm	0.036	0.850	0.270	0.764	0.993	0.374

Effects of the stressor

A One-Way Repeated Measures Analysis of Variance was conducted to investigate the effect of the stressor. The within subjects variables were the measurement before (t1) and after the stressor (t2) of Necker cube-performance and the five mood dimensions: energized, relaxed, happiness, sadness, and calm. No between-subjects factors were inserted, since only the effect of the stressor as represented by time was relevant.

The results showed a significant difference between mood before and after the stressor: Participants felt less energized, less relaxed, less happy, more sad, and less calm after the stress-induction. Performance on the Necker cube-task did not significantly change. Statistics can be found in Table 13.

Table 13: *effect of the Stressor on Necker cube-performance and the five dimensions of the mood questionnaire. An increase in Necker cube means a decrease in attention.*

	t1 (before the stressor)		t2 (after the stressor)		F	p
	M	SE	M	SE		
Necker cube	4.301	0.182	4.146	0.198	F(1, 122) = 0.694	0.406
Energized	3.641	0.049	3.461	0.058	F(1, 132) = 11.868	0.001
Relaxed	3.877	0.043	3.079	0.060	F(1, 134) = 183.092	0.000
Happiness	3.479	0.050	2.437	0.059	F(1, 134) = 244.536	0.000
Sadness	1.451	0.048	1.959	0.067	F(1, 132) = 64.607	0.000
Calm	3.304	0.053	2.578	0.059	F(1, 134) = 120.123	0.000

Number of produced associations

Two-Way Analyses of Variance explored the environment and valence-instruction differences for the produced number of associations. The independent variables were Environment, Valence-instruction, and the interaction between those two; the dependent variable was the mean of the numbers of associations per picture.

The results indicated no significant influence of Environment on number of produced associations, $F(2, 114) = 0.614$, $p = 0.435$. The influence of Valence-instruction was significant, $F(2, 114) = 12.031$, $p = 0.000$. Bonferroni post-hoc tests revealed significant differences between all three conditions: Participants in the free condition ($M_{\text{free}} = 6.150$, $SE_{\text{free}} = 0.295$) produced the most associations as compared to participants in the positive condition ($M_{\text{positive}} = 5.131$, $SE_{\text{positive}} = 0.295$, $p = 0.048$), and in the negative condition the fewest associations were produced ($M_{\text{negative}} = 4.106$, $SE_{\text{negative}} = 0.295$, $p = 0.000$). Correspondingly, participants in the positive condition produced more associations than participants in the negative condition ($p = 0.046$). Lastly, the results revealed no significant influence of the interaction effect, $F(2, 114) = 1.859$, $p = 0.161$.

Valence of the produced associations

A Two-Way Analysis of Variance was used to explore the environment and valence-instruction effects on the valence of associations. The factors were Environment, Valence-instruction, and the interaction between these two; the dependent variable was the valence of the associations.

Results revealed significant main effects and a significant interaction effect. (See Figure 3 for these effects.) Valence-instruction significantly influenced the valence of the associations, $F(2, 107) = 319.591, p = 0.000$. Bonferroni post hoc test revealed significant differences between all three valence-instructions. Participants in the positive condition ($M_{\text{positive}} = 5.842, SE_{\text{positive}} = 0.091$) rated their associations as more positive than participants in the free condition ($M_{\text{free}} = 4.877, SE_{\text{free}} = 0.087, p = 0.000$), and negative condition ($M_{\text{negative}} = 2.660, SE_{\text{negative}} = 0.092, p = 0.000$). Correspondingly, participants in the negative condition rated their associations as more negative than participants in the free condition ($p = 0.000$).

Furthermore, Environment had a significant influence on the valence of the associations, $F(2, 107) = 20.673, p = 0.000$. Means indicated that participants associated more positively with natural photographs ($M_{\text{nature}} = 4.696, SE_{\text{nature}} = 0.074$) than with urban photographs ($M_{\text{urban}} = 4.224, SE_{\text{urban}} = 0.073$).

Finally, results exposed a significant interaction effect of Environment and Valence-instruction on valence of associations, $F(2, 107) = 9.932, p = 0.000$. Means indicated that the difference in valence of the associations between the nature and urban condition was mainly caused by the free condition. Therefore contrast analyses were conducted to gain more insight in the valence differences. When analyzing the valence-instructions separately the following results were exposed. Environment had a significant effect on valence of associations only in the free condition, $F(1, 38) = 25.178, p = 0.000$. Means indicated that participants in the nature condition ($M_{\text{nature}} = 5.435, SE_{\text{nature}} = 0.157$) rated their associations as more positive than participants in the urban condition ($M_{\text{urban}} = 4.320, SE_{\text{urban}} = 0.157$). In the negative and positive conditions, Environment had no significant effect, $ps > 0.176$.

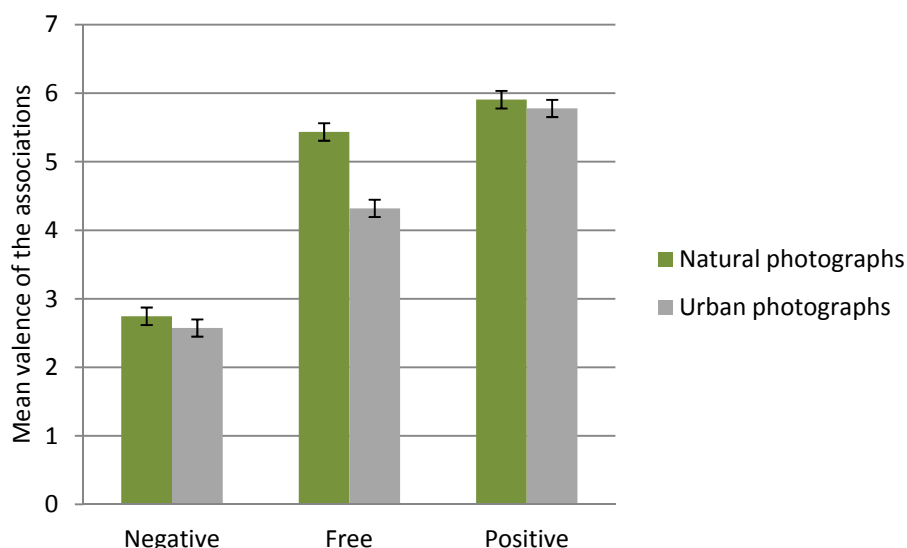


Figure 3: *interaction effect of Environment and Valence-instruction on the valence of the produced associations*

Complexity of association production

The results of study 1 showed that participants associated more positively with nature photographs as compared to urban photographs, which was replicated in the free condition of study 2. Therefore, we wanted to see if participants found it harder to produce forced-valence associations. To obtain this, we used three questions asking for difficulty of the task, amount of effort participants had put into the production of the associations, and how often participants had to suppress an incorrectly valenced association. Furthermore, a relationship between these three variables and the number of produced associations will be analyzed.

We used Two-Way Analysis of Variance to examine the influence of Environment, Valence-instruction, and an interaction effect of these two (the fixed factors) on the dependent variables difficulty and effort. A separate Two-Way Analysis of Variance was used to analyze suppression, since suppression was only measured in the forced-valence conditions. Again, Environment, Valence-instruction, and an interaction effect of these two were the fixed factors; suppression was the dependent variable. Results of these two analyses will be reported together.

The results did not indicate a main effect of Environment on difficulty ($F(1, 114) = 3.343, p = 0.070$), on effort ($F(1, 114) = 3.149, p = 0.079$), nor on suppression ($F(1, 76) = 2.206, p = 0.142$).

Valence-instruction significantly influenced difficulty $F(2, 114) = 16.377, p = 0.000$) and suppression $F(1, 76) = 35.303, p = 0.000$), but not effort $F(2, 114) = 0.600, p = 0.551$). (See Figure 4 and Figure 5 for the effects on difficulty and suppression.) Bonferroni post hoc tests showed significant differences between all three conditions for difficulty: Participants in the negative condition ($M_{\text{negative}} = 5.075, SE_{\text{negative}} = 0.213$) found it more difficult to produce associations than participants in the positive condition ($M_{\text{positive}} = 4.200, SE_{\text{positive}} = 0.213, p = 0.013$), and the free condition ($M_{\text{free}} = 3.350, SE_{\text{free}} = 0.213, p = 0.000$). Correspondingly, participants in the positive condition found it harder to produce associations than participants in the free condition ($p = 0.017$). Furthermore, the means for suppression indicated that participants in the negative condition suppressed an opposite (positive) association more often ($M_{\text{negative}} = 4.825, SE_{\text{negative}} = 0.214$) than participants in the positive condition suppressed an opposite (negative) association ($M_{\text{positive}} = 3.025, SE_{\text{positive}} = 0.214$).

The results of the Two-Way Analysis of Variance revealed a significant interaction effect of environment and valence-instruction on difficulty ($F(1, 114) = 5.242, p = 0.007$ and suppression ($F(1, 114) = 62.761, p = 0.000$), but not on effort ($F(1, 114) = 0.343, p = 0.711$). The significant interaction effect will be further elaborated on, and can be found in Figure 4 and Figure 5.

Contrast analyses of the environments showed that for urban photographs, there was no significant effect of Valence-instruction on difficulty, $F(2, 57) = 4.980, p = 0.010$. However, for nature photographs, valence-instruction had a significant effect on difficulty, $F(2, 57) = 18.804, p = 0.000$. Bonferroni post hoc test showed that producing negative associations ($M_{\text{negative}} = 5.350, SE_{\text{negative}} = 0.277$) was thought to be more difficult than producing positive associations ($M_{\text{positive}} = 3.500, SE_{\text{positive}} = 0.277, p = 0.000$) and producing associations in the free condition ($M_{\text{free}} = 3.100, SE_{\text{negative}} = 0.277, p = 0.000$). There was no difference between producing associations in the positive and free condition ($p = 0.934$).

The results of the contrast analyses for the interaction effect on suppression revealed the following. When analyzing the environments separately, Valence-instruction did not have a significant effect on suppression, $F(1, 38) = 197.153, p = 0.000$ for the urban photographs. For the nature photographs, however, Valence-instruction significantly influenced suppression, $F(1, 38) = 197.153, p = 0.000$. Means indicated that in the negative condition ($M_{\text{negative}} = 5.800, SE_{\text{negative}} = 0.212$), participants had to suppress an opposite (positive) associations more often than in the positive condition ($M_{\text{positive}} = 1.600, SE_{\text{positive}} = 0.212$).

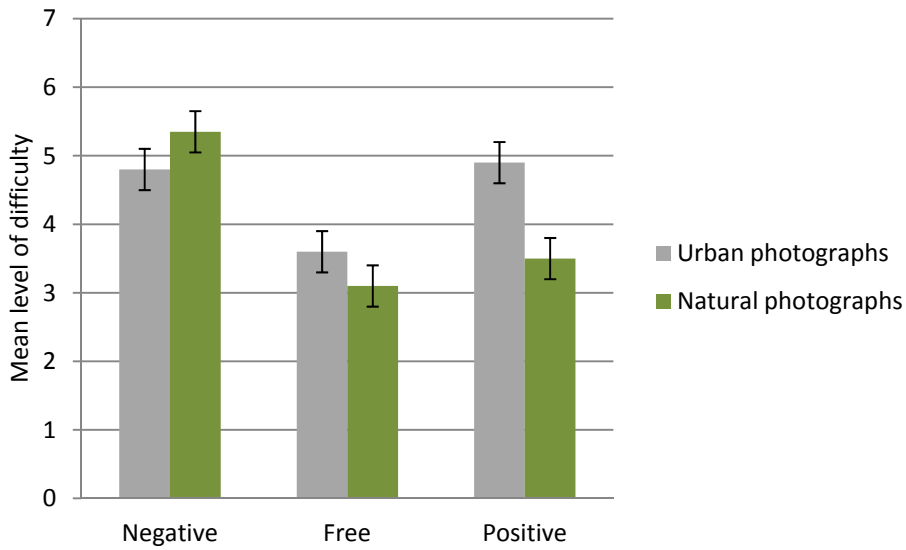


Figure 4: *interaction effect of Environment and Valence-instruction on difficulty*

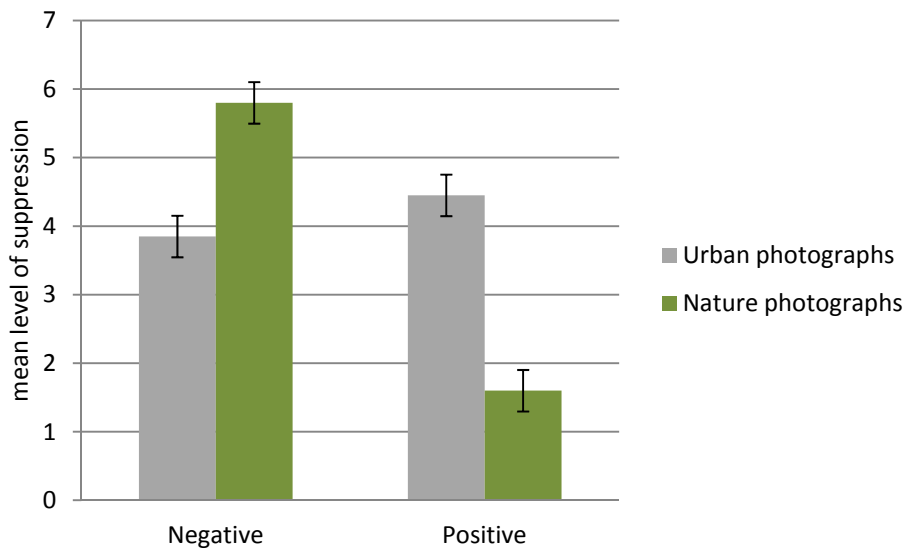


Figure 5: *interaction effect of Environment and Valence-instruction on suppression*

Correlation between complexity of associating and number of associations

Environment and Valence-instruction appeared to influence number of associations, difficulty of associating, effort, and suppression similarly to a large extent. Therefore a Pearson correlation analysis was conducted for these four variables. Results showed that number of associations is negatively correlated with difficulty and suppression. Furthermore, suppression and difficulty are positively correlated. Lastly, effort is not correlated with the other three variables. Table 14 shows these correlations.

Since we have found differences between the conditions for number of associations, difficulty, and suppression, we wanted to see if these may have influenced mood and Necker cube-performance. Therefore, these variables were initially included as covariates in the main analyses. None had a significant influence on mood or Necker cube-performance. Therefore, these variables will not be taken into further account.

Table 14: *correlations between number of associations, difficulty, effort, and suppression*

	Number of associations		Difficulty		Effort	
	r	p	r	p	r	p
Suppression	-0.315	0.004	0.515	0.000	-0.116	0.304
Effort	0.023	0.800	0.131	0.154		
Difficulty	-0.532	0.000				

Gender differences for valence of associations

A Two-Way Analysis of Variance was used to analyze the gender differences for valence of associations. Furthermore, Environment and Valence-instruction were added as fixed factors, to analyze if Gender influenced their effects on valence of associations. Therefore, the dependent variable was valence of associations; the fixed factors were Gender, Environment, and Valence-instruction.

The results revealed no significant effect of Gender on valence of associations. $F(1, 101) = 1.033, p = 0.312$. Environment and Valence-instruction had a significant effect on valence of associations ($F(1, 101) = 22.138, p = 0.000$; $F(1, 1010) = 300.976, p = 0.000$). Also, the interaction effect of Environment and Valence-instruction was significant, $F(2, 101) = 11.587, p = 0.000$. All other interaction effects were not significant, $ps > 0.128$. Since there were no gender differences for valence of associations and Gender did not influence the effects of Environment and Valence-instruction on valence of associations, Gender will not be taken into further account in the main analyses.

Main Analyses

The main purpose of study 2 was to see if Environment and the valence of the produced associations caused restoration of Necker cube-performance and mood. Therefore, we first analyzed the main and interaction effects of Environment and Valence-instruction on Necker cube-performance and the five dimensions of mood: energized, relaxed, happiness, sadness, and calm. Secondly, we explored the influence of the valence of the produced associations on the main and interaction effects.

To facilitate the interpretability of the results, restoration variables were computed for the Necker cube-performance and the mood dimensions: the value at t2 (before the production of the associations) was subtracted from t3 (after the production) for Necker cube-performance and energized, relaxed, happiness, sadness, and calm. These dependent variables were named NC-, energized-, relaxed-, happiness-, sadness-, and calm-restoration.

The restorative effect of Environment and Valence-instruction

We used Two-Way Analysis of Variance to analyze the main effect of Environment and Valence-instruction on restoration. The fixed factors were Environment, Valence-instruction, and the interaction of these two. The dependent variables were NC-, energized-, relaxed-, happiness-, sadness-, and calm-restoration.

The results revealed no significant main effect of environment on Necker cube-performance, although a trend appeared, $F(1, 101) = 3.054$, $p = 0.084$: Participants in the urban condition switched perspectives more often ($M_{\text{urban}} = 0.234$, $SE = 0.265$), while participants in the nature condition changed perspectives less often ($M_{\text{nature}} = -0.425$, $SE = 0.268$). Environment had no effect on the factors of the mood questionnaire ($ps > 0.475$).

Furthermore, a significant main effect of Valence-instruction on happiness was found, $F(2, 101) = 7.475$, $p = 0.001$. Bonferroni post hoc test revealed a significant difference between the positive and negative condition, $p = 0.001$, but no other significant differences, $p > 0.135$. Means indicated that happiness of the participants who produced positive associations increased more ($M_{\text{positive}} = 0.889$, $SE_{\text{positive}} = 0.110$) than happiness of participants in the negative condition ($M_{\text{negative}} = 0.298$, $SE_{\text{negative}} = 0.097$). No other significant main effect of Valence-instruction were found ($p > 0.085$), although a trend appeared for sadness, $F(2, 101) = 2.526$, $p = 0.085$. Bonferroni post hoc test revealed that sadness decreased more in the free condition ($M_{\text{free}} = -0.499$, $SE_{\text{negative}} = 0.103$) than in the negative condition ($M_{\text{negative}} = -0.184$, $SE_{\text{negative}} = 0.096$, $p = 0.082$). No other comparisons were significant ($p > 0.265$). Lastly, no significant interaction effects of Environment and Valence-instruction were found ($p > 0.301$).

Influence of valence of associations on the environmental and valence-instruction effects

In the preparatory analyses we have found significant differences for the valence of the produced associations between the environment and valence conditions. Therefore, we wanted to investigate if the valence of associations might have influenced the effect of Valence-instruction on happiness and sadness.

To analyze this we used Two-Way Analysis of Variance with Environment and Valence-instruction as fixed factors, with happiness- and sadness -restoration as dependent variables, and Valence of Associations as a covariate.

The results revealed no significant effects of Environment on happiness ($F(1, 104) = 2.370$, $p = 0.127$) and sadness ($F(1, 104) = 1.554$, $p = 0.215$) and no significant effects of Valence-instruction on happiness ($F(2, 104) = 0.449$, $p = 0.639$) and sadness ($F(2, 104) = 2.322$, $p = 0.103$). The interaction effect did not have a significant effect on happiness ($F(2, 104) = 1.746$, $p = 0.180$) nor on sadness ($F(2, 104) = 1.626$, $p = 0.202$). Furthermore, Valence of associations did not significantly influence happiness ($F(1, 104) = 2.370$, $p = 0.127$) and sadness ($F(1, 104) = 1.554$, $p = 0.215$).

Additional analyses

Influence of Environment and Valence-instruction on perceived restorativeness, attitude, and aesthetics

We used a Two-Way Analysis of Variance to investigate the influence of Environment and Valence-instruction (the fixed factors) on perceived restorativeness, aesthetics, and attitude (the dependent variables).

The results revealed significant effects of Environment on all three dependent variables: nature pictures were rated higher on perceived restorativeness, aesthetics, and attitude as compared to urban photographs. A summary of the statistics can be found in Table 15.

Furthermore, results showed that Valence-instruction significantly influenced perceived restorativeness ($F(2, 114) = 3.308, p = 0.040$) and attitude ($F(2, 114) = 3.787, p = 0.026$), but not aesthetics ($p = 0.255$). Bonferroni post hoc tests revealed only a significant difference between the negative and positive condition for perceived restorativeness ($M_{\text{negative}} = 3.910, SE_{\text{negative}} = 0.103, M_{\text{positive}} = 4.283, SE_{\text{positive}} = 0.103, p = 0.035$), and for attitude ($M_{\text{negative}} = 4.115, SE_{\text{negative}} = 0.109, M_{\text{positive}} = 4.523, SE_{\text{positive}} = 0.100, p = 0.027$). No other comparisons were significant, $ps > 0.160$. The means indicated that participants in the positive condition rated all pictures higher on perceived restorativeness and attitude than participants in the negative condition. There were no significant interaction effects ($ps > 0.145$).

Table 15: *the differences between nature and urban photographs for perceived restorativeness, attitude, and aesthetics.*

	Nature		Urban		F (1, 114)	p
	M	M	M	SE		
Perceived restorativeness	4.964	3.217	3.217	0.084	217.067	0.000
Attitude	5.199	3.503	3.503	0.089	182.540	0.000
Aesthetics	5.210	3.363	3.363	0.099	173.522	0.000

Mediation of associations

In study 1 we have found that valence of associations and associations with a positive character mediated the positive rating of nature on perceived restorativeness, aesthetics, and attitude. Here, we analyzed if this mediation held in study 2 as well. We discussed the four steps of mediation (see Figure 1, results study 1), and used the Sobel test to assess mediation (MacKinnon, 2008).

Step one: influence of Environment on perceived restorativeness, attitude, and aesthetics

In step 1 of the mediation analysis the independent variable (IV, in our case Environment) must have a significant influence on the dependent variable (DV, in our case perceived restorativeness, aesthetics, and attitude). The results of the above additional analyses showed that Environment significantly influenced all three dependent variables: perceived restorativeness, aesthetics, and attitude.

Step two: environmental and valence-instruction effects on valence of associations

In step 2 of the mediation analysis the IV (Environment) must have a significant effect on the mediator (M, here valence of associations). In the preparatory analysis we conducted this analysis using a Two-Way Analysis of Variance. Results revealed that Environment influenced the valence of the associations: participants associated more positively with natural pictures than with urban pictures.

Step three: influence of Valence of Associations on perceived restorativeness, attitude, and aesthetics

Step one of the mediation analysis indicated significant environmental effects on all three dependent variables: perceived restorativeness, aesthetics, and attitude. Step two demonstrated environmental effects on the valence of the associations (the potential mediator). In this third step we tested correlations between the potential mediator and the three dependent variables.

A Two-Way Analysis of Variance investigated the influence of the Valence of Associations on the ratings of the environments. The independent variable was Valence of Associations; the dependent variables were perceived restorativeness, aesthetics, and attitude. The results showed that the Valence of Associations significantly influenced the three dependent variables. A summary of the statistics can be found in Table 16.

Table 16: *influence of Valence of Associations on perceived restorativeness, aesthetics, and attitude*

	Estimate	SE	F (1, 106)	p
Perceived restorativeness	0.369	0.104	12.683	0.001
Aesthetics	0.498	0.125	15.815	0.000
Attitude	0.419	0.114	13.504	0.000

Step four: environmental effects when controlling for the valence of associations

Step 4 of the mediation analysis includes that the relation between Environment (IV) and perceived restorativeness, aesthetics, and attitude (DV's) should disappear (full mediation) or weaken (partial mediation) when valence of associations (the mediator) is controlled for. Two-Way Analysis of Variance was used to analyze this last step of mediation analysis.

The results indicated that the main effects of Environment remained significant when controlling for valence of associations. The mediator, valence of associations, had a significant effect on all dependent variables. These statistics can be found in Table 17.

Sobel tests were used to assess partial mediations. The estimates of Environment (a) and the estimates of the valence of associations (b) were used in these tests. The results were marginally significant; indicating a trend that valence of associations partially mediated the environmental effects on perceived restorativeness, aesthetics, and attitude. A summary of the statistical values of the Sobel tests can be found in Table 18.

Table 17: *environmental effects when controlling for valence of associations*

		Estimate	SE	F	p
Effect environment	Perceived restorativeness	-1.331	0.195	F(1, 106) = 171.731	0.000
Effect valence of associations		0.369	0.104	F(1, 106) = 12.683	0.001
Effect environment	Aesthetics	-1.730	0.235	F(1, 106) = 123.741	0.000
Effect valence of associations		0.498	0.125	F(1, 106) = 15.815	0.000
Effect environment	Attitude	-1.420	0.214	F(1, 106) = 127.770	0.000
Effect valence of associations		0.419	0.114	F(1, 106) = 13.504	0.000

Table 18: *data of the Sobel test for the effect of Environment by valence of associations*

	Sobel					
	a	SE _a	b	SE _b	Z	p
Perceived restorativeness	-0.580	0.271	0.230	0.067	-1.816	0.069
Aesthetics	-0.580	0.271	0.221	0.075	-1.732	0.083
Attitude	-0.580	0.271	0.254	0.067	-1.864	0.062

Conclusion Study 2

The aim of study 2 was to see if the valence-condition, next to environment, had a restorative effect, and if the valence of associations influenced the restorative effect of natural environments. To obtain this, stress was induced and participants produced associations with nature or urban photographs. The valence of the associations was directed, so participants were only allowed to associate positively or negatively, or the valence was not directed, allowing participants to associate freely.

Preparatory analyses revealed that the stressor had the intended effect: Participants' mood declined after the stress-induction. Furthermore, differences for the valence of the associations were found: Participants produced associations according to the directed valence, making the valence-instruction a valid manipulation. When valence was not directed (in the free condition), participants rated their produced associations with nature as more positive than their associations with urban environments. Gender had no effect on these findings, meaning that the same differences held for men and women. These findings are a replication of the finding of study 1 in which nature photographs also elicited more positive associations.

Moreover, participants found it harder to produce negative associations with nature photographs than positive associations. Moreover, on suppression a similar effect was found: While producing negative associations for nature photographs, positive associations had to be suppressed more often than while producing associations for urban photographs. These results appear to be in line with our finding that nature is linked to positive associations and urban settings to negative associations. However, difficulty and suppression had no significant effects on the restorative effects of environment and valence-instruction.

From the main analyses we will first consider the effects of the environment on stress restoration. Although the stress-induction appeared to be successful, we did not establish a restorative benefit of nature vs. urban scenes. No effects on subjective mood scales were found, but a trend on Necker cube-performance appeared: After exposure to urban photographs, participants' attention capacity had declined; after exposure to nature photographs, participants' attention capacity had increased. This positive influence of nature on attention is in line with studies by for instance Berman and Jonides (2008) and Hartig, et al. (1991) which found that natural environments helped to restore mental fatigue. The absence of an effect on mood does not correspond to our hypotheses and other studies, which have found a restorative effect of nature (e.g. Hartig, et al., 2003; Tennessen & Cimprich, 1995; Valtchanov, et al., 2010).

We did however observe an effect of valence-instruction on happiness: after producing positive associations, happiness improved more than after producing negative associations. The trend on sadness pointed into the same direction: Sadness declined more after producing positive associations than after producing negative associations. Interestingly this effect was not mediated by the valence of the associations. These findings are partly in line with our hypothesis and previous studies that show a restorative effect of positive circumstances, like the induction of positive affect (e.g. Tice, et al., 2000).

Although we have not found restorative benefits of nature vs. urban settings, we have found a difference for perceived restorativeness, aesthetics, and attitude: Nature was rated higher on these three as compared to nature settings. Moreover, positive associations mediated these higher ratings of natural environments. These findings are in line with the findings of study 1. Valence-instruction also influenced the ratings of the environments: Participants showed stronger preferences for spending time in the environments and settings were perceived as more restorative after producing positive associations. This effect appeared for both nature and urban settings. These findings indicate that positive associations and a positive induction can influence the appreciation of environments.

As a conclusion of study 2 it can be said that nature vs. urban settings had a limited restorative effect on attention, but no effect on mood. We did observe a restorative effect of producing positive associations on happiness, which was not mediated by the valence of the associations. Although we did not find real restoration of nature, nature settings were perceived as more restorative and participants showed a stronger preference for nature. These differences were partially mediated by the valence of the associations, meaning that positive associations influenced the positive ratings of nature. The results of the psychophysiological measures may provide a better insight into the restorative potential of the natural environments.

General discussion

The aim of this research was to gain more insight into the restorative effect of nature. Many studies have shown that exposure to nature works restorative, however relatively few specify what it is that makes nature restorative. In this research we performed two studies, using associations as a method to find an underlying mechanism of the restorative potential of nature. In our first study we explored the differences between the associations with urban and nature environments. Furthermore, Study One investigated the influence of the associations on the restorative potential of nature. The second study was based on the findings of Study One; the main difference between the associations was manipulated and real restoration was investigated.

In Study One, clear differences between nature and urban environments were found for the evaluations and for the produced associations: Nature environments were perceived as more restorative, more beautiful, and people showed stronger preferences for spending time in natural as compared to urban environments. Furthermore, nature environments elicited more associations with a positive valence. These effects were established in a within groups design, and subsequently replicated in Study Two, in which we employed new images and followed a between-groups design.

The findings of the restorative potential of and the preference for nature are in line with many studies that have found the same preferences (e.g. van den Berg, et al., 2003; Hietanen, et al., 2006; Kaplan, et al., 1972; Purcell, et al., 1994; Staats, et al., 2003; Stamps, 1996; Ulrich, 1983). Moreover, the production of positive associations with natural environments is consistent with Ulrich's theory which stated that people react to natural settings with positive affect (Ulrich, 1983).

In Study One, the valence of the associations partly mediated the effect of nature on perceived restorativeness, aesthetics, and attitude. In Study Two a similar trend was found, using different images and following a between-subjects design. This partial mediation indicates that people have positive associations with nature, and these positive associations influence the restorative potential of and peoples' preferences for natural environments.

Based on the findings of Study One, we concluded that the main differences between the associations with nature and urban settings lay in the valence, and therefore, this was further investigated in Study Two. Here, stress was induced, as a result of which real restoration of nature vs. urban images could be investigated. Furthermore, the valence of the associations was directed to study positive associations as a possible explanatory mechanism of restoration.

The results of Study Two indicated very limited evidence for the restorative effect of nature, neither in the directed valence-conditions nor in the control condition, where participants could produce associations freely. (No effects were found on mood measures, and only a marginal trend on the attention task.) The positive influence of nature on attention is in line with studies by for instance Berman and Jonides (2008) and Hartig, et al. (1991) which found a restorative influence of nature on mental fatigue. The absence of the restorative effect of nature is not consistent with the studies by for instance Hartig, et al. (1991) and Valtchanov et al. (2010), who found that after exposure to nature positive affect increased and negative affect decreased. A possible explanation for this difference is that in these studies the immersion was more extensive, since they used real nature and an imitation in virtual reality respectively. However, many studies have shown that exposure to photographs can work restorative (e.g. Berman, et al., 2008; Berto, 2005).

Therefore, the main reason for the absence of the restorative effect of nature may lie in the task of producing associations while watching the images. We will mention three reasons how producing the associations may have suppressed the restorative effect. First, writing down the associations diminished the exposure time to the photographs, as people took their eyes off the screen to write. Second, producing associations requires cognitive capacity, which could have canceled out any restorative effects of the images. Also, self-regulation was potentially needed to stay focused on producing the associations. Third, producing the associations could have prevented participants from imagining to be in the depicted environment. Therefore, in future research, to overcome this impeding effect of producing associations, participants could say their associations out loud, so that they do not have to take their eyes off the screen, or participants could be exposed to environments a while longer after producing the associations.

Furthermore, we have examined the difficulty of the association task. We have found that producing negative associations with nature settings was perceived as more difficult than producing positive associations. When analyzing the effect of difficulty on the restorative effect, we have not found a significant influence. Therefore, difficulty of the task cannot provide an explanation for the absence of the restorative effect. However, these findings underline the connection between nature environments and positive associations, since association positively with nature was perceived as a relatively easy task.

Although we have not found a restorative effect of nature vs. urban settings in Study Two, the positive association instruction showed a restorative effect after stress-induction as compared to the negative instruction; this effect accounted for both nature and urban photographs. Interestingly, this restorative effect was not mediated by the valence of the produced associations. Moreover, nature photographs as well as urban photographs were rated higher on perceived restorativeness and attitude when participants were instructed to produce positive associations as opposed to negative associations. These findings are in line with studies by Korpela and Hartig (1996), Korpela et al. (2001), and Tice et al. (2000) which showed that positive circumstances, like an induction of positive mood or a visit to one's favorite place, can work restorative, specifically, Korpela and Ylén (2009) found a positive effect on subjective wellbeing.

The results of Study One and Study Two indicated that the nature pictures had a higher perceived restorative potential than urban pictures. However, the results of Study Two showed only limited restorative effects of the nature images after stress-induction. This indicates that the measurements for perceived restoration are not or to a very limited extent equal to real restoration. A possible explanation for this difference can be that participants were experiencing a mental workload (the production of the associations) when testing real restoration, whereas during the rating on perceived restorativeness participants were only instructed to answer the questions. In future research it can be interesting to investigate if perceived restorativeness and real restorativeness measure the same process.

As a conclusion it can be said that nature and urban environments elicited different associations. Mainly, nature elicited more positive and urban settings elicited less positive associations. Furthermore, nature settings had a higher restorative potential and were preferred over urban settings; these differences were partially mediated by the valence of the associations. However, while producing associations with the environments, nature had a very limited restorative effect. In contrast, producing positive associations did have a restorative effect on mood and influenced preference for and restorative potential of environments.

Accordingly, we have found a partial mediating effect on the restorative potential of nature by positive associations in Study One and Study Two, which we could not replicate for real restoration. Due to our current research paradigm we were not able to conclude that the effect of nature on mood and performance are mediated by associations—particularly associations with a positive valence. Especially because the restorative effect did not appear when associating freely, we can conclude that the task of producing associations eliminated the restorative effect of nature. However, because we have found differences between the valence of the associations with urban and nature settings and an influence of this difference on potential restoration, this study provides further evidence for the important role of positive affect in restoration.

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Appendix A: Photographs Used in Study 1

Nature Photographs Study 1



Urban Photographs Study 1



Filler Photographs Study 1



Appendix B: Gender Differences in Ratings of and Associations with Environments

Table 19: *gender differences for perceived restorativeness, aesthetics, attitude, valence of associations and characteristics of the associations. PR means participant rated, ER means experimenter rated.*

	Main effect Gender		Interaction effect of Gender x Environment	
	F	p	F	p
Perceived restorativeness	F(1, 38) = 0.204	0.654	F(1, 38) = 0.188	0.667
Aesthetics	F(1, 76) = 1.314	0.255	F(1, 76) = 1.286	0.260
Attitude	F(1, 76) = 2.407	0.125	F(1, 76) = 1.462	0.230
Valence of associations (PR)	F(1, 76) = 1.494	0.225	F(1, 76) = 0.085	0.771
Sociality (ER)	F(1, 62) = 7.872	0.007	F(1, 62) = 0.071	0.790
Physically active (ER)	F(1, 76) = 0.724	0.398	F(1, 76) = 0.389	0.535
Activation (ER)	F(1, 67) = 0.316	0.576	F(1, 67) = 0.383	0.538
Positivity (ER)	F(1, 31.916) = 0.185	0.185	F(1, 31.383) = 0.521	0.476

Appendix C: Influence of Sociality and Activation on perceived restorativeness, aesthetics, and attitude

Linear Mixed Models investigated the influence of the Associations on the ratings of the environments. The independent variables were Sociality (ER) and Activation (ER); the dependent variables were perceived restorativeness, aesthetics, and attitude.

Table 20: *influence of Sociality (experimenter rated) on perceived restorativeness, aesthetics, and attitude*

	Estimate	SE	F	p
Perceived restorativeness	0.061	0.283	$F(1, 145.832) = 0.046$	0.830
Aesthetics	0.506	0.281	$F(1, 145.819) = 3.240$	0.074
Attitude	0.599	0.307	$F(1, 145.652) = 3.813$	0.053

Table 21: *influence of Activation (experimenter rated) on perceived restorativeness, aesthetics, and attitude*

	Estimate	SE	F	p
Perceived restorativeness	-0.644	0.260	$F(1, 172.661) = 6.144$	0.014
Aesthetics	-0.419	0.262	$F(1, 172.991) = 2.555$	0.112
Attitude	-0.393	0.285	$F(1, 173) = 1.903$	0.169

Appendix D: Additional Analyses Study 1

In these additional analyses we examined the effect of need for restoration and connectedness with nature on the ratings of and the associations with the natural and urban photographs. All additional analyses were conducted on category-level.

Influence of Need for Restoration on Ratings of and Associations with Environments

Need for restoration was measured with the Attitude towards being Mentally Fit-Scale (AMFS; Beute, et al., 2010). To simplify the interpretation of the results, we made a dummy variable of need for restoration. This was done with a median split of the AMFS-dimension (Median = 0.395). We used Linear Mixed Models to assess the influence of Need for Restoration (IV as a dummy variable) and Environment on all the dependent variables: perceived restorativeness, aesthetics, attitude, valence of associations, and characteristics of the associations.

The results showed no significant main effects of Need for Restoration or significant interaction effects with Environment on all the dependent variables. A summary of the statistical values can be found in Table 22.

Table 22: effect of need for restoration on the ratings of and the associations with environments. PR means participant rated, ER means experimenter rated.

	Main effect Need for Restoration		Interaction effect Need for Restoration x Environment	
	F	p	F	p
Perceived restorativeness	F(1, 72) = 0.380	0.540	F(1, 72) = 0.118	0.732
Aesthetics	F(1, 72) = 0.509	0.478	F(1, 72) = 0.092	0.762
Attitude	F(1, 72) = 0.768	0.348	F(1, 72) = 0.811	0.371
Valence of associations (PR)	F(1, 72) = 0.108	0.744	F(1, 72) = 1.934	0.169
Sociality (ER)	F(1, 29.722) = 0.417	0.523	F(1, 28.893) = 1.006	0.324
Physically active (ER)	F(1, 72) = 0.274	0.602	F(1, 72) = 0.142	0.707
Activation (ER)	F(1, 63) = 0.624	0.433	F(1, 63) = 0.033	0.857
Positivity (ER)	F(1, 28.540) = 0.007	0.945	F(1, 25.806) = 1.321	0.261

Influence of Connectedness with Nature on Ratings of and Associations with the Environments

We used two different measurements to assess participants' connectedness with nature: the Disposition to Connect with Nature-Scale (Brügger, et al., In Press) and the Inclusion of Nature in Self-Scale (Schultz, 2001). We analyzed for both measurements the influence on all the dependent variables.

Disposition to Connect with Nature-Scale

We made a dummy variable of the DCN-dimension by conducting a median-split (Median = -0.41). Linear Mixed Models were used to investigate the influence of the DCN-dimension and of an interaction effect with Environment (IV's) on all the dependent variables: perceived restorativeness, aesthetics, attitude, valence of associations, and characteristics of the associations.

The results showed only a significant interaction effect of environments and DCN on attitude. A summary of the statistics can be found in Table 23. Contrast analyses showed that for nature pictures, no significant effect of DCN was found ($F(1, 36) = 2.114, p = 0.155$), but for urban pictures DCN significantly influenced attitude ($F(1, 36) = 5.760, p = 0.022$; see Figure 6). Means indicated that participants with a low DCN-level rated urban pictures higher on attitude ($M_{\text{low DCN-level}} = 3.146, SE_{\text{low DCN-level}} = 0.183$) than participants with a high DCN-level ($M_{\text{high DCN-level}} = 2.589, SE_{\text{high DCN-level}} = 0.205$).

Table 23: effect of Disposition to Connect with Nature on the ratings of and the associations with environments. PR means participant rated, ER means experimenter rated.

	Main effect Disposition to Connect with Nature		Interaction effect DCN x Environment	
	F	p	F	p
Perceived restorativeness	$F(1, 36) = 0.188$	0.667	$F(1, 36) = 1.714$	0.199
Aesthetics	$F(1, 72) = 0.068$	0.795	$F(1, 72) = 3.807$	0.055
Attitude	$F(1, 72) = 0.074$	0.787	$F(1, 72) = 6.765$	0.011
Valence of associations (PR)	$F(1, 72) = 0.011$	0.917	$F(1, 72) = 2.395$	0.126
Sociality (ER)	$F(1, 26.568) = 1.067$	0.311	$F(1, 26.568) = 3.093$	0.090
Physically active (ER)	$F(1, 72) = 1.938$	0.168	$F(1, 72) = 0.723$	0.398
Activation (ER)	$F(1, 64) = 2.417$	0.125	$F(1, 64) = 3.250$	0.076
Positivity (ER)	$F(1, 30.433) = 0.007$	0.936	$F(1, 29.867) = 1.255$	0.271

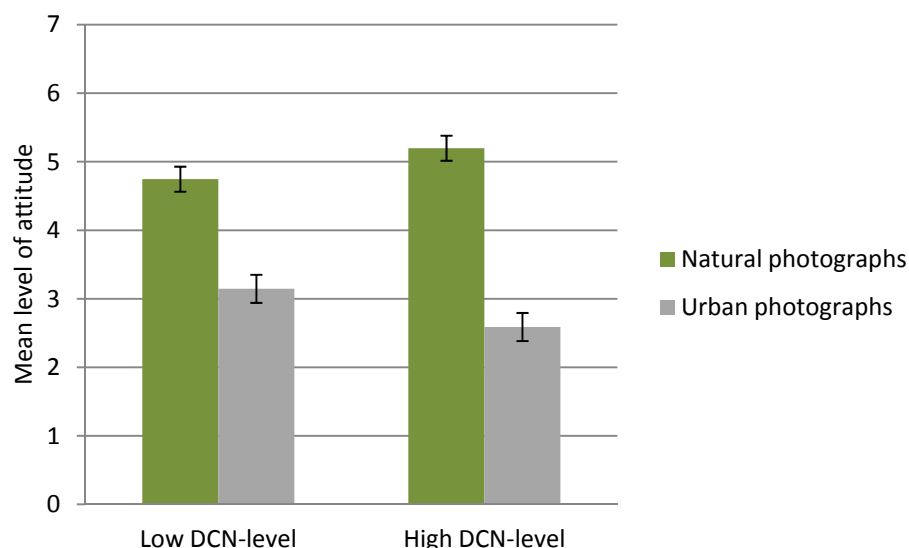


Figure 6: *interaction effect of Disposition to Connect with Nature and Environment on attitude*

Inclusion of Nature in Self-Scale

The second measurement of connectedness with nature was the Inclusion of Nature in Self-Scale (INS). A median-split (Median = 38.5) modified this variable into a dummy variable. We used Linear Mixed Models to explore the main influence of INS-dimension and as an interaction effect with Environment (IV's) on all the dependent variables: perceived restorativeness, aesthetics, attitude, valence of associations, and characteristics of the associations.

The results showed a significant main effect on perceived restorativeness, activation, and positivity, and an interaction effect on attitude. The statistics can be found in Table 24. The found significant effects will be further discussed. Means indicated that participants with a high INS-level produced more associations with an activating character ($M_{\text{high INS-level}} = 0.379$, $SE_{\text{high INS-level}} = 0.048$) than participants with a low INS-level ($M_{\text{low INS-level}} = 0.188$, $SE_{\text{low INS-level}} = 0.051$). Furthermore, means indicated that the same applied for associations with a positive character: These were also produced more by participants with a high INS-level ($M_{\text{high INS-level}} = 0.541$, $SE_{\text{high INS-level}} = 0.070$) than by participants with a low INS-level ($M_{\text{low INS-level}} = 0.290$, $SE_{\text{low INS-level}} = 0.072$). Finally, participants with a high INS-level rated nature and urban photographs higher on perceived restorativeness ($M_{\text{high INS-level}} = 3.965$, $SE_{\text{high INS-level}} = 0.101$) than participants with a low INS-level ($M_{\text{low INS-level}} = 3.679$, $SE_{\text{low INS-level}} = 0.101$).

The contrast analyses of the interaction effect on attitude showed that participants with a high INS-level rated natural photographs higher on attitude than participants with a low INS-level ($F(1, 38) = 3.086$, $p = 0.029$, $M_{\text{high INS-level}} = 5.197$, $SE_{\text{high INS-level}} = 0.214$, $M_{\text{low INS-level}} = 4.667$, $SE_{\text{low INS-level}} = 0.214$). For urban pictures, there was no significant difference, $F(1, 38) = 1.900$, $p = 0.176$. See Figure 7 for this interaction effect.

Table 24: influence of Inclusion of Nature in Self-Scale on the ratings of and the associations with the nature and urban photographs. PR means participant rated, ER means experimenter rated.

	Main effect		Interaction effect	
	Inclusion of Nature in Self		INS x Environment	
	F	p	F	p
Perceived restorativeness	F(1, 76) = 4.034	0.048	F(1, 62) = 0.192	0.662
Aesthetics	F(1, 76) = 1.219	0.273	F(1, 76) = 2.467	0.120
Attitude	F(1, 76) = 0.305	0.582	F(1, 76) = 4.986	0.029
Valence of associations (PR)	F(1, 76) = 0.042	0.838	F(1, 76) = 0.361	0.550
Sociality (ER)	F(1, 76) = 3.369	0.071	F(1, 76) = 3.369	0.071
Physically active (ER)	F(1, 76) = 1.303	0.257	F(1, 76) = 0.001	0.976
Activation (ER)	F(1, 67) = 7.414	0.008	F(1, 67) = 3.191	0.079
Positivity (ER)	F(1, 58) = 6.258	0.015	F(1, 58) = 2.395	0.127

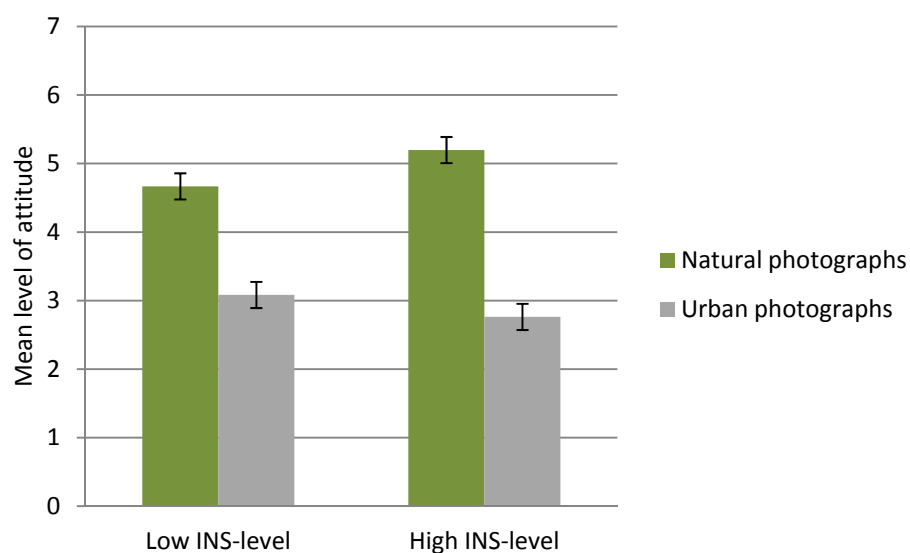


Figure 7: interaction effect of Inclusion of Nature in Self-Scale and environment on attitude

Appendix E: The Associations-Form

ASSOCIATIES		ZEER NEGATIEF					ZEER POSITIEF	
		1	2	3	4	5	6	7
FOTO 1	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
FOTO 2	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
FOTO 3	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
FOTO 4	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Figure 8: associations-form on which participants wrote down their associations and rated these on valence

Appendix F: Photographs Used in Study 2

Nature Photographs Study 2

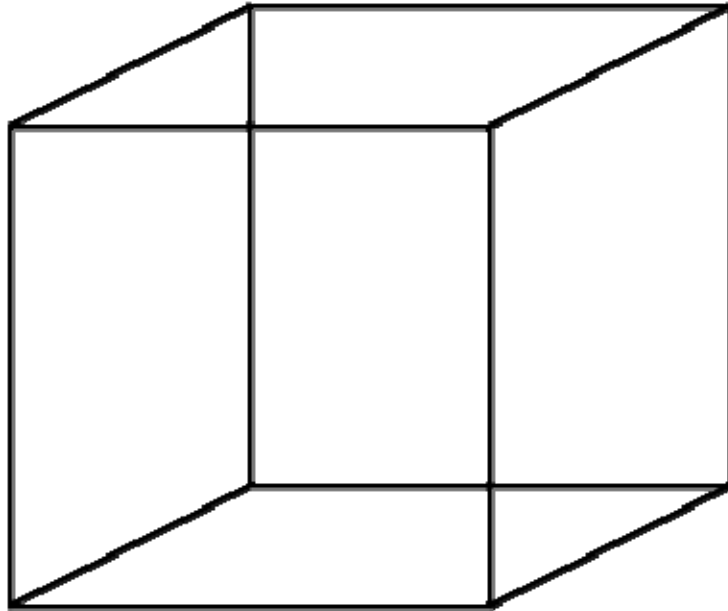


Urban Photographs Study 2

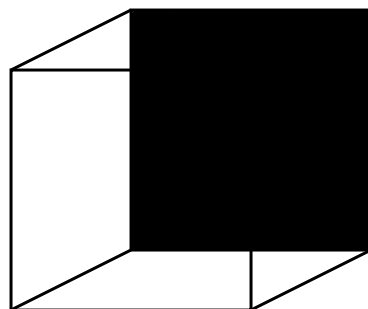
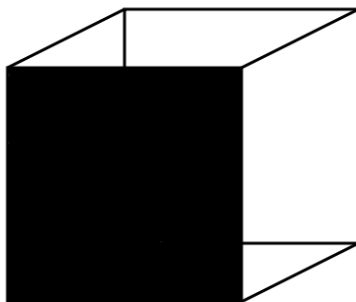
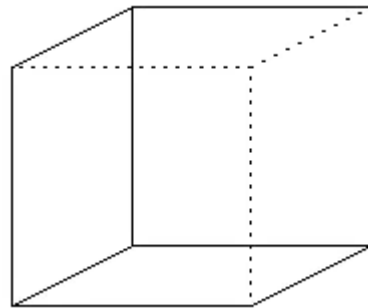
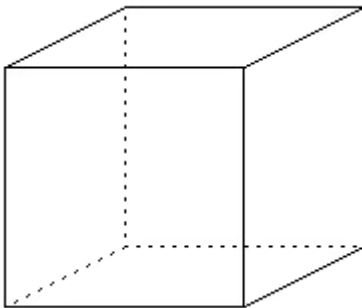


Appendix G: Instruction Sheet Necker cube-task

Necker Cube



Change of Perspective



Instructie

In het experiment komt een taak voor met deze kubus.

Eerst wil ik deze even met jou oefenen om er zeker van te zijn dat je de taak snapt.

1. Eerst kubus laten zien en perspectiefwisseling uitleggen.

Check: Snappen ze het?...

2. Dan vragen of ze even willen kijken en op de tafel tikken wanneer het perspectief wisselt

Check: Snappen ze het?...

3. Dan vragen of ze willen kijken en proberen vast te houden, en op de tafel tikken wanneer het perspectief desondanks wisselt.

Check: Snappen ze het?...

Zeg ook nog even: wanneer je probeert het perspectief vast te houden en hij wisselt toch en je drukt op de knop, dan ben je vaak even minder geconcentreerd en wisselt hij weer. Probeer je dus meteen na het drukken van de knop weer te concentreren op 1 perspectief.

Straks doe je deze taak op de computer. Hij duurt dan 30 seconden.