Promoting Social Connectedness by Combining Spacious Nature and Autobiographical Storytelling in University Students

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Abstract

The COVID-19 pandemic has led to a rise in mental health problems globally. Specifically, in university students, a comparison between pre-and post-pandemic measurements highlights a connection between pandemics and a decrease in feeling socially connected. Exposure to spacious nature and engaging in autobiographical storytelling have been shown to facilitate social connectedness. Implementing nature-based interventions can be challenging in areas where the population suffers from the consequences of ongoing urbanisation, but virtual nature exposure offers a promising alternative. This paper investigates if there is a different effect in the relationship between exposure to spaciousness versus non-spaciousness nature in combination with autobiographical versus neutral storytelling and social connectedness in university students. A 2 (Nature: Spaciousness and Non-spaciousness) x 2 (Storytelling: Autobiographical and Neutral) between-subjects design with a repeated measure of social connectedness was chosen. 135 participants between 18-30 years were assigned to fill out an online survey before watching either a spacious or non-spacious virtual nature video and engaging in an autobiographical or neutral storytelling task afterwards. As covariates, personality traits neuroticism and openness to experience were controlled for. Thereby, no significant effect of spacious nature and autobiographical storytelling on social connectedness was shown. Moreover, no significant covariation of neuroticism and openness to experience on the relationship between nature, storytelling and social connectedness was found. Overall social connectedness was not found to be low in the sample. Based on these findings it is suggested that future research is conducted with a bigger sample size or the use of virtual reality technology to increase social connectedness in university students. Furthermore, a change in study design such as a longitudinal study could lead to contrasting outcomes.

Keywords: Social connectedness, Nature, Virtual Nature, Spaciousness, Autobiographical Storytelling, University Students, Personality Traits, Neuroticism, Openness to experience

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"Lord, our Lord, how majestic is your name in all the earth!

You have set your glory in the heavens (…)

When I consider your heavens,

the work of your fingers, the moon and the stars,

which you have set in place (…)

you put everything under their feet:

all flocks and herds, and the animals of the wild, the birds in the sky, and the fish in the sea,

all that swim the paths of the seas.

Lord, our Lord, how majestic is your name in all the earth!"- Psalm 8

(*The English Standard Version (ESV) Bible - Search and Read Online*, n.d.)

Centuries ago, humankind commented on the value of the connection between living beings and nature, emphasizing their interrelatedness. Modern research examining the portrayed relationship between humans and nature in Psalm 8 of the bible interprets it as inseparable and crucial for the existence of both (Bosman, 2006). While time has changed the weight that is put on the literal translation and acceptance of bible verses, the relevance of nature for human survival remains evident (Lind & Ferraro, 2022). Despite contemporary society's apparent disregard for nature's significance, the healing impact on human health that nature exposure possesses maintains constantly explored in contemporary research (Bratman et al., 2019; Lind & Ferraro, 2022). These benefits of nature on human well-being comprise the facilitation of cognition, vascular functions, mental as well as physical activity, and sleep (Jimenez et al., 2021).

A recent increase in empirical investigations of nature's benefits to individuals is caused by the proceeding urbanisation that reduces people's access to nature on a regular daily basis (Shanahan et al., 2019). Urbanisation has set a barrier between humans and a green environment, making it difficult for residents, especially in urban centres to take a walk

outside and to frequently connect with nature (Bratman et al., 2019; Shanahan et al., 2019). According to Baxter and Pelletier (2019), contact with nature can be classified as one of the basic psychological needs of humankind. To satisfy this basic need, individuals urge to connect with nature in various ways (Baxter & Pelletier, 2019; Wyles et al., 2019). Whereas investment in an organic setting such as parks alongside benches influences the population positively by enhancing the health of individuals (Bratman et al., 2019), missing contact with nature can have significant consequences for overall human health (Baxter & Pelletier, 2019).

Since the corona pandemic in 2019, mental health issues have been on the rise. Lockdowns serving as measures to impede the spreading of COVID-19 have been established as prevention measurements by governments globally. The decrease in interpersonal contact thereby contributed to an increase in loneliness for numerous people (Cacioppo et al., 2017; Werner et al., 2021). In times of distress and suffering, the longing of humankind for social contact becomes apparent (Mendez-Lopez et al., 2022; Nitschke et al., 2021). Compared to decades ago, findings reveal that perceived loneliness significantly increased in the public within the past years, leading to loneliness being classified as an emerging public health issue (Werner et al., 2021). Young adults, especially university students, have shown a considerable rise in loneliness and depression compared to pre-pandemic studies (Werner et al., 2021). Studies investigating the effect of social connectedness on health outcomes during the pandemic reveal a significant negative relationship between social connectedness and suffering from mental health issues, including symptoms of exhaustion and fatigue (Nitschke et al., 2021).

Given the critical increase in loneliness among university students and the positive effects of nature on mental wellbeing, nature exposure is suggested to promote social connectedness in this group.

Social Connectedness

With a greater understanding of the impact social factors exert on human well-being, research on sociological components and their fundamental mechanisms is increasing (Haslam et al., 2015). In contrast to what may be assumed when being confronted with the term social connectedness, it does not depict solely the extent to which an individual is interacting within his or her social environment. The concept of social connectedness comprises various aspects and is therefore often defined in differing terms. In previous research by Nitschke et al. (2021), social connectedness is incorporated as the number of direct contacts an individual keeps during a specific timeframe. Research by Haslam et al.

(2015) underlines that the term social connectedness refers to the perceived social inclusion or kinship within a group or towards people. Nitschke et al.'s definition of social connectedness emphasises the measurement of specific social connections, while Hasalm et al.'s operationalisation highlights the subjective perception of belonging. Exposure to nature can shift the focus towards social behaviour and values, leading to increased perceptions of social connection and ultimately enhancing the quality of life (Weinstein et al., 2009). In contrast, with a missing sense of social connectedness, an individual is at risk of being affected by psychological as well as physical health problems. Similarly to an unhealthy diet, this can lead to suffering from long-term consequences (Hasalm et al., 2015; Jiminez et al., 2021). For this research, the subjective interpretation by Hasalm et al. (2015) is used because the focus lies on the participants' subjective recognition and impression of feeling socially connected after being exposed to nature.

Nature

Attention Restoration Theory

Previous research adopted the Attention Restoration Theory (ART) as a driving force in explaining nature's beneficial effects on individuals (Kaplan & Kaplan, 1989). According to ART, nature evokes feelings that catch the effortless attention of an individual, and in turn, restore mental abilities after feelings of exhaustion and fatigue (Kaplan et al., 1989; Menardo et al., 2021). Soft fascination, a crucial element of nature proposed by Attention Restoration Theory (ART), is considered instrumental in facilitating mental reconstruction and fostering an increase in social connectedness in individuals (Kaplan et al., 1989; Otten et al., 2023; van Houwelingen-Snippe et al., 2020). Nature that contains characteristics accounting for soft fascination has beneficial effects on individuals as it possesses restorative features (Kaplan and Kaplan, 1989; Kaplan, 1995). Soft fascination is evoked by environmental stimuli that we perceive as calming, for example, wind that blows through meadows. An interpretation by Basu et al. (2019) underlines soft fascination as a process taking up attention that still leaves space for loose thoughts. In general, fascination arises through bottom-up processing that involves effortless attention (Kaplan, 1995). This can be seen in contrast to top-down processing, which takes up a lot of mental capacity and is involved in many daily activities. (Celikors & Wells, 2022; Kaplan, 1995). Critics of the ART point out the vague definition of what environment can be classified as soft fascinating according to the theory (Joye & Dewitte, 2018). Therefore, emerging studies target minimal manipulation in nature to identify factors of soft fascination (Basu et al., 2019). Based on the proposed effects of soft

fascination on social connectedness the present study will use nature landscapes containing characteristics that evoke soft fascination in individuals.

Spaciousness

Studies investigating the impact exposure to virtual nature has on well-being show that spacious landscapes relate to ART in creating a soft fascination in individuals (Piff et al., 2015). In research studying the effects of spacious nature, results emphasise spaciousness as a variable that significantly increases social connectedness as well as an urge to engage in social exchange and to express emotions (Otten et al., 2023; van Houwelingen-Snippe et al., 2020). Landscapes entailing spacious characteristics involving panoramic environments that present open features let individuals perceive the nature around them as overwhelming and something greater than themselves. These evoked feelings of a small self are correlated to the stimulation of awe, which in turn enhances the feeling of social connectedness (Piff et al., 2015; Stellar et al., 2017). In particular, exposure to spacious scenery is highly associated with awe and feelings of connectedness (Allen, 2018; Piff et al., 2015; van Houwelingen-Snippe et al., 2020). In comparison, for exposure to nature stimuli entailing less spacious elements such as a forest, the encouragement to be socially active is considerably less. Notable, when being presented with a spacious scenery right before a dense nature scene, the effects of spacious nature on individuals seem to cause positive outcomes for perceiving social connectedness (Piff et al., 2015; van Houwelingen-Snippe et al., 2020). Thus, this study employs nature stimuli with spaciousness to evoke the effects soft fascination is stated to have on individuals' level of social connectedness.

Virtual Nature

Research conducted by Browing et al. (2020) indicates that virtual nature exposure can yield positive effects similar to real or digital nature exposure, offering a therapeutic approach to enhance mental health and uplift the overall mood. In particular, a study by Goldy and Piff (2020) examined the beneficial effects of nature on feeling socially connected underlining that viewing images of nature facilitate positive and social behaviour. The use of virtual nature to increase the well-being of individuals is especially important for people without access to nature. Implementing nature-based interventions can be challenging in those areas but virtual nature exposure provides a promising alternative (Browing et al., 2020).

Autobiographical Storytelling

Research indicates that storytelling, particularly autobiographical storytelling, can enhance social connectedness in individuals by increasing feelings of belonging. Personal associations that are stimulated when engaging in storytelling provide conversational material (Stargatt et al., 2022). An online study conducted during the COVID-19 pandemic examined the outcomes of individuals engaging in autobiographical storytelling. In general, autobiographical storytelling helps to a rise in mental well-being by decreasing feelings of loneliness and anxiety and providing psychological support to cope with hardships (Parson et al., 2022). In contrast to neutral writing tasks, autobiographical storytelling activates social reminiscence, which in turn promotes prosocial behaviour (Essary et al., 2021; Westerhof et al., 2010). An intervention with high school students partaking in autobiographical writing discovered positive effects on social connectedness and the promotion of companionship (Essary et al., 2021).

Also, in combination with nature cues, reminiscence through autobiographical storytelling is suggested to exert increasingly positive outcomes for overall well-being (Sun et al. 2020). Thus, while being exposed to a natural environment, the feelings of being carried back in time are proposed to stimulate autobiographical storytelling. In a previous study, Otten et al. (2023) used virtual nature exposure to investigate the effect of nature on associations. Exposure to nature triggers personal associations, making people more open to engaging in conversations or social interactions with others (Otten et al., 2023). Research likewise stresses spaciousness in nature as a factor that triggers storytelling and thereby benefits a rise in social connectedness (Stargatt et al., 2022). Therefore, exposure to spacious nature can trigger greater feelings of social connectedness if connected to autobiographical storytelling. Thus, in this study, spacious nature exposure is combined with autobiographical storytelling tasks to facilitate social connectedness in university students.

Personality Traits

Due to limited research in this field, the complexity of influential factors interacting with the beneficial effects of nature is still to be discovered in detail. Factors that are suggested to act as covariates on the relationship between the above-mentioned variables constitute the effects of different personality traits (Menardo et al., 2021; Wyles et al., 2019). Especially, personality traits such as neuroticism and openness to experience have been shown to impact the relationship between nature exposure and outcome variables (Newman & Brucks, 2016; Silvia et al., 2015). Existing research comparing the influence of natural

environments versus urban environments on individuals proposes contrasting results depending on these two personality traits (Menardo et al., 2021; Wyles et al., 2019).

Neuroticism

Neuroticism is one of five personality traits that belong to the five-factor model of personality. Individuals scoring high on neuroticism present traits of strong emotionality, sensitivity to negative stressors and anxiety, making them predisposed to psychological issues (Shokrkon & Nicoladis, 2021; Trull et al., 2022). Studies by Menardo et al. (2021) indicate that specific personality traits yield different outcomes when individuals are exposed to nature. For instance, people who exhibit high levels of neuroticism tend to prefer urban environments over natural ones, compared to people scoring lower in neuroticism (Menardo et al., 2021).

Findings by Newman and Brucks (2016), who investigated the effects of nature exposure on self-control restoration, underline a rise in self-control for individuals high in neuroticism compared to participants low in neuroticism when being exposed to urban environments. This highlights the influence of neuroticism on the relationship between exposure to nature and its effects on individuals. Especially in strongly stimulating urban environments, participants high in neuroticism present greater abilities to process arousing cues effectively. Thereby, highly neurotic individuals occupy less attentional effort while being confronted with sensitive environmental cues such as visual or auditory cues. Environments such as spacious nature presenting calm stimuli, might therefore have more effects on people scoring low in neuroticism versus people scoring high in neuroticism (Newman & Brucks, 2016).

As this study uses spacious landscapes, the effect of spacious nature on social connectedness is studied with a focus on how the personality trait neuroticism acts as a covariate. It is argued that neuroticism accounts for a variation in the relationship between nature, storytelling and social connectedness, as existing research confirms that highly neurotic individuals show greater affinity for higher stimuli environments (Newman & Brucks, 2016). Since spacious nature is characterised as calm with few attentional cues, it is suggested that these environmental characteristics appeal differently to people displaying high neurotic personality traits. Ultimately, depending on personal characteristics, the outcome of beneficial effects like social connectedness, when exposed to nature, may vary.

Openness to Experience

In addition to neuroticism, the personality trait openness to experience is suggested to covariate the relationship between nature exposure and social connectedness in individuals.

Character traits such as openness to experience increase the feeling of awe in individuals, which is connected to admiration, fascination and a feeling of being confronted with something incomprehensible (Piff et al., 2015; Stellar et al., 2017). This phenomenon of awe can be evoked by specific nature, and especially in connection to spaciousness, awe plays a considerable role in understanding the relationship between nature exposure and the healing effects on individuals (Piff et al., 2015). Spacious nature in this context refers to an environment that is perceived as greater compared to oneself (Guan et al., 2019).

Personality traits, specifically openness to experience, can play a role in the likelihood of individuals perceiving awe and therefore experiencing increased social connectedness through exposure to spacious nature (Stellar et al., 2017; van Elk et al., 2019). Research by Silvia et al. (2015) and van Elk et al. (2019) suggests that individuals high in openness to experience are more likely to experience awe when exposed to spacious nature, indicating a stronger impact for those individuals in feeling awe.

Aim of the Current Study

Overall, the beneficial effects of virtual nature exposure and storytelling on social connectedness are evident. For this research particularly spaciousness in virtual nature is used and combined with autobiographical storytelling to achieve effects on social connectedness. Based on the increase in loneliness in young adults, this research is targeted at university students to facilitate social connectedness in that particular group. Due to the little research that exists about the effects of spaciousness in nature in combination with autobiographical storytelling on social connectedness variables such as personality traits need to be examined to establish targeted interventions incorporating nature as a factor to promote social connectedness in university students. Therefore, this scientific paper investigates the confounding effects of neuroticism and openness to experience on the relationship between spacious nature exposure in combination with autobiographical storytelling and social connectedness in university students.

Research Question and Hypotheses

RQ1: Do the personality traits neuroticism and openness to experience can account for variation in the relationship between exposure to spaciousness versus non-spaciousness virtual nature in combination with autobiographical versus neutral storytelling and social connectedness in university students?

Hypothesis 1 (H1): Exposure to spaciousness virtual nature in comparison to non-spaciousness virtual nature has a positive effect on social connectedness.

Hypothesis 2 (H2): Engaging in autobiographical storytelling after exposure to virtual nature has a positive effect on social connectedness compared to neutral storytelling.

Hypothesis 3 (H3): The personality trait neuroticism has a confounding effect on the interaction between nature and storytelling on social connectedness.

Hypothesis 4 (H4): The personality trait openness to experience has a confounding effect on the interaction between nature and storytelling on social connectedness.

Methods

Design

In a 2 (Nature: Spaciousness and Non-spaciousness) x 2 (Storytelling: Autobiographical and Neutral) between-subject design the effects of the independent variables of nature and storytelling on the dependent variable of social connectedness are compared in four conditions. For the experimental conditions, the participants are either exposed to a virtual nature scene high in spaciousness and an autobiographical storytelling task (group 1), a virtual nature scene high in spaciousness and a neutral storytelling task (group 2), a virtual nature scene low in spaciousness and an autobiographical Storytelling task (group 3), or a virtual nature scene low in spaciousness and a neutral storytelling task (group 4). Participants are assessed on social connectedness before the presentation of stimuli and after being exposed to one of the conditions. Thereby, the effect of the independent variables on the outcome variable can be compared through a pre-and post-measure. As neuroticism and openness to experience are proposed to act as covariates, the participant's level of both personality traits, as well as social connectedness, is assessed using self-reported measures.

Stimuli

Pilot Study

For the pilot study the BMS lab of the University of Twente has been contacted to design nature stimuli incorporating characteristics of spaciousness versus non-spaciousness nature. Eight different nature scenes (see Appendix D) that are each 30 seconds long have been created by using the Virtual Nature Recorder developed by the BMS lab of the University of Twente. Four of the videos featured spaciousness nature scenes, whereas the other four videos presented stimuli that account for non-spaciousness containing elements like trees. With a survey designed in Qualtrics consisting of a 5-point Likert scale that

showed up after each nature video, the perceived spaciousness for each video was assessed. Thereby five statements from a vastness scale (see Appendix A) were used as synonyms for spaciousness to avoid the participant getting biased by presenting the word spaciousness. 15 participants took part in rating every video on perceived vastness. The scores of every rating of the eight videos by each participant were added and compared. Low scores equal low spaciousness whereas high scores indicate high spaciousness. After evaluating the results, the highest (see Figure 1) and lowest in vastness (see Figure 2) were chosen for the study to be used as high spacious nature and low spacious nature videos.

Main Study

To ensure ethical correctness, the main study has been granted approval by the BMS ethical committee/ Domain Humanities & Social Sciences of the University of Twente under application number 230206. In line with previous research conducted by van Houwelingen-Snippe et al. (2020), this study examines the direct impact of nature videos with high and low levels of spaciousness on individuals. Due to the use of the nature design app from the University of Twente, a minimal manipulation of the nature scene is achieved which enables to control for an exact alteration in stimuli without inadvertent changes. Moreover, every video entailed the same natural sound effects to let the video seem more vivid and to increase possible feelings for the participants to fully emerge into the virtual nature videos. The high spacious virtual nature scene is designed to appear wide as the participant views an infinite horizon glowing over a meadow overgrown with flowers. In contrast, the nature scene low in spaciousness contains many trees restricting the view of the participant.

Figure 1

High Spacious Virtual Nature Scene

Figure 2

Low Spacious Virtual Nature Scene

To measure the effect of autobiographical storytelling on social connectedness after being exposed to spacious nature scenes two conditions are tested. The first condition instructed the participants to describe a to them meaningful memory in detail:

"*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)? Can you picture it as a movie? Please take your time describing the memory."*

The second condition presented to the participants is used as control condition. In this set up the participants were asked to complete a neutral storytelling 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."

Measures

Social Connectedness

The study used the social connectedness scale developed by Lee and Robbins (1995) to measure the dependent variable of social connectedness. The scale consists of eight statements (see Appendix C) that are rated on a 5-point Likert scale ranging from strongly agree to strongly disagree, whereas a higher score states higher social connectedness. Statements like "I feel disconnected from the world around me" are included to gain an understanding of the participants' feelings and assess the social connectedness at the given moment. Total scores were computed by summing up all scores. The scale has good internal reliability, with an estimated value of α=.91 and good test stability (Lee & Robbins, 1995). Concerning the sample recruited for this study, the reliability shows a Cronbach's alpha of α=.92 for the pre-measurement and α=.93 for the post-measurement.

Neuroticism

The neuroticism scale is part of the Big Five Inventory (BFI), a self-report scale to assess personality traits. In total, the inventory is built up of five scales based on the big five personality dimensions (see Appendix C). Particularly, the neuroticism scale measures the extent of an individual scoring in the range of high on neuroticism versus high on emotional

stability. Anxiety (tense), Angry hostility (irritable), Depression (not contented), Self-consciousness (shy), Impulsiveness (moody) and Vulnerability (not self-confident) constitute the facets conceptualised in the BFI to measure different dimensions of neuroticism (John & Srivastava, 1999). The design of the neuroticism scale contains a 5-point Likert scale depicting eight statements. The participant is assigned to answer various statements related to neuroticism beginning with "I see myself as someone who...". For the neuroticism scale, items 2 ('Is relaxed, handles stress well'), 5 ('Is emotionally stable, not easily upset') and 7 ('Remains calm in tense situations') are reversed. Overall, the scale has been characterised as having a short and efficient inventory due to the limited number of items. The reliability is good considering the length of the BFI in comparison to other instruments (John & Srivastava, 1999). In this study, the reliability is good, with a Cronbach's alpha of α=.93.

Openness to Experience

The BFI is also used to measure openness to experience in this study. The openness scale from the BFI calculates openness versus closedness to experience with ten statements (see Appendix C). On a 5-point Likert scale, the scoring of an individual in openness to experience is measured in the following dimensions: Ideas (curious) Fantasy (imaginative) Aesthetics (artistic) Actions (wide interests) Feelings (excitable) Values (unconventional) (John & Srivastava, 1999). Two of the items entailed in the scale are coded negative ('prefers work that is routine' and 'has few artistic interests'). Therefore, for the openness scale, these two items are reversed. Existing research reports the reliability and validity of this scale as sufficient (John et al., 1991). In this study, the reliability is acceptable with a Cronbach's alpha of α=.74.

Procedure

After conducting the pilot study, the chosen virtual nature videos for the conditions high in spaciousness as well as low in spaciousness were incorporated into the main survey of this study. The survey was published on the website of the SONA course credit system by the University of Twente and sent by email and through social media. The aim was to achieve a high participation rate among a diverse demographic and collect representative data using a non-probability sampling method. Before the participants started the survey, informed consent was presented to verify the given consent (see Appendix B).

Afterwards, the participant is assigned to one of the four conditions. A questionnaire asking for demographics, personality, social connectedness and nature relatedness was answered before the participant was able to watch the virtual nature video. After watching the video, participants are asked if they experienced any difficulties related to sound or visual

aspects during the process. This ensures that participants were sufficiently exposed to the nature stimuli to filter out participants. Next, the participant is presented with either an autobiographical or neutral storytelling task with a text field to answer the task. To compare the changes in the participants' feelings of social connectedness after exposure to virtual nature and engaging in a storytelling task, the participant is required to fill out the social connectedness scale a second time. As the last step, the participant was allowed to write down any additional thoughts they would like to share.

Participants

The sample conducted for this research study consisted of 195 university students ranging in age from 18 years to 30 (M= 21.07, SD=2.00). After selecting the participants with missing data or those who did not meet the age requirements, the sample consisted of 135 participants. The demographics across the different conditions can be seen in Table 1. In total, the sample consisted of 92 (68%) females and 39 (29%) males, 4 nonbinary and 1 prefer not to say. Moreover, participants from 25 different countries took part in the survey, whereas 65% of participants indicated to be international students. The majority of participants (53%) stated to be German, whereas 12% of the participants were from the Netherlands. Each condition consisted of at least 25 participants. A chi-square test was conducted to check for differences in gender or nationality across the conditions. No significant association of gender on nature [x (4) = 2.49, p = .68] and storytelling [x (2) = 1.01, p = .61] was found. Moreover, nationality has no significant difference in distribution across nature [x (46) = 45.77, p = .48) or storytelling types [x (23) = 21.02, p = 0.57]. When checking for age with an ANOVA no significant effect (F (3, 131) = .03, p = .85) was found.

Table 1

Demographics across Conditions

Variable	Spacious/ Autobio. (N=38)		Spacious/ Neutral (N=25)		Non-spacious/ Autobio. (N=29)		Non-spacious/ Neutral (N=42)		Total (N=135)	
	%		%		%		%		%	
Participants	28.0		18.5		21.4		31.1		100.0	
Gender	31.5		24.0		27.5		30.9		28.8	
Male										
Female	65.8		72.0		72.4		66.6		68.0	
Other	2.6		4.0		0.0		4.7		2.0	
Nationality	52.6		72.0		65.5		34.4		53.3	
German										
Dutch	15.7		8.0		6.8		16.2		12.5	
Other	31.5		20.0		27.5		47.6		34.0	
Age	M	SD	M	SD	M	SD	M	SD	M	SD
	21.7	1.9	21.8	2.0	21.6	2.1	21.5	2.1	21.1	2.0

Note. Autobio. = Autobiographical

Data Analysis

To analyse the collected data, the statistical software RStudio is applied. The data is cleaned to exclude participants with missing values and those outside the age range of 18-30. First, the overall frequencies of the sample considering age, sex and nationality across the experimental conditions are examined using frequency tables. Additionally, chi-square tests are used to check for randomisation of gender and nationality across the conditions. Moreover, a one-way ANOVA was conducted to test for significant differences in age between the conditions.

Afterwards, descriptive statistics including the means and standard deviations were calculated to show the pre-and post-scores as well as differences of the dependent variable social connectedness across the independent variables (“Nature” and “Storytelling”) as well as the experimental conditions (“Spacious” vs “Non-spacious”/ “Autobiographical” vs “Neutral”). Additionally, the pre-, post- and difference scores of social connectedness in the whole sample are presented. Subsequently, the mean and standard deviation for neuroticism

and openness to experience scores across the different conditions and in total are displayed. To check the effect size of the within-subject variable, Cohen's d was calculated.

Hypothesis Testing

Hypothesis 1 and Hypothesis 2

To test hypotheses 1 and 2, the main effects of the independent variables nature ("Spacious" vs "Non-spacious") and storytelling ("Autobiographical" vs "Neutral") as well as the interaction effect on the dependent variable social connectedness, were tested with a two-way ANOVA. With a repeated measure design the social connectedness measure was included as a within-subject factor.

To gain a better understanding of the effect size of nature and storytelling on social connectedness, Cohen's d was calculated. Therefore, it was determined if significant effects of nature type (H1) and storytelling (H2) exist.

Additionally, a post hoc test is carried out with a paired t-test to test if there is a significant difference in interaction effect between the extreme conditions by comparing the extreme conditions "Spacious/Autobiographical" and "Non-spacious/Neutral" and checking for significant differences in social connectedness. In the t-test, the mean of the "Spacious/Autobiographical" condition is compared with the mean score of the "Non-spacious/Neutral" condition to check if there is a significant difference. Therefore, the t-test enables to calculate whether the mean of the condition "Spacious/Autobiographical" is significantly higher.

Hypothesis 3 and Hypothesis 4

As personality traits are suggested to act as confounding variables in the relationship between the independent variables nature and storytelling and the dependent variable social connectedness, neuroticism (H3) and openness to experience (H4) are tested for covariation with a covariation analysis. Therefore, hypotheses 3 and 4 are tested with a two-way ANOVA analysis controlling for the personality traits of neuroticism and openness to experience across the conditions. As a criterion for the data analysis, a 95% confidence interval with a p-value of .05 ($p<0.05$) was used.

Results

Descriptive Statistics

Table 2 and Table 3 display the means and standard deviation of the dependent variable social connectedness as well as the difference between the pre-and post-measure and both personality traits across the experimental conditions. This allows for a comprehensive analysis of social connectedness scores across different conditions and highlights noteworthy

findings when comparing social connectedness, neuroticism, and openness to experience scores within each group.

Table 2

Means and Standard Deviations across the Experimental Conditions

Variable	Spacious		Non-spacious		Autobio.		Neutral	
	M	SD	M	SD	M	SD	M	SD
SC Pre	4.03	0.92	4.02	0.83	3.89	0.97	4.16	0.74
SC Post	4.28	0.82	4.23	0.83	4.25	0.79	4.26	0.84
SC Difference	0.26	0.64	0.21	0.74	0.35	0.83	0.12	0.50
Neuroticism	2.92	0.76	3.04	0.76	3.02	0.72	2.96	0.81
Openness	3.81	0.53	3.70	0.55	3.67	0.56	3.83	0.51

Note. SC Pre= Social connectedness Pre, SC Post= Social connectedness Post, Autobio. =Autobiographical

Table 3

Means and Standard Deviations across the Experimental Conditions

Variable	Spacious/ Autobio.		Spacious/ Neutral		Non-spacious/ Autobio.		Non-spacious/Neutral		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
SC Pre	3.84	1.07	4.23	0.70	3.94	0.81	4.14	0.74	4.03	0.86
SC Post	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
Neuroticism	2.95	0.73	2.89	0.79	3.04	0.71	3.03	0.83	2.98	0.77
Openness	3.67	0.61	3.91	0.43	3.66	0.53	3.75	0.58	3.75	0.54

Note. SC Pre= Social connectedness Pre, SC Post= Social connectedness Post, Autobio. =Autobiographical

The mean score for social connectedness of the total sample before exposure to the nature video and storytelling task was 4.03 (SD = .86), indicating that, on average, participants tended to express a level of "somewhat disagree" on the 5-point Likert scale (“1” (strongly agree) to “5” (strongly disagree)).

When examining the post-condition of social connectedness in the total sample after nature exposure and the storytelling task, it was found that the mean score for social connectedness was 4.27 (SD = .81), suggesting a general improvement in social connectedness. In line with that, the difference between pre-and post-measures of social connectedness is .24 (SD = .69) in the total sample, indicating an overall increase in social connectedness after the stimuli presentation. To assess the effect size for the within-subjects analysis, Cohen's d (*d* = .29) was computed, indicating a small effect size

Additionally, the total mean score for neuroticism was 2.98 (SD = .77), indicating an average score on the neuroticism scale within the sample. Moreover, the mean score for openness to experience was 3.75 (SD = .54), indicating that participants in total scored slightly above average in openness.

Hypotheses Testing

Hypothesis 1 and Hypothesis 2

Hypotheses 1 and 2 were tested with a two-way ANOVA analysis including nature and storytelling as independent variables and social connectedness as dependent variables.

Firstly, among the independent variable nature, the “Spacious” condition (M = .29, SD = .79) showed a greater increase in social connectedness compared to the “Non-spacious” condition (M = .19, SD = .59). To test the hypothesis 1, the two-way ANOVA was conducted to examine the effect of nature, differentiating between spacious nature and non-spacious nature, on social connectedness. The analysis revealed an insignificant effect of nature on social connectedness (F (1, 133) = .07, p = .93). The effect size of nature comparing spacious and non-spacious nature was measured using Cohen’s d, indicating a small effect size (d = .13). Therefore, hypothesis 1 was rejected.

Regarding hypothesis 2, the difference in social connectedness between the “Autobiographical” condition (M = 0.35, SD = 0.82) and the “Neutral” condition (M = 0.13, SD = 0.51) indicated a greater mean difference for the autobiographical storytelling group. Therefore, the effect of storytelling on social connectedness was tested by exploring the difference between autobiographical and neutral storytelling. The findings indicated an

insignificant effect of storytelling on social connectedness (F (1, 133) = 2.94, p = .09). For storytelling comparing autobiographical and neutral storytelling a small effect size (d = .31) was computed. To gain an insight into the interaction of storytelling and nature on the dependent variable of social connectedness, the interaction effect of nature and storytelling was tested. Results showed a not significant interaction effect of nature and storytelling (F (1, 133) = .53, p = .47) on social connectedness. Consequently, the results suggest that "Storytelling" as well as the interaction between "Nature" and "Storytelling" do not have a significant effect on social connectedness. Thus, hypothesis 2 was rejected.

Overall, when comparing the difference between pre-measured and post-measured social connectedness scores, the "Spacious/Autobiographical" condition exhibited the largest increase in mean score with a difference of 0.38 (SD = .98), while the "Non-spacious/Neutral" condition showed the lowest increase with a difference of 0.12 (SD = .59). Nevertheless, with the post hoc test no significant difference was found between the extreme conditions "Spacious/Autobiographical" and "Non-spacious/Neutral" (t (60) = 1.4, p = .16), suggesting no significant difference between the two extreme conditions. Therefore, the condition with spacious nature and autobiographical storytelling task did not result in a significantly higher mean than the condition in which participants were exposed to non-spacious nature and a neutral storytelling task.

Hypothesis 3 and Hypothesis 4

For the covariation analysis, the two-way ANOVA analysis was conducted adding first neuroticism, and second openness to experience to assess the relationship between nature, storytelling, and social connectedness while controlling for neuroticism and openness. The results indicated an insignificant interaction effect of nature and storytelling (F (1, 133) = .8, p = 0.37) when including neuroticism, suggesting neuroticism as a covariate to have no significant contribution to the model. The analysis controlling for openness to experience showed similar nonsignificant effects, with no interaction effect of nature and storytelling when controlling for openness to experience (F (1,133) = .42, p = .52). Therefore, both the third and fourth hypotheses were rejected.

Discussion

Main Findings

This study explored how the combination of spacious nature exposure and autobiographical storytelling influences social connectedness among university students. The main research question guiding this study was whether the personality traits of neuroticism and openness to experience could explain the variation in the relationship between exposure to spaciousness or non-spaciousness nature, combined with autobiographical or neutral storytelling, and social connectedness in university students. To address this research question four hypotheses were formulated and tested based on the results obtained from the statistical analysis. Exposure to spacious nature in comparison to non-spacious nature is suggested to have a positive effect on social connectedness. Furthermore, engaging in autobiographical storytelling compared to neutral storytelling is proposed to have a beneficial impact on social connectedness as well. Moreover, the covariation of the personality traits neuroticism and openness to experience are examined in this relationship.

The hypotheses have been rejected as no significant effect was found between nature, storytelling, and the variable of interest, social connectedness. Furthermore, no covariation of neuroticism or openness to experience has been found. The current findings do not confirm that either spacious nature, autobiographical storytelling or the combination of these two variables may have an effect in enhancing social connectedness among university students. Therefore, the results should be compared to the existing literature in terms of differences in study design as well as possible limitations that could have caused these deviations.

Contrary to hypothesis 1, the results did not yield significantly different outcomes after exposure to spacious nature. Unlike the findings of van Houwelingen-Snippe et al. (2020), where the "Non-spacious" nature" condition had a significant impact on interpersonal communication compared to the "Non-spacious" nature condition, the current study did not find a significant effect of exposure to non-spacious nature on social connectedness. Van Houwelingen-Snippe et al. (2020) highlighted the importance of stimulus order, as the greatest difference in effects between spacious and non-spacious scenes was observed when a spacious stimulus preceded a non-spacious stimulus. Therefore, being exposed to both nature types, especially the spacious nature before the non-spacious nature, may have greater effects on the social connectedness level of the participants (van Houwelingen-Snippe et al. (2020).

In Otten et al.'s (2023) research, it was found that exposure to virtual nature in older adults creates associations that can form the basis for conversations. Whereas the study by Otten et al. (2023) was conducted with Dutch participants over 60 years old, the current study

was carried out with international university students between 18-30 years old. The differences in sample characteristics between the two studies may explain the insignificant results, as older adults might be more responsive to nature exposure. Another possible explanation is that older adults experience more personal associations after nature exposure compared to young adults. Less personal associations when being confronted with nature might also cause less effect on social connectedness as associations have been shown to play a role in nature exposure and its beneficial outcomes (Hendriks et al. 2016; Otten et al. 2023).

In contrast to the research conducted by van Houwelingen-Snippe et al. (2020), which utilized two 4K projectors and a scent machine for nature exposure stimuli, this study presented participants with a short video on smartphones or laptops. This difference in stimuli presentation and development may have led to less immersion in the nature scene, as immersion is a crucial advantage of digital multisensory nature exposure (van Houwelingen-Snippe et al., 2020). Although the current study included nature sounds, which enhance immersion (Ratcliffe et al., 2013), it did not incorporate a similar smell component as used by van Houwelingen-Snippe et al. (2020). Since smell is known to be one of the key distinctions between actual nature and virtual nature, utilising multisensory nature exposure could have resulted in greater effects of the nature stimuli on social connectedness (Kjellgren & Buhrkall, 2010).

Furthermore, unlike van Houwelingen-Snippe et al. (2020), this research did not examine the effect of spacious nature without a storytelling task. Previous studies indicate that nature exposure evokes positive emotions, which subsequently promote prosocial behaviour (Zhang et al., 2014). It is worth considering that negative associations can negatively impact mental well-being (Westerhof et al., 2010). Since the storytelling task in this study did not specifically instruct participants to recall a positive memory or control for potential negative associations, it may have influenced participants' emotions and interfered with the potential positive emotions induced by the nature scene. Therefore, without the inclusion of storytelling, the effect of spacious nature alone could have had a stronger impact on the participants' level of social connectedness (van Houwelingen-Snippe et al., 2020).

Similarly, hypothesis 2 was not supported, as there was no significant increase in social connectedness after engaging in the autobiographical storytelling task. These findings suggest that neither spacious nature nor storytelling had a significant impact on social connectedness. In contrast, Parson et al. (2022) examined the effects of pandemic journaling, where participants documented their experiences during the COVID-19 pandemic to share with others. An important aspect is that unlike this study, where the participants completed a

single short writing task, Parson et al. (2022) involved participants in weekly journaling over a period of time. Considering the lack of repeated storytelling in this study, the limited engagement in storytelling may have been insufficient to produce significant effects.

Moreover, the storytelling task solely involved an online writing activity. Studies by Stargatt et al. (2022) found that storytelling enhances conversational material, while Gogu and Kumar (2021) noted a decrease in social connectedness when transitioning from face-to-face to online classes, highlighting the benefits of in-person conversations. Possibly, face-to-face storytelling tasks result in greater beneficial effects on social connectedness. Therefore, a different study design involving interviews or participants who can engage in actual conversations may lead to a more significant increase in social connectedness.

Hypotheses 3 and 4, which examined the covariation of neuroticism and openness to experience, were rejected. These results suggest that personality traits did not affect the relationship outcomes. Unlike the results reported by Newman and Brucks (2016), which indicated that individuals with high scores in neuroticism exhibited a different response to nature exposure than individuals scoring low in neuroticism, this study did not find any indication of neuroticism as a covariate. This might have been caused by the comparison between the two nature scenes. Particularly, Newman and Brucks (2016) and Mendardo et al. (2021) suggest that neuroticism plays a role when comparing nature and urban environments, with high neuroticism being associated with beneficial effects in urban environments. As the current study compared spacious and non-spacious nature, neuroticism may not have played a role in the comparison of these specific nature scenes.

Studies by Silvia et al. (2015) and van Elk et al. (2019) emphasize the connection between high openness to experience and awe. Awe is known to positively influence the impact of nature on individuals' sense of social connectedness with higher levels of awe being associated with stronger effects of nature. However, since this study did not specifically investigated feelings of awe after nature exposure, it cannot ensure that participants experienced awe during the study (Piff et al., 2015; Stellar et al., 2017). Worth mentioning is that in the pilot test, items related to vastness from the awe scale were used to assess the designed nature scenes. Hence, it can be argued that the nature scene at least partially should have evoked awe in the participants. Nevertheless, controlling for the variable of awe, specifically, could lead to more precise findings regarding the effects of awe and its relationship with openness to experience and nature exposure.

Overall, the baseline levels of social connectedness in university students were relatively high during the pre-measurements, with participants tending to disagree with the

items on the scale. This suggests a possible ceiling effect, making it challenging to detect significant differences between pre-and post-measures and observe strong effects of nature exposure on social connectedness. Unlike previous studies focusing on university students, this finding challenges the assumption of low social connectedness among this population. (van Houwelingen-Snippe et al., 2020; Lederer et al., 2021). It indicates that many students still exhibit a significant degree of social connectedness despite the challenges posed by the pandemic such as less social contact (Lederer et al., 2021). Additionally, the shift from online to on-campus education following the pandemic may have contributed to an overall increase in social connectedness among university students (Gogu & Kumar, 2021). These findings highlight the adaptability of students and their ability to recover from pandemic-related consequences, indicating the need for further research on social connectedness in this population.

Limitations & Strengths

Possible explanations for the main findings in this study could be attributed to methodological limitations, sample characteristics, or the specific design of the interventions. First, the results suggest a ceiling effect on the social connectedness scale due to the highly negative phrasing, as indicated by the high mean scores. Participants generally disagreed somewhat with the scale items in the pre-test, indicating no lack of social connectedness. This aligns with a study by Lee and Lee (2001) which revised a social connectedness scale due to the absence of positively phrased items. The extremely negative phrasing may have limited the scale's ability to capture the full concept of social connectedness (Lee & Robbins, 1995), possibly contributing to the absence of significant effects in this study.

Additionally, participants' comments in the survey indicated dissatisfaction with the quality of the nature video, hindering their immersion in the video. One participant commented: "*The video that selected seemed somehow out of place, the unrealistic environment, the low FPS, the graphics, it all seemed fake or outdated. If modern graphics or real nature were used, I would have felt completely different*." indicating that many participants might have felt different after being exposed to real nature or a high-quality video. This aligns with a study by Kjellgren & Buhrkall (2010), which compared the restorative effects of actual nature versus simulated nature. The findings highlight that actual nature generates more positive associations and energy recovery than simulated nature, possibly due to greater altered states of consciousness and fascination (Kjellgren & Buhrkall, 2010).

The stimuli in this study were carefully controlled to primarily differ in terms of Spacious characteristics. The nature videos were designed using software that allowed minimal manipulation between the "Spacious and "Non-spacious" nature conditions, specifically focusing on spaciousness as the differentiating factor. This excluded other changes in natural characteristics that could have influenced the outcome variable. Previous research suggests that different nature characteristics, such as the mystery of nature with hills and pathways, evoke specific associations (Otten et al., 2023). A less specific manipulation might have caused changes in nature characteristics that could have had a stronger effect on the outcome variable. Nevertheless, the software used to create the nature videos had certain limitations, preventing the inclusion of specific features. For instance, it was not possible to design a perspective that simulates an overlooking view, which is known to evoke a feeling of smallness and spaciousness (Piff et al., 2015).

Moreover, participants in this study expressed a desire for a longer video duration to enhance their immersion in the nature scene. Previous research highlights the importance of nature immersion and the use of virtual reality to increase immersion (Mostajeran et al., 2021; Ratcliffe et al., 2013). Van Houwelingen-Snippe et al. (2020) found that distractions and lack of presence hindered immersion and the beneficial effects of nature. This study did not measure immersion or presence. Therefore, it was not possible to gain further insight into the participants' level of immersion. Participants mentioned their inability to fully immerse in the video, indicating a potential lack of immersion. Hence, a longer and higher-quality video could have a stronger effect on the outcome variable. The limitation in the stimuli design, particularly the video duration, may have influenced the impact of spacious nature on social connectedness.

One notable strength of this study is the representative sample that accurately reflects the target group in terms of gender, age, and educational degree. However, increasing the sample size could have improved the statistical power of the study and potentially yielded different outcomes, as some p-values were close to significance ($p < .10$) but did not reach conventional levels of significance ($p < .05$). Therefore, conducting the study with a larger number of participants could have resulted in significant findings.

Furthermore, a pilot test was successfully conducted to evaluate and rate the nature scenes in terms of high and low spacious videos.

Recommendations for Future Research

With limitations taken into account combining spacious nature and autobiographical storytelling holds promise as a potentially effective approach. However, future research

should address the limitations of this study including working with a larger and diverse sample, the consideration of additional personality traits, and the use of alternative stimuli developments.

Due to the negative feedback regarding both nature videos, it is highly recommended to make use of high-quality videos in future studies. Another possibility would be to test this study design with virtual reality technology, similar to the study by van Houwelingen-Snippe et al. (2020) which showed significant effects with presenting nature stimuli via a 4K projector. With virtual reality methods, an interactive environment can be simulated through head-mounted display (HMD) technology creating a 360-degree environment (Reece et al., 2020). Therefore, the participant might be better able to immerse in the virtual nature. It is also suggested to check a comparison between virtual nature videos and digital nature videos since it was often argued that immersion might have been better possible if the nature exposure would have been a digital video, for example, filming a walk through a forest.

To check whether the social connectedness scale indeed presents items that are phrased too negatively it is suggested for future research to make use of the revised social connectedness scale by Lee and Lee (2001) or a different scale. This will also give another insight into the overall social connectedness within the target group, as this study suggests no significant deficiency of social connectedness in the used sample. Alternatively, future research could use a lack of social connectedness as an inclusion criterion or explore a different population that experiences a lack of social connectedness, such as older adults (Vozikaki et al., 2018).

A longitudinal research study is suggested to test the conditions in the long run. As the participant is only exposed to a short video and has to engage in a brief storytelling task the exposure might have been too short to impact the social connectedness of the participants. Similar to the storytelling task in the study by Parson et al. (2022) participants could carry out a storytelling task each week. Therefore, a study design where participants are exposed to the stimuli multiple times within a longer time frame might increase the effect on social connectedness.

To investigate the role of neuroticism in the relationship between spacious nature on social connectedness it might have been more effective to use a video that exposed the participant to an environment with more cues (Menardo et al. 2021; Newman & Brucks, 2016). As existing research suggests that especially urban environments have beneficial effects on the well-being of individuals high in neuroticism, comparing a spacious nature

scene with an urban environment might have highlighted a greater difference between the two conditions (Menardo et al. 2021).

Furthermore, since no significant effect of openness to experience was found and considering the known correlation between openness and feelings of awe, it is recommended that future studies thoroughly investigate the relationship between these two variables (Piff et al., 2015; Stellar et al., 2017).

Lastly, it is important to acknowledge that other personality traits not examined in this study may still contribute to variations in the outcome of nature interventions. Research by Di Fabio and Rosen (2019) underlines the relationship between agreeableness and extraversion on nature connectedness. Further research exploring the interplay between various personality dimensions and intervention outcomes would provide a more comprehensive understanding of these relationships.

Conclusion

Overall, this study provides valuable insights into the potential of combining spacious nature and autobiographical storytelling to enhance social connectedness among university students. To conclude, neither spacious nature nor autobiographical storytelling had a significant effect on social connectedness. Additionally, the analysis did not find any covariation of the personality traits neuroticism or openness to experience. Since this is contrasting with existing studies, these findings underline the need for further research to investigate the complexities of these relationships. Future research can build upon these findings by using multisensory stimuli, interactive storytelling tasks or a focus on other personality traits to develop more effective interventions for promoting social connectedness in this population.

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Appendix

Appendix A: Pilot Test

Please rate video 1 on the scale

I felt that I was in the presence of something grand

I experienced something greater than myself

I perceived something much larger than myself

I felt in the presence of greatness

I perceived vastness

Appendix B: Informed Consent

Dear student,

You are being invited to participate in a research study "Promoting Social connectedness by combining storytelling and nature".

This study is conducted by Hannah Lütke-Bohmert, Serafima Anickova and Jana Schultheiss from the Faculty of Behavioural, Management and Social Sciences at the University of Twente. The supervisors of the current study are Prof. Gerben Westerhof and Kars Otten.

The purpose of this research study is to gain more insight into digital nature and storytelling and will take you approximately 15 minutes to complete.

Please take time to read the following information carefully before you decide whether or not to take part, it is important for you to understand what participation in the study will involve.

We are looking for participants who are at least 18 years old.

Participants need:

a stable internet connection

headphones to listen to the audio in the video

to be in a quiet place without distractions

to have a good command of the English language.

Your participation in this study is entirely voluntary and you can withdraw at any time.

Your answers in this study will remain confidential. We will minimize any risks by anonymising all names and personal information and secure the collected data according to the ethical standards of the BMS faculty University of Twente. Therefore, we ask you to answer as honestly as possible.

Before you can start with the survey, we ask you to read the information on the next page carefully, and agree by clicking 'YES'.

Thank you in advance for your participation!

Please feel free to contact the researchers if you have any questions:

h.lutke-bohmert@student.utwente.nl
j.schultheiss@student.utwente.nl
s.anickova@student.utwente.nl

Informed Consent

By clicking YES below, I agree to the following:
I understand that my participation is voluntary. I also understand that I have the right to withdraw from the study at any time without needing to give a reason if I experience any discomfort or distress. Furthermore, it is clear to me that all data that are collected are treated completely anonymously and cannot and will not be traced back to my identity.
I agree to participate in the study:

Appendix C: Pre-Test

Demographics

Item 1: What is your age?

Item 2: What is your sex?

Item 3: What is your nationality?

Item 4: What is the highest level of education you have completed or the highest degree you have received?

Item 5: Are you an international student at your university?

Neuroticism

Please answer these statements below: I see myself as someone who...

Item 1: Is depressed, blue

Item 2: Is relaxed, handles stress well

Item 3: Can be tense

Item 4: Worries a lot

Item 5: Is emotionally stable, not easily upset

Item 6: Can be moody

Item 7: Remains calm in tense situations

Item 8: Gets nervous easily

Openness to experience

Please answer these statements below: I see myself as someone who...

Item 1: Is original, comes up with new ideas

Item 2: Is curious about many different things

Item 3: Is ingenious, a deep thinker

Item 4: Has an active imagination

Item 5: Is inventive

Item 6: Values artistic, aesthetic experiences

Item 7: Prefers work that is routine

Item 8: Likes to reflect, play with ideas

Item 9: Has few artistic interests

Item 10: Is sophisticated in art, music or literature

Social connectedness

Please think about your relations with people/society and answer these statements below.

Item 1: I feel disconnected from the world around me

Item 2: Even around people i know, I dont feel that I really belong

Item 3: I feel so distant from people

Item 4: I have no sense of togetherness with my peers

Item 5: I dont feel related to anyone

Item 6: I catch myself loosing all sense of connectedness with society

Item 7: Even among my friends, there is no sense of brother/sisterhood

Item 8: I dont feel that I participate with anyone or any group

Appendix D: Pilot Study- Nature Stimuli

Figure D1

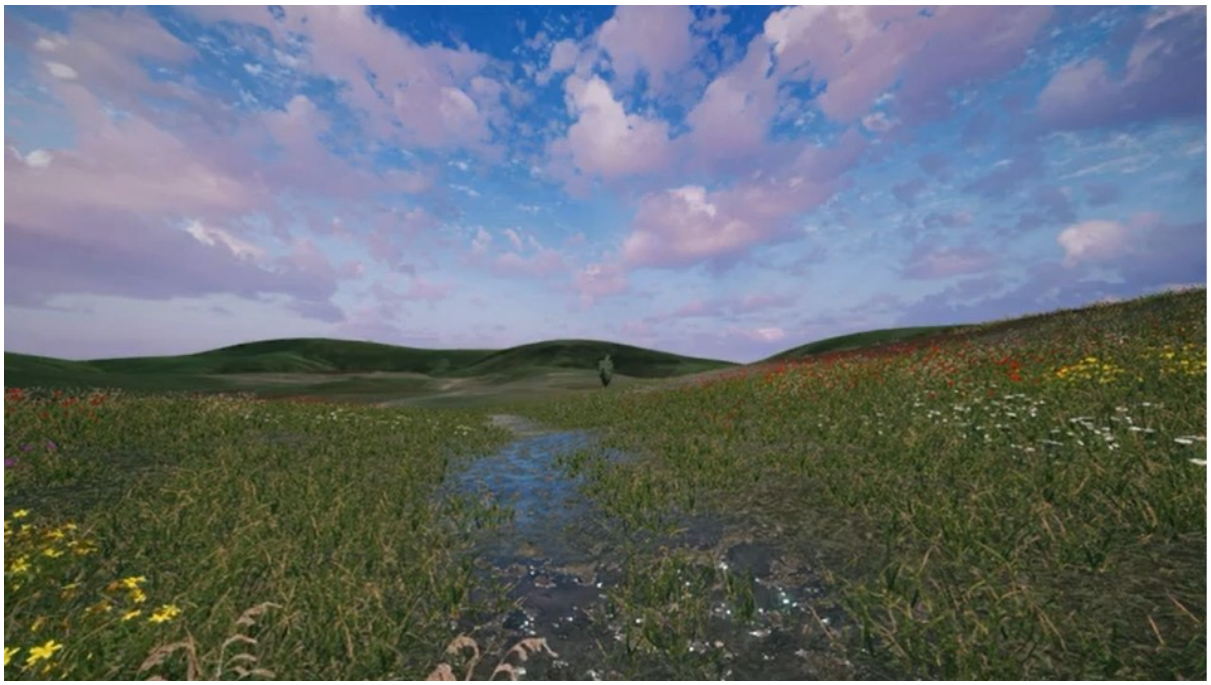

Figure D2

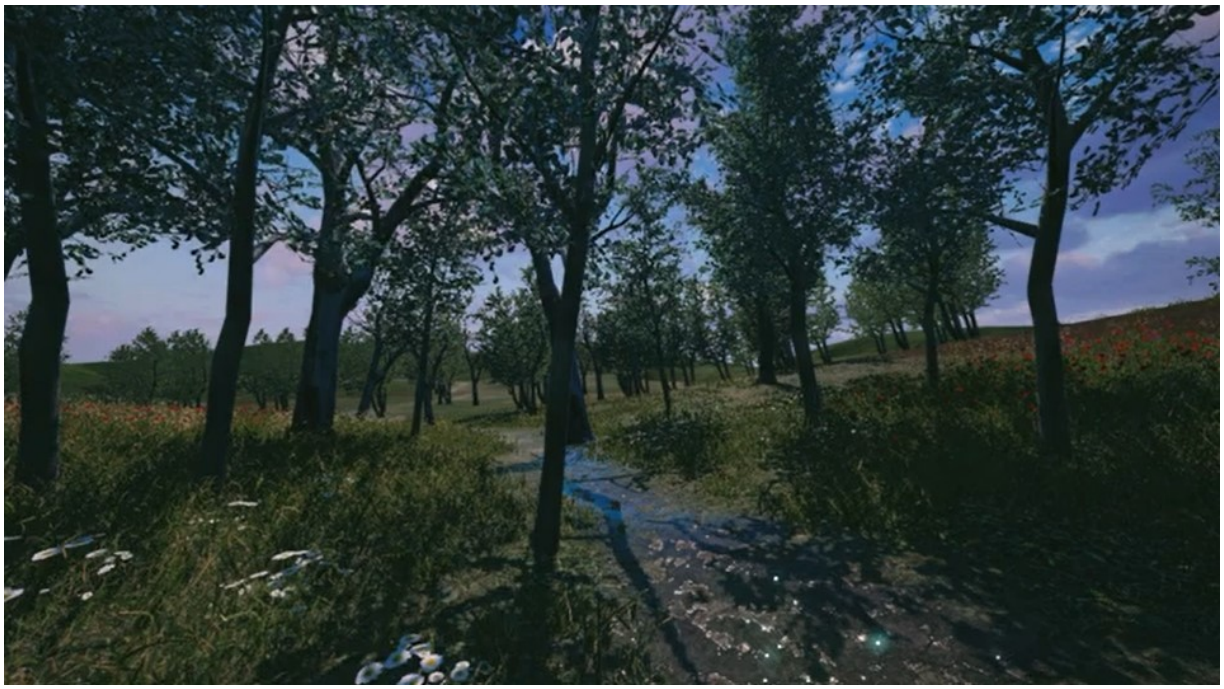

Figure D3

Figure D4

Figure D5

Figure D6

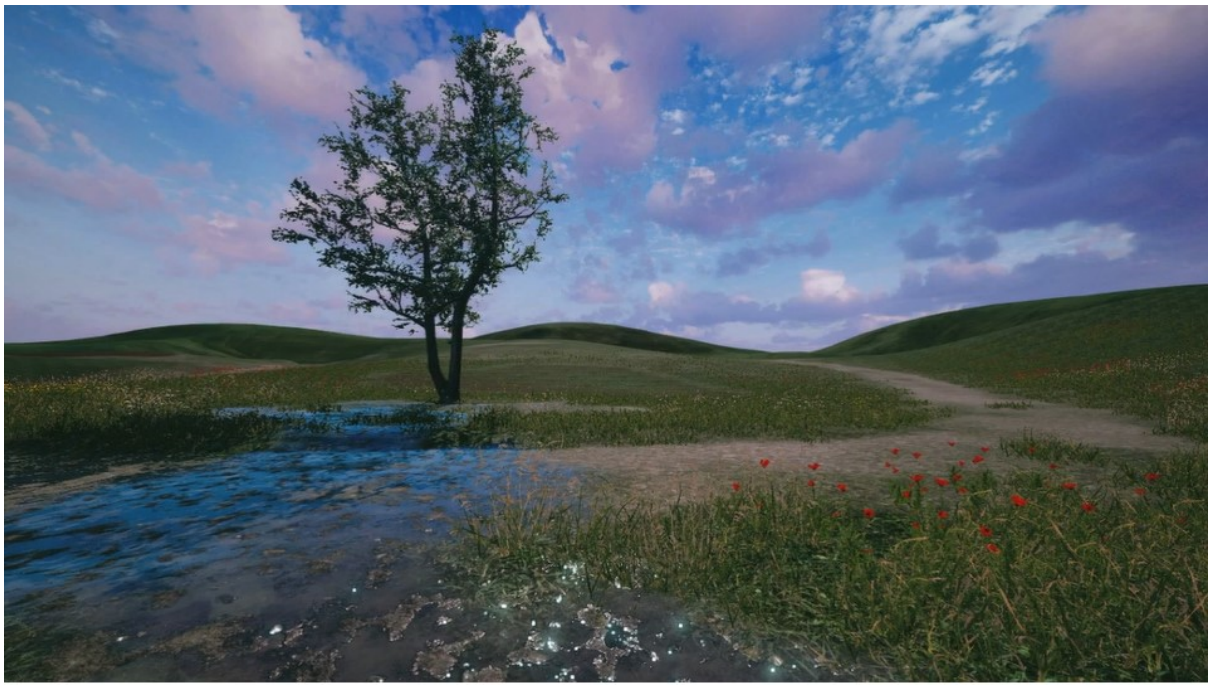

Figure D7

Figure D8