UNIVERSITY OF TWENTE.

Faculty of Behavioural Management and Social Science

Master Communication Science

Master Thesis

Nature in the age of hectic life

How digital nature contact promotes restorative experiences

Researcher: Marie Willmann

Student number: s2419548

Supervisor: Dr. Thomas J.L. van Rompay

Second examiner: Kars Otten

Wordcount: 8387

November 27th, 2021

Abstract

Due to the COVID pandemic and lockdowns in 2020 and 2021, there have been fewer opportunities for nature interaction and at times social contact has only been possible online. In developed regions of the world, the number of people living far from nature is increasing and thus many are suffering from stress caused by overstimulating urban environments. At the same time, the danger of becoming mentally ill is constantly increasing. This study undertakes basic research about the underlying principles of nature and restoration at a time when stress in everyday life increases and nature contact is lagging behind. In this context, digital nature is a means for making nature accessible. According to attention restoration theory and a large existing body of nature research, nature contact can help in recovering from mental strain. Research also suggests that multisensory exposure to nature is more effective than only triggering the visual sense. This study questions the extent to which restorative experiences can be promoted through digital nature. The focus is placed on how soft fascination and multisensory exposure affect restorative experiences and ascertaining the extent to which nature relatedness influences these dynamics. This study (N=120) used a 3x2 (levels of soft fascination: low, medium, high x presence sound, absence sound) experimental research design, finding that the higher the level of soft fascination, the more likely that restoration occurs. Sound fitting the digital nature scenes helps in reducing stress and is strongly linked to emotional affect. Nature relatedness is a determining factor for restoring through digital nature, while this study shows that a high degree of nature relatedness is positively related to restoration, emotions and connectedness.

Keywords: Attention restoration, soft fascination, stress reduction, multisensory, nature relatedness, digital nature, emotion, connectedness

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1. Introduction

In the wake of the COVID-19 pandemic spreading worldwide in 2020 and 2021, increasing attention has been paid to public health. Along with those who have experienced severe disease progression due to the coronavirus infection, many groups of people have suffered from the pandemic in a variety of ways, starting with the professional group of nurses who are currently celebrated as our "frontline heroes" or "soldiers of hope" (Dimino et al., 2020), while being at high risk of suffering from insomnia and burnout (Aydin Sayilan et al. 2020). In general, adults are at a higher risk of developing depression (Pietrabissa & Simpson, 2020) and some are struggling with the so-called COVID stress syndrome, an adjustment disorder (Taylor, 2021). Additionally, in developed regions of the world the number of people living in urbanised environments is increasing and thus many are facing stress caused by overstimulation connected to fewer opportunities for contact with nature (Baxter & Pelletier, 2019; Pelgrims et al., 2021). At the same time, the danger of becoming mentally ill constantly increases. All of these life circumstances indicate that mental and physical health demands new solutions in times of social isolation and hectic everyday life. It is therefore essential to pay closer attention to dealing with stress and searching for ways to restore, not only during a pandemic but also in the general context of our increasingly complex and urbanised world.

The notions that nature holds strong potential for well-being and helps to restore attention and that happiness correlates with nature connection are widely-mentioned observations in the research theory (Ulrich, 1981; Kaplan, 1995; Nisbet & Zelenski, 2013). A central theory of nature research is the attention restoration theory (ART), developed by Kaplan and Kaplan in the 1980s. Building on basic ideas of cognitive psychology, the ART proposes that attention fatigue results in decision-making difficulties and irritated feelings (Ohly et al., 2016). In turn, nature holds strong potential to restore attention. One of its key concepts is "soft fascination". Compared to fascination – which can be the general expression of emotional excitement – soft fascination describes a state that can only be evoked by nature and enables being the moment and experiencing a state of not demanding fascination (Kaplan S., 1995).

Since nature environments can enable individuals to hold attention effortlessly through being soft fascinated, these have much higher potential to contribute to restorative experiences than urban environments (Ulrich, 1981; Ulrich, 1984; Ulrich et al., 1991). Central to Ulrich's research that led to this realisation was his study in a hospital where he observed that windows facing nature promote the psychological well-being of both patients and employees (Ulrich, 1984). In the context of Ulrich's research in the health sector, a scientific field has emerged that deals with healing environments, showing that nature can be helpful to treat burnout (Putrino et al., 2020; Schweitzer et al., 2004) and reduce stress (Higuera-Trujillo et al., 2020) within healthcare facilities. For instance, Higuera-Trujillo et al. (2020) used videos of nature scenes, exposed them on monitors in paedeatric waiting rooms and finally

observed significant stress reduction. Putrino et al. (2020) designed a nature-inspired recharge room for healthcare workers and oberseved that a 15-minute stay already led to a significant decrease in stress. In both studies, the researchers used multisensory elements such as smell and sound in addtion to a visual features and explored it as a useful tool for creating artificial nature contact (Higuera-Trujillo, et al., 2020; Putrino, et al., 2020).

In different research contexts, it has already been discovered that the senses are the tools for human beings to perceive their surroundings, and they make a situation even more deeply experience-able if several are reached in a multisensory manner (Hedblom et al., 2019). In this respect, it has been observed that virtual environments addressing multiple senses at the same time can counteract stress more efficiently (Schebella et al., 2020). At the same time, experiencing digital nature can complement real nature regarding psychological and social well-being (van Houwelingen-Snippe et al., 2020a) and emotions can be generated almost equally strongly digitally as in a physical environment (Chirico & Gaggioli, 2019).

Research suggests that the appreciation and effects of nature varies with the degree to which individuals feel related to nature (Zelenski & Nisbet, 2014; Baxter & Pelletier, 2019). People with a high nature relatedness tend to report better subjective well-being, especially when the nature at which they are looking is perceived as beautiful (Zhang et al., 2014). Therefore, it is interesting to study whether this also applies to the use of digital nature.

This study is located between the fields of environmental design and nature research in the digital context, whereby a focus shall be placed on the effects of fascination, the use of multisensory elements and the foundation of nature relatedness. Restorative experiences containing restoration, emotions and connectedness are serving as the outcome measures. Therefore, the main research questions are:

How can digital nature promote restorative experiences? To what extent do effects of digital nature vary with soft fascination, multisensory exposure and nature relatedness?

2. Theoretical Framework

This section aims to take a closer look at the underlying principles of nature research to scientifically underpin the research construct and clarify the aims and added value of this study. A brief introduction to the scientific fields of environmental design and its connections to nature research will follow. Subsequently, the foundations of this research will be explained. First, the independent variables used in this study will be conceptualised, namely soft fascination, sound and nature relatedness. Finally, the links between the independent variables and the outcome measures dealing with the dimensions of restoration, emotions and connectedness will be explained.

In environmental design, there is increasing attention to so-called healing environments in which nature-based elements are widely adopted (Huisman et al., 2012; Schweitzer et al., 2004). Even

if nature is more often used, it is not clear what elements are important to promote recovery. Thus, it is becoming increasingly important to familiarise oneself with the principles of nature research and examine the entire dynamics of restoration and stress reduction.

2.1 Attention restoration theory and soft fascination

Attention restoration theory (ART; Kaplan & Kaplan, 1989) is central to the processes studied in this research. ART provides strong evidence that the experience of nature can help in restoring from mental tasks and counteracting the directed attention fatigue effecting a loss of concentration (Kaplan, 1995; Ohly et al., 2016). Kaplan (1995) claimed that fascination is a decisive factor for restoring attention but that there are different kinds of fascination with different effects. He describes 'hard fascination' as a state elicited during higher arousal like watching a car race and 'soft fascination' as a characteristic of nature that promotes restoration even more (Kaplan S., 1995, p. 172). As the term soft fascination was introduced by Kaplan in the 1980s, it was used to describe a nature scene that finds its pleasing potential in a state of moderate fascination (Hartig et al., 1997). Harting et al. (1997) suggested that even levels higher than moderate fascination may also benefit restoration, which in turn emphasises that nature can even be strongly fascinating yet still pleasant.

One widely-used measure of restoration is the perceived restorativeness scale (PRS; Appendix A). A large research body already exists evaluating PRS as a reliable and well-established measure for restoration in the context of nature (Hartig et al., 1997; Ratcliffe et al., 2016; Peschardt & Stigsdotter, 2013). Hartig and his colleagues initially developed the PRS in 1991 and validated it through four studies by using Kaplan and Kaplan's ART (1989) as a basis (Hartig et al., 1997).

Research suggests that the view of both water and – to a lesser extent – plants has the potential to effectively capture attention (Ulrich, 1981). It was also taken into account that forest scenes are particularly associated with relaxing the viewer (Tsunetsugu, et al., 2013) and that in a setting with wild nature, the presence of other people might help to feel safe und thus favours restoration (Staats & Hartig, 2004). Regarding evolutionary theory, the survival instinct contributes to feeling safe, especially in environments where water and shelter are available (Bratman et al., 2021). Additionally, highly salient scene content is associated with fascination in theory, which in turn contains stronger potential to relax the exposed individual (Jagt et al., 2017).

In the context of digital nature, Putrino et al. (2020) observed that a restorative effect can be reached by creating a gentle environment that is well balanced in the respect that a person feels fascinated but can still indulge in thought. Most likely the senses of hearing and sight are known to elicit this kind of nature experience through shifting tense attention into a more relaxed version of it (Putrino et al., 2020). In the context of the conceptual side of this study, restoration is meant as a concept containing the participants' perceived restorativeness and stress reduction after being exposed to digital nature.

Accordingly, hypothesis (H1) is:

H1: The higher the level of soft fascination present in the digital nature scene, the higher the participants' perceived restorativeness degree.

2.2 Stress reduction and sound

As investigated decades ago, people are less overwhelmed when they are in touch with nature than when facing urban environments, and the stress-reducing potential is higher when facing nature (Ulrich, 1981; Ulrich, 1984). In his early laboratory study, Ulrich (1981) investigated the notion that nature has stronger potential to attract the viewer's interest than urban settings. In a later field study, Ulrich (1984) observed that at hospitals, windows with nature views favour patients' healing and the well-being of employees. Alongside a lifted mood, both groups reported a reduced stress level while being exposed to windows facing nature rather than when exposed to windows facing a brick building wall (Ulrich, 1984). Ulrich et al. (1991) later followed up on the realisation that nature (versus urban) environments have stronger potential for restoration, which is decisively connected with attention and fascination. As already alluded to by Ulrich, it is an increasingly important finding today that indirect contact with nature can already effectively reduce stress (Wooller et. al., 2018). Like a window view of nature (Kaplan, 2001; Ulrich, 1984), using pictures of nature scenes (Ulrich, 1981), videos (Schebella et.al., 2020) or virtual reality (Annerstedt et al., 2013; Higuera-Trujillo et al., 2020) can prove effective in this respect.

In nature-based rehabilitation (NBR), soundscapes play an important role (Cerwén et al., 2016). While conducting a study comparing the effect of three different sound themes within a garden setting, Cerwén at al. (2016) investigated that sound can positively as well as negatively influence the overall rehabilitation process. They observed that technical sounds are perceived as highly disturbing, while the evaluation of human sounds is more likely bound to the several emotional circumstances of the exposed individual. There is strong scientific evidence that nature sounds favour stress reduction and perceived restoration (Alvarsson et al., 2010; Annerstedt et al., 2013; Medvedev et al., 2015). Annerstedt et al. (2013) recognised the sound of water and bird singing as stress-reducing and technological sounds as increasing unpleasant arousal. They also described that soundscapes in general are multi-layered while balancing through the dimensions of noise, music, and sound.

The multisensory concept appears in many areas of psychology and behavioural research, and it plays a major role in nature research. It essentially means that multiple senses are addressed at the same time. Since the senses enable individuals to interactively experience the world, it makes a scene more intense when stimulated in a multisensory manner (Krishna & Schwarz, 2014). As part of studies measuring multisensory expression by means of the psychological effect, it has been investigated that auditory stimulation contains stronger potential in reducing stress than visual features (Hedblom et al., 2019; Higuera-Trujillo et al., 2020), and it should therefore be considered when digital nature is

designed to promote restoration containing both, stress reduction and perceived restoration (Medvedev et al., 2015). In this context, a strong restoration is reached when the stress reduction and the perceived restorativeness are high.

Accordingly, hypothesis (H2) is:

H2: When sound is present in the digital nature scene, the participants report a stronger restoration after being exposed to it than after a scene with visual stimuli only.

2.3 Nature relatedness, emotions and connectedness

Nature relatedness is a construct that addresses the link between humans and nature. It is well known in the fields of psychological health and environmental behaviour that happiness and sustainable behaviour are associated with strong nature relatedness (Zelenski & Nisbet, 2014). Modern lifestyle – especially in developed regions – contributes to creating an ever-greater distance between man and nature, which can have negative consequences for both (Baxter & Pelletier, 2019; Zelenski & Nisbet, 2014).

Baxter and Pelletier (2019) defined nature relatedness as a "basic human psychological need to feel a secure and pleasant experiential connection to nature in a cognitive, emotional and physical sense" (p. 22). This means that in turn nature experiences which are balanced according to the principles of security and pleasantness may promote nature relatedness.

Already decades ago, it became a research interest to measure positive and negative emotional affect (Watson et al., 1988), and it remains a central factor in nature research (Chirico & Gaggioli, 2019). Additionally, in nature research awe is an emotion that is not yet deeply understood compared to others (Chirico et al. 2018). Awe is described as "a complex emotion composed of an appraisal of vastness and a need for accommodation" (Yaden et al., 2019, p. 1). Although awe is associated with pro-sociality (Guan et al., 2019), holding a viewer's attention, relaxing, and creating fascination, its restorative potential is far from conclusive (Collado & Manrique, 2020). Even if awe has negative as well as positive levels of perception (Yaden et al., 2019), it is rather associated with positive emotions under the condition of digital nature (Chirico et al., 2018). Chirico et al. (2018) designed four interactive virtual environments, while three of them – a forest scene, mountains and a perspective on the globe from space – were designed to evoke awe, and one – showing gras and flowers – was designed as neutral. The authors discovered the mountain view with snow and a wide view into the valley as well as the globe view from space as the most awe-inducing scenes, while joy, fear and the feeling of vastness were present (Chirico et al., 2018). The need for accommodation was equal in the mountain, globe view and the forest, while the mountain and forest were perceived as more engaging than the globe view and the neutral scene (Chirico et al., 2018).

Connectedness also plays an important role in nature research. In theory, it has been observed that according to the self-centredness/selflessness happiness model (SSHM), positive emotions are

associated with the perception of less salient body boundaries (Dambrun, 2016). The perception that one's own body boundaries are salient means that one feels like a foreclosed entity and imperceptible body boundaries mean that one feels more connected with the surrounding world (Dambrun, 2016). The perceived body boundaries as a concept describing subjective connection between the individuum and the surroundings shows that a decrease in perceived body boundaries can in turn increase well-being (Hanley et al., 2020). In this context, another relevant construct is the extent to which the participants feel connected to the community and world at large (Mashek et al., 2007). In theory, being exposed to nature can favour the connection to others (van Houwelingen-Snippe et al., 2020) and thus prosocial behaviour, which is especially true when the environment is beautiful and awe-evoking (Goldy & Piff, 2020).

In the context of this study, both the principles of emotion and connectedness are seen as parts of the restorative experience which make it richer by creating a positive and pleasant contact with nature. However, the question of what is perceived as pleasant is extremely complex. How much wildness in combination with human influences is understood as optimal can strongly vary between individuals (Davis & Gatersleben, 2013). In general, people who feel connected to nature have better subjective well-being, which is especially true when they perceive the nature offered as beautiful (Zhang et al., 2014). Nature relatedness is a fundamental criterion for how people experience the world and how receptive they are to restoring through nature contact (Baxter & Pelletier, 2019; Nisbet & Zelenski, 2013; Zelenski & Nisbet, 2014). In the context of this study, nature relatedness is considered as a variable moderating the effect of the independent variables.

Accordingly, hypothesis (H3) is:

H3: Restorative experiences of digital nature are more pronounced for people with high rather than low nature relatedness.

2.4 Interaction and restorative experiences

Addressing the senses in a multisensory manner, soft fascination paves the way to restoration, which in turn creates a positive impression for all actors who are exposed to a specific environment (Schebella et al., 2020). Restoration is often more efficient when the environment appeals to more than simply the visual sense, and especially sound has the property of reducing stress (Annerstedt et al., 2013; Alvarsson et al., 2010; Cerwén et al., 2016).

A study about the restoring potential of virtual reality nature showed that it can even create some degree of anxiety and discomfort when being exposed to a silent VR forest (Annerstedt et al., 2013). Additionally, it is expected that the degree of the participants' personal nature relatedness (low, high) moderates the overall perception of the nature scene.

As shown in the conceptual model (Figure 1), the effect of the independent variables of soft fascination (V1) and multisensory condition (V2) on the dependent variable of restorative experiences

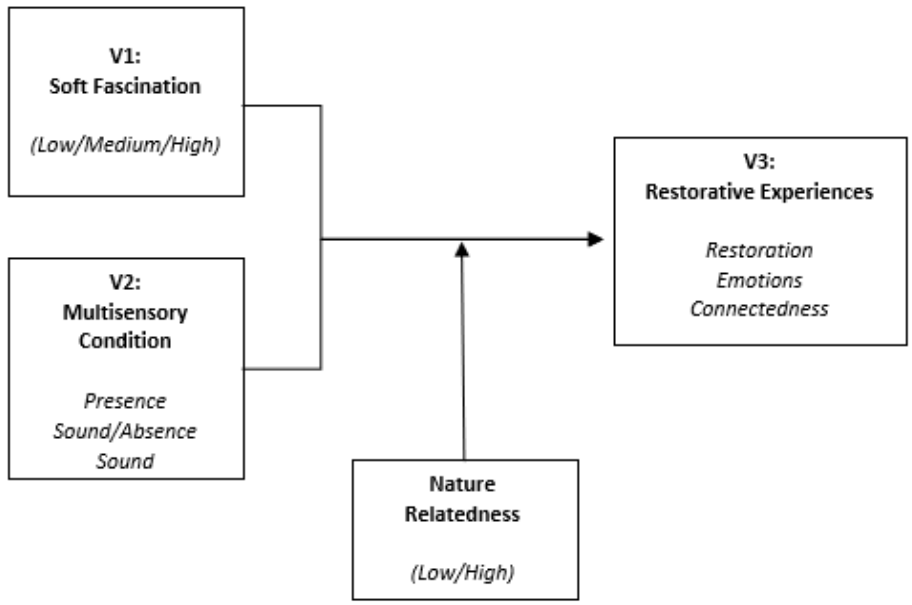
is moderated by nature relatedness. In the concept of this study, the restorative experiences are described as strong when the restoration is high in perceived restoration and stress reduction and the emotional measures as well as the connectedness are high (low body boundaries and high community connection).

Accordingly, hypothesis (H4) is:

H4: The higher the degree of soft fascination present in the digital nature scene and the degree of nature relatedness together with the presence of sound, the stronger the restorative experiences.

Figure 1

Conceptual model



3. Method

3.1 Research design

The research follows a 3x2 between-subject design and every participant was exposed to one of the six experimental conditions depending on the randomisation function of the survey tool Qualtrics. The six videos visually varied in three different levels of soft fascination (V1; low, medium, high) and the multisensory condition (V2; presence sound, absence sound). The scenes were designed according to the fascination concept of the PRS (Hartig et al., 1997) which contains elements of attention and interest. The variation in soft fascination was mainly guided by the finding that water and to lesser extent plants effectively capture attention (Ulrich, 1981). In this context a low level of soft fascination was elicited by creating a barren landscape with little variety, whereas a high level of soft fascination was created by using many elements such as water, trees and a hilly landscape. The pattern that highly salient scene contents can be particularly fascination generating (Jagt et al., 2017), was also relevant for this.

The initial situation was to increase the stress level of the participants with a stressor, for which a video was used that showed a visually and acoustically stimulating city scene. The conceptual model (Figure 1) considers nature relatedness as a moderating factor of the independent variables on the restoration process. The dependent variable of restorative experiences (V3) contains the concepts used for measuring the overall effects of the independent variables, namely restoration (stress and perceived restorativeness), emotions (awe experience and PANAS) and connectedness (perceived body boundaries and community connection). The fact that this study was affected by the conditions of the COVID-19 pandemic meant that it was suitable to conduct the study online. During the literature review, it emerged that researching the impact of digital nature actually opens up a promising and contemporary field of research. The concept of the study was reviewed and approved by the ethical committee of the University of Twente (Appendix B).

3.2 Pre-test

To design the stimulus material in such a way that sound and image fit together in the best possible way and achieve the desired effect, a two-part preliminary study was carried out. Qualtrics was used for this purpose and two consecutive questionnaires were created. The first part dealt with the visual design of the nature video and the second part with the sound selection.

3.2.1 Visual design

A total of nine videos – each approximately 20 seconds long – were designed (Figure 2), using a nature design program of the BMS lab of the University of Twente. With the aim of reaching different gradations of soft fascination (low, medium, high), the possibilities of the program were exploited as much as possible without using sound yet. Two types of landscapes (flat versus mountainous),

constellations of clouds and sun, grass, flowers, trees as well as the view of a lake and running people in the background were used.

Figure 2

Visual part of the nature scenes (first selection)

As for the fascination manipulation of the visual design, sixteen participants (6 male, 10 female; mean age 28.4 years) evaluated the nature scenes representing the three fascination levels using the five-item fascination construct from the perceived restorativeness scale (Appendix A; α= .966). Participants indicated (using five-point Likert scales ranging from "not at all" to "very much so") the extent to which they considered these items descriptive of the different nature scenes. The nine different scenes were presented in random order. To achieve a general fascination measure, the items were combined and the average was calculated. Comparing the means showed for low fascination that scenes b and c were least fascinating (low a: M=2.48, SD=.86; low b: M=2.35, SD=.68; low c: M=2.35, SD=.82), for medium fascination that scene a was most likely medium fascinating (medium a: M =2.85, SD=.89, medium b: M=3.09, SD=.99; medium c: M=3.39, SD=1.07) and for high fascination that scenes b and c were almost equally high fascinating (high a: M=3,38, SD=1.2; high b: M=3.48, SD=1.12; high c: M=3.45, SD=1.07).

In order to to capture the most extreme poles possible, a short follow-up questionnaire was used to select the least and most stimulating scene. The questions were formulated as follows: "If you compare the scenes just shown: Which one do you find more boring?" and "If you compare the scenes

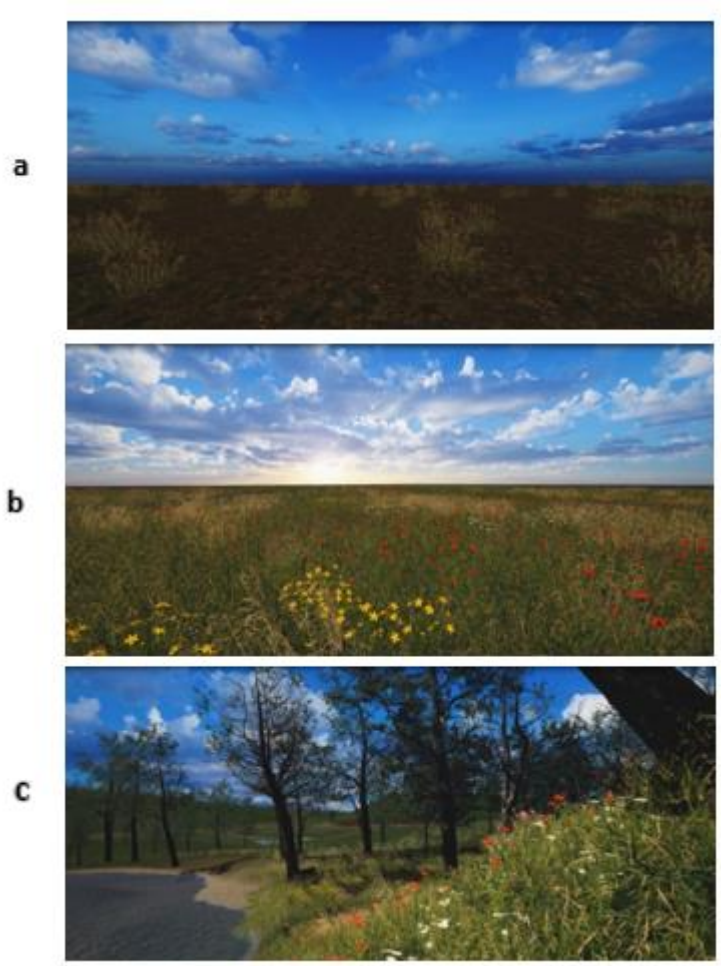
just shown: Which one do you find more fascinating?". For both questions, a multiple choice was used allowing one answer each.

First, six participants had to indicate which scene was the most boring by comparing scene Low b with scene Low c (Figure 2) and offering some ideas on how to design an even more boring scene. Second, they had to indicate which scene was the most fascinating by comparing scene High b and High c (Figure 2) and offering some ideas on how to design a scene that was even more fascinating. The result was that all participants perceived scene Low c as the most boring and most participants (four out of six) identified scene High c as the most fascinating. Due to these results and the given design ideas, the following three nature scenes were created (Figure 3).

The low fascinating scene (Figure 3a) showed a brown field with little grass and a slightly cloudy sky. The medium-fascinating scene (Figure 3b) – like the first – showed a flat landscape but many floral elements and a sky with many clouds illuminated by the centrally-placed sun. The high fascinating scene (Figure 3c) – in contrast to the previous ones – showed a mountainous landscape with many trees, floral elements, a lake, a bench and people walking around in the background. During the videos, there were moving elements like plants swaying in the wind, which differed in their intensity due to the richness of the environments.

Figure 3

Visual part of the nature scenes (final selection)



Note. Picture a corresponds to the classification as low fascinating, picture b as medium fascinating and picture c as high fascinating.

3.2.2 Sound selection

In the second pre-test, the three scenes (Figure 3) were merged with three different sounds each. Participants were exposed to visual scenes separately and after every scene they listened to three sounds. Twelve participants (five male, seven female; mean age 28.9) indicated for every sound (using five-point Likert scales ranging from "not at all matching" to "perfectly matching") the extent to which

they considered these sounds to fit the corresponding nature scene. The three blocks containing one nature scene and three sounds each were presented in random order.

Comparing the means showed for the sounds exposed after the low fascination scene that sound two – a simple wind noise – was the most fitting (sound 1: M=2.33, SD=1.07; sound 2: M=4, SD=1.04, sound 3: M=3, SD=.85).

For the sounds exposed after the medium fascination scene, sounds one – containing bird singing and sounds of a swarm of insects – and three – containing bird singing and the humming of a single bee that seems to fly from one flower to the next – were equally fitting (sound 1: M=3.25, SD=.97, sound 2: M=3.08, SD=1.17, sound 3: M=3.25, SD=1.36). Sound three was selected as the final sound due to the consideration that sound one might be slightly too exiting for a medium-fascinating scene.

For the sounds exposed after the high fascination scene, sound two – containing loud birds and water noise – was the most fitting (sound 1: M=3.92, SD=.79, sound 2: M=4, SD=.95, sound 3: M=3, SD=1.13).

3.3 Participants

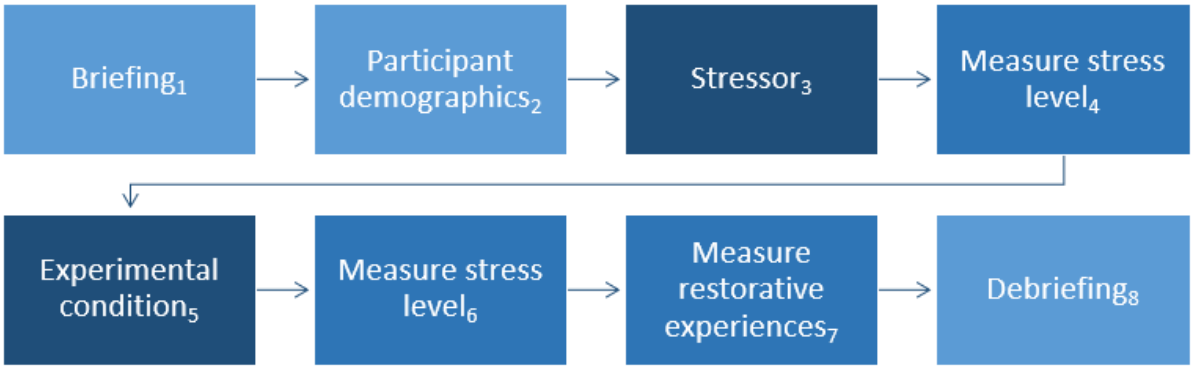
The final aim of the study was to discover the effect of digital nature experience on the perceived restoration of people. Therefore, the general population aged 18 and older from all social backgrounds and nationalities were targeted. The only restrictions were a sufficient knowledge of the English language and that the participants completed the questionnaire using a desktop PC or laptop. Anyone using another type of device was automatically excluded by the survey programme. The methods of convenience sampling and snowballing were combined to find participants. For further dissemination, social media and a university test subject pool were used.

In the results, the participants were not evenly distributed between the gender groups, with a tendency of more females (male: 35%; female: 62.5%; other: 2.5%). The most common nationality given was German (83.8%). More than half were students (55.8%), followed by full-time employees (28.3%). The mean age was 31 years. Most of the participants reported currently living in a rather urbanised area and 85% reported feeling highly related to nature. The experiment took place online and gathered 120 valid responses overall. The desired goal of gathering twenty participants per condition slightly varied (soft fascination low, no sound: 18; soft fascination low, sound: 21; soft fascination medium, no sound: 19; soft fascination medium, sound: 20; soft fascination high, no sound: 20; soft fascination high, sound: 22) since many incomplete responses had to be erased throughout the data collection.

3.4 Procedure

Figure 4

Experiment structure



Note. **1** Brief introduction to the research topic, information and contact details of the researcher, broad outline of the study, asking for consent, advice to use a desktop PC or laptop with the sound on.; **2** Gender, age, employment status, country of origin, daily environment (7-point bipolar scale ranging from "urbanised" to "rural"), nature relatedness; **3** City scene; **4+6** Single-item stress measurement; **5** Nature scene (one out of six conditions); **7** Through restoration (stress, perceived restorativeness), emotions (awe, positive and negative affect scales) and connectedness (body boundaries, community connection); **8** Disclosure of research interest and further encourage feedback.

The aim of this study is to clarify the extent to which soft fascination, sound and nature relatedness influence the experience of digital nature stimulation more closely, as well as the extent to which these can contribute to relaxation. The experiment was conducted online via the survey tool Qualtrics and followed the order displayed in Figure 5. To influence the participants' baseline condition in the online setting, an artificial stressor was included that aimed to increase the stress level in advance. In the past, other researchers already used to implement stressors prior to their studies since not all had the chance – like Putrino et al. (2000) or Higuera-Trujillo et al. (2020) – to conduct studies in the natural setting where a high stress potential was already present.

Since this study could not take place in a face-to-face laboratory setting, a digital tool for inducing stress had to be used. Cities have been widely studied as places with a high stress-inducing potential and noise pollution has been identified as a critical factor for causing stress and even being harmful to health (Radicchi, et al., 2021; Zipf, Primack, & Rothendler, 2020). Leaning towards these facts, this study implemented a new kind of stress inducer that more likely fit the whole experiment setup. Prior to exposure to the experimental condition, an existing and freely accessible video displaying a hectic city scene with intense visual and auditive stimuli was shown for one minute.

3.5 Measures

3.5.1 Manipulation checks

As mentioned in the pre-test section, the different nature scenes were designed according to the principle of fascination. This measurement was still included in the main study as a part of the perceived restorativeness scale (Appendix A, five-item fascination construct). The concept used scored very high for reliability with a $\alpha = .93$

3.5.2 Nature relatedness

To measure the participants' relationship with nature as a basic prerequisite for how nature is generally perceived, a short measure of nature relatedness – the NR-6 (Nisbet & Zelenski, 2013) – was used (Appendix A). While organising the final data set, a median split was used to create two equally-sized groups: one for participants reporting low nature relatedness and one for participants reporting high nature relatedness. In application in this study, the concept used scored very high for reliability with a $\alpha = .85$.

3.5.3 Dependent measures

The restoration process was measured through the variable restorative experiences (V3) consisting of the three concepts restoration, emotions and connectedness. Restoration was measured based on the participants' self-reported stress levels and perceived restorativeness. Emotions were measured based on the feelings of awe and the positive and negative affect scales. Connectedness was measured based on the perceived body boundaries and the community connection.

Stress.

Several studies did not have the opportunity to track stress via physiological measures like – for instance – the skin conductance levels (Hedblom et al., 2019; Alvarsson et al., 2010). Those often used self-reported single-item scales to measure stress (Putrino et al., 2020; Higuera-Trujillo et al., 2020). Putrino et al. (2020) used a stress inducer and measured stress twice with a single-item stress measurement. This study used the same approach, but the wording of the question was slightly changed to better fit the experimental setup: "How would you rate your current stress level?". This was asked once after the stressor and once after the stimuli exposure. By using a seven-point Likert scale ranging from "very calm" to "very stressed", the participants had to indicate their stress level at the respective time points.

Perceived restorativeness scale (PRS).

To further observe the restoration process that the participants would presumably experience, three of the four PRS concepts (Appendix A) were used: being away (two items), fascination (five items) and compatibility (five items). The concept of coherence was left out. The concepts used scored very high for reliability with a $\alpha = .95$.

Awe experience scale.

To measure the extent to which the created nature scenes elicited feelings of awe, parts of the awe experience scale (Yadene et al., 2019) were used. In application in this study, the concepts used of time, self-loss and psychological (Appendix A) scored very high for reliability with a α= .93.

Positive and negative affect scales (PANAS).

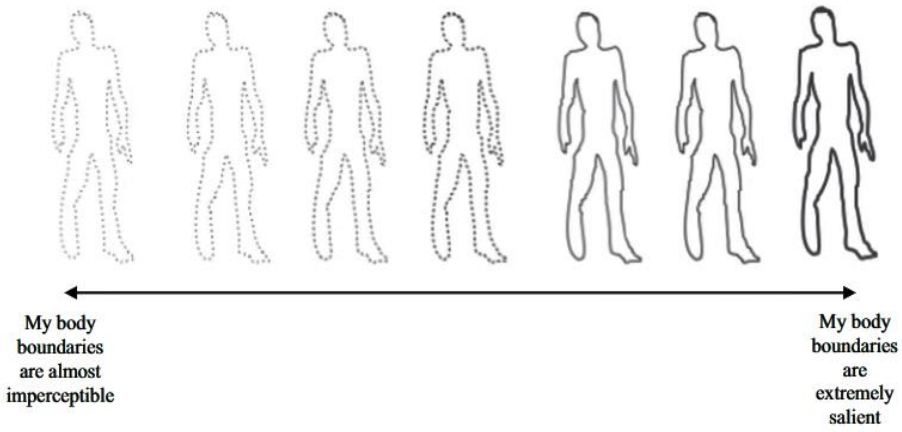
The PANAS scale developed by Watson et al. (1988) was used to measure emotional affect. By containing twenty items overall – ten each for negative and positive affect (Appendix A) – an early attempt was made to extract a brief measure of emotion out of the existing stock of scales. The concepts used scored very high for reliability with a α= .9

Body boundaries.

In the context of body scan mediation, Dambrun et al. (2016) used a pictorial scale (Figure 5) showing human silhouettes that are pale to strongly outlined. The labelling of the scale ranges between the poles "My body boundaries are almost imperceptible" and "My body boundaries are extremely salient".

Figure 5

Perceived Body Boundaries



Note. According to the number of shapes above the scale a 7-point Likert scale was used in this study corresponding to one of the shapes each. From "When the dissolution of perceived body boundaries elicits happiness: The effect of selflessness induced by a body scan meditation," by M. Dambrun, 2016, *Consciousness and Cognition,* 46, p. 89-98.

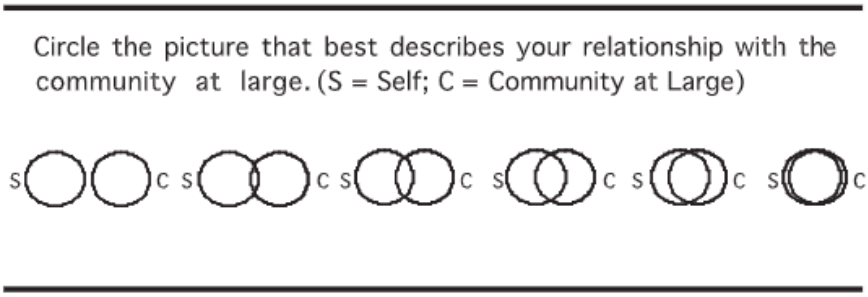
Community connection.

To measure the extent to which the participants feel connected to their surroundings, the community in the self scale (ICS; Mashek et al. 2007) – a single-item measure for community connectedness— was used. Drawing of the work of Aron et al. (1992) who developed the inclusion of others in self scale (IOS), Mashek et al. (2007) developed the inclusion of community in the self scale (ICS). As

shown in Figure 6, the scale comprises six circle pairs, one representing the self and the other representing the community at large. Overlapping circles correspond to a high degree of connectedness between oneself and others. Distant circles correspond to a low degree of connectedness between the self and the community at large. For this study, the wording of "community at large" was replaced with "others" for reasons of simplification.

Figure 6

Inclusion of community in self scale



Note. For the sake of clarity, this scale was embedded in the questionnaire as follows: According to the number of circle pairs, multiple choice was used in this study with each choice corresponding to one of the pairs and allowing one answer. From "Inclusion of community in self scale: A single-item pictorial measure of community connectedness," by D. Mashek, L. Cannaday and J. Tangney, 2007, *Journal of Community Psychology*, 35(2), p. 257–275.

4. Results

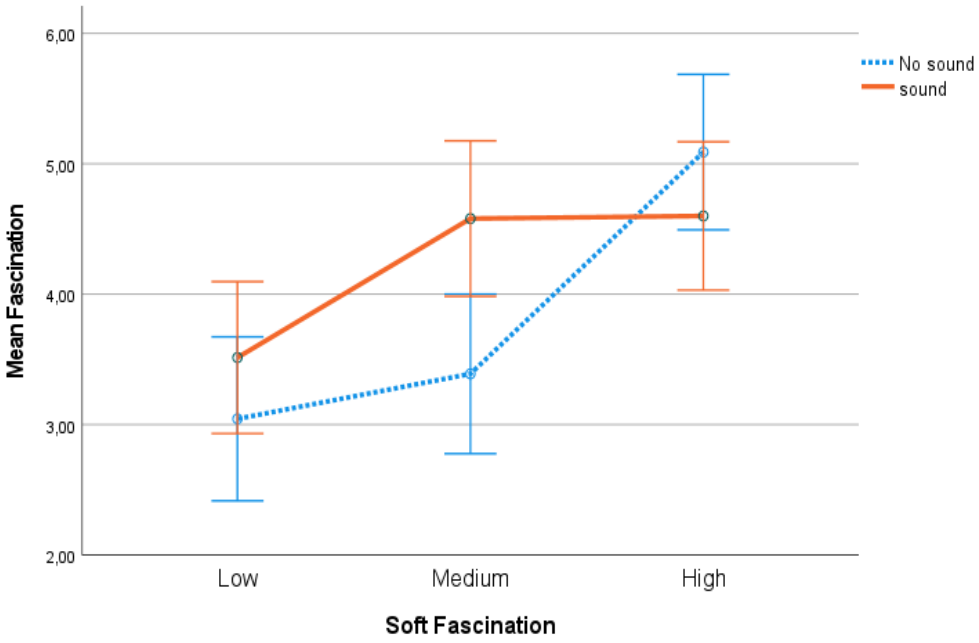
The data was analysed by using a 2 (Sound: Present versus Absent) x 3 (Soft Fascination: Low, Medium, High) between-subject design. Nature relatedness (Low, High) was considered as a moderator and therefore as a third independent variable. The statistical program SPSS was used for the data analysis.

4.1 Manipulation checks

To test whether soft fascination (low, medium, high), sound (presence, absence) and the environmental relatedness (low, high*)* had significant influence on the participants' restorative experiences, a univariate ANOVA was conducted. As already used in the pre-test for developing the visual stimulus materials, a new fascination variable was computed using the 'fascination' construct from the PRS scale (Appendix A). The fascination variable was used as the dependent variable. The independent variables soft fascination, sound, and nature relatedness were set as fixed factors.

Figure 7

Interaction effect sound and soft fascination on fascination



Significant results (Figure 10) were found in the main effect of soft fascination ($F(2, 108)= 14.654$, $p < .01$) and marginally significant results in the main effect of nature relatedness ($F(1, 108)= 3.16$, $p = .08$). No significant results were found for the main effect of sound on fascination ($F(1, 108)=1.821$, $p = .18$). For the interaction effects, only soft fascination x sound (Figure 7) had a significant effect on fascination ($F(2, 108)= 3.82$, $p < 0.05$). No significant interaction effects were found for soft fascination x nature relatedness, sound x nature relatedness and soft fascination x sound x nature relatedness (Figure 10). This implies that the manipulations worked as expected, but for sound only in interaction with soft fascination.

Comparing the means offered the insight that the higher the soft fascination level, the more fascination that the scene elicited (soft fascination low: M= 3.29, SD= 1.41; soft fascination medium: M= 4. SD= 1.46; soft fascination high: M= 4.83, SD= 1.29). Similarly, a high degree of nature relatedness

was associated with a higher fascination level than a low degree of nature relatedness (nature relatedness low: M= 3.81, SD= 1.45; nature relatedness high: M= 4.31, SD= 1.55). Under the interaction effect of soft fascination x sound, the fascination level increased with increasing soft fascination. It was higher for those scenes with sound, except in combination with high soft fascination (soft fascination low, absence sound: M= 3.04 , SD= 1.12 versus soft fascination, presence sound: M= 3.51, SD= 1.62; soft fascination medium, absence sound: M= 3.39, SD= 1.55 versus soft fascination medium, presence sound: M= 4.58, SD= 1.14; soft fascination high, absence sound: M= 5.09, SD= 1.11 versus soft fascination high, presence sound: M= 4.6, SD= 1.42).

4.2 Dependent Measures

Stress

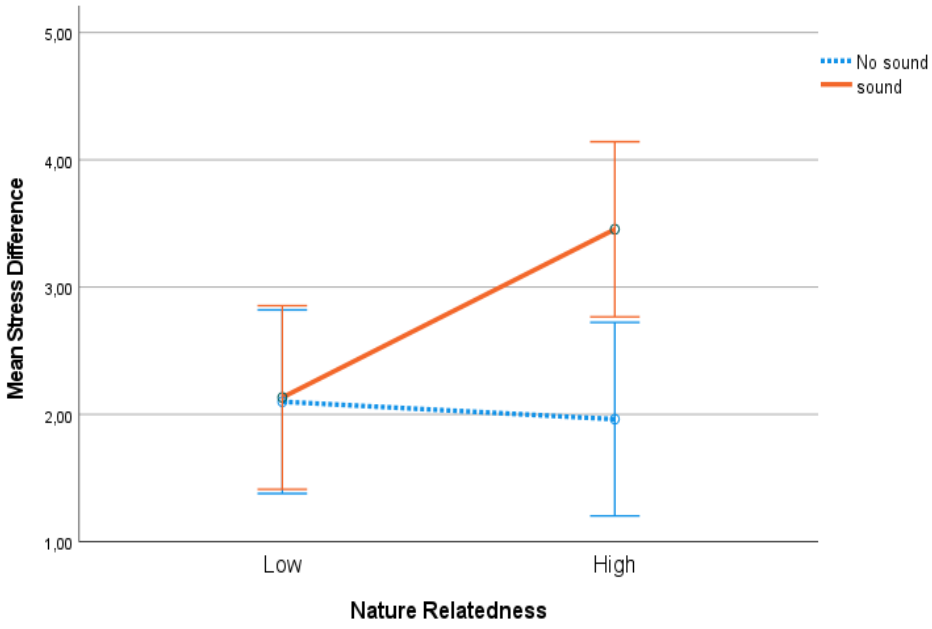
Comparing the means of the two stress levels (after the city scene versus after the nature scene) via a paired sample t-test showed a significant difference (t(119)=12.99, p<.001).

To analyse the effects of the independent variables on stress, a new variable displaying the difference of the stress levels was computed and further used.

Only the main effect of sound on the stress difference was significant (sound: F(1,108)=4.21, p<0.05; Figure 10). Additionally, the interaction effect of sound x nature relatedness on the stress difference was marginally significant (F(1,108)=3.59, p=.061, Figure 8) but no other significant results were found (Figure 10).

Figure 8

Interaction effect of sound and nature relatedness on the stress difference



Comparing the means showed that the stress difference was higher when sound was present than when it was absent (presence sound: M=2.83, SD=2.14; absence sound: M=2.04, SD=1.91). Under the interaction effect of sound and nature relatedness, the stress difference was highest when sound was present and the nature relatedness was high (absence sound, low nature relatedness: M=2.1, SD=2; absence sound, high nature relatedness: M=1.96, SD=1.83; presence sound, low nature relatedness: M=2.13, SD=2.13; presence sound, high nature relatedness: M=3.46, SD=1.99).

Perceived restorativeness (PRS)

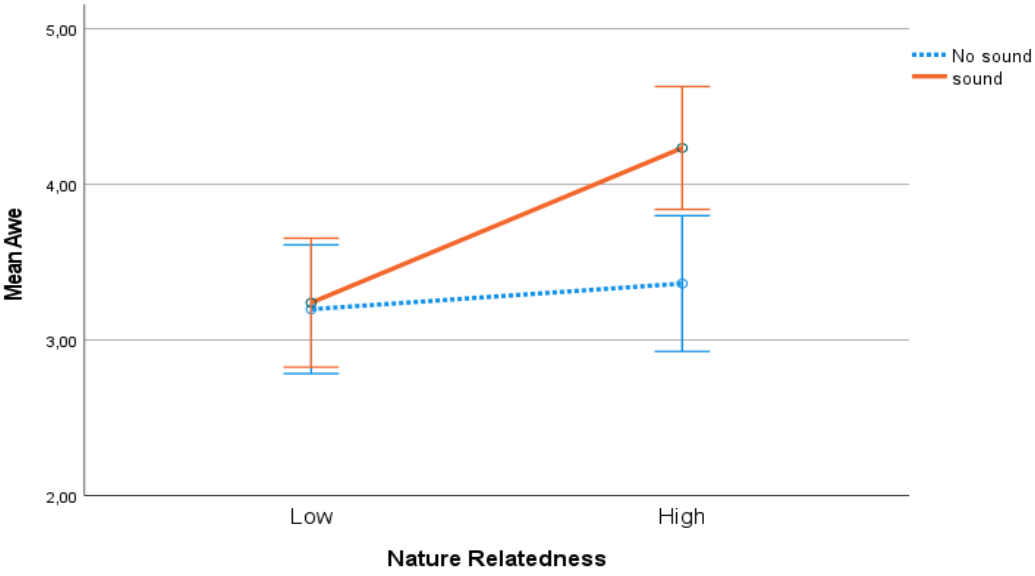
The ANOVA with the PRS as a dependent variable showed significant effects of soft fascination and nature relatedness (soft fascination: $F(2,108)=10.62$, $p<0.01$; nature relatedness: $F(1,108)=4.4$, $p<0.05$). Neither sound nor the interaction of the independent variables turned out to have significant effects on the perceived restorativeness (Figure 10). Comparing the means showed that the higher the soft fascination level, the higher the degree of perceived restoration (soft fascination low: M=3.61, SD=1.33; soft fascination medium: M=4.25, SD=1.45; soft fascination high: M=4.87, SD=1.16). Those participants who were high in nature relatedness reported a higher level of perceived restorativeness than those with a low nature relatedness (nature relatedness low: M=3.99, SD=1.29; nature relatedness high: M=4.53, SD=1.47).

Awe

The ANOVA with the awe scale as a dependent variable showed that sound as well as nature relatedness had significant direct effects on the perception of awe (sound: $F(1,108)=4.46$, $p<0.05$; nature relatedness: $F(1,108)=6.92$, $p<0.05$). Additionally, there was a marginally significant interaction effect of sound x nature relatedness on awe ($F(1,108)=3.7$, $p=.057$; Figure 9). No other significant effects of the independent variables on awe were found (Figure 10).

Figure 9

Interaction effect of sound and nature relatedness on awe



Comparing the means showed that the presence of sound was associated with a higher awe score than when sound was absent (presence sound: M=3.76, SD=1.27; absence around: M=3.28, SD=1.1). Those participants who were high in nature relatedness reported a higher awe score than those with a low nature relatedness (nature relatedness low: M=3.22, SD=1.21; nature relatedness high: M=3.84, SD=1.14). Under the interaction effect of sound and nature relatedness, the awe score was highest when sound was present and the nature relatedness was high (absence sound, low nature relatedness:

M=3.2, SD=1.25; absence sound, high nature relatedness: M=3.36, SD=.92; presence sound, low nature relatedness: M=3.24, SD=1.18; presence sound, high nature relatedness: M=4.23, SD=1.17).

Positive and negative affect schedule (PANAS)

The ANOVA with the PANAS as a dependent variable showed that only nature relatedness had a significant direct effect on the PANAS score (nature relatedness: $F(1,108)=7.94$, $p<0.01$). No other significant direct or interaction effects of the independent variables on the PANAS score were found (Figure 10). Comparing the means showed that those participants who were high in nature relatedness reported a higher PANAS score than those with a low nature relatedness (nature relatedness low: M=2.52, SD=.83; nature relatedness high: M=2.98, SD=.88).

Body boundaries

The ANOVA with the perceived body boundaries as a dependent variable showed that only nature relatedness had a marginally significant effect on how salient participants perceived their body boundaries (nature relatedness: $F(1,108)=2.79$, $p=.098$; Figure 10). No significant interaction effects of the independent variables on the perceived body boundaries were found (Figure 10). Comparing the means showed that those participants who were high in nature relatedness perceived their body boundaries as less salient than those with a low nature relatedness (nature relatedness low: M=4.58, SD=1.32; nature relatedness high M=4.12, SD=1.61).

Community connection

The ANOVA with the community connection as a dependent variable showed that only nature relatedness had a significant effect on how connected to other people the participants felt (nature relatedness: $F(1,108)=5.82$, $p<0.05$; Figure 10). Comparing the means showed that those participants who were high in nature relatedness reported a higher degree of connectedness with others than those with a low nature relatedness (nature relatedness low: M=3.12, SD=1.14; nature relatedness high: M=3.67, SD=1.22).

Figure 10

Main and interaction effects of independent on dependent variables

	Main effects			*Interaction effects*			
	Soft Fascination (SF)	Sound (S)	Nature Relatedness (NR)				
				SF*S	SF*NR	S*NR	SF*S*NR
			F/ Sig.				
Fascination	14.654/ .000	1.821/ .180	3.16/ .08	3.82/ .025	.861/ .426	1.953/ .165	.663/ .518
Stress Difference	1.237/ .294	4.214/ .043	2.250/ .137	.960/ .386	1.183/ .310	3.587/ .061	.024/ .976
Perceived Restorativeness	10.621/ .000	2.056/ .155	4.403/ .038	2.287/ .106	1.359/ .261	1.74/ .19	.433/ .65
Awe	.723/ .488	4.462/ .037	6.922/ .01	.378/ .686	.084/ .92	3.7/ .057	.303/ .739
PANAS	.055/ .947	.243/ .623	7.942/ .006	2.24/ .111	1.253/ .29	.309/ .579	.495/ .611
Body Boundaries	.879/ .418	.870/ .353	2.794/ .098	.149/ .862	.933/ .396	2.556/ .113	.083/ .920
Community Connection	1.198/ .306	.132/ .717	5.817/ .018	.476/ .623	.005/ .995	.352/ .554	.734/ .482
df/ error	2/ 108	1/ 108	1/ 108	2/ 108	2/ 108	1/ 108	2/ 108

5. General Discussion

The results presented support the basic ideas of nature research that nature can promote restoration. When using digital nature, soft fascination was central to creating fascination and promoting perceived restoration. As expected, soft fascination and nature relatedness had significant effects on the perceived restoration. This confirms the conviction of ART that soft fascination as a nature-specific quality can restore attention (Kaplan S., 1995) and furthermore that digital nature has a similar effect (van Houwelingen-Snippe et al., 2020a; Chirico & Gaggioli, 2019). Moreover, nature relatedness as a moderator had a significant effect on all dependent measures except stress. In this context, sound is associated with stress reduction and influencing the feeling of awe. The fact that sound has no effect on perceived restoration is unexpected since sound stands out in research about stress reduction (Ulrich et al., 1991) as well as perceived restoration (Medvedev et al., 2015). Awe is in the context of digital nature associated with positive emotions (Chirico et al., 2018). The discovered stress reducing and awe-evoking effect of sound leads to the conclusion that in this study the stress-reducing potential of sound was stronger than its restorative potential and that sound is an important element for digital nature to promote positive emotions.

Leaning to those observations, Hypothesis H1 ("H1: The higher the level of soft fascination present in the digital nature scene, the higher the participants' perceived restorativeness degree.") and hypothesis H2 ("When sound is present in the digital nature scene, the participants report a stronger restoration after being exposed to it than after a scene with visual stimuli only.") are supported. Hypothesis H3 ("Restorative experiences of digital nature are more pronounced for people with high rather than low nature relatedness") is partially supported in so far as it emerged that nature relatedness had significant effects on all measures of restorative experience except for the stress difference. Hypothesis H4 ("The higher the degree of soft fascination present in the digital nature scene and the degree of nature relatedness together with the presence of sound, the stronger the restorative experiences.") seems to be in line with the findings of this study, but when looking at the interaction effects there is no significant support for this hypothesis.

Concerning the manipulation checks, both the main effect of soft fascination on fascination and in interaction with sound led to significant results. This suggests that soft fascination underlying the visual design had a more fundamental impact on eliciting fascination than sound alone. In addition, nature relatedness also influences the perceived fascination of the scene, albeit only marginally significantly. Apart from the fact that the participants were briefed, the only approach to influence their basic mood was the artificial stressor in the form of an overstimulating city scene. The results showed that there were significant differences between the first measurement of stress after the city scene and the second measurement after the nature scene. This may lead to the conclusion that the stressor helped to increase the stress level of the participants beforehand and that the nature scenes had a

stress-reducing effect. Both soft fascination and nature relatedness as well as the interaction of sound and soft fascination were relevant in stress reduction. It cannot be conclusively clarified in retrospect which elements in turn contributed to the increase in the stress level and whether the significant difference between the two measurements of the stress level is more due to the outstanding effect of the stressor or the nature scene.

Concerning the feeling of awe, sound and nature relatedness alone as well as – to a marginal extent – their interaction had significant effects. This leads to the assumption that sound strongly contributes to generating emotions and that nature relatedness also plays a major role in how the experience of nature is perceived. As entirely silent scenes can be less engaging (Chirico et al., 2018), the finding of this support that at least the use of sound promotes an emotional experience of a scene.

Nature relatedness proved to be a fundamental factor that should always be considered when designing digital nature since it can promote the experience and intensity of the qualities of nature. Surprisingly, neither soft fascination nor the use of sound had significant influence on the emotional affect (PANAS) and the connectedness measures. Nature relatedness in turn was the only variable showing at least a marginally significant effect on the PANAS, which can be explained as follows. In connection to the theory, a reduction in perceived body boundaries leads to favourable emotions (Dambrun, 2016). In this study, only the main effect of nature relatedness on the perceived body boundaries was marginally significant. This suggest that a strong affinity with nature can favour the human need for resolved body boundaries and in connection to research theory the ability to gather positive emotions through nature scenes (Hanley et al., 2020). This is further supported by the finding that nature relatedness is also the only independent variable that has a significant direct effect on the emotional affect, measured by the PANAS scale (Watson et al, 1988).

The same applied for the main effect of nature relatedness on the community connection scale. In theory it had been observed that digital nature significantly increases feelings of connectedness and thus favours social and mental well-being (van Houwelingen-Snippe et al., 2020b (Bratman et al., 2021). The fact that in this study no other measure influenced community connection significantly besides nature relatedness leads to the suggestion that still nature relatedness plays an important role for feeling connected through digital nature but the fascination as well as sound dimensions did not.

Since there is a large body of research on the notion that nature can have a positive effect on mental balance (Kaplan, 1995; Ulrich, 1981; Hartig et al., 1997) and that the type of stressor used in this study has only been used in a similar form before (Ulrich, 1981), it can be argued that the stress-reducing effect of the nature scene was the decisive factor. The state of research states that nature sounds particularly contribute to reducing stress (Alvarsson et al., 2010; Annerstedt et al., 2013;

Medvedev et al., 2015), which was also the case in this study. Furthermore, the interaction between sound and nature relatedness also led to a significant effect on stress reduction.

5.1 Limitation and future research

One limitation of this study was that the experiment took place online. This relates to a general shortcoming of research methodology that outside of face-to-face contact in a laboratory setting the conditions that affect the participant during the experiment are not controllable. According to the theory, the restoration and emotion-triggering effect of digital nature is not very different from that of direct contact with nature (van Houwelingen-Snippe et al., 2020a; Chirico & Gaggioli, 2019).

Nonetheless, digital nature should not be considered as a replacement for real nature interaction but rather it can be used as complementary since multisensory experience is still difficult to simulate online. In this context, another limitation is that the videos were created with a rather minimalistic program. The participants did not have the opportunity to directly interact with the scenes. The online setting and the technical boundaries made it impossible to implement more multisensory features. Nonetheless, it would be very interesting to include other sensory dimensions such as smell in future research. Smell is known as an instinctive sense, it can easily trigger emotions and has strong potential to increase a person's environmental relatedness (Truong et al., 2020). Natural smells can be effectively used to favour well-being and they are particularly connected to memory (Spence, 2020). The inclusion of the sense of smell in this study would certainly have given an even more complete picture of the possibilities of helping people to relax through generated nature contact. In terms of both bringing in other senses and encouraging interaction with digital nature, augmented reality could be a technical solution.

One investigation of this study is that nature relatedness is indeed a crucial factor restorative experiences induced by digital nature. Looking at the distribution of the participants, it is noticeable that most of them claimed to be high in nature relatedness. This suggests that the effect of the digital nature used here was fundamentally determined by this fact and casts doubt on whether its positive effect also applies to those who feel less nature related. A future study might use this consideration and investigate the possibilities of influencing people to feel high nature related to consequently increase their capability of restoring through digital nature by having positive emotions.

5.2 Conclusion

By referring back to the main research questions concerning how digital nature can promote restorative experiences and the extent to which effects of digital nature vary with soft fascination, multisensory exposure and nature relatedness, this study has once again shown that nature and particularly digital nature can be a useful tool for creating restorative experiences. For the mechanisms considered in this study – namely the use of soft fascination and nature sound – it was shown how essential these are when creating digital environments for restoration and stress reduction. Nature

relatedness is an important criterion for restorative experiences, especially for emotions and connectedness. It has been shown indeed that a high fascination level together with the use of sound on the foundation of high nature relatedness can promote restorative experiences in the digital setting. To conclude, this study is a further step towards understanding the dynamics of digital nature and restoration, which will certainly be followed by many more and will not least be fuelled by technological progress in the future.

References

Alvarsson, J., Wiens, S., & Nilsson, M. (2010). Stress recovery during exposure to nature sound and environmental noise. *International Journal of Environmental Research and Public Health, 7*(3), pp. 1036–1046. doi:10.3390/ijerph7031036

Annerstedt, M., Jönsson, P., Wallergård, M., Johansson, G., Karlson, B., Grahn, P., Hansen, Å., Währborg, P. (2013). Inducing physiological stress recovery with sounds of nature in a virtual reality forest. Results from a pilot study. *Physiology & Behavior, 118*, pp. 240–250. doi:10.1016/j.physbeh.2013.05.023

Aron, A., Aron, E., & Smollan, D. (1992). Inclusion of Other in the Self Scale and the Structure of Interpersonal Closeness. *Journal of Personality and Social Psychology, 63*(4), 596-612. doi:10.1037/0022-3514.63.4.596

Aydin Sayilan, A., Kulakaç, N., & Uzun, S. (2020, June). Burnout levels and sleep quality of COVID-19 heroes. *Perspectives in Psychiatric Care*, pp. 15-20. doi:10.1111/ppc.12678

Baxter, D., & Pelletier, L. (2019). Is nature relatedness a basic human psychological need? A critical examination of the extant literature. *Canadian Psychology, 60*(1), pp. 21-34. doi:10.1037/cap0000145

Cerwén, G., Pedersen, E., & Pálsdóttir, A. (2016). The role of soundscape in nature-based rehabilitation: A patient perspective. *International Journal of Environmental Research and Public Health, 13*(12). doi:10.3390/ijerph13121229

Chirico, A., & Gaggioli, A. (2019). When Virtual Feels Real: Comparing Emotional Responses and Presence in Virtual and Natural Environments. *Cyberpsychology, Behavior, and Social Networking, 22*(3), pp. 220-226. doi:10.1089/cyber.2018.0393

Chirico, A., Ferrise, F., Cordella, L., & Gaggioli, A. (2018). Designing awe in virtual reality: An experimental study. *Frontiers in Psychology, 8*, pp. 1-14. doi:10.3389/fpsyg.2017.02351

Collado, S., & Manrique, H. (2020). Exposure to Awe-Evoking Natural and Built Scenes Has Positive Effects on Cognitive Performance and Affect. *Environment and Behavior, 52*(10), pp. 1105-1132. doi:10.1177/0013916519868733

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*, pp. 89-98. doi:10.1016/j.concog.2016.09.013

Davis, N., & Gatersleben, B. (2013). Transcendent experiences in wild and manicured settings: The influence of the trait "connectedness to nature". *Ecopsychology, 5*(2), pp. 92-102. doi:10.1089/eco.2013.0016

Dimino, K., Horan, K., & Stephenson, C. (2020). Leading Our Frontline Heroes Through Times of Crisis With a Sense of Hope, Efficacy, Resilience, and Optimism. *Nurse Leader, 18*(6), pp. 592–596. doi:10.1016/j.mnl.2020.05.011

Goldy, S., & Piff, P. (2020). Toward a social ecology of prosociality: why, when, and where nature enhances social connection. *Current Opinion in Psychology, 32*, pp. 27-31. doi:10.1016/j.copsyc.2019.06.016

Graziosi, M., & Yaden, D. (2021). Interpersonal awe: Exploring the social domain of awe elicitors. *Journal of Positive Psychology, 16*(2), pp. 263-271. doi:10.1080/17439760.2019.1689422

Guan, F., Chen, J., Chen, O., Liu, L., & Zha, Y. (2019). Awe and prosocial tendency. *Current Psychology, 38*(4), pp. 1033-1041. doi:10.1007/s12144-019-00244-7

Hanley, A., Dambrun, M., & Garland, E. (2020). Effects of Mindfulness Meditation on Self-Transcendent States:Perceived Body Boundaries and Spatial Frames of Reference. *Mindfulness, 11*(5), pp. 1194-1203. doi:10.1007/s12671-020-01330-9

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

Hedblom, M., Gunnarsson, B., Iravani, B., Knez, I., Schaefer, M., Thorsson, P., & Lundström, J. (2019). Reduction of physiological stress by urban green space in a multisensory virtual experiment. *Scientific Reports, 9*(1), pp. 1-11. doi:10.1038/s41598-019-46099-7

Higuera-Trujillo, J. L., Llinares Millán, C., Montañana i Aviñó, A., & Rojas, J. C. (2020). Multisensory stress reduction: a neuro-architecture study of paediatric waiting rooms. *Building Research and Information, 48*(3), pp. 269–285. doi:10.1080/09613218.2019.1612228

Huisman, E. R., Morales, E., van Hoof, J., & Kort, H. S. (2012). Healing environment: A review of the impact of physical environmental factors on users. *Building and Environment, 58*, pp. 70-80. doi:10.1016/j.buildenv.2012.06.016

Jagt, A., van Der, C., Brewer, M., & Pearson, D. (2017). A view not to be missed : Salient scene content interferes with cognitive restoration. *PLoS ONE, 12*(7), pp. 1-18. doi:10.1371/journal.pone.0169997

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

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

Kaplan, R. (2001). The nature of the view from home psychological benefits. *Environment and behavior, 33*(4), pp. 507-542. doi:10.1177/00139160121973115

Krishna, A. (2012). An integrative review of sensory marketing: Engaging the senses to affect perception, judgment and behavior. *Journal of Consumer Psychology, vol. 22(3)*, pp. 332–351.

Krishna, A., & Schwarz, N. (2014). Sensory marketing, embodiment, and grounded cognition: A review and introduction. *Journal of Consumer Psychology, 24*(2), pp. 159–168. doi:10.1016/J.JCPS.2013.12.006

Mashek, D., Cannaday, L., & Tangney, J. (2007). Inclusion of community in self scale: A single-item pictorial measure of community connectedness. *Journal of Community Psychology, 35*(2), pp. 257–275. doi:10.1002/jcop.20146

Medvedev, O., Shepherd, D., & Hautus, M. (2015). The restorative potential of soundscapes: A physiological investigation. *Applied Acoustics, 96*, pp. 20-26. doi:10.1016/j.apacoust.2015.03.004

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

Ohly, H., White, M., Wheeler, B., Bethel, A., Ukoumunne, O., Nikolaou, V., & Garside, R. (2016). Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, 19*(7), pp. 305–343. doi:10.1080/10937404.2016.1196155

Pelgrims , I., Devleesschauwer, B., Guyot , M., Keune , H., Nawrot , T., Remmen, R., Saenen, N., Trabelsi, S., Thomas, I., Aerts, R., De Clercq, E. (2021). Association between urban environment and mental health in Brussels, Belgium. *BMC Public Health, 21*(1). doi:10.1186/s12889-021-10557-7

Peschardt, K., & Stigsdotter, U. (2013). Associations between park characteristics and perceived restorativeness of small public urban green spaces. *Landscape and Urban Planning, 112*(1), pp. 29-39. doi:10.1016/j.landurbplan.2012.12.013

Pietrabissa, G., & Simpson, S. (2020). Psychological Consequences of Social Isolation During COVID-19 Outbreak. *Frontiers in Psychology, 11*. doi:10.3389/fpsyg.2020.02201

Putrino, D., Ripp, J., Herrera, J., Cortes, M., Kellner, C., Rizk, D., & Dams-O'Connor, K. (2020). Multisensory, Nature-Inspired Recharge Rooms Yield Short-Term Reductions in Perceived Stress Among Frontline Healthcare Workers. *Frontiers in Psychology, 11*, 1-6. doi:10.3389/fpsyg.2020.560833

Radicchi, A., Cevikayak Yelmi, P., Chung, A., Jordan, P., Stewart, S., Tsaligopoulos, A., McCunn, L., Grant, M. (2021). Sound and the healthy city. *Cities & Health, 5*(1-2), pp. 1-13. doi:10.1080/23748834.2020.1821980

Ratcliffe, E., Gatersleben, B., & Sowden, P. (2016). Associations with bird sounds: How do they relate to perceived restorative potential? *Journal of Environmental Psychology, 47*, pp. 136-144. doi:10.1016/j.jenvp.2016.05.009

Schebella, M., Weber, D., Schultz, L., & Weinstein, P. (2020). The nature of reality: Human stress recovery during exposure to biodiverse, multisensory virtual environments. *International Journal of Environmental Research and Public Health, 17*(1), pp. 1-24. doi:10.3390/ijerph17010056

Schweitzer, M., Gilpin, L., & Frampton, S. (2004). Healing spaces: Elements of environmental design that make an impact on health. *Journal of Alternative and Complementary Medicine, 10(1)*. doi:10.1089/acm.2004.10.s-71

Spence, C. (2020). Using Ambient Scent to Enhance Well-Being in the Multisensory Built Environment. *Frontiers in Psychology, 11*, 1–19. doi:10.3389/fpsyg.2020.598859

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. doi:10.1016/j.jenvp.2003.12.005

Taylor, S. (2021). COVID Stress Syndrome: Clinical and Nosological Considerations. *Current Psychiatry Reports, 23(19)*. doi:10.1007/s11920-021-01226-y/Published

Truong, M., Bonnefoy, B., & Prévot, A. (2020). About smells and nature: an exploratory study on the links between environmental identity, smell sensitivity, and sensory uses of natural spaces. *Psyecology, 11(1)*, 7-20. doi:10.1080/21711976.2019.1643987

Tsunetsugu, Y., Lee, J., Park, B., Tyrväinen, L., Kagawa, T., & Miyazaki, Y. (2013). Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements. *Landscape and Urban Planning, 113*, 90-93. doi:10.1016/j.landurbplan.2013.01.014

Ulrich, R. (1981). Natural versus urban scenes: Some psychophysiological effects. *Environment and Behavior, 13*, pp. 523-556. doi:10.1177/0013916581135001

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

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

van Houwelingen-Snippe, J., van Rompay, T., & Allouch, S. (2020a). Feeling connected after experiencing digital nature: A survey study. *International Journal of Environmental Research and Public Health, 17(18)*, 1-16. doi:10.3390/ijerph17186879

van Houwelingen-Snippe, J., van Rompay, T., de Jong, M., & Allouch, S. (2020b). Does digital nature enhance social aspirations? An experimental study. *International Journal of Environmental Research and Public Health, 17(4)*. doi:10.3390/ijerph17041454

Watson, D., Clark, L., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. Journal of personality and social psychology. *Journal of personality and social psychology, 54(6)*, 1063-1070. doi:10.1037/0022-3514.54.6.1063

Wooller, J., Rogerson, M., Barton, J., Micklewright, D., & Gladwell, V. (2018). Can simulated green exercise improve recovery from acute mental stress? *Frontiers in Psychology, 9*. doi:10.3389/fpsyg.2018.02167

Yaden, D., Kaufman, S., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J., & Keltner, D. (2019). The development of the Awe Experience Scale (AWE-S): A multifactorial measure for a complex emotion. *Journal of Positive Psychology, 14(4)*, 474-488. doi:10.1080/17439760.2018.1484940

Zelenski, J., & Nisbet, E. (2014). Happiness and Feeling Connected: The Distinct Role of Nature Relatedness. *Environment and Behavior, 46(1)*, 3-23. doi:10.1177/0013916512451901

Zhang, E. (2010). Multisensory Design: Reaching Out to Touch the Consumer. *Psychology & Marketing, vol, 30(6)*, 461–469. doi:10.1002/mar

Zhang, J., Howell, R., & Iyer, R. (2014). Engagement with natural beauty moderates the positive relation between connectedness with nature and psychological well-being. *Journal of Environmental Psychology, 38*, 55-63. doi:10.1016/j.jenvp.2013.12.013

Zipf, L., Primack, R., & Rothendler, M. (2020). Citizen scientists and university students monitor noise pollution in cities and protected areas with smartphones. *PloS ONE, 15*. doi:10.1371/journal.pone.0236785

Appendix A: Measurements

Scale	Constructs	Items	
Perceived Restorativeness Scale (PRS)	Being Away	(1)	It is an escape experience
		(2)	Spending time here gives me a good break from my day-to-day routine
	Fascination	(1)	The setting has fascinating qualities
		(2)	My attention is drawn to many interesting things
		(3)	I would like to get to know this place better
		(4)	There is much to explore and discover here
		(5)	I would like to spend more time looking at the surroundings
	Compatibility	(1)	I can do things I like here
		(2)	I have a sense that I belong here
		(3)	I have a sense of oneness with this setting
		(4)	Being here suits my personality
		(5)	I could find ways to enjoy myself in a place like this
Awe Experience Scale	Time	(1)	I sensed things momentarily slowdown
		(2)	I noticed time slowing
		(3)	I felt my sense of time change
		(4)	I experienced the passage of time differently
		(5)	I had the sense that a moment lasted longer than usual
	Self-loss	(1)	I felt that my sense of self was diminished
		(2)	I felt my sense of self shrink
		(3)	I experienced a reduced sense of self
		(4)	I felt my sense of self become somehow smaller
		(5)	I felt small compared to everything else
	Physiological	(1)	I felt my jaw drop
		(2)	I had goosebumps
		(3)	I gasped
		(4)	I had chills
		(5)	I felt my eyes widen
Nature Relatedness (NR-6)		(1)	My ideal vacation spot would be a remote, wilderness area
		(2)	I always think about how my actions affect the environment
		(3)	My connection to nature and the environment is a part of my spirituality
		(4)	I take notice of wildlife wherever I am
		(5)	My relationship to nature is an important part of who I am
		(6)	I feel very connected to all living things and the earth
Positive and Negative Affect Schedule (PANAS)	Positive Affect	(1)	Enthusiastic
		(2)	Interested
		(3)	Determined
		(4)	Excited
		(5)	Inspired
		(6)	Alert
		(7)	Active
		(8)	Strong
		(9)	Proud
		(10)	Attentive
	Negative Affect	(1)	Scared
		(2)	Afraid
		(3)	Upset
		(4)	Distressed
		(5)	Jittery
		(6)	Nervous
		(7)	Ashamed
		(8)	Guilty
		(9)	Irritable
		(10)	Hostile

Appendix B: Ethical Approval

UNIVERSITY OF TWENTE.
FACULTY BMS

210945 REQUEST FOR ETHICAL REVIEW

Request nr: 210945
Researcher: Willmann, M.
Supervisor: Rompay, T.J.L. van
Reviewer: Galetzka, M.
Status: Approved by commission
Version: 2

1. START

A. TITLE AND CONTEXT OF THE RESEARCH PROJECT

1. What is the title of the research project? (max. 100 characters)

Restoring by nature: A multisensory design approach to digital nature stimulation

2. In which context will you conduct this research?

Master's Thesis

3. Date of the application

10-06-2021

5. Is this research project closely connected to a research project previously assessed by the BMS Ethics Committee?

No/Unknown

B. CONTACT INFORMATION

6. Contact information for the lead researcher

6a. Initials:

M.

6b. Surname:

Willmann

6c. Education/Department (if applicable):

M-COM

6d. Staff or Student number:

2419548

6e. Email address:

m.willmann@student.utwente.nl

6f. Telephone number (during the research project):

+4915170807727

6g. If additional researchers (students and/or staff) will be involved in carrying out this research, please name them:

6h. Have you completed a PhD degree?

No

7. Contact information for the BMS Supervisor

7a. Initials:

T.J.L.

7b. Surname:

van Rompay

7c. Department:

BMS-CS

7d. Email address:

t.j.l.vanrompay@utwente.nl

7e. Telephone number (during the research project):

+31534893607

8. Is one of the ethics committee reviewers involved in your research? Note: not everyone is a reviewer.

No

C. RESEARCH PROJECT DESCRIPTION

9a. Please provide a brief description (150 words max.) of the background and aim(s) of your research project in non-expert language.

The study is oriented in the domain of environmental design and focusses on the connection between the experience of nature and restoration. This will be connected with the role of multisensory expression, the concepts of soft fascination and nature connectedness. Therefore, an online experiement via the survey tool Qualtrics will be conducted displaying nature scenes and using existing scales for fascination, stress and environmental connectedness. In times of busy daily life (private or job) nature may be a useful tool for relaxiation and mental health.

9b. Approximate starting date/end date of data collection:

Starting date: 2021-06-13
End date: 2021-06-27

9c. If applicable: indicate which external organization(s) has/have commissioned and/or provided funding for your research.

Commissioning organization(s):

Not applicable

Funding organization(s):

Not applicable

2. TYPE OF STUDY

Please select the type of study you plan to conduct:

I will be collecting new data from individuals acting as respondents, interviewees, participants or informants.

4. RESEARCH INVOLVING THE COLLECTION OF NEW DATA

A: RESEARCH POPULATION

20. Please provide a brief description of the intended research population(s):

The research will be conducted as an online experiment. Since the topic of restoring by nature is not expected to be a factors applicable for an exclusive group it is indended to include a large audience. Therefore, people in the ages of 18 and older of all demographical backgrounds are targeted. It can be suggested that the majority will nevertheless be formed by dutch and german citizens.

21. How many individuals will be involved in your research?

Since the experiment contains 6 setting (combinations of 3 visual scenes differentiated by fascination levels and the 2 conditions either including or excluding sound) at least 120 valid responses shall be collected.

22. Which characteristics must participants/sources possess in order to be included in your research?

Including: People form all demographical backgrounds who meet at least following requirements: 1. Internet access (via desktop computer or laptop; because a design experiment needs warranty of clear presentation) 2. Understanding the English language 3. Average to good hearing and vision as well as comprehension skills

23. Does this research specifically target minors (<16 years), people with cognitive impairments, people under institutional care (e.g. hospitals, nursing homes, prisons), specific ethnic groups, people in another country or any other special group that may be more vulnerable than the general population?

No

24. Are you planning to recruit participants for your research through the BMS test subject pool, SONA

Yes

B. METHODS OF DATA COLLECTION

25. What is the best description of your research?

- (Online) survey research
- Experimental/intervention research

26. Please prove a brief yet sufficiently detailed overview of activities, as you would in the Procedure section of your thesis or paper. Among other things, please provide information about the information given to your research population, the manipulations (if applicable), the measures you use (at construct level), etc. in a way that is understandable for a relative lay person.

After conducting 2 pre-tests (1. for designing the visual stimuli materials, 2. for choosing fitting sounds accordning to the scenes): The participant take part in an online survey and are ask to do this by using a desktop computer or Laptop (since it is a design project a clear presentation of the stimuli materials shall be assured). The structure is as follows: 1.Reading the introduction (including: Brief purpose of research, some information and contact details of the researcher, information about data protection) and give consent to participate in the study 2.Answering demographical questions (gender, age, profession, nationality) 3.Answering some personal questions (current home environment (urbanised/ rural), nature conectedness) 4. Stress inducer: Exposure towards a stressful scene (eg. video: walkthrough in busy city) 5. Reporting current stress level (self-reported stress scale, Putrino et al. 2020) 6. Exposure to one of the 6 nature scenes (they are randomized and exposed evenly throughout the data collection) 7. Answering questions according to Perceived Restorativeness Scale (Harting, 1997). Especially the concept of soft fascination 8. Again: Reporting current stress level (self-reported stress scale, Putrino et al. 2020)

How much time will each participant spend (mention the number of sessions/meetings in which they will participate and the time per session/meeting)?

1 session, approximately 10 minutes

C: BURDEN AND RISKS OF PARTICIPATION

27. Please provide a brief description of these burdens and/or risks and how you plan to minimize them:

To prevent confusing and pave a smooth start there shall be an introduction right at the beginning of the survey. This shall also include advice for using a desktop computer or laptop and the information that they will be exposed to videos which can include sound and therefore should be prepared for this. Indeed the stress inducer will cause some degree of stress since that's the purpose at this point. There shall be a brief warning before that the following scene can be loud and can be visually exhausting.

28. Can the participants benefit from the research and/or their participation in any way?

Yes

Please Explain:

The research will give a deeper insight in specific element within the dynamic of nature experience and restoration. For the benefit of the participants this will contribute to form guidlines to design the environment more appealing in terms of stress reduction and attention restoration.

29. Will the study expose the researcher to any risks (e.g. when collecting data in potentially dangerous environments or through dangerous activities, when dealing with sensitive or distressing topics, or when working in a setting that may pose 'lone worker' risks)?

No

D. INFORMED CONSENT

30. Will you inform potential research participants (and/or their legal repsentative(s), in case of non-competent participants) about the aims, activities, burdens and risks of the research before they decide whether to take part in the research?

Yes

Briefly clarify how:

Before giving consent to participate in the survey, an introduction is provided including the topic of the research (domain: environmental design; topic: Nature and restoration) and which tasks they will face. To prevent bias it is not mentioned in deepth that the stress inducer is there to induce stress or that the nature scenes are expected to calm down or recharge.

32. How will you obtain the voluntary, informed consent of the research participants (or their legal repsentatives in case of non-competent participants)?

Active online consent

33. Will you clearly inform research participants that they can withdraw from the research at any time without explanation/justification?

Yes

34. Are the research participants somehow dependent on or in a subordinate position to the researcher(s) (e.g. students or relatives)?

No

35. Will participants receive any rewards, incentives or payments for participating in the research?

- No

36. In the interest of transparency, it is a good practice to inform participants about what will happen after their participation is completed. How will you inform participants about what will happen after their participation is concluded?

- Participants will receive the researcher's contact details, so that they can contact the researcher if they have questions/would like to know more.

E. CONFIDENTIALITY AND ANONYMITY

37. Does the data collected contain personal identifiable information that can be traced back to specific individuals/organizations?

No

39. Will you make use of audio or video recording?

No

5. DATA MANAGEMENT

- I have read the UT Data policy.
- I am aware of my responsibilities for the proper handling of data, regarding working with personal data, storage of data, sharing and presentation/publication of data.

6. OTHER POTENTIAL ETHICAL ISSUES/CONFLICTS OF INTEREST

40. Do you anticipate any other ethical issues/conflicts of interest in your research project that have not been previously noted in this application? Please state any issues and explain how you propose to deal with them. Additionally, if known indicate the purpose your results have (i.e. the results are used for e.g. policy, management, strategic or societal purposes).

Since the visual stimuli material is designed with an computer program of the UT it has some boundaries in Graphical and professional ways. That means that the scenes itself are not an accurate representation of reality and lack behind high-tech possibilities. Therefore, it can be expected that the results may not be entirely on spot but still give a significant tendency.

7. ATTACHMENTS

intro&consent.pdf

8. COMMENTS

Galetzka, M. (11-06-2021 11:26):

NB: The approval given for your research project is conditional. Your study intends to make use of methods requiring social and physical interaction. This poses risks for both participants and researchers, which have to be taken into account. You have to comply with the current restrictions on social and physical interaction regarding the COVID19 outbreak. This may imply that you have to find alternative ways to collect data or to delay the start of your study until the restrictions have been adjusted or lifted. If adjustments lead to substantive changes in the design of your study (excluded: digital/online means to get in contact with your participants), send your changes to ethicscommittee-bms@utwente.nl stating your request number. Please consult the standing guidelines of the UT and national authorities on research and educational activities www.utwente.nl/corona

9. CONCLUSION

Status: Approved by commission

The BMS ethical committee / Domain Humanities & Social Sciences has assessed the ethical aspects of your research project. On the basis of the information you provided, the committee does not have any ethical concerns regarding this research project. It is your responsibility to ensure that the research is carried out in line with the information provided in the application you submitted for ethical review. If you make changes to the proposal that affect the approach to research on humans, you must resubmit the changed project or grant agreement to the ethical committee with these changes highlighted.

Moreover, novel ethical issues may emerge while carrying out your research. It is important that you re-

consider and discuss the ethical aspects and implications of your research regularly, and that you proceed as a responsible scientist.

Finally, your research is subject to regulations such as the EU General Data Protection Regulation (GDPR), the Code of Conduct for the use of personal data in Scientific Research by VSNU (the Association of Universities in the Netherlands), further codes of conduct that are applicable in your field, and the obligation to report a security incident (data breach or otherwise) at the UT.