Out of the head, into healing with nature

Exploring the role of specific features of nature on our well-being within Virtual Reality

Sandra Oran, *S1885707*

Master Thesis in Communication Science (MSc)

Supervised by Dr. Thomas van Rompay & Dr. Mirjam Galetzka

Department of Behavioural, Management and Social Sciences

25th of March 2022

UNIVERSITY OF TWENTE.

Abstract

Since the worldwide Covid-19 lockdowns, social isolation and mental health issues are becoming serious public health concerns. Inspired by the free resources of nature and it's benefits, the present study explores to what extent wild/tended nature, and spaciousness can improve our well-being by walking in nature. This research aims at combining Virtual Reality with different types of natural environments that can reduce mental health related issues. By comparing the different types of environments, this study aims to find an environment that maximizes both stress reduction, the improvement of mood and connectedness to the world at large.

To this end, participants walked in Virtual Reality video's presenting natural environments varying in type of nature and level of spaciousness. Participants' stress levels were measured by a questionnaire before- and after the virtual experience. High spacious environments reduced stress levels significantly. Furthermore, participants reported better moods, more connectedness to self- and community, and sensed less perceived body boundaries in high spacious nature versus low spacious nature. The effect of type of nature on stress level was not significant. However, participants did report less anxiety, and perceived more restoration in tended nature versus wild nature. These findings demonstrate that a high level of spaciousness in natural environments, especially in tended nature, is likely to form a powerful combination with great potential for improving well-being.

Keywords: Virtual Reality, type of nature, well-being, spaciousness, awe, mental health, connectedness

Acknowledgements

First, I would like to thank my supervisor Dr. Thomas van Rompay for all the useful feedback, great suggestions and great availability to answer any question. Additionally, I would also like to thank my second supervisor Dr. Mirjam Galetzka for the new insights that helped this thesis in the right direction.

Finally, I also want to express my gratitude towards all the people who participated in the main study and pre-tests.

Thank you!

Sandra Oran

Table of contents

1. Introduction

Since the worldwide Covid-19 lockdowns, social isolation and mental health issues are becoming serious public health concerns. The measures of these lockdowns have been related with deteriorated mental health and well-being, including stress symptoms, confusion, anger, and anxiety (Armitage & Nellums, 2020). Since research has shown that nature has positive effects on our mental health and well-being, it is interesting to take a closer look at the opportunities of connecting to nature during the challenges of daily life (Berto, 2014; Tendais & Ribeiro, 2020).

Previous research shows that exposure to nature has many benefits, even when contact with nature is limited (Bringslimark, Hartig, Patil, 2009). Exposure to nature evokes pleasant moods (Nisbet & Zelenski, 2011b), and reduces stress- and mental exhaustion. Plenty of experimental studies show that solely viewing nature scenes can have a positive effect on long-term stress and well-being. It has the potential to restore attention (Kaplan, 1989), and may help people to cope better with stressful events and adversity (van den Berg, 2010; Marselle et al., 2019; Berto, 2014). For instance, Kuo and Sullivan (2001) found, for example, that people who live nearby nature can cope better with problems and frustrations than those who live far away from nature. Also interaction with nature is associated with less feelings of loneliness, enhanced feelings of social support (Maas et al, 2009), more connection to the world at large (Zelenski & Nisbet, 2014), and an improved manageability of life tasks (Roe & Aspinall, 2011).

It is obvious that interaction with nature can have positive influences on our mental health and well-being. However, so far, there is a lack of insights on specific features of nature and its potential to improve well-being (Bratman et al, 2019). Previous research

concerning spaciousness in environments has shown that spacious, open settings may encourage feelings of freedom and enhance self-expression (Meyers-Levy & Zhu, 2007; Okken, Van Rompay, & Pruyn, 2013a). Also, findings from a more recent study, show that certain types of nature, such as tended nature is perceived more safe compared to wild nature due to signs of ''human care'' (Herzog & Miller, 1998; Toby & Cosmides, 1990)

In this study, an experiment was held in which 80 participants watched a 'walkthrough' video of existing natural environments in Virtual Reality. To this end, a 2 (type of nature: wild versus tended) x 2 (spaciousness: high versus low) between subjects design was employed to study participants' evaluations before- and after experiencing a virtual 'walkthrough' video.

The main research question in this study was to explore the effects of specific features of natural environments and spaciousness on stress level, mood, anxiety, connectedness, perceived body boundaries, and perceived restoration during a virtual experience. Before elaborating on the details of this research, the involved key constructs will be explained first.

2. Theoretical Framework

2.1 Nature on our well-being

An increased amount of research emphasizes the positive influences of nature on our social- and mental well-being (Bratman et al 2019; Kaplan, 1989). Nature seems to have many benefits, even when contact with nature is limited (Bringslimark et al., 2009). It has the potential to reduce stress and mental exhaustion (Bratman et al, 2015), increase positive mood and affect (Allen, 2018), restore attention (Kaplan & Kaplan, 1989), and reduce anxiety (Mackay & Neill, 2010). Generally, natural environments are easier to process for humans due to their structure and coherence (Kaplan & Kaplan, 1989), which requires less cognitive activity compared to urban settings (Joye & Van den Berg, 2011). Environments containing natural elements, such as parks, woods, rivers, and coastlines are beneficial for our health and well-being, further underlining the importance of exposure to nature (De Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003).

The role of nature in enhancing well-being can be explained by the Stress Reduction Theory (Ulrich, 1991). It claims that the presence of natural scenery, like greenery, or waters induces positive emotions and feelings like interest, pleasure, calmness, and a decrease in heart rate and blood pressure, restoring our state of alertness in a stressful situation. As humans developed in natural environments, Ulrich (1991) proposed that interaction with such environments continues to have positive effects for modern humans. Assuming the stress reducing effects of the presence of natural scenery, a study by Beukeboom et al. (2012) showed that exposure to real plants or posters of landscapes in hospital waiting rooms lowered perceived stress in patients while waiting, compared to no exposure of

neither plants or posters in the waiting room. Furthermore, walking in green environments is linked to increased overall mood levels and self-esteem (Barton, Hines, & Pretty, 2009).

Another main theory is the Attention Restoration Theory (Kaplan, 1995), which suggests that exposure to nature helps to improve our focus and ability to concentrate after mental energy through unconscious cognitive processes.

Although it is well established that natural environments offer plenty health benefits, limited research is available about specific environmental features of nature and their outcomes on our well-being. Most theories are limited in scope, and mainly address cognition and stress, rather than the experience of self and the body.

2.2 Types of nature

Nature comes in many sizes, types and qualities. One could consider the amount of vegetation (the presence or absence of trees), and the level of wilderness (the presence of human intervention such as walking paths, benches, the presence or absence of water, and lightning). It is proven that natural environments have more restorative effects compared to non-natural environments (Cackowski & Nasar, 2003; Hartig et al., 2003; Ulrich et al., 1991). However, very limited research has examined specific features of restorative environments (Bowler et al., 2010). Currently, the vast majority of studies have focused their attention on comparing natural environments versus stressful built environments (Berto, 2005; Hartig et al., 2003; Parsons et al., 1998). However, what about the comparison of specific features of natural environments and their potential to restore well-being?

There have been a few studies focusing on specific features of natural environments and its effects. For example, studies on wild nature report positive effects for several reasons.

Wild nature provides opportunity for exploration and new experiences (Kaplan & Kaplan, 1989; Velarde, Fry & Tveit, 2007). Also wild- and unpredictable nature (i.e. without a walking path) is more mysterious (Stamps, 2004; Szolosi et al., 2014), more fascinating and creates a stronger sense of ''being away'' (Van Rompay & Jol, 2016). On the other hand, research also shows that wild environments may be perceived more dangerous (Herzog & Miller, 1998). One could think of natural threats, such as animals, dark lightning, or tripping over a snake or tree (Tooby & Cosmides, 1990). The fear of being attacked by another person in a closed dense wooded area is also not uncommon, especially for women (Coble et al., 2003; Henderson & Bialeschki, 1993). Without a walking path, an environment might come across as unstructured or incoherent, which might trigger the fear of getting lost. This is in line with the coherence model of Kaplan and Kaplan (1989), which states that humans have two basic needs in environments: to understand and to explore. Therefore, an environment without a walking path might come across as incoherent and illegible.

To summarize, not all types of nature offer a relaxation break from our daily stressors in life. In the context of stress, mood and anxiety recovery, tended nature might be more preferable to walk through because of the presence of clear signs, and maintenance which enhances perceived safety (Jorgensen et al., 2007). Also signs of human intervention such as benches, lanterns, or flower beds create more comfort (Staats & Hartig, 2004), which might be more beneficial for relaxation purposes. However, the relaxing effects of different types of natural environments have not yet been studied in detail. For example, Staats, Gatersleben and Hartig (1997) studied the effects of accessibility (presence of a walking path or not) and density on mood change. They concluded that low levels of accessibility during a simulated hike had negative effects on levels of pleasure. This is one of very few researches concerning

the de-stressing effects of specific features of nature. Hence, in the present research it is proposed that:

(H1) A walk through tended nature creates safety and comfort due to the presence of structure and coherence, thus has more beneficial outcomes on stress level, mood, anxiety, and perceived restoration, as opposed to wild nature.

2.3 Spaciousness: feeling safe and connected

2.3.1 Awe

It has been long known that gazing at the heavens evokes feelings of awe. Awe research provides insights on the effects of nature on the self, whereas traditional theories mostly focus on cognition. Awe is described as the primary feeling when facing something incomprehensible or sublime (Gallagher, 2015). According to Shiota, Keltner, and Mossman (2007) people oftentimes experience awe when facing immense things, or vast settings. One could think of the vastness of the Canyons in the United States, churches like the Sagrada Familia, or impressive pieces of architectural work. An important aspect of spaciousness or vastness in landscapes, is that it elicits the emotion ''awe'', Awe is elicited by perceptual vastness or spaciousness, and stimulates a need for accommodation. It alters one's understanding of the world.

Research shows that awe influences people's time perception, it can elicit feelings of having more time available, which can enhance well-being in many ways (Rudd, et al., 2012). Time perception generally affects the choices people make in life. For example, unhealthy diets, or minimal engagement in leisure activities are often associated with the lack of time (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). One's sense of time availability is

often a measure for health- and well-being. For example, the feelings of having restricted time is associated with headaches, stomach pain, and poor sleep quality (Kivimäki, Kalimo, & Julkunen, 1996; Spence, Helmreich, & Pred, 1987).

Another study shows that participants who were exposed to awe-eliciting experiences were more willing to help other people, and were less impatient. The willingness to help other people stimulates pro-social behaviour (Pfiff et al., 2015), which diminishes one's personal concerns (small self), and shift the focus of small self to a more established collective mind set (collective self) (Pfiff et al., 2015; Shiota et al., 2017). This results in more feelings of connectedness to other people and to humanity as a whole. On a physiological level, the shift from self-centeredness to selflessness can be measured by perceived body boundaries (Dambrun, 2016). Perceived body boundaries derives from the Self-Centeredness/Selflessness Happiness Model (Dambrun & Ricard, 2011). This model posits that a self-transcendence state such as meditation leads to a reduction of the self, which leads to more awareness of the present moment or awareness of one's surroundings. Along with meditation, awe eliciting experiences such as nature also have the potential to reach self-transcendence states (Chirico & Yaden, 2018). The dissolution of the self, elicited by awe may reduce the separateness from the world, resulting in reduced perceived body boundaries and less rumination, leading to more connectedness in the present moment, and the world at large.

Awe may also elicit positive moods and improve well-being. In one study, participants who watched awe eliciting natural scenes experienced a mood boost compared to participants who watched neutral scenes. Another recent study, found that awe functions as a key element in nature's ability to decrease stress and improve well-being (Anderson,

Monroy, & Keltner, 2018). The authors of this study researched the symptoms of stress and the overall well-being in military veterans and youth from undeserved communities in a white water rafting experiment. Their results showed that the amount of awe participants experienced during the experiment could predict the improvement of their stress symptoms and indicators of well-being one week later.

Other research shows that awe can be elicited by many experiences, however, interaction with nature seems to be particularly important (Shiota et al., 2007). Other findings claim that awe is elicited in wide, spacious landscapes (Chirico & Yaden, 2018), with a profound level of beauty (Cohen, Gruber, & Keltner, 2010).

2.3.2 Physical spaciousness

Spaciousness is also defined as '' the feeling of openness or room to wander'' (Herzog, 1992, p. 238). The importance for certain spacious environments for modern humans can be explained by the prospect-refuge theory (Appleton, 1975). It states that humans need large spaces in order to feel safe or seek refuge on one hand, and need exploration and prospect on the other hand. That is, humans like to have a clear prospect of their surroundings in order to anticipate potential threats or dangers, and simultaneously being able to avoid potential threats coming from places which are not visible. At the same time, refuge (e.g. vegetation) might also act as a potential hiding place for threats (Warr, 1990; Hassinger, 1985; Fisher & Nasar, 1992). Therefore, experimental studies demonstrate that environments high in refuge, and low in prospect and escape are perceived as less safe, compared to environments high in prospect and escape, but low in refuge (Fisher & Nasar, 1992; Nasar & Jones, 1997; Petherick, 2000/2001; Wang & Taylor, 2006). This is also

confirmed by Berlyne (1951), which states that if uncertainty in environments is increased beyond a point of novelty, feelings of anxiety begin to occur. This may influence the perceived and actual restorative potential in an environment, which may subconsciously impact our emotions and bodily sensations, which is directly related to our day-to-day decision-making (Ellard, 2009). One could think of the judgment of different situations, the way we see and feel in the world, pursue a task, or categorise information. Thus, nature has the potential to evoke awe, which stimulates pro-social behaviours and more connectedness. Since spaciousness is of importance for awe, it could be expected that spacious natural environments evoke more feelings of awe than dense/closed environments, suggesting that they trigger more feelings of connectedness (Van Rompay & Jol, 2016). Hence, in the present research it is proposed that:

(H2) A walk through high spacious nature elicits more feelings of awe, reducing the salience of Perceived Body Boundaries, thus creating more connectedness to the community at large, as apposed to low spacious nature.

2.4 Aim of present study

Above findings demonstrate that nature and spaciousness have a great impact on human behaviour. However, while above mentioned studies prove initial results for the comparison of wild versus tended nature, only few studies focus on the healing effects of these types of nature. Also, very little research is known about spaciousness in various natural settings. Based on literature research, only the study of Van Rompay and Jol (2016) includes the concept of both nature and spaciousness.

To test the mentioned hypothesis, and explorative research question, we conducted a 2 (type of nature: wild versus tended) x 2 (level of spaciousness: high versus low) between-subject design to test whether specific features of natural environments differently impact stress level, mood, anxiety, connectedness, and perceived restoration.

3. Method

3.1 Pre-tests

To determine the degree of wild versus tended nature, and low spacious versus high spacious environments, a pre-test was conducted before the actual experiment began. For the pre-test, a total of 15 participants watched and rated 10 videos that would be used as potential stimuli in the experiment. Participants aged from 18 to 35, including both male and female. The pre-test was conducted sitting in front of a laptop with a 360 degrees view walkthrough video. While individually watching the video of two minutes, participants were also able to explore the environment with the touchpad. After exposing participants to the stimuli, they were required to rate the 10 video's they watched, based on 11 statements. A 7-point Likert Scale has been used varying from ''completely agree'' to ''completely disagree'' An overview of the 10 video's used in the pre-test can be found in Appendix 1.

The 11 statements measured the following items: perceived spaciousness, perceived wilderness perceived tendedness, and perceived attractiveness. The 10 environments used in the pre-test were intentionally selected based on their level of spaciousness, wilderness/tendedness, and attractivity. Furthermore, all environments were rated on the same items, which are presented in Table 1. In order to test which environments represented the items the best, environments were manipulated by varying in the amount of trees to increase wilderness, or differentiating the level of spaciousness by surrounding trees which minimized the perceived openness. Attractiveness of the environments was also taken into consideration. This was manipulated by varying the level of monotony of the environment.

During filming the video's, control conditions were also taken into consideration. All video's were filmed within three days with the same weather conditions. For example, each

condition contains almost the same amount of sunlight and blue sky. The pre-test video's were tested without sound, because the noise of the wind and footsteps were too distracting.

After collecting responses, data was analysed, and four videos were selected as stimulus material for the main experiment. The four video's used in the main experiment were shortened to an amount of two minutes each. Also a spring soundtrack (singing birds) was added to the video's in order to maintain the same conditions for each environment.

Items	**Statements**
Perceived spaciousness	The environment feels spaciousness to me The environment feels open to me The environment feels closed to me The environment feels narrow to me This environment give me feelings of freedom
Perceived wilderness	I perceive this environment as wild nature This environment looks untouched to me This environment looks natural to me
Perceived tendedness	I perceive this environment as man made (built) nature
Perceived attractiveness	I find this environment attractive to see I find this environment monotonous

Table 1. Items and statements used in the pre-test

3.1.1 Results

Table 2 presents the results of the pre-test. The grey highlighted rows were rated the highest, thus represented the items the best. Therefore, video 1, 4, 7 and 9 were selected for the main experiment, which are presented in Figure 2.

Video	**Condition**	**Spaciousness**		**Wild**		**Tended**		**Attractiveness**	
		M	SD	M	SD	M	SD	M	SD
1	High-spacious/wild	7	0	7	0	1.07	0.25	7	0
2	High-spacious/wild	5.73	0.44	6.3	0.5	2.60	1.33	5.67	0.70
3	High-spacious/wild	6.43	0.73	3.43	1.35	3.5	1.50	1.86	0.83
4	High-spacious/tended	7	0	1.47	0.5	6.60	0.61	7	0
5	High-spacious/tended	5.87	0.34	2.60	1.02	6.07	0.57	4.33	0.94
6	High-spacious/tended	3.93	1.34	4.33	1.19	3.93	1.18	5.73	1.24
7	Low-spacious/wild	1	0	7	0.10	1.43	1.55	6.86	0.35
8	Low-spacious/wild	2.07	1.12	6.20	0.50	1.67	0.60	3.93	1.98
9	Low-spacious/tended	1	0	1.93	0.77	5.87	1.26	7	0
10	Low-spacious/tended	2.60	1.25	3.20	1.28	5.20	0.95	4.20	1.17

Table 2. Results of the pre-test

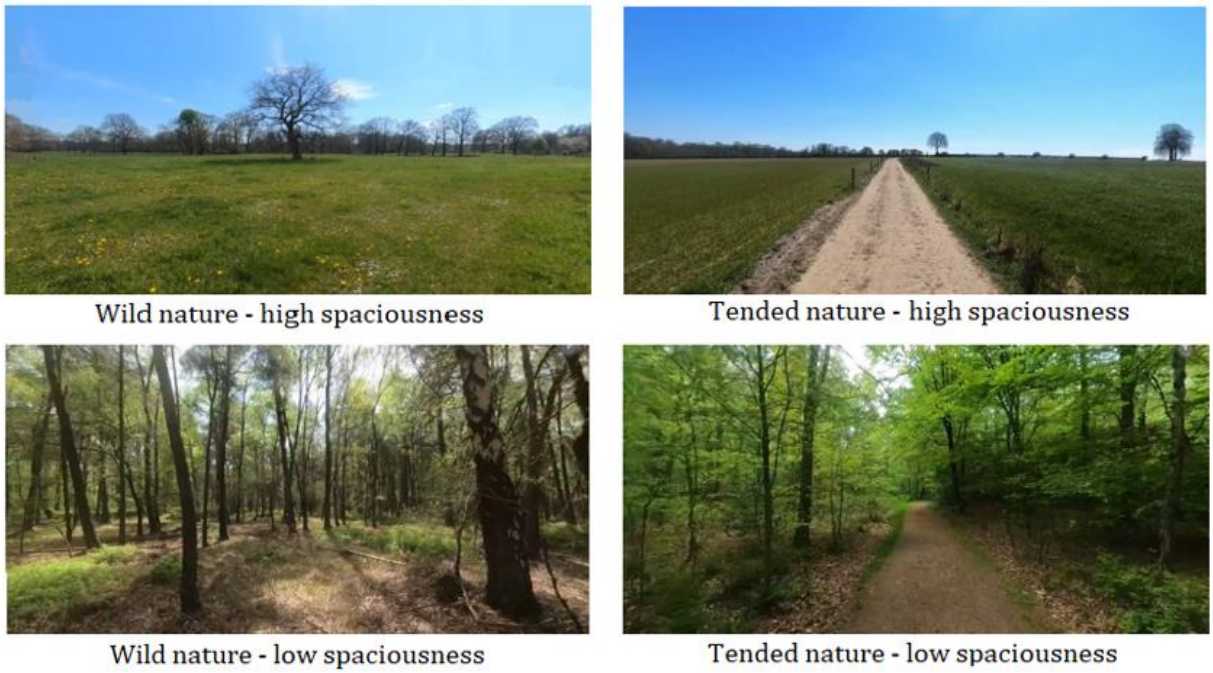


Figure 2. Screenshots of nature video's in the main experiment (from top left to bottom right: C1-C4).

3.2. Experiment design

This experiment had a 2 (type of nature: wild versus tended) x 2 (level of spaciousness: high versus low) between subjects design. The main dependent variables that were tested in the experiment were stress level, mood, connectedness, anxiety, and perceived restoration. Figure 1 presents the research design. The independent variables (type of nature and level of spaciousness) are presented on the left of Figure 1, and the dependent variables are presented on the right.

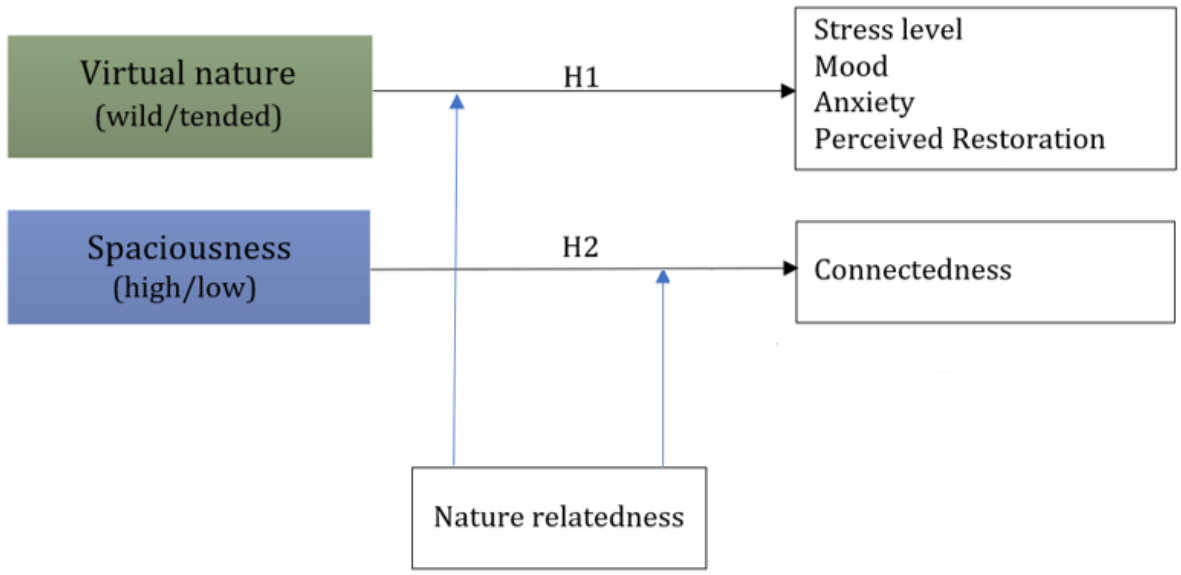


Figure 1. Research design

3.2.1 Data collection

The experiment took place on the campus of University of Twente during the period between 24th of September and 8th of October 2021. Students and others were kindly asked to participate in the study, and most of them were willing to participate. During the process of

data collection, participants were randomly sampled. Besides, each video (representing each condition) was also randomly assigned to participants.

Before participating in the experiment, participants were explicitly told that the purpose of this experiment was to collect data on environmental experiences in nature within Virtual Reality.

3.3 Participants

An amount of 80 participants took part in the final experiment of this study, of which 40 were female and 40 male. The average age of the participants was 25 years, with a standard deviation of 5.61. The execution of the main experiment took place within a time span of 15 days. Each participant had enough knowledge to work accurately with the VR glasses, tablet or smartphone, in order to answer the questionnaire afterwards.

3.4 Experiment procedure

To start with, the participant verbally agreed to participate in the experiment, on the chosen date and location. The participant was informed by the experimenter concerning the instructions during the experiment, including expectations of the participant. Instructions concerning the use of the VR glasses were given, while the experimenter prepared to start one of the four video's. Before the countdown, the experimenter asked if the VR glasses were comfortably fastened, and if the video was displayed correctly. After this, the participant could start the video with a controller and watch the environment in 120 seconds in total through the VR glasses. When the video had ended, the participant was instructed to take the glasses off, and was asked to fill in the questionnaire. The questionnaire could be accessed either through a tablet provided by the experimenter, or by the participants' own

smartphone, by scanning a QR-code redirecting to the questionnaire. The participant would also provide a digital written consent at the start of the survey (after verbal consent was given). After finishing the entire questionnaire, the participant was thanked and was given a voucher with an amount of three Euro's, which could be used at the Waaier on the Campus (Food Corner).

3.5 Measurement

This study used a questionnaire in an experimental situation to measure participants' responses. The questionnaire consisted of pre- and post-experiment questions. Pre-experiment questions were only measured for the variable stress level. Other variables such as mood, anxiety, connectedness, and perceived restoration were only measured post-experiment. Furthermore, the questionnaire also included demographic details such as age and gender. The full list of questions that participants had to answer can be found in Appendix 3. The survey was made in Qualtrics. The various dependable variables were tested by using validated scales retrieved from other studies. Self-reporting measures were also used to measure for instance participants' stress or anxiety level at that moment. All responses were measured by using 7-point rating scales.

3.5.1 Stress level

Stress level was measured in this study by using the four items of Levenstein (1993) that was validated by Fliege (2005) (Cronbach's Alpha: .88). They were sometimes adapted in minor ways to make sure that they fit the context of this research well, which resulted in statements such as "I feel tense" and "I feel like I have a lot of worries". Stress level was

measured pre- and post-experiment. For the analysis, a variable ''Stress difference'' was calculated by subtracting ''Pre- stress level'' minus ''Post-stress level'' (Cronbach's Alpha .93).

3.5.2 Mood

Mood was measured using the Positive and Negative Affect Scale (PANAS) by Watson and others (1988) (Cronbach's Alpha: .88). This self-report measurement for mood consists of fourteen items such as ''I feel happy'', and ''I feel sad''.

3.5.3 Connectedness

The item connectedness was measured by using the scale of Mashek and colleagues' (2007). The Inclusion of Community in the Self scale is viewed in Figure 3. Furthermore, also 3 subcategories of the Awe Experience Scale were used to measure time perception, for example ''I sensed things momentarily slow down'' (Cronbach's Alpha varying between .68 and .86), self-diminishment, ''I felt that my sense of self was diminished'' (Cronbach's Alpha varying between .60 and .79), and connectedness to other people and the environment ''I had the sense of being connected to everything'' (Yaden et al, 2018) (Cronbach's Alpha, varying between .67 and .77). The overall Cronbach's Alpha of the Awe Experience Scale is .88.

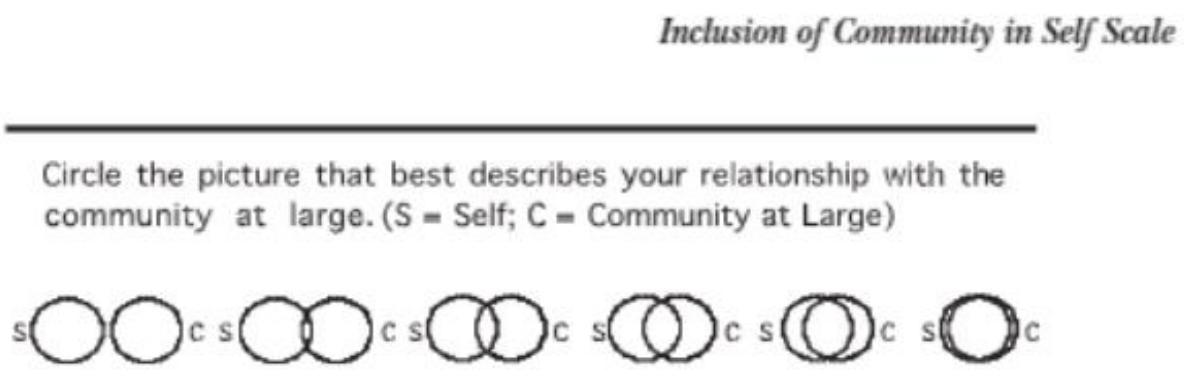


Figure 3. Inclusion of Community in the Self scale by Mashek et al. (2007)

The Perceived Body Boundaries Scale by Dambrun (2016) as shown in Figure 4 outlines seven states of human body boundaries, ranging from almost not sensible to extremely sensible. Participants had to indicate to which one of the figures they related themselves with the most at that current moment.

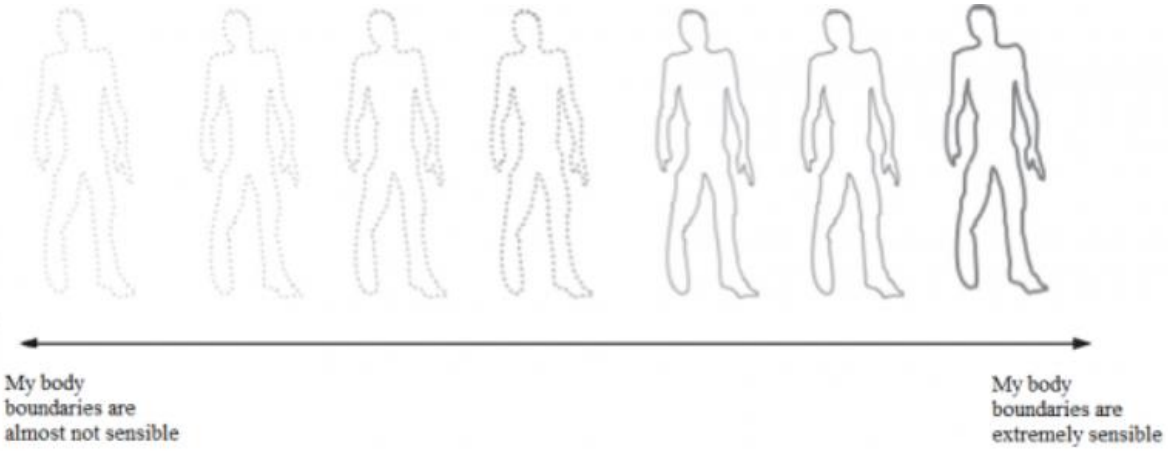


Figure 4. Perceived Body Boundary Scale Dambrun (2016)

3.5.4 Anxiety

Anxiety was measured by using the STAIS-5 Anxiety Scale by Zsido, Teleki, Csokasi, Rozsa, and Bandi (2020). This scale is a short version of the Spielberger State, Trait Anxiety Inventory (Spielberger, 1983), and consists of items such as ''I feel upset'', and ''I feel frightened'' (Cronbach's Alpha: .88).

3.5.5 Perceived restoration

Perceived restoration was measured by using the Perceived Restoration Scale by Hartig (1991). The scale consists of four subcategories which measures the experience of being away, fascination, coherence, and compatibility. Some examples of the items being measured are ''It is an escape experience'', ''The setting has fascinating qualities'', ''There is too much going on'', and ''I can do things I like here''. The overall Cronbach's Alpha of all items is .72.

3.5.6 Nature relatedness

Nature relatedness was measured using Nisbet and Zelenski's (2013) nature relatedness scale. This scale consists of six items such as ''My ideal vacation spot would be a remote, wilderness area'', and ''My connection to nature and the environment is a part of my spirituality'' (Cronbach's Alpha .82)

4. Results

Data was analysed by using a 2 (type of nature: wild versus tended) x 2 (spaciousness: high versus low) between subjects design.

4.1 Stress level

Type of nature is not significant on stress difference for pre- and post-experiment ($F(1.76) = 1.242$, $p = .130$). On the other hand, level of spaciousness is significant ($F(1.76) = 4.174$, $p = 0.045$); participants experienced more stress-reduction in the high spacious conditions ($M = 3.23$, $SD = 5.51$), compared to the low spacious conditions ($M = 1.03$, $SD = 4.12$). No significant interaction effect is found between type of nature and level of spaciousness ($F(1.76) = 1.242$, $p = .269$).

4.2 Mood

A univariate analysis showed that there is no significant difference in type of nature on the variable mood ($F(1, 76) = 1.328$, $p = .253$). The main effect of spaciousness however, is significant ($F(1,76) = 16.271$, $p < 0.01$), indicating that participants in high spacious environments ($M = 4.93$, $SD = 1.12$) registered more positive moods compared to low spacious environments ($M = 3.88$, $SD = 1.29$). A marginally significant interaction effect is observed between type of nature and level of spaciousness ($F(1,76), = 2.825$, $p = .097$). However, if we take a closer look within the interaction effect, we can conclude that spaciousness in wild nature is significant ($F(1.76) = 16.327$, $p = .000$), and spaciousness in tended nature is marginally significant ($F(1.76) = 2.768$, $p = .100$). This means that the

difference on mood between the high- and low spacious environments is more pronounced in the wild nature condition, as shown in Figure 5.

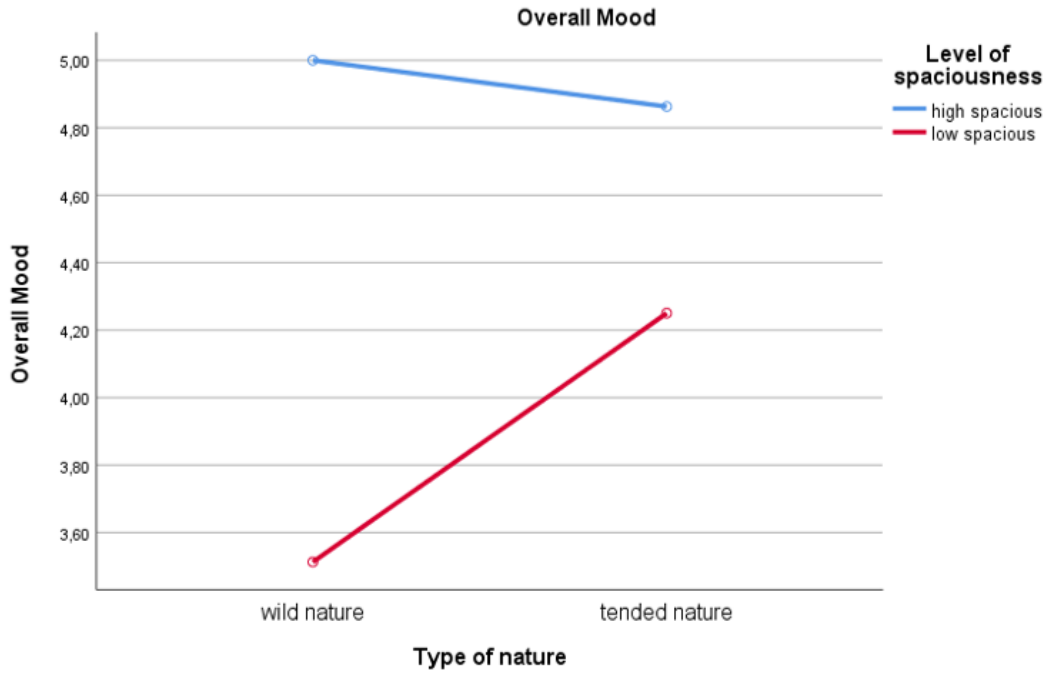


Figure 5. Plot interaction effect (type of nature and spaciousness on mood)

4.3 Connectedness

A univariate analysis showed that there is no significant effect of type of nature on the variable connectedness (F (1,76) = .515, p = .475). However, the main effect of spaciousness is significant (F (1,76) = 9.255, p = 0.003), indicating that participants felt more connected in the high spacious conditions (M = 4.325, SD = 1.13), compared to the low spacious conditions (M = 3.67, SD = .88). No significant interaction effect is found between type of nature and level of spaciousness (F (1,76) = 2.580, p = .112)

4.3.1 Inclusion of self

No main effect is found for type of nature on the variable inclusion of self (F (1,76) = 1.619, p = .207). Level of spaciousness on the other hand is significant (F (1,76) = 55.089, p = .000); participants felt more connected to the community in high spacious conditions (M = 4.05, SD = 1.09), compared to the low spacious conditions (M = 2.30, SD = 1.02). No significant interaction effect is found (F (1,76) = .000, p = 1.000).

4.3.2 Perceived body boundaries

A univariate analysis showed that there is no significant difference in type of nature on perceived body boundaries (F (1,76) = 4.441, p = .149). The main effect of level of spaciousness is significant (F (1,76) = 19.158, p = .000); participants sensed less body boundaries in the high spacious conditions (M = 3.65, SD= 1.53), compared to the low spacious conditions (M = 5.00, SD = 1.30). Furthermore, a significant interaction effect is found (F (1,76) = 4.441, p = .038). If we take a closer look within the interaction effect, we can conclude that the effect of spaciousness is significant in tended nature (F (1,76) = 21.024, p = .000), and not significant in wild nature (F (1,76) = 2.575, p = .113). This means that the difference in perceived body boundaries between the high- and low spacious environments is more pronounced in the tended nature condition.

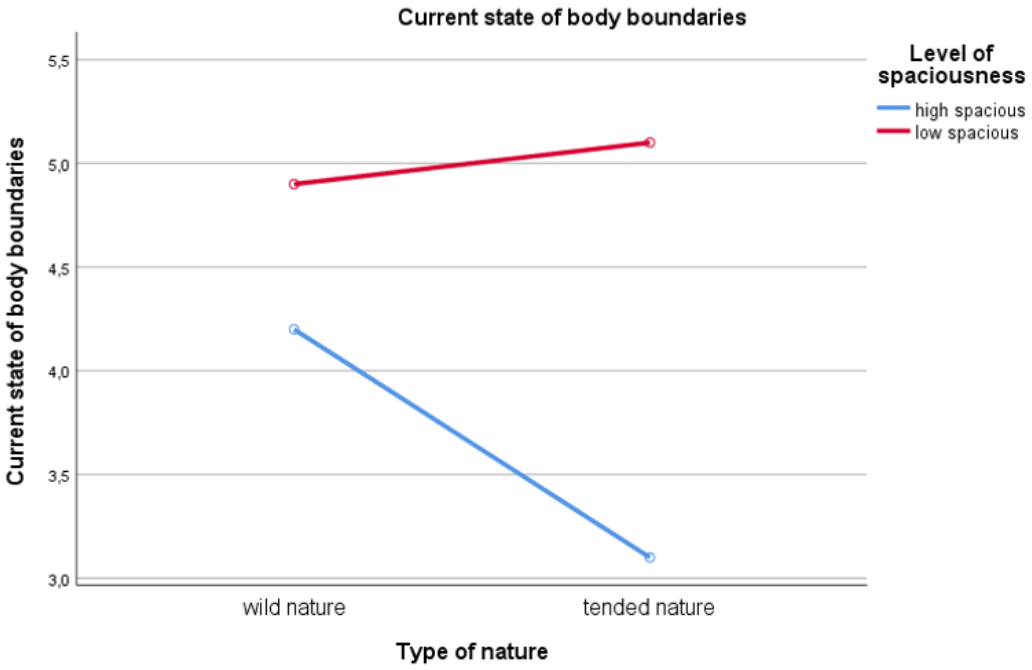


Figure 6. Profile plot interaction effect (type of nature and level of spaciousness on perceived body boundaries)

4.4 Anxiety

The main effect of type of nature on anxiety is significant (F (1,76) = 3.823, p = .044); participants felt less anxiety in tended nature (M = 2.97, SD = 1.39), compared to wild nature (M = 3.52, SD = 1.56). The main effect of spaciousness on anxiety is also significant (F (1,76) = 24,686, p = .000); participants felt less anxiety in high spacious nature (M = 2.55, SD = 1.07), compared to low spacious nature (M = 3.94, SD = 1.55). An interaction effect is found between level of spaciousness and type of nature on anxiety (F (1,76) = 9.189, p = .003). If we take a closer look within the interaction effect, we can conclude that the effect of spaciousness in wild nature is significant (F (1,76) = 31.999, p = .000), and that the effect of spaciousness in tended nature is not significant (F (1.76) = 1.876, p = .175). This means that

the difference in anxiety between the low- and high spacious environments is more pronounced in the wild nature condition. Figure 7 shows the interaction effect.

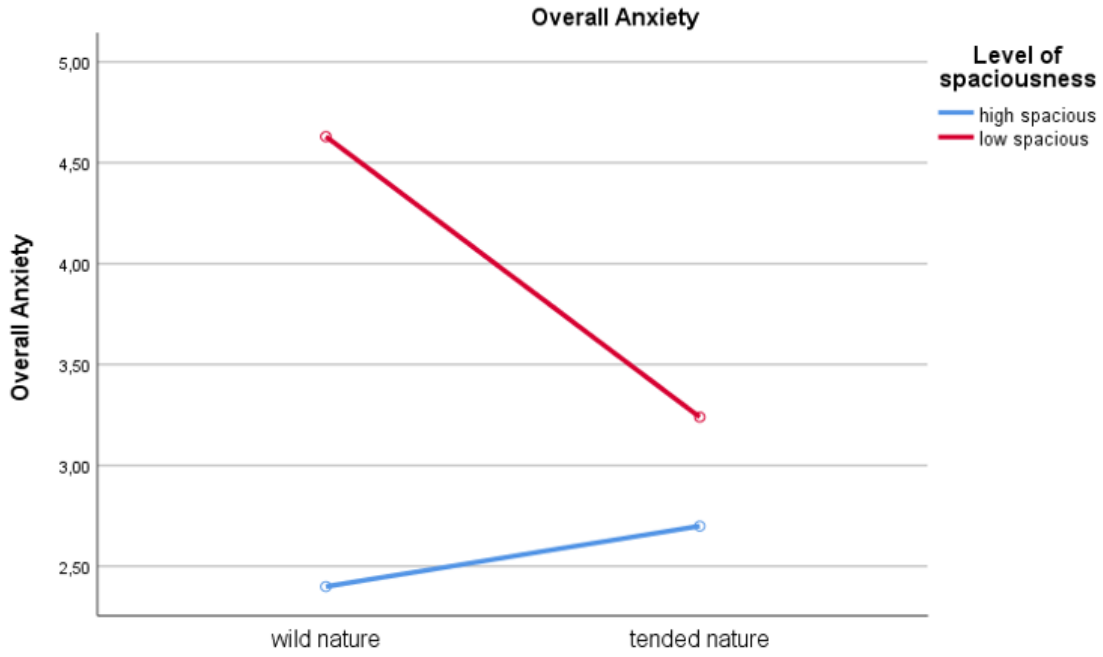


Figure 7. Plot interaction effect (type of nature and spaciousness on anxiety)

4.5 Perceived restoration

A marginally significant effect is found of type of nature on the variable perceived restoration (F (1,76) = 3.052, p = .085); participants perceived more restoration in tended nature (M = 4.25, SD = .89), compared to wild nature (M = 3.94, SD = .68). As for level of spaciousness, no main effect is found (F (1,76) = 1.276, p = .262). Similarly, no significant interaction effect is obtained (F (1,76) = .005, p = .944).

4.6 Nature relatedness

The main effect of type of nature is significant for the variable nature relatedness ($F(1,76) = 4{,}406$, $p = .039$); participants felt more related in tended nature ($M = 5.15$, $SD = .99$), compared to wild nature ($M = 4.68$, $SD = .99$). No significant main effect is found for level of spaciousness ($F(1,76) = .006$, $p = .940$). Also, no significant interaction effect is found ($F(1,76) = .680$, $p = .412$).

5. Discussion

5.1 Discussion of the results

In the present study, participants reported responses in an online survey after watching one of four videos in Virtual Reality, varying in terms of type of nature and level of spaciousness. The survey included measures for stress level (pre- and post-experience), mood, anxiety, connectedness, perceived body boundaries, and perceived restoration. Nature relatedness was measured in order to explore if it could possibly strengthen the effects of the above mentioned variables.

The first aim of the study was to explore whether a walk through tended nature, versus wild nature would have more beneficial outcomes on stress level, mood, anxiety, and perceived restoration. We hypothesized that a walk through tended nature would be more beneficial on these outcomes, as opposed to wild nature. Findings indeed show a significant main effect of type of nature on anxiety, suggesting that participants felt less anxious in tended nature versus wild nature. This can be supported by Kaplan and Kaplan (1989), which posits that people have the need to understand and explore environments. Participants feeling less anxious in the tended nature environment might be due to the structured walking path, which provides more structure and legibility. Also, Jorgensen et al. (2007), states that tended nature might be more preferable to walk through because of the presence of clear signs which enhances perceived safety. Tended nature also had a marginally significant main effect on perceived restoration. This suggests that in the present study, participants experienced more feelings of being away, more fascination, coherence and compatibility in tended nature versus wild nature. This is in line with the study of Staats and Hartig (2004), which suggests that signs of human intervention such as benches,

lanterns or flower beds create more comfort, which might be more beneficial for restorative purposes.

Contrary to our hypothesis, type of nature was not a significant predictor of stress level or mood. We may conclude that by means of a short dose of virtual nature, participants feel less anxious and perceive more restoration in tended nature versus wild nature. A comparison between tended versus wild nature shows a difference in participants' state, however no conclusions can be drawn upon pre- or post states.

The second aim of the study was to explore if connectedness to self- and community would be different for high spacious versus low spacious conditions. We hypothesized that feelings of connectedness would be more present in high spacious conditions, based on the assumptions that large or vast landscapes evoke feelings of awe (Shiota, Keltner & Mossman, 2007), which stimulates pro-social behaviour (Pfiff et al., 2015), and enhances connectedness (Allen, 2018). Findings of the present study indeed confirm that high spacious settings increase perceived connectedness. Participants in high spacious nature felt their sense of time slow down, a diminishment of one personal concerns, and more feelings of connectedness to other people. Participants also felt more connected to the community at large in the high spacious conditions compared to the low spacious conditions. We may conclude that by means of a short dose of virtual nature, participants feel more connected to self and the community at large in high spacious nature versus low spacious nature.

Spaciousness also showed a significant main effect on perceived body boundaries. Participants sensed less body boundaries in the high spacious conditions compared to the low spacious conditions. These results can be supported by the effects of awe, which are experienced in our bodies as well (Shiota et al., 2011). Experiencing awe can effect a number

of bodily sensations, including changes in the autonomic nervous system, goosebumps, chills and reduced inflammation. The experience of awe induced by the vastness of spacious landscapes might activate the parasympathetic branch in our autonomic nervous system, which controls the ''resting and digesting'' function in our body. This response is associated with safety and relaxation, which also allows us to socially interact with people and our environment (Porges, 1994). Since awe requires focussing on an outside stimulus, one might also feel less separation between one's body and the rest of the world, which leads to less perceived body boundaries. Furthermore, a significant interaction effect was found between level of spaciousness and type of nature. We may conclude that the effect of spaciousness on perceived body boundaries was more pronounced in tended nature. This might be due to the comfort that tended nature offers, which also could have an effect on perceived safety in one's body and environment. Also, wild nature could be perceived as an unstructured, which might create confusion and anxiety (Kaplan & Kaplan, 1989; Berlyne, 1951).

Next to the significant outcomes of spaciousness on connectedness, this study also suggests other significant results of spaciousness on the other dependent variables, which were initially not hypothesized. To start with, level of spaciousness had a significant main effect on stress level, which was measured pre-and post-experiment. Participants experienced more stress-reduction in the high spacious conditions compared to the low spacious conditions. These results are in line with several studies which suggest that spacious environments have plenty benefits for our well-being. For example, the prospect-refuge theory (Appleton, 1975) states that humans like to have a clear prospect of their surroundings in order to anticipate potential threats or dangers, and simultaneously being able to avoid potential threats coming from places which are not visible. Likewise, a study by

Meyers-Levi and Zhu (2007) posits that perceived spaciousness in rooms tends to evoke feelings of freedom. Thus, perceived safety (Fisher & Nasar, 1992), in combination with a certain level of vastness or awe might lower stress levels (Anderson, Monroy, & Keltner, 2018) , and lead to more well-being (Shiota et al., 2007).

Spaciousness also shows a significant main effect on mood; participants registered more positive moods in the high spacious conditions compared to the low spacious conditions. More positive moods in high spacious conditions might be due to the perceived vastness or openness, elicited by awe (Anderson, Monroy, & Keltner, 2018), which could create a short-term uplift in life satisfaction (Rudd., et al, 2012). Another explanation for more positive moods in high spaciousness conditions might be due to the amount of (sun)light in nature. Sunlight and darkness are responsible for the release of hormones in our body. Whereas exposure to sunlight releases serotonin, boosts mood and increases calmness, darkness on the other hand releases melatonin which is responsible to help us sleep (Sansone, 2013). Thus, low spacious conditions contain less (sun)light, which might have a negative influence on mood.

Finally, nature relatedness was also measured to see whether people who feel more connected to nature would have different outcomes on the results. No main significant effect is found. From the results we can only conclude that participants could relate more to the tended nature conditions compared to the wild nature conditions.

5.2 Limitations

As with most studies, this research also had some limitations. The fact that no effect of type of nature was found on stress level and mood in the present study, while such an

effect was found in other studies (Herzog & Miller, 1998), might be due to the absence of different levels of human intervention. The present study did not allow to elaborate more on different levels of human intervention, such as benches, lanterns or flower beds. In light of the theory of Staats and Hartig (2004) it may be well worth to explore these signs separately. The only human intervention used in this study was a walking path. Therefore, some environments in the current study might not be realistic to walk through in daily life. For example, the wild forest conditions did not contain a walking path. It is unclear how attractive or likely it is for people to walk through an almost inaccessible environment in their free time. Without a walking path one might have the fear of getting lost, or might have the fear of being attacked by animals or other people (Coble et al., 2003; Henderson & Bialeschki, 1993). This could have influenced the significancy of type of nature on the variables. Thus, future research is recommended to incorporate more signs of human intervention and to create more levels of tended or wild nature, instead of only using a walking path as in the present study.

A second limitation within this study is that a few participants were nauseas due to the 360 degrees view within Virtual Reality. This might have influenced results. Future research may consider to let participants try out Virtual Reality before doing any experiment, in order to eliminate possible uncomfortable feelings.

A third limitation within this study is the majority of (young)students within the sample. Previous research suggests that preference for landscapes could vary with age and gender (Van den Berg & Koole, 2006). Since the present study included more students than non-students this might also have an effect on the outcomes. For example, elderly people (with mobility restrictions) or other people with limited access to nature have difference

needs and requirements for environments. Such differences might reflect in preferences for type of nature (wild versus tended) (Van Houwelingen-Snippe, van Rompay, de Jong, Ben Allouch, 2020). Furthermore, students and non-students might experience different types of stress, for example student exams versus a casual work-day, future research might consider different samples to verify generalisability.

5.3 Implications

The results of the present study offer scientific support for the effectiveness of high spacious natural environments on reducing stress levels within Virtual Reality. Furthermore, this study suggests that participants also reported better moods, felt less anxiety, felt more connected to self and the community, sensed less body boundaries, and perceived more restoration in high spacious natural environments. In addition, the results suggest that participants experienced less anxiety, and perceived more restoration in tended nature compared to wild nature.

There are a number of matters in which these findings can be used to the advantage on our well-being. First, these findings could be of interest to people who seek out to nature for relaxation. They can choose to visit nature with open landscapes instead of dense woods, which limit space and lightning. Secondly, these findings could be applied in virtual matters, such as Virtual Reality and work out video's (i.e. spinning classes or treadmills). Furthermore, designers of public spaces such as nature- or hiking parks could take the advantages of spaciousness into consideration, in order to create experiences which are beneficial for our well-being.

References

Anderson, C. L., Monroy, M., & Keltner, D. (2018). Awe in nature heals: Evidence from military veterans, at-risk youth, and college students. *Emotion*, *18*(8), 1195-1202. https://doi.org/10.1037/emo0000442

Armitage, R., & Nellums, L. B. (2020). Covid-19 and the consequences of isolating the elderly. *The Lancet Public Health*, *5*(5), e256. https://doi.org/10.1016/s2468-2667(20)30061-x

Ballew, M. T., & Omoto, A. M. (2018). Absorption: How nature experiences promote awe and other positive emotions. *Ecopsychology*, *10*(1), 26-35. https://doi.org/10.1089/eco.2017.0044

Barton, J., Hine, R., & Pretty, J. (2009). The health benefits of walking in greenspaces of high natural and heritage value. *Journal of Integrative Environmental Sciences*, *6*(4), 261-278. https://doi.org/10.1080/19438150903378425

Berlyne, D. E. (1951). Attention, perception and behavior theory. *Psychological Review*, *58*(2), 137-146. https://doi.org/10.1037/h0058364

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

Berto, R. (2014). The role of nature in coping with psycho-physiological stress: A literature review on Restorativeness. *Behavioral Sciences*, *4*(4), 394-409. https://doi.org/10.3390/bs4040394

Beukeboom, C. J., Langeveld, D., & Tanja-Dijkstra, K. (2012). Stress-reducing effects of real and artificial nature in a hospital waiting room. *The Journal of Alternative and Complementary Medicine*, *18*(4), 329-333. https://doi.org/10.1089/acm.2011.0488

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*(1). https://doi.org/10.1186/1471-2458-10-456

Bowler, D. E., Buyung-Ali, L. M., Knight, T. M., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health*, *10*(1). https://doi.org/10.1186/1471-2458-10-456

Branand, B., Mashek, D., Wray-Lake, L., & Coffey, J. K. (2015). Inclusion of college community in the self: A longitudinal study of the role of self-expansion in students' satisfaction. *Journal of College Student Development*, *56*(8), 829-844. https://doi.org/10.1353/csd.2015.0080

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., De Vries, S., Flanders, J., Folke, C., Frumkin, H., Gross, J. J., Hartig, T., Kahn, P. H., Kuo, M., Lawler, J. J., Levin, P. S., Lindahl, T., Meyer-Lindenberg, A., Mitchell, R., Ouyang, Z., Roe, J., … Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. *Science Advances*, *5*(7). https://doi.org/10.1126/sciadv.aax0903

Bringslimark, T., Hartig, T., & Patil, G. G. (2009). The psychological benefits of indoor plants: A critical review of the experimental literature. *Journal of Environmental Psychology*, *29*(4), 422-433. https://doi.org/10.1016/j.jenvp.2009.05.001

Cackowski, J. M., & Nasar, J. L. (2003). The restorative effects of roadside vegetation. *Environment and Behavior*, *35*(6), 736-751. https://doi.org/10.1177/0013916503256267

Coble, T. G., Selin, S. W., & Erickson, B. B. (2003). Hiking alone: Understanding fear, negotiation strategies and leisure experience. *Journal of Leisure Research*, *35*(1), 1-22. https://doi.org/10.18666/jlr-2003-v35-i1-608

Coeterier, J. (1996). Dominant attributes in the perception and evaluation of the Dutch landscape. *Landscape and Urban Planning*, *34*(1), 27-44. https://doi.org/10.1016/0169-2046(95)00204-9

Cohen, A. B., Gruber, J., & Keltner, D. (2010). Comparing spiritual transformations and experiences of profound beauty. *Psychology of Religion and Spirituality*, *2*(3), 127-135. https://doi.org/10.1037/a0019126

Dambrun, M. (2016). When the dissolution of perceived body boundaries elicits happiness: The effect of selflessness induced by a body scan meditation. *Consciousness and Cognition*, *46*, 89-98. https://doi.org/10.1016/j.concog.2016.09.013

De Vries, S., Verheij, R. A., Groenewegen, P. P., & Spreeuwenberg, P. (2003). Natural environments—Healthy environments? An exploratory analysis of the relationship between Greenspace and health. *Environment and Planning A: Economy and Space*, *35*(10), 1717-1731. https://doi.org/10.1068/a35111

Ellard C (2009) You are here: why we can find our way to the moon, but get lost in the mall. Anchor Books, New York

The experience of landscape. (1975). *Landscape Research*, *1*(10), 15-16. https://doi.org/10.1080/01426397508705780

Fisher, B. S., & Nasar, J. L. (1992). Fear of crime in relation to three exterior site features. *Environment and Behavior*, *24*(1), 35-65. https://doi.org/10.1177/0013916592241002

Gallagher, S., Reinerman-Jones, L., Janz, B., Bockelman, P., & Trempler, J. (2015). The very idea of non-reductionist science. *A Neurophenomenology of Awe and Wonder*, 153-173. https://doi.org/10.1057/9781137496058_8

Hartig, T., Korpela, K., Evans, G. W., & Gärling, T. (1997). A measure of restorative quality in environments. *Scandinavian Housing and Planning Research*, *14*(4), 175-194. https://doi.org/10.1080/02815739708730435

Hassinger, J. (1985). Fear of crime in public environments. Journal of Architectural and Planning Research, 2, 289-300

Henderson, K. A., & Bialeschki, M. D. (1993). Negotiating constraints to women's physical recreation. *Loisir et Société / Society and Leisure*, *16*(2), 389-411. https://doi.org/10.1080/07053436.1993.10715459

Herzog, T. R. (1992). A cognitive analysis of preference for urban spaces. *Journal of Environmental Psychology*, *12*(3), 237-248. https://doi.org/10.1016/s0272-4944(05)80138-0

Herzog, T. R., & Miller, E. J. (1998). The role of mystery in perceived danger and environmental preference. *Environment and Behavior*, *30*(4), 429-449. https://doi.org/10.1177/001391659803000401

Joye, Y., & Van den Berg, A. (2011). Is love for green in our genes? A critical analysis of evolutionary assumptions in restorative environments research. *Urban Forestry & Urban Greening*, *10*(4), 261-268. https://doi.org/10.1016/j.ufug.2011.07.004

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169-182. https://doi.org/10.1016/0272-4944(95)90001-2

Kuo, F., & Sullivan, W. (2001). Environment and crime in the inner city: Does vegetation reduce crime? *Environment & Behavior*, *33*(3), 343-367. https://doi.org/10.1177/00139160121973025

Levenstein, S., Prantera, C., Varvo, V., Scribano, M., Berto, E., Luzi, C., & Andreoli, A. (1993). Development of the perceived stress questionnaire: A new tool for psychosomatic research. *Journal of Psychosomatic Research*, *37*(1), 19-32. https://doi.org/10.1016/0022-3999(93)90120-5

Maas, J., Van Dillen, S. M., Verheij, R. A., & Groenewegen, P. P. (2009). Social contacts as a possible mechanism behind the relation between green space and health. *Health & Place*, *15*(2), 586-595. https://doi.org/10.1016/j.healthplace.2008.09.006

Maas, J., Verheij, R. A., De Vries, S., Spreeuwenberg, P., Schellevis, F. G., & Groenewegen, P. P. (2009). Morbidity is related to a green living environment. *Journal of Epidemiology & Community Health*, *63*(12), 967-973. https://doi.org/10.1136/jech.2008.079038

Mackay, G. J., & Neill, J. T. (2010). The effect of "green exercise" on state anxiety and the role of exercise duration, intensity, and greenness: A quasi-experimental study. *Psychology of Sport and Exercise*, *11*(3), 238-245. https://doi.org/10.1016/j.psychsport.2010.01.002

Meyers-Levy, J., & Zhu, R. (2007). The influence of ceiling height: The effect of priming on the type of processing that people use. *Journal of Consumer Research*, *34*(2), 174-186. https://doi.org/10.1086/519146

Nisbet, E. K., & Zelenski, J. M. (2011). Underestimating nearby nature. *Psychological Science*, *22*(9), 1101-1106. https://doi.org/10.1177/0956797611418527

Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: A new brief measure of nature relatedness. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00813

Okken, V., Van Rompay, T., & Pruyn, A. (2012). Room to move. *Environment and Behavior*, *45*(6), 737-760. https://doi.org/10.1177/0013916512444780

Penning-Rowsell, E. C. (1992). Book reviews: Kaplan, R. and Kaplan, S. 1990: The experience of nature: a psychological perspective. Cambridge: Cambridge University press. 340 pp. £32.50 cloth, £10.95 paper. ISBN: 0 521 341396. *Progress in Human Geography*, *16*(3), 462-463. https://doi.org/10.1177/030913259201600333

Petherick, N. (2000/2001). Environmental Design and Fear: The Prospect-Refuge Model and the University College of the Cariboo Campus. Western Geography, 10/11, 89-112.

Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., & Keltner, D. (2015). Awe, the small self, and prosocial behavior. *Journal of Personality and Social Psychology*, *108*(6), 883-899. https://doi.org/10.1037/pspi0000018

Porges, S. W., Doussard-Roosevelt, J. A., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. Monographs of the Society for Research in Child Development, 59(2/3), 167. https://doi.org/10.2307/1166144

Roe, J., & Aspinall, P. (2011). The restorative benefits of walking in urban and rural settings in adults with good and poor mental health. *Health & Place*, *17*(1), 103-113. https://doi.org/10.1016/j.healthplace.2010.09.003

Rudd, M., Vohs, K. D., & Aaker, J. (2012). Awe expands people's perception of time, alters decision making, and enhances well-being. Psychological Science, 23, 1130 –1136. http://dx.doi.org/10.1177/ 0956797612438731

Sansone. (2013). Sunshine, Serotonin, and Skin: A Partial Explanation for Seasonal Patterns in Psychopathology? *Innovations in Clinical Neuroscience*.

Shiota, M. N., Keltner, D., & John, O. P. (2006). Positive emotion dispositions differentially associated with Big Five personality and attachment style. *The Journal of Positive Psychology*, *1*(2), 61-71. https://doi.org/10.1080/17439760500510833

Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition and Emotion*, *21*(5), 944-963. https://doi.org/10.1080/02699930600923668

Spielberger, C. D. (1983). State-Trait Anxiety Inventory for adults. *PsycTESTS Dataset*. https://doi.org/10.1037/t06496-000

Staats, H., Gatersleben, B., & Hartig, T. (1997). Change in mood as a function of environmental design: Arousal and pleasure on a simulated forest hike. *Journal of Environmental Psychology*, *17*(4), 283-300. https://doi.org/10.1006/jevp.1997.0069

Staats, H., & Hartig, T. (2004). Alone or with a friend: A social context for psychological restoration and environmental preferences. *Journal of Environmental Psychology*, *24*(2), 199-211. https://doi.org/10.1016/j.jenvp.2003.12.005

Stamps, A. E. (2004). Mystery, complexity, legibility and coherence: A meta-analysis. *Journal of Environmental Psychology*, *24*(1), 1-16. https://doi.org/10.1016/s0272-4944(03)00023-9

Szolosi, A. M., Watson, J. M., & Ruddell, E. J. (2014). The benefits of mystery in nature on attention: Assessing the impacts of presentation duration. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01360

Tooby, J., & Cosmides, L. (1990). The past explains the present. *Ethology and Sociobiology*, *11*(4-5), 375-424. https://doi.org/10.1016/0162-3095(90)90017-z

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology*, *11*(3), 201-230. https://doi.org/10.1016/s0272-4944(05)80184-7

Van den Berg, A. E., Jorgensen, A., & Wilson, E. R. (2014). Evaluating restoration in urban green spaces: Does setting type make a difference? *Landscape and Urban Planning*, *127*, 173-181. https://doi.org/10.1016/j.landurbplan.2014.04.012

Van den Berg, A. E., & Koole, S. L. (2006). New wilderness in The Netherlands: An investigation of visual preferences for nature development landscapes. *Landscape and Urban Planning*, *78*(4), 362-372. https://doi.org/10.1016/j.landurbplan.2005.11.006

Van Houwelingen-Snippe, J.; van Rompay, T.J.L.; de Jong, M.D.T.; Ben Allouch, S. (2020) Does digital nature enhance social aspirations? An experimental study. Int. J. Environ. Res. Public Health 2020, 17, 1454. [CrossRef]

Van Rompay, T. J., & Jol, T. (2016). Wild and free: Unpredictability and spaciousness as predictors of creative performance. *Journal of Environmental Psychology*, *48*, 140-148. https://doi.org/10.1016/j.jenvp.2016.10.001

Velarde, M., Fry, G., & Tveit, M. (2007). Health effects of viewing landscapes – Landscape types in environmental psychology. *Urban Forestry & Urban Greening*, *6*(4), 199-212. https://doi.org/10.1016/j.ufug.2007.07.001

Wang, K., & Taylor, R. B. (2006). Simulated walks through dangerous alleys: Impacts of features and progress on fear. *Journal of Environmental Psychology*, *26*(4), 269-283. https://doi.org/10.1016/j.jenvp.2006.07.006

Warr, M. (1990). Dangerous situations: Social context and fear of victimization. *Social Forces*, *68*(3), 891. https://doi.org/10.2307/2579359

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063-1070. https://doi.org/10.1037/0022-3514.54.6.1063

Yaden, D. B., Kaufman, S. B., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J. W., & Keltner, D. (2018). The development of the awe experience scale (AWE-S): A multifactorial measure for a complex emotion. *The Journal of Positive Psychology*, *14*(4), 474-488. https://doi.org/10.1080/17439760.2018.1484940

Zelenski, J. M., & Nisbet, E. K. (2012). Happiness and feeling connected. *Environment and Behavior*, *46*(1), 3-23. https://doi.org/10.1177/0013916512451901

Zelenski, J. M., & Nisbet, E. K. (2014). Happiness and feeling connected. *Environment and Behavior*, *46*(1), 3-23. https://doi.org/10.1177/0013916512451901

Zsido, A. N., Teleki, S. A., Csokasi, K., Rozsa, S., & Bandi, S. A. (2020). Development of the short version of the spielberger state—trait anxiety inventory. *Psychiatry Research*, *291*, 113223. https://doi.org/10.1016/j.psychres.2020.113223

Enclosures

Appendix 1 Pre-test materials

PRE-TEST QUESTIONNAIRE

Please watch video 1. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 2. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 3. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 4. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 5. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 6. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 7. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 8. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 9. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

Please watch video 10. To what extent do you agree the following questions?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
This environment feels spacious to me	○	○	○	○	○	○	○
This environment feels open to me	○	○	○	○	○	○	○
This environment feels closed to me	○	○	○	○	○	○	○
This environment feels narrow to me	○	○	○	○	○	○	○
I perceive this environment as wild nature	○	○	○	○	○	○	○
This environment looks untouched to me	○	○	○	○	○	○	○
This environment looks natural to me	○	○	○	○	○	○	○
I perceive this environment as manmade(built) nature	○	○	○	○	○	○	○
I find this environment attractive to see	○	○	○	○	○	○	○
I find this environment monotonous	○	○	○	○	○	○	○
This environment gives me feelings of freedom	○	○	○	○	○	○	○

PRE-TEST CONDITIONS

Figure 1. Imagery varying in spaciousness/wild/tended nature (Image numbers and experimental condition indicators correspond to those presented in Table 1)

Appendix 2 Analysis results

RESULTS PRE-STRESS LEVEL

Tests of Between-Subjects Effects

Dependent Variable: COMPUTE PreStresslevel=PreStresslevelFeelingUnderPressure + PreStresslevelTension + PreStresslevelWorries + PreStresslevelFrustration

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	491,837[a]	3	163,946	5,246	,002	,172
Intercept	25884,013	1	25884,013	828,236	,000	,916
Idv1TypeOfNature	21,013	1	21,013	,672	,415	,009
Idv2LevelOfSpaciousness	400,513	1	400,513	12,816	,001	,144
Idv1TypeOfNature * Idv2LevelOfSpaciousness	70,313	1	70,313	2,250	,138	,029
Error	2375,150	76	31,252			
Total	28751,000	80				
Corrected Total	2866,987	79				

a. R Squared = ,172 (Adjusted R Squared = ,139)

Descriptive Statistics

Dependent Variable: COMPUTE PreStresslevel=PreStresslevelFeelingUnderPressure + PreStresslevelTension + PreStresslevelWorries + PreStresslevelFrustration

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	14,3000	6,31706	20
	tended nature	17,2000	6,03150	20
	Total	15,7500	6,27061	40
low spacious	wild nature	20,6500	4,48712	20
	tended nature	19,8000	5,34691	20
	Total	20,2250	4,89106	40
Total	wild nature	17,4750	6,29199	40
	tended nature	18,5000	5,77794	40
	Total	17,9875	6,02420	80

RESULTS POST-STRESS LEVEL

Tests of Between-Subjects Effects

Dependent Variable: COMPUTE PostStresslevel=MoodStressFeelingUnderPressure + MoodStressTension + MoodStressWorries + MoodStressFrustration

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1088,038[a]	3	362,679	8,945	,000	,261
Intercept	20129,513	1	20129,513	496,469	,000	,867
Idv2LevelOfSpaciousness	891,113	1	891,113	21,978	,000	,224
Idv1TypeOfNature	7,813	1	7,813	,193	,662	,003
Idv2LevelOfSpaciousness * Idv1TypeOfNature	189,113	1	189,113	4,664	,034	,058
Error	3081,450	76	40,545			
Total	24299,000	80				
Corrected Total	4169,488	79				

a. R Squared = ,261 (Adjusted R Squared = ,232)

Descriptive Statistics

Dependent Variable: COMPUTE PostStresslevel=MoodStressFeelingUnderPressure + MoodStressTension + MoodStressWorries + MoodStressFrustration

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	11,3000	6,00088	20
	tended nature	13,7500	6,49595	20
	Total	12,5250	6,29606	40
low spacious	wild nature	21,0500	5,38492	20
	tended nature	17,3500	7,41460	20
	Total	19,2000	6,66487	40
Total	wild nature	16,1750	7,48636	40
	tended nature	15,5500	7,11787	40
	Total	15,8625	7,26487	80

RESULTS MOOD

Tests of Between-Subjects Effects

Dependent Variable: Mood

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	719,838[a]	3	239,946	7,959	,000
Intercept	40906,013	1	40906,013	1356,898	,000
Idv1TypeOfNature	30,013	1	30,013	,996	,322
Idv2LevelOfSpaciousness	599,513	1	599,513	19,886	,000
Idv1TypeOfNature * Idv2LevelOfSpaciousness	90,312	1	90,312	2,996	,088
Error	2291,150	76	30,147		
Total	43917,000	80			
Corrected Total	3010,988	79			

a. R Squared = ,239 (Adjusted R Squared = ,209)

Descriptive Statistics

Dependent Variable: COMPUTE Mood=MoodHappy + MoodRelaxed + MoodCheerful + MoodSerene

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	20,0000	5,17077	20
	tended nature	19,4500	4,85012	20
	Total	19,7250	4,95615	40
low spacious	wild nature	14,0500	3,64872	20
	tended nature	17,0000	4,81227	20
	Total	15,5250	4,47206	40
Total	wild nature	17,0250	5,34688	40
	tended nature	18,2250	4,92762	40
	Total	17,6250	5,14443	80

RESULTS CONNECTEDNESS

Tests of Between-Subjects Effects

Dependent Variable: Connectedness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3295,600[a]	3	1098,533	4,570	,005	,153
Intercept	318528,800	1	318528,800	1325,053	,000	,946
Idv2LevelOfSpaciousness	2553,800	1	2553,800	10,624	,002	,123
Idv1TypeOfNature	180,000	1	180,000	,749	,390	,010
Idv2LevelOfSpaciousness * Idv1TypeOfNature	561,800	1	561,800	2,337	,130	,030
Error	18269,600	76	240,389			
Total	340094,000	80				
Corrected Total	21565,200	79				

a. R Squared = ,153 (Adjusted R Squared = ,119)

Descriptive Statistics

Dependent Variable: Connectedness

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	64,6000	15,91887	20
	tended nature	72,9000	17,92939	20
	Total	68,7500	17,25488	40
low spacious	wild nature	58,6000	11,55035	20
	tended nature	56,3000	15,91457	20
	Total	57,4500	13,77465	40
Total	wild nature	61,6000	14,05994	40
	tended nature	64,6000	18,72582	40
	Total	63,1000	16,52202	80

RESULTS INCLUSION OF SELF

Tests of Between-Subjects Effects

Dependent Variable: Relationship between you and the community

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	63,050[a]	3	21,017	18,903	,000	,427
Intercept	806,450	1	806,450	725,328	,000	,905
Idv1TypeOfNature	1,800	1	1,800	1,619	,207	,021
Idv2LevelOfSpaciousness	61,250	1	61,250	55,089	,000	,420
Idv1TypeOfNature * Idv2LevelOfSpaciousness	,000	1	,000	,000	1,000	,000
Error	84,500	76	1,112			
Total	954,000	80				
Corrected Total	147,550	79				

a. R Squared = ,427 (Adjusted R Squared = ,405)

Descriptive Statistics

Dependent Variable: Relationship between you and the community

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	3,90	,968	20
	tended nature	4,20	1,196	20
	Total	4,05	1,085	40
low spacious	wild nature	2,15	1,226	20
	tended nature	2,45	,759	20
	Total	2,30	1,018	40
Total	wild nature	3,03	1,405	40
	tended nature	3,33	1,328	40
	Total	3,17	1,367	80

RESULTS ANXIETY

Tests of Between-Subjects Effects

Dependent Variable: COMPUTE Anxiety=MoodAnxietyUpset + MoodAnxietyFrightened + MoodAnxietyNervous + MoodAnxietyJittery + MoodAnxietyConfused

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1464,637[a]	3	488,212	12,566	,000	,332
Intercept	21027,613	1	21027,613	541,224	,000	,877
Idv2LevelOfSpaciousness	959,113	1	959,113	24,686	,000	,245
Idv1TypeOfNature	148,513	1	148,513	3,823	,044	,048
Idv2LevelOfSpaciousness * Idv1TypeOfNature	357,013	1	357,013	9,189	,003	,108
Error	2952,750	76	38,852			
Total	25445,000	80				
Corrected Total	4417,387	79				

a. R Squared = ,332 (Adjusted R Squared = ,305)

Descriptive Statistics

Dependent Variable: COMPUTE Anxiety=MoodAnxietyUpset + MoodAnxietyFrightened + MoodAnxietyNervous + MoodAnxietyJittery + MoodAnxietyConfused

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	12,0000	5,77654	20
	tended nature	13,5000	4,86123	20
	Total	12,7500	5,32411	40
low spacious	wild nature	23,1500	5,16338	20
	tended nature	16,2000	8,47038	20
	Total	19,6750	7,76708	40
Total	wild nature	17,5750	7,81808	40
	tended nature	14,8500	6,95240	40
	Total	16,2125	7,47772	80

RESULTS PERCEIVED RESTORATION

Tests of Between-Subjects Effects

Dependent Variable: PerceivedRestoration

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	695,650[a]	3	231,883	1,444	,237	,054
Intercept	344006,450	1	344006,450	2142,657	,000	,966
Idv2LevelOfSpaciousness	204,800	1	204,800	1,276	,262	,017
Idv1TypeOfNature	490,050	1	490,050	3,052	,085	,039
Idv2LevelOfSpaciousness * Idv1TypeOfNature	,800	1	,800	,005	,944	,000
Error	12201,900	76	160,551			
Total	356904,000	80				
Corrected Total	12897,550	79				

a. R Squared = ,054 (Adjusted R Squared = ,017)

Descriptive Statistics

Dependent Variable: PerceivedRestoration

Level of spaciousness	Type of nature	Mean	Std. Deviation	N
high spacious	wild nature	64,8000	12,61828	20
	tended nature	69,5500	14,06928	20
	Total	67,1750	13,40855	40
low spacious	wild nature	61,4000	8,64139	20
	tended nature	66,5500	14,50399	20
	Total	63,9750	12,06922	40
Total	wild nature	63,1000	10,81262	40
	tended nature	68,0500	14,18549	40
	Total	65,5750	12,77733	80

RESULTS PERCEIVED BODY BOUNDARIES

Tests of Between-Subjects Effects

Dependent Variable: Current state of body boundaries

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	48,950[a]	3	16,317	8,576	,000	,253
Intercept	1496,450	1	1496,450	786,516	,000	,912
Idv1TypeOfNature	4,050	1	4,050	2,129	,149	,027
Idv2LevelOfSpaciousness	36,450	1	36,450	19,158	,000	,201
Idv1TypeOfNature * Idv2LevelOfSpaciousness	8,450	1	8,450	4,441	,038	,055
Error	144,600	76	1,903			
Total	1690,000	80				
Corrected Total	193,550	79				

a. R Squared = ,253 (Adjusted R Squared = ,223)

Descriptive Statistics

Dependent Variable: Current state of body boundaries

Type of nature	Level of spaciousness	Mean	Std. Deviation	N
wild nature	high spacious	4,20	1,542	20
	low spacious	4,90	1,071	20
	Total	4,55	1,358	40
tended nature	high spacious	3,10	1,334	20
	low spacious	5,10	1,518	20
	Total	4,10	1,736	40
Total	high spacious	3,65	1,528	40
	low spacious	5,00	1,301	40
	Total	4,33	1,565	80

RESULTS NATURE RELATEDNESS SKILL

Tests of Between-Subjects Effects

Dependent Variable: COMPUTE NatureRelatednessSkill=NatureRelatednessIdealVacationWilderness + NatureRelatednessActionsAffectEnvironment + NatureRelatednessPartOfSpirituality + NatureRelatednessTakingNoticeOfWildlife + NatureRelatednessRelationshipNatureImportant + NatureRelat

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	181,200[a]	3	60,400	1,697	,175	,063
Intercept	69620,000	1	69620,000	1956,196	,000	,963
Idv1TypeOfNature	156,800	1	156,800	4,406	,039	,055
Idv2LevelOfSpaciousness	,200	1	,200	,006	,940	,000
Idv1TypeOfNature * Idv2LevelOfSpaciousness	24,200	1	24,200	,680	,412	,009
Error	2704,800	76	35,589			
Total	72506,000	80				
Corrected Total	2886,000	79				

a. R Squared = ,063 (Adjusted R Squared = ,026)

Descriptive Statistics

Dependent Variable: COMPUTE NatureRelatednessSkill=NatureRelatednessIdealVacationWilderness + NatureRelatednessActionsAffectEnvironment + NatureRelatednessPartOfSpirituality + NatureRelatednessTakingNoticeOfWildlife + NatureRelatednessRelationshipNatureImportant + NatureRelat

Type of nature	Level of spaciousness	Mean	Std. Deviation	N
wild nature	high spacious	27,5000	5,93385	20
	low spacious	28,7000	5,99210	20
	Total	28,1000	5,91738	40
tended nature	high spacious	31,4000	6,27778	20
	low spacious	30,4000	5,64195	20
	Total	30,9000	5,91305	40
Total	high spacious	29,4500	6,34459	40
	low spacious	29,5500	5,80870	40
	Total	29,5000	6,04414	80

Appendix 3 Questionnaire main experiment

Dear participant, Thank you for participating in this survey. This survey is part of my thesis for my master Communication Science at the University of Twente. The experiment deals with the relationship between virtual reality environments and wellbeing. To this end, you will be asked to wear VR glasses and fill out a questionnaire in which you indicate your first impressions of this environment.

The research has been approved by the BMS Ethics Committee. Doing the experiment and filling in the questionnaire will take about 12 minutes of your time. All your data, including basic demographics, will be kept strictly confidential and anonymous. In case you do not want to start or finish this questionnaire, you can always close this survey without any negative repercussions.

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions or withdraw my participation at any time without providing a reason:

○ Yes, I consent.

→

PART 1:

First, we would like to know how you feel **at this very moment**. Please indicate to what extend you agree with the following statements.

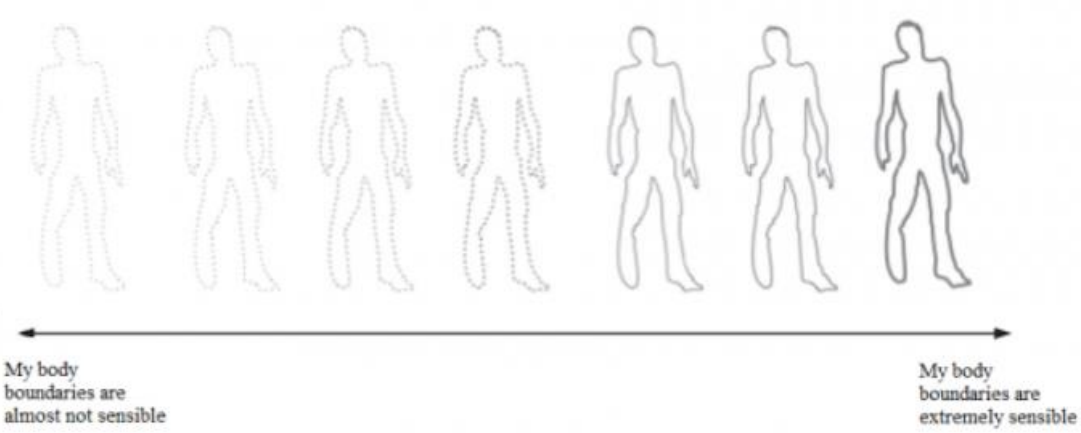
	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
I feel under pressure from deadlines	○	○	○	○	○	○	○
I feel tense	○	○	○	○	○	○	○
I feel like I have many worries	○	○	○	○	○	○	○
I feel like I am frustrated	○	○	○	○	○	○	○

UNIVERSITY OF TWENTE.

You will now watch the video with the VR glasses on your head. You may stand behind the chair next to you. Put on the VR glasses and adjust the size according to your head. Help and instructions will be given. When the video is finished, you can take off the glasses and take a seat behind the desk where the laptop is located. Here you may fill in the questionnaire.

→

The next question is about how the video influenced your bodily sensations. Below you see a scale that depicts seven human bodies with body boundaries which vary from almost not sensible (left pole) to extremely sensible (right pole). Please indicate which of the bodies presented below best represents the way you experience your body at this moment.



- ○ 1 (far left)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7 (far right)

The following statements are about the Virtual Environment you have just experienced. To what extend do you agree with the following statements?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
It is an escape experience	○	○	○	○	○	○	○
Spending time here gives me a good break from my day to day routine	○	○	○	○	○	○	○
The setting has fascinating qualities	○	○	○	○	○	○	○
My attention is drawn to many interesting things	○	○	○	○	○	○	○
I would like to get to know this place better	○	○	○	○	○	○	○

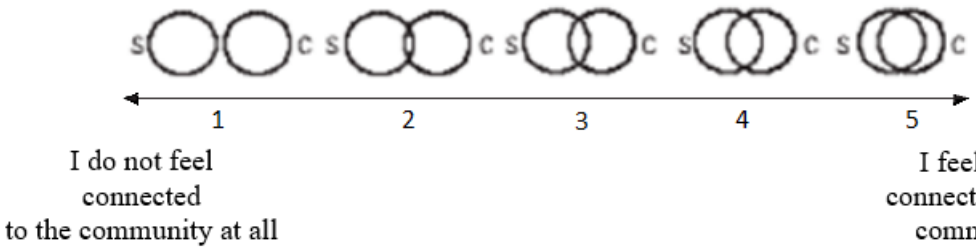
There is much to explore and to discover here	○	○	○	○	○	○	○
I would like to spend more time looking at the surroundings	○	○	○	○	○	○	○
There is too much going on	○	○	○	○	○	○	○
It is a confusing place	○	○	○	○	○	○	○
There is a great deal of distraction	○	○	○	○	○	○	○
It is chaotic here	○	○	○	○	○	○	○
I can do things I like here	○	○	○	○	○	○	○
I have a sense that I belong here	○	○	○	○	○	○	○
I have a sense of oneness with this setting	○	○	○	○	○	○	○
Being here suits my personality	○	○	○	○	○	○	○
I could find ways to enjoy myself in a place like this	○	○	○	○	○	○	○

The following questions are about the extend to which the video made you feel connected to other people and the world. Please indicate to what extend you agree with the following statements.
After watching the video;

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
I sensed things momentarily slowed down	○	○	○	○	○	○	○
I noticed time slowing	○	○	○	○	○	○	○
I felt my sense of time change	○	○	○	○	○	○	○
I experienced the passage of time differently	○	○	○	○	○	○	○
I had the sense that a moment lasted longer than usual	○	○	○	○	○	○	○
I felt that my sense of self was diminished.	○	○	○	○	○	○	○
I felt my sense of self shrink	○	○	○	○	○	○	○

I experienced a reduced sense of self	○	○	○	○	○	○	○
I felt my sense of self become somehow smaller	○	○	○	○	○	○	○
I felt small compared to everything else	○	○	○	○	○	○	○
I had the sense of being connected to everything	○	○	○	○	○	○	○
I felt a sense of communion with all living things	○	○	○	○	○	○	○
I experienced a sense of oneness with all things	○	○	○	○	○	○	○
I felt a sense of communion with all living things	○	○	○	○	○	○	○
I felt closely connected to humanity	○	○	○	○	○	○	○
I had a sense of complete connectedness	○	○	○	○	○	○	○

Nearly there! The next question is about your relationship between you and the community. If one of these circles shows yourself (S) and the other is the community (C) at large, which of the following combination of circles would best describe the relationship between you and the community **at this moment?**



- ○ 1 (far left)
- ○ 2
- ○ 3
- ○ 4
- ○ 5 (far right)

This next part is about feelings of stress and related emotions you have right **at this moment.** Do not take too long to think about your answers here, just take the first thing that pops in your mind. There are of course no right or wrong answers.

After watching the video, to what extend do you agree with the following statements? Right now:

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
I feel happy	○	○	○	○	○	○	○
I feel sad	○	○	○	○	○	○	○
I feel relaxed	○	○	○	○	○	○	○
I feel cheerful	○	○	○	○	○	○	○
I feel serene	○	○	○	○	○	○	○
I feel upset	○	○	○	○	○	○	○
I feel frightened	○	○	○	○	○	○	○
I feel nervous	○	○	○	○	○	○	○
I feel jumpy	○	○	○	○	○	○	○

I feel frightened	○	○	○	○	○	○	○
I feel nervous	○	○	○	○	○	○	○
I feel jumpy	○	○	○	○	○	○	○
I feel confused	○	○	○	○	○	○	○
I feel under pressure from deadlines	○	○	○	○	○	○	○
I feel tense	○	○	○	○	○	○	○
I feel like I have many worries	○	○	○	○	○	○	○
I feel like I am frustrated	○	○	○	○	○	○	○

Please indicate if you agree with the following statements.

At this moment:

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
I feel like I have lots in time in which I can get things done	○	○	○	○	○	○	○
I feel time is plentiful	○	○	○	○	○	○	○
I feel like time is boundless/limitless	○	○	○	○	○	○	○

The video I just saw was:

- ○ A closed forest with a clear pathway

- ○ An open field with no clear pathway

- ○ A wild forest with no clear pathway

- ○ An open field with a clear pathway

You're basically done! Lastly, some standard demographic questions to complete the questionnaire.

What is your age in years?

What is your gender?

- ○ Male
- ○ Female
- ○ Prefer not to say

What is your nationality?

What is the highest level of education you have completed (so far)?

- ○ High school or similar
- ○ MBO or similar
- ○ HBO/University of Applied Sciences bachelor or similar
- ○ WO/University bachelor or similar
- ○ HBO or WO master
- ○ PhD
- ○ Not applicable/Don't want to answer

Finally, these statements are about your connection to nature in general. To what extend do you agree with the following statements?

	Completely disagree	Moderately disagree	Slightly disagree	Neutral	Slightly agree	Moderately agree	Completely agree
My ideal vacation spot would be a remote, wilderness area	○	○	○	○	○	○	○
I always think about how my actions affect the environment	○	○	○	○	○	○	○
My connection to nature and the environment is a part of my spirituality	○	○	○	○	○	○	○
I take notice of wildlife wherever I am	○	○	○	○	○	○	○

My relationship to nature is an important part of who I am	○	○	○	○	○	○	○
I feel very connected to all living things and the earth	○	○	○	○	○	○	○

UNIVERSITY OF TWENTE.

We thank you for your time spent taking this survey.
Your response has been recorded.