

**The Effect of Spacious Virtual Nature and Personal Storytelling on Social Connectedness  
in Young Adults**

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## Abstract

Social connectedness decreases in young adults in modern society. This study was designed to explore how spacious virtual nature (VN) and personal storytelling can work together to promote social connectedness in young adults as spacious VN was found to stimulate social aspirations in individuals whereas personal storytelling was observed to be an essential component of personal meaning-making and feelings of belonging.

Hence, this study hypothesized that spacious VN will lead to a higher degree of social connectedness than non-spacious VN. Furthermore, it was hypothesized that personal storytelling will lead to a higher degree of social connectedness than a neutral writing task and both spacious VN and personal storytelling will lead to the greatest degree of social connectedness in comparison to the other groups. Awe and nature-relatedness were hypothesized moderators of the effect of spacious VN on social connectedness. In order to test this, 135 students between 18 and 30 were recruited and a 2 (Virtual Nature: Spacious versus non-spacious) x 2 (Storytelling: Personal vs Neutral) between-subjects experimental study design was applied, with social connectedness as a within-subjects variable. No significant main effects or interaction effects of spacious VN and personal storytelling on social connectedness were found and thus no support for the hypotheses was found in this sample. A limitation of the study seems to be the VN stimulus as participants commented that the VN was difficult to immerse in. In future studies, the immersion in VN should be improved by adding more multisensory levels to the nature stimuli by designing a virtual reality with scent and somatosensory experience for example. Nevertheless, participants created long extensive stories in the personal storytelling condition. Hence, prospectively, a qualitative study design could be applied to examine the content of the stories. Overall, a longitudinal design should be used to examine VN and storytelling and their effects on social connectedness over time.

**Keywords:** Social Connectedness, Virtual Nature, Spaciousness, Awe, Nature-Relatedness, Personal Storytelling, Young Adults

## **The Effect of Spacious Virtual Nature and Personal Storytelling on Social Connectedness in Young Adults**

“We are all connected; To each other, biologically. To the earth, chemically. To the rest of the universe atomically” is a powerful quote from astrophysicist Dr Neil DeGrasse Tyson who emphasizes the interconnectedness of everything (Kumala, 2010).

In the life of humans, social connectedness is so deeply enrooted, that the absence of it activates pain in an individual that feels isolated (Cacioppo & Patrick, 2008). It makes evolutionary sense, as our ancestors’ lives depended on social bonds for survival and reproduction (Cacioppo & Patrick, 2008). Feeling connected to other human beings is a universal and basic need which is reflected in our neural wiring, as natural selection developed internal mechanisms in people that reward social contact and punish social deprivation (Cacioppo & Patrick, 2008). Following this, most articles perceive social connectedness as closely related to the construct of belongingness (Lee and Robbins, 1995) and Haslam et al. (2015, p.1) conceive social connectedness as “the sense of belonging and subjective psychological bond that people feel in relation to individuals and groups of others”. However, Lee & Robbins (2000, p. 484) characterize social connectedness more broadly as “an enduring and ubiquitous sense of the self in relation to the world”. This study will use the latter definition, as the study links social connectedness with two other fundamental and intrinsic human needs: nature and storytelling. Nature was found to be significantly related to humans’ feelings of connectedness to themselves and the world at large (Van Houwelingen-Snippe et al., 2020) whereas storytelling is pivotal in each life to create personal meaning and a feeling of unity (Westerhof, 2015). The following sections will discuss the importance of social connectedness and elaborate on the effects of spacious virtual nature (VN) and personal storytelling and how they can work together to promote social connectedness in young adults.

### **The importance of social connectedness**

Researchers accumulate evidence about how social connectedness shapes the individual’s mental as well as physical health. Lee & Robbins (1998) found that social connectedness serves as a social lens through which to view and interact with the world and can positively impact

cognitive processes such as self-evaluation and social comparison and counteract a negative outlook on the self and others. Thus, it can work as a buffer against anxiety and depression (Lee & Robbins, 1998). Moreover, the literature suggests that social connectedness enhances social identification as it helps in integrating one's actual self and one's ideal self through continuous social feedback and support (Heinrich & Gullone, 2006; Lee & Robbins, 1995). In addition to that, social connectedness positively correlates with self-esteem as having close social relationships promotes feelings of social self-efficacy and competence which make individuals view themselves more positively (Lee & Robbins, 1995). Finally, Heinrich and Gullone (2006) have demonstrated that social connectedness is also important for one's physical health since the absence of social connectedness can lead to physical problems such as an impaired immune system and impaired cardiovascular activity.

### **Decrease of social connectedness in modern society**

These findings about the importance of social connectedness are more relevant than ever since recent research shows how social connectedness quickly decreases in modern society and has an effect on all age groups (Monbiot, 2017). Most affected are young adults, of whom 20-48% report feeling severely disconnected and lonely (Williams & Braun, 2019). The increased establishment of technology in young people's lives appears to be one factor in the trend toward disconnection (James et al., 2017). James et al. (2017) found that the increase in online communication in young adults can lead to a decrease in intimacy as it results in less face-to-face contact and can represent a distractor when interacting in the real world. Notwithstanding, literature seems to be unclear on the implications of technology as Irvine (2009) relates technology to social disconnection and mental health problems such as depression and anxiety while Boyd (2009) and Wu et al. (2016) argue that technology can create a space for young adults to connect with each other.

From a broader perspective, Qualter et al. (2015) argue, that young adults are torn between the expectations of modern capitalist society that want them to conform to the system, but want them to strive towards individuation and independence at the same time. As a consequence, individuals struggle to find the right balance between belongingness and individuation which often

makes them disconnect from society at large (Qualter et al, 2015). Monbiot (2017) adds that society is increasingly celebrating extrinsic aspirations (money, fame, image) over intrinsic aspirations (growth, intimacy, community) which leads to children now responding ‘they just want to be rich’ to the question about their motivation in life (Monbiot, 2017; Matthews, 2019). Matthews (2019) concludes, capitalism’s relentless pursuit of profit and the essential needs of people are incompatible in the long term and result in social disconnection and severe mental health problems.

### **The Effect of Nature**

The United Nations (2014) displays how humanity becomes increasingly separated from nature as more than half of the world’s population lives in urban areas and the hegemonic modern Western worldview emphasizes dominance and control over nature (Berry, 1991). Research by Weinstein et al., (2009), links the previous findings about the capitalist system and the dissociation from self and others to the separation from nature. Weinstein et al. (2009) found that nature can represent a space of freedom and autonomy, leading to more valued intrinsic than extrinsic goals. In contrast to modern society, which expects conformity to the system in place, nature allows individuals to explore and follow their curiosities rather than societal pressures and expectations, and this autonomy encourages individuals to pursue intrinsic psychological needs such as personal growth, intimacy, and community rather than extrinsic goals that are rewarded by others such as money, fame and image (Weinstein et al., 2009). This is supported by the research of Frantz et al. (2005), which suggests that urban environments lead to feelings of isolation and self-alienation, whereas exposure to nature leads to humanizing effects, and increases authenticity and connectedness (Weinstein et al., 2009).

### **Spacious Nature and Awe**

The findings above are mainly associated with one specific characteristic of nature; spaciousness. The characteristic of ‘spaciousness’ of nature, refers to wide, open sceneries, such as the night sky or an open landscape (Van Houwelingen-Snippe et al., 2020). Van Rompay and Jol, (2016) argue that spacious nature fulfils people's basic need for freedom and exploration and

thus stimulates a state of “sensitivity, curiosity and flexibility” (p.7), that allows people to momentarily leave their rigid state and create more positive perspectives on life. Research by Van Houwelingen-Snippe et al. (2020) has shown that the subsequent prosocial effects might be a result of awe, a powerful emotion that directs attention to something bigger than the self and conveys the feeling of being in a wider life than that of one's society and one's own ego. Piff et al. (2015) emphasize the loss of self as a key factor of spacious nature that helps shift one's attention to something greater than oneself. Attending to the larger entities one is a part of, such as nature and humanity, often leads to the motivation of being good to others (Piff et al., 2015). Hence, the results of previous research show that the experience of spaciousness and awe heightened a sense of connectedness to other fellow beings and the world at large (Van Houwelingen-Snippe et al., 2020) and can serve a vital social function.

### **Virtual Nature**

As previously discussed, people increasingly live in urban areas and are separate from nature, which makes interacting with nature not always possible (Van Houwelingen-Snippe et al., 2020). However, especially young adults, have access to technology which can potentially offer a new mechanism to access nature (James et al., 2017). Even though, technology cannot and should not fully replace real nature (Kahn et al., 2009), a growing body of research indicates that indirect contact with nature in the form of pictures and videos can transmit at least a few benefits of real nature (Van Houwelingen-Snippe et al., 2020; Valtchanov et al., 2010). Literature shows that VN is positively related to feelings of social connectedness and prosocial aspirations just as real nature (Van Houwelingen-Snippe et al., 2020; Piff et al., 2015).

### **The connection between nature and creative processes**

Intriguingly, Otten et al. (2023) investigated the potential of VN for stimulating conversations and found that it triggers a wide range of associations that could be useful in creating conversational material for older adults. Keniger et al. (2013) explain this range of associations by observing in their study that nature increases inspiration as it cognitively restores and simultaneously strengthens feelings of connectedness to a broader reality. For instance, Schertz et

al. (2018) have investigated how natural environments might change journal entries and revealed that natural environments encourage people to reflect more positively about life, nature and their relationships. Thus, the cumulative findings that nature provokes reflection and stimulates social interaction, transition into another aspect that is intrinsically human and can be used to increase social connectedness in young adults; storytelling.

### **Storytelling**

Storytelling serves a vital social function and is fundamentally human (Gottschall, 2012). Davidhizar & Lonser (2003) refer to storytelling as “a powerful communication vehicle” (p.217) because it communicates across groups, communities and nations and uses different mediums. Just as Keniger et al. (2013) found that nature inspires us, our ancestors have always been inspired by the phenomena of the natural world (Gottschall, 2012). Since their existence, they tried to understand the nature surrounding them and told each other stories about the origins of the sun and the stars, the nature of gods and the spirits and all it entails (Gottschall, 2012). Nowadays, through storytelling, parents pass on their family history to their children so they can integrate them into their personal memory, thus acting as a social glue that strengthens intra-group identity (Bietti et al., 2019). Through storytelling, friends experience a shared reality that fosters social bonds and feelings of belonging (Polletta et al., 2011). Storytelling is pivotal as it strengthens social connectedness, and it gives us meaning in life (Gottschall, 2012).

### **Meaningful stories**

According to narrative psychology, people’s personal memories have the goal to create a story of one’s life, thus construing a narrative identity and enhancing their sense of purpose and unity (Westerhof, 2015). For example, research by Chiang et al. (2010) shows how personal storytelling is used in therapy to help people organize their experiences and sharpen their sense of meaning in life. Westerhof (2015) emphasized that reminiscing is not merely about neutrally recollecting memories. It is about the construction of meaning in personal memories that help people navigate through their life by creating a direction and goals. Therefore, it is very important to differentiate between semantic knowledge which is simply retrieved from people's archives of

memories, such as their knowledge about what they did yesterday, and personal memories which are involved in people's meaning-making (Westerhof, 2015).

Concerning social connectedness, literature on reminiscence therapy suggests that storytelling about a personal memory can increase social connectedness as it induces a state of reminiscing and reminds the person of positive experiences, increases their sense of belonging and encourages bonding (Chiang et al., 2010; Fujiwara et al., 2012). For instance, Parson et al. (2022) found that weekly journaling on a public but anonymous platform can provide a space to share one's life and experiences with others and thus, it can enhance personal meaning and social connectedness. According to Schertz et al. (2018) findings, the restorative effects of nature can support this reminiscence process by providing individuals with the cognitive space to reflect positively on their life, nature and their relationships with others. Furthermore, nature can induce inspiration and a shift of focus to social aspirations in this meaning-making process (Keniger et al., 2013; Van Houwelingen-Snippe et al., 2020). Finally, throughout longitudinal studies, it has been shown that constructive use of personal, meaningful memories has been beneficial for individuals' sense of purpose and feeling of unity (McAdams & Syen, 2013; Parson et al., 2022).

### **Aim of this study**

Even though, both VN and storytelling have been investigated in previous research, there is a gap in the literature about the concurrence of spacious VN, awe, and personal storytelling. This paper aims to fill in this gap by combining the effects of nature and storytelling as both have separately proven to enrich social connectedness. More specifically, it investigates the interaction between spacious VN and personal storytelling since these have been related to social aspirations and feelings of unity in individuals which are promising factors to promote social connectedness. Furthermore, this study aims to enrich current research on awe and nature-relatedness by exploring their relationship with VN and social connectedness. Overall, this study specifically addresses the issues of young adults and was tailored to their experience of social connectedness in modern society. Thus, in contrast to other available studies, it aims at exploring the effects of VN and storytelling in relation to this specific target group.



### **The study's hypotheses:**

- H1: Exposure to VN high in spaciousness will increase social connectedness more than VN low in spaciousness.
- H2: Personal Storytelling will increase social connectedness more than a neutral writing task.
- H3: The interaction between VN high in spaciousness and personal storytelling will lead to the highest level of social connectedness in comparison with the other groups.

### **Awe**

Research into spacious nature has shown that it can evoke the awe response which results in the loss of self and shifts the attention to greater entities such as humanity and nature and thus facilitates a greater feeling of connectedness to the (social) world around us (Van Houwelingen-Snippe et al., 2020; Piff et al., 2015). Thus, the following hypothesis is posed.

- H4: Exposure to VN high in spaciousness will have a greater effect on individuals who have a larger awe response than on individuals with a smaller awe response.

### **Nature-relatedness**

Literature on nature draws attention to the role of nature-relatedness in the effects of nature (Marselle et al., 2021). Nature-relatedness refers to the mental connection of an individual with nature (Nisbet et al., 2009). Thus, it is additionally hypothesized that VN high in spaciousness has a greater effect on people who feel more related to nature.

- H5: Exposure to VN high in spaciousness has a greater effect on individuals who feel highly related to nature than on individuals who feel little relatedness to nature.

## Methods

### Design

A 2 (Virtual Nature: Spacious versus Non-Spacious) x 2 (Storytelling: Personal vs Neutral) between-subjects experimental study design was used to test for the effectiveness of the independent variables VN and storytelling on the dependent variable social connectedness. Social connectedness was used as a within-subject factor as it was measured before and after the exposure to the independent variables. In all conditions, a 30-second-long video of a VN environment was used with the difference of being spacious or non-spacious, followed by a storytelling task that was either personal or neutral. Thus, four conditions resulted, and each participant was randomly assigned to one of the four conditions.

### Participants

Of the 195 participants who were invited to complete the online survey, 59 participants failed to complete the questionnaire and were excluded from the study. Therefore, data from a total of 135 participants was used to analyze the effects of VN and storytelling on social connectedness. The participants were students ranging from 18 to 30 years old ( $M = 21.07$ ,  $SD = 2.00$ ) and consisted of 29 % males, 68% females and 3% non-binary people. In total, participants reported to come from 25 different countries, however, most participants reported to come from Germany (53%) and the Netherlands (12%). It is worth noting, that chi-square tests showed that there were no significant differences found between the different demographics and the conditions type. Sex showed neither a significant association with nature types [ $\chi(4) = 2.49$ ,  $p = 0.68$ ] nor with storytelling types [ $\chi(2) = 1.01$ ,  $p = 0.61$ ]. Likewise, nationality showed no significant association with nature types [ $\chi(46) = 45.77$ ,  $p = 0.48$ ] or with storytelling types [ $\chi(23) = 21.02$ ,  $p = 0.57$ ]. Age did not have a significant effect when included in the ANOVA model [ $F(3, 131) = 0.034$ ,  $p = 0.85$ ]. Table 1 displays the demographics of the participants across the different conditions.

*Table 1 Demographics of participants*

Variable	Spacious/Personal (N = 38)	Spacious/Neutral (N = 25)	Non- Spacious/Pers onal (N = 29)	Non- Spacious/Neu tral (N = 42)	Total (N = 135)
	%	%	%	%	%
Participants	28	18.5	21.4	31.1	100
Gender					
Male	31.5	24	27,5	30.9	28.8
Female	65.8	72	72.4	66.6	68
Other	2.6	4	0	4.7	2
Nationality					
German	52.6	72	65.5	34.4	53.3
Dutch	15.7	8	6.8	16.2	12.5
Other	31.5	20	27.5	47.6	34
Age (mean, SD)	21.7, 1.92	21.8, 2.02	21.6, 2.08	21.5, 2.08	21.07, 2.01

### **Stimuli**

The stimuli that were used for the experimental manipulation of the independent variable nature and the independent variable storytelling consisted of a VN video and a storytelling assignment. In order to design the VN nature stimuli, the Nature Healing Environment was used, which is a software developed by the University of Twente (BMS Lab, 2020). It allows for the manipulation of natural environments by adding and removing characteristics such as trees,

benches and people and can be exported in the form of images and videos. Based on previous research, spacious VN was created by capturing a wide and open scenery and non-spacious nature was designed by adding a high density of trees (Van Houwelingen-Snippe et al., 2020). To remove the subjective bias of the researchers, 8 different stimuli were created and shown to a sample of individuals during a pilot study. Participants of the pilot study were asked to rate the videos on the vastness subscale of the awe scale by Yaden et al. (2019). The scale entails items such as “I felt that I was in the presence of something grand” and “I experienced something greater than myself”, which were shown to be characteristics of spaciousness (Van Houwelingen-Snippe et al., 2020). The scale has high reliability in the sample ( $\alpha = .78$ ). As a result, the video with the highest score was chosen as the spacious nature stimuli (see Figure 1) and the video with the lowest score was chosen as the non-spacious stimuli (see Figure 2). Appendix A displays the stimuli used in the pilot test and all items of the vastness scale.

**Figure 1**

*Spacious Virtual Nature Scene*



**Figure 2***Non-spacious Virtual Nature Scene*

To compare the effect of personal storytelling and neutral storytelling, two different writing tasks were designed. Both conditions entailed encouraging participants to remember something and elaborating on their memory as much as possible. The personal writing task, however, asked participants to remember one specific, meaningful memory whereas the neutral condition asked them to remember what happened yesterday. Below, the exact wording of the writing tasks is shown:

**Personal Storytelling Writing Task:**

*“After watching the video, please try to remember a memory that has been meaningful to you. Describe it as detailed as possible. Think about:*

*Who was the main person in this situation, you or someone else? When and where did this happen?*

*What happened, what did you do or say, what did others do or say? Are there sensory details (see,*

*hear, smell, feel, taste)? Can you picture it as a movie? Please take your time describing the memory.”*

Neutral Writing Task:

*“After watching the video, please write down what you have done yesterday. Try to remember it as detailed as possible and describe it. Think about where you were, who you were with and what happened. Please take your time describing the course of your day.”*

Both writing tasks were designed as similarly as possible in terms of cognitive engagement. The greatest difference was the meaningfulness of the described memory, since participants in the personal condition were specifically encouraged to think about a meaningful situation and participants in the neutral condition were simply asked to report on past behaviour.

## **Instruments**

### ***Social Connectedness***

The dependent variable social connectedness was measured with the help of “The Social Connectedness Scale - Revised” (Lee & Robbins, 1995), which assesses the degree to which young adults feel connected to others in their social environment. The Scale has high reliability in this sample of students (internal consistency  $\alpha > .92$ ). The original scale entails a total of 20 items, which measure social connectedness and social assurance. This study makes use of the 8 items that specifically refer to social connectedness. Example items from the scale look like this: “I feel disconnected from the world around me” or “Even among my friends, there is no sense of brotherhood/sisterhood.” Participants are asked to respond on a 5 items Likert scale from strongly agree (1) to strongly disagree (5). Then, the items are summed and averaged, thus a higher score on the items indicates more social connectedness. A higher difference score indicates that social connectedness increased between the pre and post-test. Appendix C displays the complete scale.

### ***Awe***

The experience of awe was measured with one part of the awe questionnaire that investigates the loss of self, designed by Yaden et al. (2019). This part of the scale was used as the

loss of self was found to be an important component of the awe response which leads to increased feelings of social connectedness (Piff et al., 2015). This scale entails 5 items of which example items are: “I felt a reduced sense of self” and “I felt small compared to everything else.” Participants are again asked to answer these statements on a 5-point Likert scale (1=strongly disagree, 5= strongly agree). The items are summed and averaged; thus a higher score indicates a greater feeling of awe. These 5 items together show strong internal reliability in this sample ( $\alpha = .85$ ). The complete scale can be found in Appendix B.

### ***Nature-Relatedness***

Nature-relatedness of the participants was measured with the short version of the Nature Relatedness Scale (Nisbet & Zelenski, 2013). The scale consists of six items in total and includes example items such as “I feel very connected to all living things and the earth” and “My relationship to nature is an important part of who I am.” Participants respond to these statements using a 5-point Likert scale (1= strongly disagree, 5 = strongly agree). The items are averaged, and a higher score indicates greater nature-relatedness. Reliability analyses indicate that together, these items form a reliable scale in this sample ( $\alpha = 0.78$ ). The complete scale can be found in Appendix D.

### **Procedure**

Before conducting the study, it was approved by the BMS ethics committee of the University of Twente under the number 230206. The collected data was handled carefully according to the ethical standard of the American Psychological Association (APA). All participants were provided with information and asked for consent. Consequently, all names and personal information were anonymized. The recruitment of participants occurred through the platform SONA, which publishes studies in which students from the University of Twente can participate in exchange for credits. Furthermore, social media platforms like WhatsApp were used to share the study with fellow students of the same year and other students through snowball sampling. Qualtrics was used to create the online survey, combining all scales in one questionnaire.

First of all, participants were briefed about the topic and aim of the study and then asked to give consent. Next, demographic information was obtained, and all participants were asked to answer the social connectedness and nature-relatedness scale. Subsequently, the participants were

randomly assigned to one of the four conditions. According to their condition, the participants were first exposed to the VN stimuli and then asked to do one of the writing assignments. Next, they were asked to fill out the awe questionnaire and the social connectedness scale once again. Finally, the participants had the chance to leave their thoughts and comment on the study if they wished to and then debriefed and thanked for their participation.

### **Analyses**

After collecting the data, RStudio was used to analyze the data.

First of all, descriptive statistics such as the means and standard deviations of the dependent variable social connectedness were computed to get a first insight into the pre-, post- and difference scores (post minus pre) in the whole sample. Cohen's D was computed to get more insight into the effect size. As a randomization check, chi-square tests tested for significant associations between the demographics gender, nationality and age and the conditions to make sure these are not confounding variables. Then, the means and standard deviations of the variables were computed across the experimental conditions to get a better insight into the variables across the conditions. Furthermore, Pearson correlations between the variables and their associated p-values were examined to analyze the relationship between the concepts of awe, nature relatedness and social connectedness in the sample of students.

Regarding hypotheses 1 - 3, the mean and standard deviation of the variables were measured to get a better understanding of the variables across the levels of the independent variables (spacious vs non-spacious and personal vs neutral). A two-way ANOVA examined the main effects of the independent variables VN with the levels spacious/non-spacious (H1) and storytelling with the levels personal/neutral (H2) as well as the interaction effect of both (H3) on the dependent variable social connectedness. A repeated measure design was applied to take the measure of the dependent variable as a within-subject factor into account. An independent t-test was conducted as post-hoc analysis to understand the significance and magnitude of the difference between the spacious/personal condition and the non-spacious/neutral condition (H3).

Additionally, in line with hypotheses 4 and 5, awe and nature-relatedness were separately included in the ANOVA model as predictor variables to test whether there is an interaction effect with VN. More specifically, regarding the awe variable, participants were divided into high-on-



awe (score  $> 3$ ) and low-on-awe (score  $\leq 3$ ) and the awe variable with the two levels (high and low) was included as a predictor variable in the model to see if there is an interaction effect between awe and VN on social connectedness (H4). Similarly, the participants were divided into high-on-nature-relatedness (score  $> 3$ ) and low-on-nature-relatedness (score  $\leq 3$ ). Then, the model included the nature-relatedness variable with the two levels (high and low) to test whether there is an interaction effect between nature-relatedness and VN on social connectedness (H5).

## Results

### Descriptive statistics

In the whole sample, social connectedness before showed a mean of 4.03 (SD = 0.86), which places the participant close to “somewhat disagree”, on average on a scale from 1 (strongly agree) to 5 (strongly disagree). Social connectedness after the presentation of the stimuli showed a slightly higher mean of 4.27 (SD = 0.81). The difference in social connectedness in the whole sample was 0.24 (SD = 0.69), indicating a higher degree of social connectedness than before the exposure to the stimuli. Cohen’s D measured the effect size for the within-subjects variable ( $d = 0.29$ ), which indicates a small effect. Table 2 displays the means and standard deviations of the social connectedness scores in the whole sample and across the experimental conditions.

*Table 2: Means and standard deviations across the experimental conditions*

Variable	Spacious/Personal (N = 38)		Spacious/Neutral (N = 25)		Non-Spacious/Personal (N = 29)		Non-Spacious/Neutral (N = 42)		Total (N = 135)	
	M	SD	M	SD	M	SD	M	SD	M	SD
SC Before	3.84	1.07	4.23	0.70	3.94	0.81	4.14	0.74	4.03	0.86
SC After	4.22	0.86	4.38	0.74	4.25	0.79	4.26	0.84	4.27	0.81
SC Difference	0.38	0.98	0.15	0.31	0.30	0.56	0.12	0.59	0.24	0.69

Next, correlations between the variables were measured to provide some context and understanding of the strength, direction, and significance of the relationship between the variables.

Social connectedness before was significantly correlated with social connectedness after and the difference score. However, no significant correlations were found between social connectedness, awe, and nature relatedness in this sample. All correlations between the variables are portrayed in Table 3.

*Table 3: Pearson Correlations between the Social Connectedness Scores, Awe, and Nature Relatedness in a Sample of Students (n = 135)*

	SC Before	SC After	SC Diff	Awe	Nature Relatedness
SC Before		0.66**	-0.46**	-0.02	0.16
SC After			0.35**	-0.15	0.08
SC Diff				-0.14	-0.10
Awe					-0.06

*Note.* \* $p < .01$  \*\*  $p < .001$ .

### Testing hypotheses 1 - 3

In line with hypothesis 1, the mean difference in social connectedness in the conditions with spacious VN ( $M = 0.29$ ,  $SD = 0.79$ ) was higher than in the non-spacious conditions ( $M = 0.19$ ,  $SD = 0.59$ ). However, the results of the ANOVA showed no significant effect of VN on social connectedness [ $F(1, 133) = 0.074$ ,  $p = 0.92$ ], indicating that the observed variability in social connectedness does not significantly differ between spacious and non-spacious VN. Hence, hypothesis 1 “Exposure to VN high in spaciousness will increase social connectedness more than VN low in spaciousness” must be rejected.

In line with hypothesis 2, the mean difference in social connectedness was higher in the personal storytelling conditions ( $M = 0.35$ ,  $SD = 0.82$ ) than in the conditions entailing the neutral writing task ( $M = 0.13$ ,  $SD = 0.51$ ). However, no significant effect was found for storytelling on social connectedness ( $F(1, 133) = 2.94$ ,  $p = 0.08$ ), indicating that the observed variability in social connectedness does not significantly differ between personal storytelling and a neutral writing task. Thus, there was no evidence found for hypothesis 2 “Personal Storytelling will increase social connectedness more than a neutral writing task” and it must be rejected.

In line with hypothesis 3, participants assigned to the condition with exposure to non-spacious VN and the neutral writing task had the lowest mean difference in social connectedness ( $M = 0.12$ ,  $SD = 0.59$ ) while the mean difference of the spacious/personal condition was highest on average ( $M = 0.385$ ,  $SD = 0.988$ ). However, the ANOVA showed no significant interaction effect between VN and storytelling [ $F(1, 133) = 0.53$ ,  $p = 0.46$ ]. A subsequent independent t-test as a post-hoc analysis between the spacious/personal condition and the non-spacious/neutral control condition showed no significant difference [ $t(60) = 1.4$ ,  $p = 0.16$ ]. Therefore, hypothesis 3 “Exposure to VN high in spaciousness and personal storytelling will lead to the highest level of social connectedness in comparison with the other groups” must be rejected. All means and standard deviations of the variables across the independent variables nature and storytelling are displayed in Table 4.

Table 4: Means and standard deviations across the variables VN and Storytelling

Variable	Spacious (N = 72)		Non- Spacious (N = 63)		Personal (N = 67)		Neutral (N = 68)	
	M	SD	M	SD	M	SD	M	SD
SC Before	4.00	0.95	4.06	0.78	3.89	0.96	4.17	0.72
SC After	4.29	0.81	4.26	0.82	4.24	0.82	4.31	0.80
SC Difference	0.29	0.79	0.19	0.59	0.35	0.82	0.13	0.51
Awe	2.48	0.95	2.42	0.91	2.52	0.94	2.37	0.91
Nature relatedness	3.89	0.95	3.78	0.92	3.88	0.86	3.79	0.99

#### Testing hypotheses 4 - 5

In order to test hypotheses 4 and 5, the variables were included in the ANOVA model. An ANOVA analysis, with awe as a predictor variable with two levels (high and low), showed no significant interaction effect with VN on social connectedness [ $F(1, 133) = 0.97, p = 0.42$ ], suggesting that there is no significant difference in the effect of spacious VN on social connectedness between individuals with high and low awe scores. Therefore, no support was found for hypothesis 4 “Exposure to VN high in spaciousness will have a greater effect on individuals who have a larger awe response than on individuals who have a smaller awe response” and it must be rejected.

Furthermore, when including the variable nature relatedness with the levels of high nature relatedness and low nature relatedness in the ANOVA, there was no significant interaction effect found between nature relatedness and VN on social connectedness [ $F(1, 133) = 0.53, p = 0.71$ ]. Thus, hypothesis 5 “Exposure to VN high in spaciousness has a greater effect on individuals who

score high on nature-relatedness than on people who score low on nature-relatedness” must be rejected.

## **Discussion**

### **Main findings**

This study aimed to test how spacious virtual nature (VN) and personal storytelling can work together to promote social connectedness in young adults. In line with previous research by Van-Houwelingen-Snippe et al. (2020), which related spacious VN to social aspirations, it was hypothesized that spacious VN increases social connectedness more than non-spacious VN (H1). Based on research by Westerhof (2015), which related meaningful memories to enhanced feelings of unity, it was further hypothesized that personal storytelling will increase social connectedness more than a neutral writing task (H2). Taken together with research by Otten et al. (2023), which found an association between VN and conversational material, it was hypothesized that spacious VN and personal storytelling will increase social connectedness the most in comparison with the other conditions (H3). Finally, awe (H4) and nature relatedness (H5) were hypothesized to influence the effect of spacious VN on social connectedness (Piff et al., 2015; Nisbet et al., 2009). The current study did not find statistical support for a relationship between spacious VN, personal storytelling and social connectedness and no support was found for the hypotheses posed in the study. Following these results, it is crucial to look back at the design and methodology of the study and compare it to previous studies.

Regarding the expected effects of spacious VN on social connectedness (H1), the proposed hypothesis could not be confirmed, in contrast to research that highlights the connection between spacious VN and social aspirations (Van Houwelingen-Snippe et al., 2020). One explanation could be the low immersion in the VN, as suggested by the participants feedback at the end of the study. For example, participants commented: “The video was not that immersive for me. It was too bright and looked artificial”. The reason for the low immersion in the current study could be the lack of sensory experiences while being exposed to the stimulus. Several studies emphasize the importance of immersion in VN (Van Houwelingen-Snippe et al., 2020; Valtchanov et al., 2010). For example, the study of Van Houwelingen-Snippe et al. (2020), which found significant effects of spaciousness on social aspiration, underlines the importance of sensory experiences for

immersion. Their study added multisensory elements to the VN scenes such as sound and scent and invited participants to watch the scene of a projector on a white wall to stimulate immersion in the VN. Another study experimenting with VN set up a virtual reality of a three-dimensional photo-realistic forest the participants can freely walk through and was successful in observing its digital nature's restorative effects (Valtchanov et al., 2010). In comparison, in this research, participants completed the study via laptop or mobile phone. Even though sound was added to facilitate immersion, scent and somatosensory feedback appear to be crucial components of the nature experience (Van Houwelingen-Snippe et al., 2020; Valtchanov et al., 2010; Kjellgren & Buhrkall, 2010). Additionally, participants commented on the short exposure of the stimulus: "The video seems a bit short for any meaningful effect". Compared to the virtual reality study by Valtchanov et al. (2010), in which participants were exposed to the natural stimulus for 10 minutes, the stimulus in this study lasted 30 seconds. Thus, the exposure might have been too short for the participants to immerse into the VN in the current study. In conclusion, participants feedback and the comparison with previous studies suggest that low immersion in the nature stimulus may explain the lack of effects of the spacious VN on social connectedness designed in this study (Van Houwelingen-Snippe et al., 2020; Valtchanov et al., 2010).

Regarding the expected effects of personal storytelling on social connectedness (H2), the proposed hypothesis could not be confirmed, in contrast to previous insights on storytelling promoting social bonding (Bietti et al., 2019; Polletta et al., 2011) and meaningful memories providing a sense of purpose, unity and belonging (Westerhof, 2015). One possible explanation could be the nature of the study. For example, while this study consisted of only a short storytelling task and social connectedness was measured immediately after the storytelling task, participants in Parson et al.'s (2022) study kept a diary once a week over two years and their entries were evaluated over a considerable time span. Their analysis suggests that personal storytelling promotes self-reflection and social connectedness when used consistently over time (Parson et al., 2022). Therefore, participation in one storytelling task may have been too brief to detect an effect on social connectedness immediately afterwards.

Although no support was found for the effect of personal storytelling on social connectedness, it is worth noting that a possible link between VN and conversational material may

have surfaced as highlighted by Otten et al. (2023). One glance into the storytelling assignments, especially in the personal condition, revealed that participants wrote down detailed stories about their personal experiences with nature. In summary, the short-term nature and quantitative study design could explain the lack of findings on the impact of personal storytelling on social connectedness in this study.

Regarding the hypothesized interaction effect of spacious VN and personal storytelling on social connectedness, the study could not confirm the proposed hypothesis (H3). This finding is opposed to existing research that suggests a positive effect of nature on prosocial aspirations (Weinstein et al., 2009) and on journaling (Schertz et al., 2018) and thus, on overall social connectedness (Weinstein et al., 2009; Schertz et al., 2018). One explanation for the contrasting findings could be the experimental design of the study. For instance, compared to Schertz et al. (2018) design that analyzed naturally occurring thoughts in a natural environment, this study utilized an experimental design in which participants were prompted to come up with a story at the time of the study. Just as emphasized by Weinstein et al. (2009), the effect of freedom and autonomy is essential for the positive effect of nature on prosocial aspirations. Thus, this experimental design might have decreased the effect of freedom and autonomy nature provides (Weinstein et al., 2009). Another reason for the absent interaction effect between spacious VN and personal storytelling might be the absent restorative effects of nature that Schertz et al. (2018) linked with creative processes and increased feelings of social connectedness. The feedback of participants suggests that the low immersion in the VN may not have evoked these restorative effects in the first place. Therefore, no interaction effect between spacious VN and personal storytelling on social connectedness could be found. To sum up, the effects of spacious VN and personal storytelling that were associated with social connectedness, might have been impacted by the experimental design and the low immersion in the spacious VN.

Regarding the hypothesized interaction effect between awe and spacious VN on social connectedness (H4), the hypothesis could not be supported by the findings. This contrasts with previous findings showing an association between spacious VN, awe and social connectedness (Van Houwelingen-Snippe et al., 2020; Piff et al., 2015). The low immersion in the VN might, similarly to H1, explain the rather low awe response of participants and the absent interaction

effect with nature. Just as Van Rompay and Jol (2016) and Van Houwelingen-Snippe et al. (2020) found, the awe response is evoked when spaciousness stimulates a state of freedom and full presence in the moment and the world around oneself. Chirico et al. (2018) research, for instance, used an immersive virtual environment and demonstrated the potential of VN to induce awe. The rather low average awe scores in the current study suggest that the low immersion in the VN did not induce the awe response and thus no interaction effect between awe and spacious VN was found in the current study.

Furthermore, the hypothesis for the interaction effect between spacious VN and nature-relatedness on social connectedness could not be confirmed (H5). The finding that the participants' nature-relatedness is not an important component for the effects of nature on social connectedness contrasts with the study by Nisbet et al. (2009). The authors highlight that nature-relatedness strengthens the effect of nature. Again, the lack of immersion in the VN stimulus could be one reason why no interaction between nature-relatedness and spacious VN on social connectedness was found in this study.

Overall, the pre-measures on nature-relatedness and social connectedness revealed noteworthy findings. For instance, a rather high average score on nature-relatedness was reported by the participants across all conditions. This finding suggests that the young adults in this sample still have an important mental connection with nature, which is more optimistic than the report of the United Nations (2014), that puts its emphasis on humanity's separation from nature. One reason for the high nature-relatedness in this sample could be that most participants were recruited from the University of Twente which provides a large nature campus to the students (Universiteit Twente, 2023). This would be in accordance with findings of Prasetyo et al. (2018) who found that a green campus increases students' nature-relatedness. Since nature-relatedness did not affect the VN experience in this study, it is imperative to consider that the mental connection with real nature might not be easily replaced with VN as VN is still an evolving technology and the connection with it must be acquired slowly (Kahn et al., 2009). Hence, this study serves as one insight into the difficulties of designing VN and demonstrated that VN is not an easy solution. To sum up, just as Kahn et al. (2009) point out the ponderous distinction between real nature and VN, these



findings reinforce the importance of designing VN carefully in order to transmit the benefits of real nature.

Concerning social connectedness, the pre-test showed that social connectedness was quite high in the sample of students, and it represents a higher degree of social connectedness than was assumed based on previous research (Williams & Braun, 2019). This might be a promising finding of the study in itself. It might point out that young adults in this sample benefit from a green campus, and their social connectedness is bolstered (Universiteit Twente, 2023). However, more research into the effect of green campuses is needed (Prasetyo et al., 2018). The finding of higher social connectedness scores might also point out the ambiguity of the influence of technology on young adults that was expressed in previous research (Wu et al., 2016; Boyd, 2008; Irvine, 2009). For instance, while Irvine (2009) relates technology to loneliness in young adults and to mental health problems such as depression and anxiety, Boyd (2009) and Wu et al (2016) argue that technology creates a space for young adults to connect with each other and enhance their sense of self. As a result, it might be reductionist to infer that technology reduces social connectedness in all young adults. In summary, the findings of the study suggest that VN as well as the overall value of technology seems to be complex and further research is required about its effects on the social connectedness in young adults.

### **Limitations and Strengths**

The main findings need to be further discussed against the background of the methodology and the design of the study as well as the sample characteristics. To begin with, the nature of the social connectedness scale must be critically looked at as it represents the body of this research. Hence, it must be noted that the scale received negative feedback from the participants. Participants addressed the negatively phrased statements of the scale and reported wanting to strongly disagree with such absolute statements. Thus, the scale might have led to a ceiling effect, reflecting a higher degree of social connectedness than would a positively phrased scale perhaps do (Lee & Robbins, 1995).

Another limitation is the immersion of the VN, as was discussed above. In contrast to the study of Van-Houwelingen-Snippe et al. (2018), the current study did not measure immersion as a factor which is one limitation of the study itself. The importance of immersion as a facilitator of

the effect of nature was demonstrated in the study by Liszio et al. (2018), for instance, which found greater immersion in nature and greater effects of nature in the virtual reality group than in the desktop group. Considering that this study employed a VN video which was accessible from a smartphone or laptop, this might have impaired the immersion. Participant's feedback supports this assumption. As highlighted in research by Van-Houwelingen-Snippe et al. (2020), awe research in particular needs to be carefully designed as it requires a vast and immersive natural scene to evoke awe in participants. For example, Chirico et al. (2018) showed that an immersive virtual environment can induce significantly higher levels of awe and presence than a neutral virtual environment. Even though the VN was pretested on the criteria of being vast, the experimental design of the study, limited the usage of a night sky or a panoramic view from a mountain that was associated with spaciousness (Van-Houwelingen-Snippe et al., 2020), as no counterpart for the non-spacious condition could be designed that entailed the same environment with only differing in the spaciousness component. Thus, in addition to the low immersion, the spacious VN stimulus might have been not spacious enough to evoke an awe response.

One strength of the study was the diversity of participants. Participants were students from different countries and different majors which makes the sample more representative of young adults across the world. Another strength of the study was the integrated feedback question, as it gave participants the chance to express their thoughts at the end of the study and thus provided a lot of transparency into the participants' experience and potential shortcomings. Thus, even though no support for the hypotheses can be reported, the findings of this study might serve the purpose of enriching future research into VN and storytelling.

### **Recommendations for future research**

Future research should consider immersion as a defining feature. More specifically, this could be inspired by research that was more successful in designing a VN stimulus high in immersion, such as research by Van Houwelingen-Snippe et al. (2020) which designed a multisensory VN with sound and scent or by Valtchanov et al., (2010) design in which the nature stimulus was composed of a virtual reality to freely walk through. Moreover, regarding the awe response, future research could be inspired by the study of Chirico et al., (2018), and develop an immersive and vast nature stimulus to induce the awe response. To measure the concept of social

connectedness, it might be wise to rephrase the items of the social connectedness scale to be positive (Lee & Robbins, 1995) or use a different scale that entails a wider range of positively phrased items and measures social connectedness in a more differentiated way.

Furthermore, due to the quantitative nature of the study, the content of the personal storytelling task remained mostly untouched. However, in line with literature that suggests a stimulating effect of nature on storytelling (Otten et al., 2023), future research might examine the relationship between spacious VN and personal storytelling more closely by analyzing the content of the stories that were created. Even though no effect on social connectedness was found, it might be interesting to investigate the specific content and look for clues of social connectedness in the stories. Based on previous research on spacious nature (Van Houwelingen-Snippe et al., 2020) and reminiscing about personal memories (Westerhof, 2015), prospective researchers might find expression of individuals' sense of belonging and the meaning-making process in their stories. Furthermore, a qualitative study design that investigates the difference between the spacious/personal and non-spacious/personal condition more closely might provide more insight into the awe response than responses on an awe scale, as it might be possible to look for motives in individuals' stories, that are associated with awe in previous findings, such as the loss of self or the emphasis on intimacy in their stories (Piff et al., 2015). Finally, it is recommended to make use of a longitudinal research design that entails consistent exposure to spacious VN and personal storytelling over the course of time and measures the degree of social connectedness over a longer term (McAdams & Syen, 2013; Parson et al., 2022).

## **Conclusion**

In conclusion, the study attempted to gather more knowledge about the effects of spacious VN on social connectedness and its connection with awe and nature-relatedness. Moreover, it aimed to investigate the effect of personal storytelling on social connectedness and taken together, close a gap in the existing literature on the effects of spacious VN and personal storytelling on social connectedness in young adults. Even though this research was not able to find conclusive support for the hypothesized effects of spacious nature and personal storytelling, it demonstrated the importance of nature and storytelling with the help of an extensive literature review and by showing that VN is not an easy solution and must be constructed carefully to be able to provide

benefits similar to real nature. Furthermore, it attempted to show the creative and social effects of storytelling. In this context, it inspired qualitative design to utilize the content of the storytelling to a greater extent within prospective research. Finally, directions for future research were emphasized that should keep clarifying the importance of our interconnectedness with each other and nature and then find ways to promote it in our future: young adults.

## References

- Berry, T. (1991). *The ecozoic era*: EF Schumacher Society
- Bietti, L. M., Tilston, O., & Bangerter, A. (2019). Storytelling as Adaptive Collective Sensemaking. *Topics in Cognitive Science*, *11*(4), 710–732.  
<https://doi.org/10.1111/tops.12358>
- BMS Lab (2020) Virtual Nature Healing Environment. Available at  
<https://bmslab.utwente.nl/virtual-nature-healing-environment/>.
- Boyd, D. (2007). Why Youth Heart Social Network Sites: The Role of Networked Publics in Teenage Social Life. *MIT Press*, 119–142.  
[http://research.fit.edu/sealevelriselibrary/documents/doc\\_mgr/1006/Boyd.\\_2008.\\_Why\\_teens\\_love\\_social\\_media.pdf](http://research.fit.edu/sealevelriselibrary/documents/doc_mgr/1006/Boyd._2008._Why_teens_love_social_media.pdf)
- Cacioppo, J. T., & Patrick, W. L. (2008). Loneliness: human nature and the need for social connection. *Choice Reviews Online*, *46*(03), 46–1765.  
<https://doi.org/10.5860/choice.46-1765>
- Chiang, K., Chu, H., Chang, H., Chung, M. Y., Chen, C., Chiou, H. Y., & Chou, K. R. (2010). The effects of reminiscence therapy on psychological well-being, depression, and loneliness among the institutionalized aged. *International Journal of Geriatric Psychiatry*, *25*(4), 380–388. <https://doi.org/10.1002/gps.2350>
- Chirico, A., Ferrise, F., Cordella, L., & Gaggioli, A. (2018). Designing Awe in Virtual Reality: An Experimental Study. *Frontiers in Psychology*, *8*.  
<https://doi.org/10.3389/fpsyg.2017.02351>

- Davidhizar, R., & Lonser, G. (2003). Storytelling as a Teaching Technique. *Nurse Educator*, 28(5), 217–221. <https://doi.org/10.1097/00006223-200309000-00008>
- Frantz, C. M., Mayer, F. S., Norton, C., & Rock, M. S. (2005). There is no “I” in nature: The influence of self-awareness on connectedness to nature. *Journal of Environmental Psychology*, 25(4), 427–436. <https://doi.org/10.1016/j.jenvp.2005.10.002>
- Fujiwara, E., Otsuka, K., Sakai, A., Hoshi, K., Sekiai, S., Kamisaki, M. S., Ishikawa, Y., Iwato, S., & Chida, F. (2012). Usefulness of reminiscence therapy for community mental health. *Psychiatry and Clinical Neurosciences*. <https://doi.org/10.1111/j.1440-1819.2011.02283.x>
- Gottschall, J. (2012). The storytelling animal: how stories make us human. *Choice Reviews Online*, 50(01), 50–0062. <https://doi.org/10.5860/choice.50-0062>
- Haslam, C., Cruwys, T., Haslam, S. A., & Jetten, J. (2015). Social Connectedness and Health. In *Springer eBooks* (pp. 1–10). [https://doi.org/10.1007/978-981-287-080-3\\_46-2](https://doi.org/10.1007/978-981-287-080-3_46-2)
- Heinrich, L. M., & Gullone, E. (2006). The clinical significance of loneliness: A literature review. *Clinical Psychology Review*, 26(6), 695–718. <https://doi.org/10.1016/j.cpr.2006.04.002>
- Irvine, C. (2009). Excessive chatting on Facebook can lead to depression in teenage. Resource document. The Daily Telegraph. [http://www.telegraph.co.uk/technology/facebook/4405741/Excessive-chatting-on-Facebook-can-lead-to-depression-in-teen age-girls.html](http://www.telegraph.co.uk/technology/facebook/4405741/Excessive-chatting-on-Facebook-can-lead-to-depression-in-teen-age-girls.html).

- James, C., Davis, K., Charmaraman, L., Konrath, S., Slovák, P., Weinstein, E., & Yarosh, L. (2017). Digital Life and Youth Well-being, Social Connectedness, Empathy, and Narcissism. *Pediatrics*, *140*(Supplement\_2), S71–S75. <https://doi.org/10.1542/peds.2016-1758f>
- Kahn, P. H., Severson, R. L., & Ruckert, J. H. (2009). The Human Relation With Nature and Technological Nature. *Current Directions in Psychological Science*, *18*(1), 37–42. <https://doi.org/10.1111/j.1467-8721.2009.01602.x>
- Keniger, L., Gaston, K. J., Irvine, K. N., & Fuller, R. A. (2013). What are the Benefits of Interacting with Nature? *International Journal of Environmental Research and Public Health*, *10*(3), 913–935. <https://doi.org/10.3390/ijerph10030913>
- Kjellgren, A., & Buhrkall, H. (2010). A comparison of the restorative effect of a natural environment with that of a simulated natural environment. *Journal of Environmental Psychology*, *30*(4), 464–472. <https://doi.org/10.1016/j.jenvp.2010.01.011>
- Kumala, M. (2010). The Neverending Story—Using the Narrative as a Fundamental Approach to Teaching Biology and Beyond. *Evolution: Education and Outreach*, *3*(4), 526–531. <https://doi.org/10.1007/s12052-010-0277-2>
- Lee, R. T., & Robbins, S. J. (1995). Measuring belongingness: The Social Connectedness and the Social Assurance scales. *Journal of Counseling Psychology*, *42*(2), 232–241. <https://doi.org/10.1037/0022-0167.42.2.232>

- Lee, R. T., & Robbins, S. J. (1998). The relationship between social connectedness and anxiety, self-esteem, and social identity. *Journal of Counseling Psychology, 45*(3), 338–345. <https://doi.org/10.1037/0022-0167.45.3.338>
- Lee, R. T., & Robbins, S. J. (2000). Understanding Social Connectedness in College Women and Men. *Journal of Counseling and Development, 78*(4), 484–491. <https://doi.org/10.1002/j.1556-6676.2000.tb01932.x>
- Liszio, S., Graf, L. A., & Masuch, M. (2018). The relaxing effect of virtual nature: Immersive technology provides relief in acute stress situations. In *Annual review of Cybertherapy and Telemedicine*. <https://psycnet.apa.org/record/2019-27383-012>
- Marselle, M. R., Hartig, T., Cox, D. J., De Bell, S., Knapp, S., Lindley, S., Triguero-Mas, M., Böhning-Gaese, K., Braubach, M., Cook, P. A., De Vries, S., Heintz-Buschart, A., Hofmann, M., Irvine, K. N., Kabisch, N., Kolek, F., Jacobs, S., Markevych, I., Martens, D., . . . Bonn, A. (2021). Pathways linking biodiversity to human health: A conceptual framework. *Environment International, 150*, 106420. <https://doi.org/10.1016/j.envint.2021.106420>
- Matthews, D. R. (2019). Capitalism and Mental Health. *Monthly Review, 49–62*. [https://doi.org/10.14452/mr-070-08-2019-01\\_5](https://doi.org/10.14452/mr-070-08-2019-01_5)
- McAdams, D. P., & Syed, M. (2013). Narrative Identity. *Current Directions in Psychological Science, 22*(3), 233–238. <https://doi.org/10.1177/0963721413475622>



- Monbiot, G. (2017, November 30). The age of loneliness is killing us. *The Guardian*.  
<https://www.theguardian.com/commentisfree/2014/oct/14/age-of-loneliness-killing-us>
- 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>
- Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The Nature Relatedness Scale. *Environment and Behavior*, 41(5), 715–740.  
<https://doi.org/10.1177/0013916508318748>
- Onze Campus. Campus. Universiteit Twente.* (2023) Universiteit Twente.  
<https://www.utwente.nl/campus/>
- Otten, K., Van Rompay, T. J. L., Van 't Klooster, J. J. R., Gerritsen, D. L., & Westerhof, G. J. (2023). Exploring associations of older adults with virtual nature: a randomised factorial online survey. *Ageing & Society*, 1–19.  
<https://doi.org/10.1017/s0144686x23000090>
- Parson, N., Wurtz, H., Lowrey, M., & Santos, C. (2022). “Life will go on with the beauty of the roses”: The moral dimensions of coping with distress through autobiographical writing during Covid-19. *SSM Mental Health*, 2, 100156.  
<https://doi.org/10.1016/j.ssmmh.2022.100156>
- 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>

- Polletta, F., Chen, P., Gardner, B., & Motes, A. (2011). The Sociology of Storytelling. *Annual Review of Sociology*, 37(1), 109–130. <https://doi.org/10.1146/annurev-soc-081309-150106>
- Prasetyo, D. T., Djuwita, R., & Ariyanto, A. (2018). Are The Students from Green Campus More Related to the Nature? <http://seminars.unj.ac.id/icuic/wp-content/uploads/2018/08/Are-The-Students-from-Green-Campus-More-Related-to-the-Nature.docx.pdf>
- Qualter, P., Vanhalst, J., Harris, R., Van Roekel, E., Lodder, G. M., Bangee, M., Maes, M., & Verhagen, M. (2015). Loneliness Across the Life Span. *Perspectives on Psychological Science*, 10(2), 250–264. <https://doi.org/10.1177/1745691615568999>
- Schertz, K. E., Sachdeva, S., Kardan, O., Kotabe, H. P., Wolf, K. L., & Berman, M. G. (2018). A thought in the park: The influence of naturalness and low-level visual features on expressed thoughts. *Cognition*, 174, 82–93. <https://doi.org/10.1016/j.cognition.2018.01.011>
- United Nations (2014). World urbanization prospects. In *Statistical papers - United Nations. Series A, Population and vital statistics report*. <https://doi.org/10.18356/527e5125-en>
- Valtchanov, D., Barton, K., & Ellard, C. G. (2010). Restorative Effects of Virtual Nature Settings. *Cyberpsychology, Behavior, and Social Networking*, 13(5), 503–512. <https://doi.org/10.1089/cyber.2009.0308>

- Van Houwelingen-Snippe, J., Van Rompay, T. J. L., Junger, M., & Allouch, S. B. (2020). Does Digital Nature Enhance Social Aspirations? An Experimental Study. *International Journal of Environmental Research and Public Health*, *17*(4), 1454. <https://doi.org/10.3390/ijerph17041454>
- Van Rompay, T. J. L., & 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>
- Weinstein, N., Przybylski, A. K., & Ryan, R. M. (2009). Can Nature Make Us More Caring? Effects of Immersion in Nature on Intrinsic Aspirations and Generosity. *Personality and Social Psychology Bulletin*, *35*(10), 1315–1329. <https://doi.org/10.1177/0146167209341649>
- Westerhof, G. J. (2015) Life Review and Life-Story Work. 1-5. *The Encyclopedia of Adulthood and Aging*. <https://doi.org/10.1002/9781118521373.wbeaa209>
- Williams, S. W., & Braun, B. (2019). Loneliness and Social Isolation—A Private Problem, A Public Issue. *Journal of Family and Consumer Sciences*, *111*(1), 7–14. <https://doi.org/10.14307/jfcs111.1.7>
- Wu, Y., Outley, C., Matarrita-Cascante, D., & Murphrey, T. P. (2016). A Systematic Review of Recent Research on Adolescent Social Connectedness and Mental Health with Internet Technology Use. *Adolescent Research Review*, *1*(2), 153–162. <https://doi.org/10.1007/s40894-015-0013-9>
- Yaden, D. B., Kaufman, S. B., 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. *The Journal of Positive Psychology*,  
14(4), 474–488. <https://doi.org/10.1080/17439760.2018.1484940>

## Appendix

### Appendix A - Pilot Study

*Figure 1*



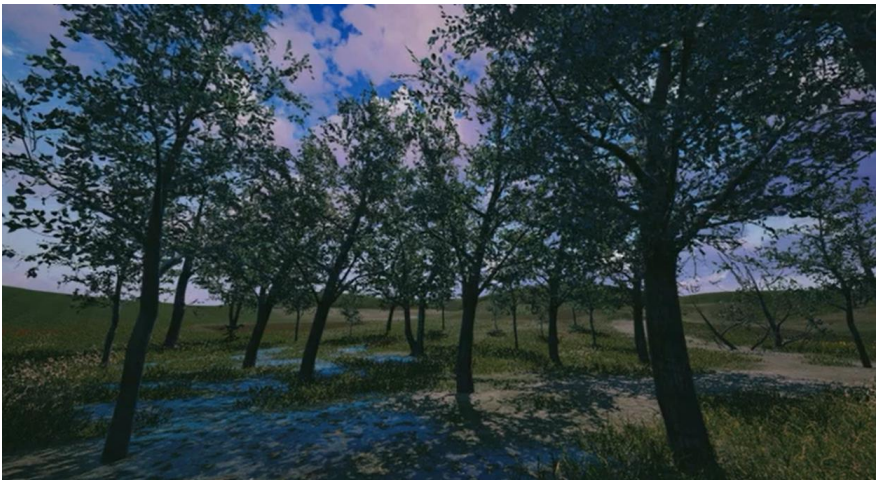
*Figure 2*



*Figure 3*



*Figure 4*



*Figure 5*



*Figure 6*



*Figure 7*



*Figure 8*



Awe Scale - Factor vastness (Yaden et al., 2019)

1. I felt that I was in the presence of something grand
2. I experienced something greater than myself
3. I felt in the presence of greatness
4. I perceived something that was much larger than me.
5. I perceived vastness



Appendix B - Awe scale - Factor Loss of Self  
(Yaden et al., 2019)

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.

Appendix C - Social Connectedness Scale  
(Lee & Robbins, 1995)

1. I feel disconnected from the world around me.
2. Even around people I know, I don't feel that I really belong.
3. I feel so distant from people.
4. I have no sense of togetherness with my peers.
5. I don't feel related to anyone.
6. I catch myself losing all sense of connectedness with society.
7. Even among my friends, there is no sense of brother/sisterhood.
8. I don't feel that I participate with anyone or any group.

Appendix D - Short Form Version of the Nature Relatedness Scale (NR-6)  
(Nisbet and Zelenski, 2013)

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.