Understanding the Influence of Awe in Virtual Reality on Social Well-being

B. Sc. Thesis

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Abstract

Awe is a self-transcendent emotion, which was found to have a strong transformative impact on social cognition and behaviour (e.g. increased prosocial behaviour and social connectedness (Piff et al., 2015; Rudd et al., 2012; Nelson Coffey et al. 2019, Yaden et al. 2019). Because both factors were found to be related to increased social well-being (Helliwell et al. 2017; Iqbal, 2022; Sulaiman; 2007), this study aims to explore how a single induction of awe in variant virtual environments impacts the individual dimensions and the general level of social well-being. The effects were tested in three experimental conditions. The conditions were "Humanmade structures", "Space" and "Nature". Each condition was an immersive virtual environment (VE) that participants explored using Virtual Reality (VR) glasses. It was hypothesized that the overall level of awe and social well-being should increase after exposure to the virtual stimulus in each condition. The following dimensions of social well-being where thought to be affected by the VEs of this study: Social actualization was thought to increase in the condition "Humanmade structures" which was a 3d model of London, social integration in the condition "Space" which granted participants a look at the earth from space and social coherence in the condition "Nature" which was 3d model of the Mount Everest. A significant effect on awe was only found in the "Humanmade structures" and "Space" conditions. No significant effect on general social well-being levels was found in any condition. Social integration was the only dimension that significantly increased after the experiment in the conditions: "Humanmade structures" and "Space". The findings of this study strengthen the claim that social integration is positively affected by awe and that it can be increased through a single VR experience. Through experimentation with further factors (e.g., social cues or different environments), effects on social well-being and its dimensions should be further tested.

Introduction

According to Reddy (2009), self-transcendent emotions have been largely overlooked in traditional emotional research. Newer findings that found self-transcendent emotions to play a crucial role in promoting prosocial behaviour and social cohesion motivate investigation into its precise mode of action (Haidt, 2009). Scientific research of the last years revealed the potential of self-transcendent emotions to increase well-being as well as their overall positive effect on physical and mental health (Yaden et al., 2017; Salovey et al., 2000; Monroy et al., 2023). Emotions identified as self-transcendent are e.g., compassion, awe, and gratitude (Stellar et al., 2017). In the current understanding of self-transcendent emotions, they are thought to shift the perception towards memorable stimuli outside the self and have a strong transformative influence on the cognition and emotions of individuals (Van Cappellen, 2017; Chirico et al., 2018). More specifically acting as promoters of cooperation and group stability, amplifying connectedness in social relationships (Haidt, 2003).

Strong transformative potential on psychological and physiological levels found in awe specifically raises questions about the way it effects wellbeing and whether it can be utilized in clinical practice (Chirico et al.,2018). Research indicates that the induction of awe can for example lead to a more generous attitude towards the stimulus presented (Piff et al., 2015; Prade & Saroglou, 2016), higher satisfaction in life and even positively affecting the immune system minimizing the risk of catching cardiovascular diseases (Krause & Hayward, 2015; Stellar et al., 2015). Awe can be described as an overwhelming emotion that humans feel after being presented with a stimulus that they find difficult to comprehend. It is often accompanied by a feeling of connectedness to the world and a decreasing perception of the importance of the self compared to the grandness of the stimulus (Chen & Morgrain, 2020; Bai et al., 2017). Monroy et al. (2021)

identified four different pathways through which awe can positively affect mental and physical health: neurophysiological changes, diminished sense of self, increased prosocial relationality, increased social integration, and increased sense of meaning or serving a larger purpose. The theoretical understanding of this emotion, which was thought to be too complex to measure for a long time is getting more extensive making the analysis of its effects on mental health easier, motivating studies as such (Monroy et. al, 2021). Awe occurs when individuals are exposed to stimuli that are vast on a perceptual, conceptual, or semantic level. (Keltner & Haidt, 2003). When the grandness of the stimuli exceeds the current frame of reference, existing mental structures are adjusted to process what has been perceived (Keltner & Haidt, 2003). Awe can be directed towards objects or persons (Monroy et al., 2018). Examples of experiences that can trigger awe are panoramic views of sunsets, consuming art or seeing the Earth from out of space. (Monroy et al., 2021)

In the last few years, the ability to simulate such scenarios to induce awe digitally through videos or virtual reality (VR) and its benefits have become an increasing focus of research. With the rapid advancement of technology, the question arises about the potential value added by inventions like VR to the research and practice of mental health. VR enables users to immerse into a computer-generated environment and produce a seemingly authentic experience interacting with the created framework. It was found that simulating real-life scenarios through VR can evoke strong emotional reactions in a controllable way as research about its use in exposure therapy shows (Rothbaum et al., 2016; Meyerbröker et al., 2014). An experimental study by Chirico et al. (2018) investigated the power of Virtual Environments (VE) to induce awe and found scenarios where participants were shown woods with large trees, a panoramic view from a mountain with snow and a look of the earth from space to significantly induce awe.

The view from the mountain was able to elicit the strongest feelings of awe. As vastness and the need for accommodation were reported exceptionally high in this condition, it may be that the height of the mountain and the panoramic complexity remembered the participants strongly about the fragility and unimportance of their small self, compared to the vast and powerful stimulus (Chirico et al., 2018). The usage of VR to induce awe promises to have the ability to create any scenario and make experiences easier to track, through the controllability of stimuli and technological measurements in a laboratory setting compared to traditional ways of visiting awe-inducing places in nature (Chirico et al., 2019). Therefore, interest lies in the expansion of research on the potential role of VR in the practical implementation of awe-related research.

Among many other positive effects, the induction of awe in laboratory and naturalistic settings was found to be related to prosocial tendencies (e.g. willingness to participate in charity activities), prosocial behaviour towards the researcher and participants (e.g. pens dropped by the researcher were picked up and given back more often by participants and higher generosity in economic games was found) and stronger feelings of connection with the social and natural world (e.g. increased collective concern, as well as increased identification with humankind and the planet as a whole) (Piff et al., 2015; Rudd et al., 2012; Nelson Coffey et al. 2019, Yaden et al. 2019). Behaving prosocial or having the tendency to do so refers to a voluntary act to help others, even if the actor gains no advantages (Wittek & Bekkers, 2015). Studies found that such behaviours are connected to higher subjective well-being with the strongest effects found when such behaviours increase the social capital (Helliwell et al. 2017). According to the Oxford Learner's Dictionary social capital is defined as "the networks of relationships among people who live and work in a particular society, enabling that society to function effectively" (Social Capital - Oxford Learner's Dictionaries, n.d.). One aspect through which social capital can be

increased is interpersonal relationships. It describes how well two or more people are associated, connected, or affiliated. Research suggests that feeling more strongly connected to the personal social network relates to increased social capital. A few papers found positive associations between social capital and social well-being (Iqbal, 2022; Sulaiman; 2007). This would suggest that the increased feeling of connectedness to society that participants feel after experiencing awe should increase their social capital and finally social well-being. Keyes (1998) defined social well-being as the individual's evaluation of the quality of their relationship with other people, the neighbourhood and society. He argues that social well-being is composed of five dimensions: social integration, social contribution, social coherence, social actualization, and social acceptance. Social integration is about the evaluation of how strongly someone has something in common, belongs to, or feels part of their social environment. Social contribution relates to how strongly an individual feels like they can contribute something useful to their social network or society in general. Social coherence can be defined as the level of caring and understanding an individual has about the world, they live in. Social actualization comprises feelings of hope about society's trajectory, seeing its potential and understanding what importance the actions of everyone can have in forming a better world. Lastly, social acceptance is about the evaluation of human nature in general. It can be expressed by feelings of trust in people's ability to be kind and industrious. The positive impact of awe found on social cognition and behaviour, as earlier discussed in the paper raises the question of whether a single induction of awe with VR can significantly influence social well-being or any of its corresponding dimensions and whether the type of VE used to induce awe influences which dimension is affected. A single induction was chosen, because previous studies on the transformative properties of awe in naturalistic as well as laboratory settings, showed a single awe experience to

produce significant effects on a variety of social factors thought to be involved in the development of social well-being (e.g. increased social connectedness, social integration, and prosocial behaviour) (Piff et al., 2015; Rudd et al., 2012; Nelson Coffey et al. 2019, Yaden et al. 2019).

The first VE “Nature” was the Mount Everest. As the name suggests, this environment contained the context of nature. In the history of awe related research, this is a recurring context of stimulus, used in laboratory and naturalistic settings to induce awe (Chirico et al., 2018; Monroy et al., 2022). This is due to the variety of vast stimuli that can be found in nature. In the first experimental study on the induction of awe through VR the simulation of a panoramic view from a mountain was found to effectively induce awe (Chirico et al., 2018). Seeing nature’s ability to produce awe raises the question whether the naturalistic context influences the effect on participants social wellbeing differently than other scenarios. In this condition, significantly high levels of social coherence are expected, because seeing the complexity and beauty of nature paired with the increased appreciation for the stimulus found with awe experiences (Piff et al., 2015; Prade & Saroglou, 2016) may increase participants' acknowledgement for nature and trigger a person's need to care for it. Furthermore, participants may experience a perspective shift to the core of life, with natures being simple but vast and compared to their self-centered thoughts and problems this look outside may help them understand their role in the world.

The second environment “Space” was the view from out of space towards the Earth. In this condition the context differs towards “Nature” in a sense that participants get an unusual perspective, which would outside of VR be reserved for astronauts on space missions. It is interesting to see how participants react on a vast, exclusively perspective changing stimulus that cannot be revisited in the real life. This study hypothesizes that participants from the space

condition report higher levels of social integration compared to participants from other experimental groups. Because looking at the earth from a distance expands the scope and shows the world as one functioning unit, feelings of separation towards other humans may decrease. This could lead to feeling more strongly socially integrated. The ability to produce awe by looking at the Earth from Space is backed up by science and rooted in the so-called overview effect. The overview effect describes the phenomenon where astronauts coming back from space missions recall strong experiences of connectedness to the world, awe, and self-transcendence after looking down on the Earth for the first time (Yaden et al., 2016). In previous studies, it was also found to be a scenario that induces feelings of awe strongly in VR (Stepanova et al., 2019).

The last environment “Humanmade structures” will be in London. Having a natural simplistic but vast context and exclusive perspective changing context, it was decided to add another context incorporates a stimulus that is strongly related to the work of humanity. Because awe is triggered by vast stimuli, that are difficult to comprehend it is interesting to find out how strongly such feelings can be evoked by architectural buildings, which have a complexity that humans may find fascinating and difficult to grasp. It is also interesting to find out how the effect on social well-being” differs in an awe-inducing stimulus created by humans compared to stimuli in nature or space. For this environment, it is hypothesized that social actualization increases significantly higher compared to the other conditions. Seeing the complexity and grandness of things humans have created through the example of the big city of London may lead to appreciation, paired with increased connectedness awe triggers (Bai et al., 2017) of the potential that lies in society to deal with problems and evolve itself. To explore how strongly one single VR-induced awe experience can increase social well-being the following research question and its corresponding hypotheses are posed:

To what extent does VR-induced awe influence social well-being and how do the effects among its dimensions differ between variant stimuli?

H1: The level of awe significantly increased after exposure to the virtual stimulus in every experimental condition.

H2: Social well-being significantly increases after exposure to the virtual stimulus in every experimental condition.

H3: Social actualization significantly increases after exposure to the virtual stimulus in experimental condition “Human-made structures”.

H4: Social integration significantly increases after exposure to the virtual stimulus experimental condition “Space”.

H5: Social coherence significantly increases after exposure to the virtual stimulus experimental condition “Nature”.

Methods

3.1 Design

To test the abovementioned research question and its corresponding hypotheses a between-subject pretest-posttest design with 3 experimental groups thought to induce awe was chosen. Those conditions were equally distributed between the participants to ensure a fair comparison of the experimental groups. Because previous research found effects of VR inducing awe and the study investigated differences between the experimental groups on social well-being a control group was not necessary (Chirico et al., 2018, Quesnel & Riecke., 2018).

3.2 Participants

40 participants were gathered in 22 days through voluntary response- and convenience-sampling. They included 20 (50%) males and 18 females (45%) and 2 non-binary (5%) participants were between the ages of 18 and 29 years with an average age of 22 (*SD* = 1.73). Most respondents indicated their ethnic origin to be German (90 %), followed by Dutch (5 %), greek (2.5 %) and half Polish half American (2.5 %). Students of the Faculty Behavioural, Management and Social Sciences gained access to voluntary sign-up via SONA (https://www.sona-systems.com), friends and family of the researchers were asked to participate and information about the study were published on social media (Instagram story of researchers, WhatsApp group chat of bachelor psychology students) to reach as many participants as possible. Each trial took approximately 30 minutes for which participants who signed up via SONA were granted 1 credit point. Inclusion Criteria for participation were being ≥ 18 years old and having moderate English skills to understand the instructions and questionnaires. People with proneness to motion sickness or a history of epilepsy were excluded from the study to minimize potential danger triggered by VR. The “Humanmade structures” condition had 13 participants, The “Space” condition had 14 participants and the “Nature” condition had 13 participants. The study was approved by the ethics committee of the BMS Faculty.

3.3 Materials

The study took place in the Flexperiment room 6 of the Cubicus building on the campus of the University of Twente. The room with two chairs to perform the study in as well as VR goggles with a computer running the software were rented from the BMS Lab (https://www.utwente.nl/en/bmslab/). To simulate awe-inducing scenarios Oculus Rift S VR Glasses including controllers and the app Google Earth VR from the Oculus Store were chosen.

Google Earth VR offers 3d models of real places free of charge (https://www.realityremake.com/articles/google-earth-vr-is-a-mind-blowing-experience). Google Earth VRs accessibility and a great number of intricately detailed places on Earth delivered a quick and uncomplicated way to choose three different environments that promise to elicit awe. The first experimental group exposed participants to humanmade structures and its VE was in London (see Figure 1). The second group explored space and was granted a look at the Earth from far away (see Figure 2) and the last experimental group was set in nature showing participants the Mount Everest (see Figure 3). The surveys, including the informed consent form (see Appendix K), demographic questions about participants age, gender, education, and ethnic origin, as well as the experimental instructions (see Appendix A) and both questionnaires (AWE-S and SW-S) were implemented into Qualtrics which is an online survey tool that enables uncomplicated data management (https://library.maastrichtuniversity.nl/apps-tools/qualtrics/). Participants were either able to access the survey via their smartphone or via the computer that was provided in the room and were standing throughout the VR experiment.

Figure 1.

"Humanmade structures" condition (Google Earth VR preset: London)

Figure 2

"Space" condition (Google Earth VR preset: Space)

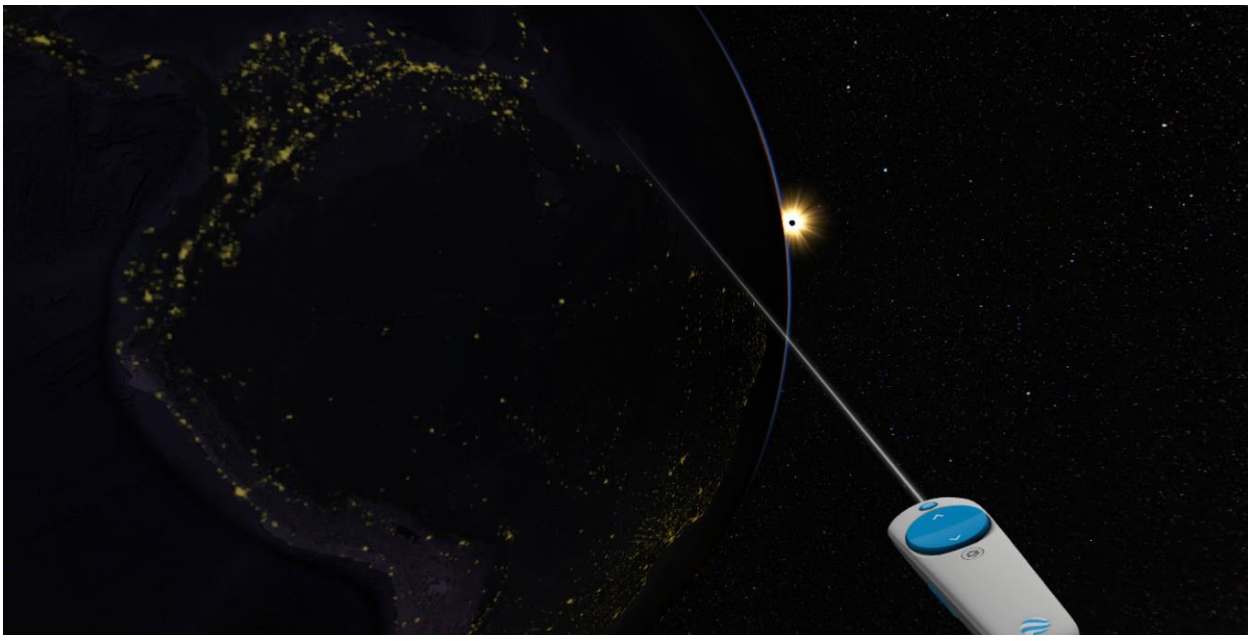

Figure 3

"Nature" condition (Google Earth VR preset: Mount Everest)

3.4.1 Awe Experience Scale (AWE-S)

The AWE-S is a self-report measure of awe that consists of 30 items (Yaden et al., 2018). It is a 7-point Likert scale (ranging from 1= Strongly Agree to 7 = Strongly Disagree) with all items being positively coded. It is comprised out of 6 factors: time, self-loss, connectedness, vastness, physiological, and accommodation. Each factor is measured through 5 individual items. Each factor is measured by the addition of scores of its items and all dimensions added together make up the general level of awe. One example item is "I sensed things momentarily slow down" which belongs to the factor time. The overall internal consistency of this scale was measured to be $\alpha = .92$. The internal consistency of each dimension is the following altered time perception $\alpha = .85$; self-diminishment $\alpha = .81$; connectedness $\alpha = .89$; vastness $\alpha = .88$; physical sensations $\alpha = .89$; need for accommodation $\alpha = .81$ (Yaden et al., 2018). All dimensions of the AWE-S exceed the threshold of .80 showing that each has a good reliability. The overall scale even

exceeds a value of .90 which corresponds to an excellent internal consistency of the chosen scale.

3.4.2 Social Well-being Scale (SW-S)

Social well-being was assessed using the SW-S (Keyes, 1998). This self-report questionnaire consists of 33 items and measures 5 dimensions of social well-being. 7 items belong to social integration, 7 items to social acceptance, 6 items to social contribution, 7 items to social actualization and 6 items to social coherence. It is a 6-point Likert scale (ranging from 1= Strongly Agree to 6 = Strongly Disagree) with 14 positively and 19 reverse-coded items. Each dimension is measured by the addition of scores of its items and all dimensions added together make up the general level of social well-being. One example item is “The world is too complex for you” which measures social coherence. The internal consistency of each dimension is the following: social integration $\alpha = .57$, social acceptance $\alpha = .69$, social contribution$\alpha = .81$, social actualization $\alpha = .75$, social coherence $\alpha = .77$ (Keyes, 1988). These values suggest good internal consistency for 3 dimensions, with Cronbach's alpha coefficients exceeding the commonly accepted threshold of 0.70. The internal consistency of social integration and social actualization is acceptable with social actualization nearly reaching the threshold of 0.70.

3.5 Procedure

Upon arrival, participants were instructed by the researchers about awe, social well-being, the rationale of the study and what to expect when immersing into the VE. Participants were told that the study aimed to measure differences in their effect on awe and social well-being between 3 different VEs and that each participant would be randomly assigned to one of the conditions. The day on which the study took place determined to which condition participants were assigned (e.g. “Nature” condition on Monday, “Space” condition on Wednesday and “Humanmade

structures" on Friday) . More specific information on the investigated differences was not disclosed to prevent biases when filling out the questionnaires. After a brief verbal instruction by the researchers' participants were instructed to open the Qualtrics link where the study continued, and they were further guided in written form. If participants gave their written consent to voluntary participate (see Appendix K), questions about their demographics were asked. Respondents thereupon were instructed to take between one and two minutes to focus their attention on the present moment (See Appendix A). They were instructed to absorb visual and auditive impressions of the current situation and freely decide when to stop, following through with the survey. Based on their experience focusing on the present moment participants were then asked to fill out the AWE-S to collect their baseline of awe. The pretests were then finished with the SW-S measuring their baseline of social well-being. Now they were given verbal instructions on how to pick up and use the VR glasses and what to expect when immersing into a VE. They were additionally reminded to tell the researcher if they felt unwell and informed that in such cases the study would be stopped immediately. Participants now entered their assigned condition in Google Earth VR, which was dependent on the selection of conditions for the specific day. After a short briefing on the controls, participants were asked to explore their given environment for about 5 minutes. They could fly, look at their surroundings and change between day and night. After 5 minutes participants were told by the researchers to find a place in the environment that they find particularly interesting and focus on the present moment for 1 – 2 minutes again. The experiment was then finished, and the VR Glasses were taken off. Now the AWE-S was filled out once again. This time referring to the experience made in the VE. Lastly, the survey on the SW-S was taken one more time. After finishing both questionnaires, the study ended.

3.6 Data Analysis

The dataset, downloaded from Qualtrics, was cleaned, and formatted using Excel. The dataset had no missing values. After the data was fully cleaned, it was analyzed using the software environment R Studio. The following packages were downloaded: tidyverse, readxl, haven, magrittr, dplyr, coin, base, ggplot2, survival, stats. Descriptive statistics including mean and standard deviation of the participants age, gender, ethnic origin, and level of graduation were determined using mean() and sd() functions. The normality of each experimental condition was checked using the boxplot function boxplot() and the histogram function hist(). The results of the normality check can be seen in Appendix B – J. It shows that the data was not normally distributed. It was therefore decided to pick a non-parametric test to be able to compare all conditions accurately. Descriptive statistics from the pre-post differences of awe and social well-being were also computed using the mean scores and the standard deviation. To test for the significance of differences between the pre and post-test scores the Wilcoxon rank sum test with a correction for tied values was used. This test allows median-based comparisons between two groups with data that is not normally distributed. In R the wilcox.test() function was used to perform the test. Afterwards, the results from the Wilcoxon rank sum test were converted into z scores, they were however not used to interpret the results as they were not appropriate for the number of participants collected, which will be addressed later in the discussion. Results from the mean differences and the Wilcoxon rank sum test were used to come up with a direction and significance of the found group differences.

Results

4.1 Preliminary Analysis

In the present study, descriptive statistics were computed to summarize the pretest and posttest differences in awe, social well-being, and its dimensions across the three experimental conditions: "Nature," "Space," and "Humanmade Structures" (see Table 1). For further investigation, inferential analyses were used to test the significance of the found central tendencies.

Table 1:

Descriptive statistics of pretest posttest differences of awe, social well-being, and its dimensions.

	"Humanmade structures" (***N***=13)	"Space" (***N***=14)	"Nature" (***N***=13)	Total (***N***=40)
Awe	*M* = 1.86 *SD* = 0.8	*M* = 1.98 *SD* = 1.21	*M* = 2.86 *SD* = 1.34	*M* = 2.23 *SD* = 1.2
Social well-being	*M* = -0.09 *SD* = 0.6	*M* = 0.18 *SD* = 0.23	*M* = 0.17 *SD* = 0.43	*M* = 0.09 *SD* = 0.45
- Social integration	*M* = 0.30 *SD* = 0.55	*M* = 0.39 *SD* = 0.05	*M* = 0.39 *SD* = 0.05	*M* = 0.27 *SD* = 0.71
- Social acceptance	*M* = 0.27 *SD* = 0.79	*M* = 0.09 *SD* = 0.44	*M* = 0.09 *SD* = 0.44	*M* = 0.05 *SD* = 0.64
- Social contribution	*M* = 0.1 *SD* = 0.71	*M* = 0 *SD* = 0.48	*M* = 0 *SD* = 0.48	*M* = 0.02 *SD* = 0.88
- Social actualization	*M* = 0.18 *SD* = 0.53	*M* = 0.35 *SD* = 0.46	*M* = 0.35 *SD* = 0.46	*M* = 0.13 *SD* = 0.65
- Social coherence	*M* = -0.03 *SD* = 0.48	*M* = 0.04 *SD* = 0.37	*M* = 0.04 *SD* = 0.37	*M* = -0.05 *SD* = 0.4

4.2 Inferential Analysis

H1: Awe levels following the exposure to the experimental conditions.

The results in Table 1 and Table 2 suggest that there was a significant increase in awe following exposure to the virtual stimulus in the experimental group "Humanmade structures" ($M = 1.86$; $p < .0001$), "Space" ($M = 1.98$; $p = .00003$), and "Nature ($M = 2.86$; $p = .0001$) Therefore, hypothesis 1 was accepted.

H2: Social well-being levels following the exposure to the experimental conditions.

The results from the Mean differences and the Wilcoxon rank sum test suggest that in each experimental group "Humanmade Structures" ($M = -0.09$; $p = .681$), "Space," ($M = 0.18$; $p = .134$), and "Nature" ($M = 0.17$; $p = .316$) there is no significant increase in social well-being following exposure to the awe-eliciting stimulus (see Table 1 & Table 2). Accordingly, hypothesis 2 was rejected.

H3: The effect of the "Humanmade structures" condition on social actualization.

In the condition "Humanmade structures", the Mean differences and the Wilcoxon rank sum test indicated no significant increase in social actualization after exposure to the virtual stimulus ($M = 0.18$; $p = .837$) (see Table 1 & Table 2). As a result, hypothesis 3 was rejected.

H4: The effect of the "Space" condition on social integration.

In the condition "Space", the Mean differences and the Wilcoxon rank sum test indicated a significant positive difference in social integration after the experiment ($M = 0.39$; $p = .019$) (see Table 1 & Table 2). Consequently, hypothesis 4 was accepted.

H5: The effect of the "Nature" condition on social coherence.

In the condition “Nature”, the Mean differences and the Wilcoxon rank sum test indicated no significant difference in social coherence between the pre and post-test (M = 0.04; p = .897) (see Table 1 & Table 2). For that reason, hypothesis 5 was rejected.

Table 2:

Pretest-posttest group comparison of awe, social well-being, and its dimensions.

	“Humanmade structures” (N=13)	“Space” (N=14)	“Nature” (N=13)	Total (N=40)
Awe	W = 8**	W = 6**	W = 0**	W = 40**
Social Wellbeing	W = 76	W = 65	W = 64.5	W = 651.5
- Social Integration	W = 58.5**	W = 47*	W = 58	W = 529**
- Social Acceptance	W = 100.5	W = 80	W = 69	W = 747.5
- Social Contribution	W = 82.5	W = 90	W = 83.5	W = 762
- Social Actualization	W = 80	W = 75	W = 74.5	W = 706
- Social Coherence	W = 98	W = 85	W = 87.5	W = 806

Note. * = Wilcoxon rank sum test was used to compare the pre and post-test values per condition; p-value < 0.05; ** = p-value < 0.01

Discussion

5.1 Key Findings

In this study the conditions “Humanmade structures”, “Space” and “Nature” were all found to increase awe in the participants. The strongest difference in Awe levels was found after exposure to the “Nature” condition, “Space” was the second strongest and “Humanmade structures” the least strong predictor of awe. None of the tested VE was found to influence general social wellbeing levels. The only dimension found to be affected by several awe inducing VEs was social integration. It was increased in the “Space” condition which had the strongest effect and in the “Humanmade structures” condition. Based on those finding scientific evidence was gathered for the effectivity of each condition to induce awe and for the positive effect of awe on social integration in the two different conditions (“Humanmade structures”, “Space”).

5.2 Interpretation of the results

5.2.1 The effect of variant stimuli on awe

To explore the effect of awe on social wellbeing it was firstly, checked whether the chosen conditions were able to induce awe effectively. As expected, “Humanmade structures” “Nature” and “Space” were all found to increase participants awe levels. The findings that the “Nature” and “Space” condition were able to induce awe is in line with findings from Chirico et al., 2018 that found a panoramic view from a mountain and a look at Earth from space effective awe-inducing stimuli in VR. According to Keltner & Haidt 2003 vast stimuli, that induce the need for accommodation trigger awe. The vastness found in the “Nature” and “Humanmade structures” conditions may be described as perceptual. In the “Nature” condition the mountains seen are create panoramic width, which complexity seem to trigger the mentioned need for accommodation. Similarly, in the “Humanmade structures” condition large complexes of

buildings and structures relate to each other and are connected through streets which creates the unifying picture of a skyline which seems to trigger the need for accommodation as well. In the "Space" condition the need for accommodation may be explained by conceptual vastness. The interconnection of the world is shown and every place on the earth is shown in a compact visualization, that creates concept of unity, by zooming out of our normal perspective and being able to experience the interconnectedness of the world. This again is in line with reports of astronauts coming back from space, that mention feelings of unity and self-transcendence that elevate their perspective on the world after they had look on the earth from space (Yaden et al., 2016).

5.2.2 The effects of awe and its contexts on social well-being

This study did not find any of the VEs that were found to significantly trigger experiences of awe to be related with social well-being levels apart from its dimension social integration. This is contrary to the assumption earlier made in this paper and the study by Monroy et al. (2022). In this meta-analysis particular pathways, like increased prosocial relationality or increased social integration were identified as effects of awe experiences and their positive impact on social well-being was predicted. Furthermore, studies found experiences of awe to be positively associated with social connectedness and prosocial tendencies, which positively impact social capital which can positively influence social well-being (Chen & Morgrain, 2020; Bai et al., 2017; Piff et al., 2015; Iqbal, 2022; Sulaiman, 2007).

A possible explanation may be the lack of social cues in the VEs. Some participants reported the VE to be lifeless, being alone in the world and having no contact with other humans. Embedding the experience of awe in a social context has been a factor various studies incorporated that found effects of awe on social connectedness or prosocial behaviour. In a study

where elderly individuals participated in an awe group walk (walking through beautiful, vast places in nature) they reported higher levels of social connectedness afterwards (Sturm et al., 2020). In studies where participants showed prosocial behaviour through higher generosity in games or picking up pens that the researcher dropped, they either experienced awe with at least one partner or expressed their behaviour later in a social context (e.g. playing a game together) (Piff et al., 2015). Such observations lead to the hypothesis that the social effects of awe may be affected by the social context in which they are embedded. What speaks against this assumption is the fact that social integration was positively affected even though social cues were missing. Still, it is possible that social integration is more strongly or directly related to awe than other dimensions making the social cues unnecessary for its effect to unfold.

An alternative explanation for the not-found effects on social well-being and its dimensions apart from social integration may be that some dimensions of social well-being take more time or even several experiences to be affected by awe. Social well-being builds up on every social experience we have in life (Keyes et al., 1999). So, one short experience of awe may not be strong enough compared to the collected personal experiences of the asked participants to influence social well-being.

5.3 Strengths and Limitations

A few positive remarks can be made about the overall procedure of this study. Many participants reported this study to be extraordinarily fun and exciting. Participants specifically pointed out that they never experienced VR before and that the environments offered unique perspectives on places different from the perspectives taken in their daily lives. This showed the attractive nature of such immersive experiences, which should simplify the gathering of participants in future research. It can also be pointed out that no participants reported any forms of motion sickness. It

can therefore be stated that exposure of around 5 to 10 minutes in similar VEs should not pose serious health threats for participants and the time was well chosen. In contrast to previous awe-related research in VR (Chirico et al, 2019; Monroy et al., 2018), participants were able to fly through each environment. This enabled participants to get even more unique perspectives on the places shown. Additionally, it should be noted that Google Earth VR is free of charge, which made its usage attractive for this study.

The arguably biggest limitation of this study was tied values that were found in the scores of the AWE- S and SW-S. R studio reported tied values in the scores of the Wilcoxon rank sum test. Although a tool to correct those values was used in R, an error message was still given about found tied values and potentially inaccurate p-values that resulted from this. After converting the W scores into z scores, extreme values were found which would give each dimension extremely significant scores. Such extreme scores suggest that the sample size is too small to produce accurate z scores. According to Piovesana (2014), the size of a sample should not be below 30 to produce z scores that can be used in clinical practice. Because the sample size of each condition was under this given threshold, it was decided to present the results of the mean differences alongside the p-value from the Wilcoxon rank sum test.

The found tied values may possible be explained by respondent fatigue, which is a phenomenon where extensive surveys can lead to fatigue in participants resulting in the report of more similar values and consequently tied scores (O'Reilly-Shah, 2017). According to Jeong et al., (2022), no absolute number of items per survey can universally guarantee the prevention of respondent fatigue, however shortening the survey as well as splitting one big survey into several smaller ones seems to decrease the occurrence of respondent fatigue.

The downside of using Google Earth VR was that the customizability of each environment was restricted by the prebuild selection of VEs provided. For higher customizability of environments and factors that change the impact of awe on social well-being programs should be used that allow individual programming of the scenario wished to create. In the environments chosen social interactions with humans were missing which may have led to a less intensive experience of the VE and different effects on social well-being.

5.4 Future Research

An effect of awe on social well-being was not found after a single induction of awe in VR. As the literature implies a connection between both variables the relationship may be further explored with a few changes of the design used in this study. In future research longitudinal designs may be used to test the previously discussed assumption that the effects on certain aspects of social wellbeing take time or need several experiences of awe. One example of such design may be the comparison of dispositional awe on the development of social wellbeing over time, meaning that it could be tested if phases in life with more awe experiences relate to higher levels of social wellbeing. Furthermore, the used design in this study could also be revised focusing on the incorporation of social cues in VEs. Possible ideas would be to have humans walking around or cars driving in the VEs and a condition group without these factors to test whether social context has an influence on the effect between awe and social well-being. To prevent tied values in following studies, questions that ask participants about their fatigue level may be used in pilot studies and survey lengths may be accordingly adjusted. Lastly, because theory implies the crucial role of social connectedness and prosocial behaviour in the connection between awe and social well-being, experiments that test this connection should use measures to

test both factors ensuring that the given stimulus induces not only awe but also social connectedness and prosocial behaviour.

5.5 Conclusion

Overall, it can be concluded that the research on the functions and roles that awe plays in the context of physical and mental health, as well as the implications of VEs to explore this complex emotion needs to be further extended. Even though no effect between awe experiences and overall social wellbeing as well as with any of its dimension except social integration was found, this study gathered evidence that the effect on social integration may be dependent on the type of context in which awe is induced. This may show the importance of context in the effect of awe on social cognition and motivate the further investigation of the relationship between awe and social wellbeing with a focus on yet underestimated factors like social cues or time.

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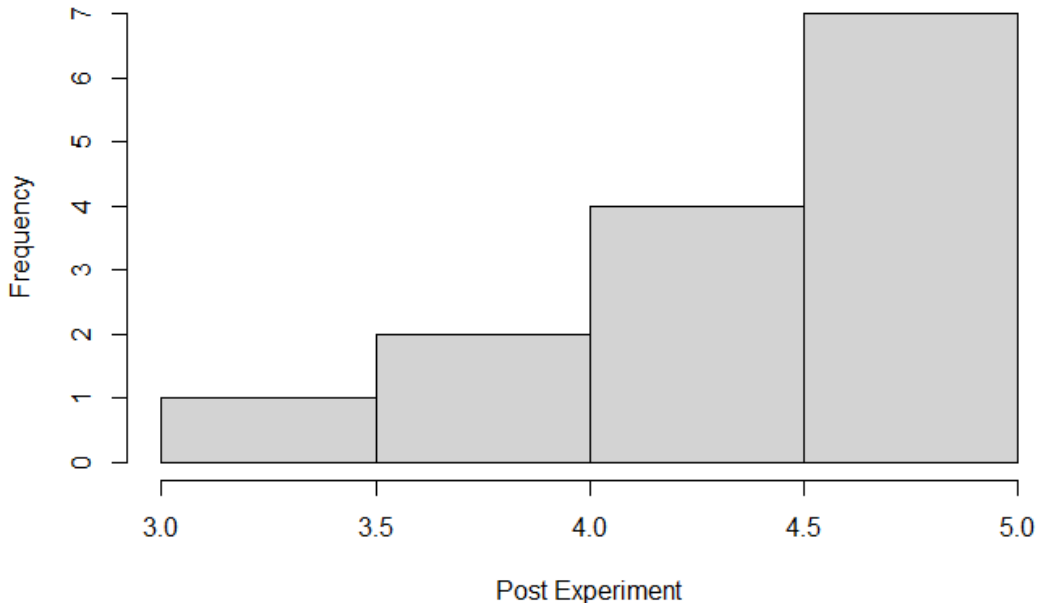
Appendix

Appendix A

Please take a minute or two trying to focus on the present moment. You can look around the room, listen to your surroundings and let the sensations of the situation have their impact on you. When you feel like you gathered a few impressions of the current situation you can click to the next page.

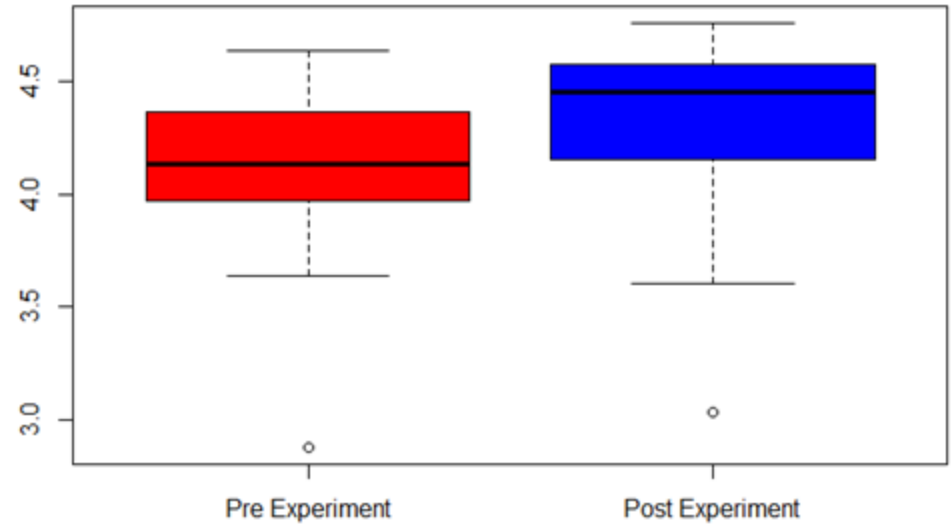
Appendix B

Histogram of social well-being scores in "Space" condition post-experiment



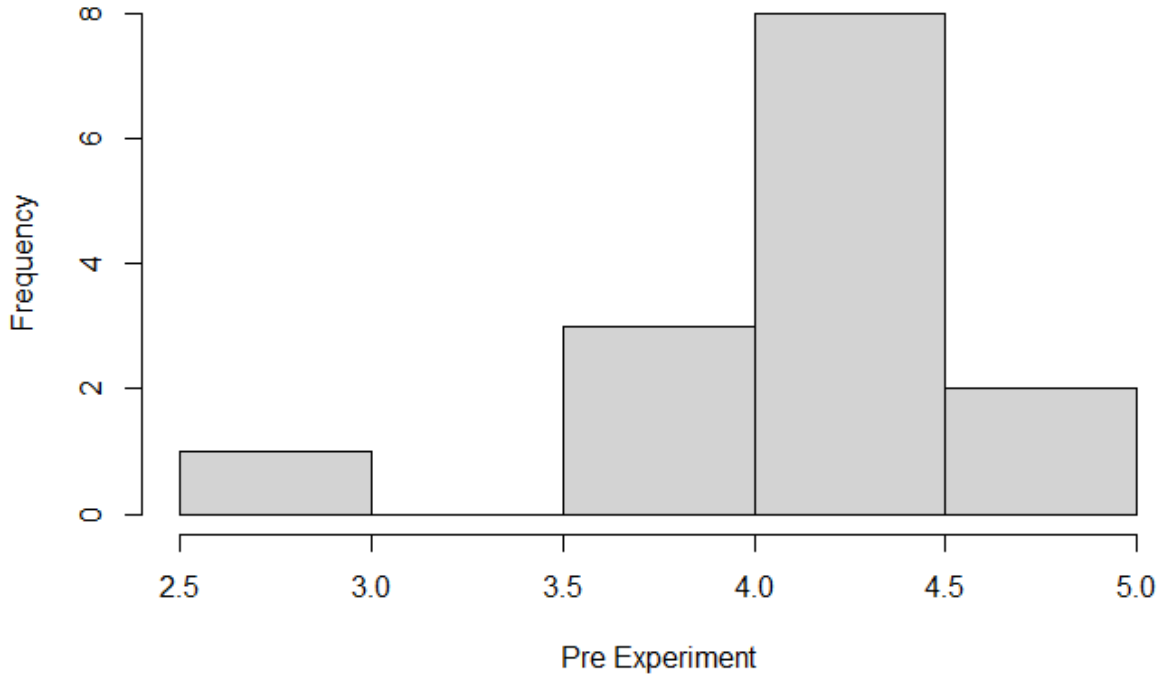
Appendix C

Distribution of social well-being scores in "Space" condition.



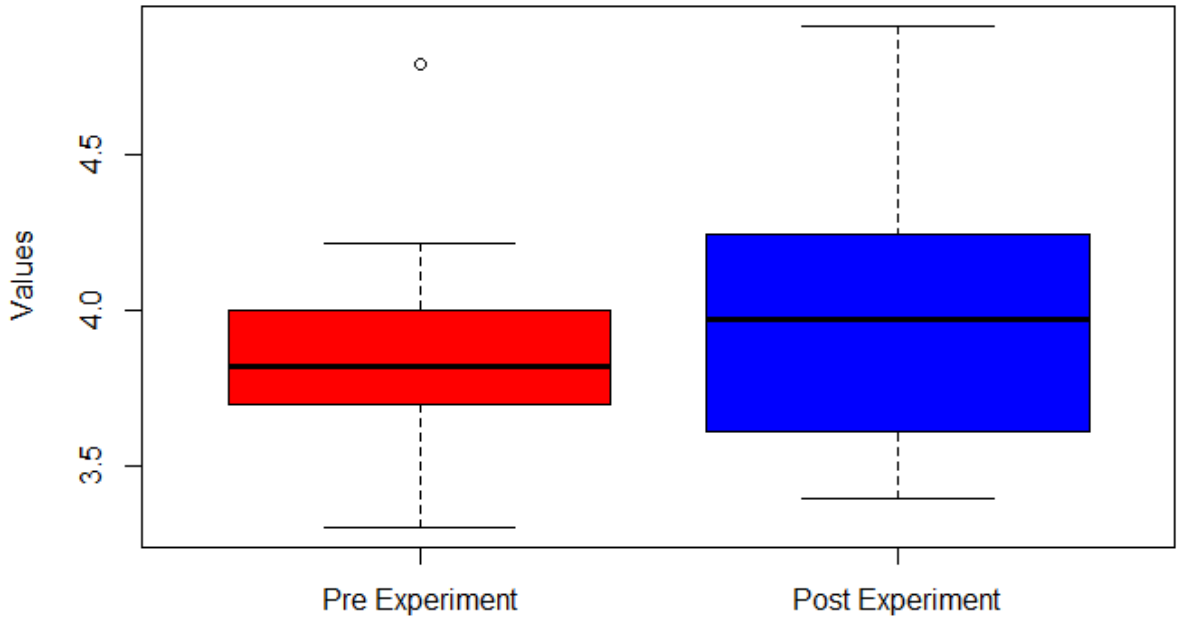
Appendix D

Histogram of social well-being scores in "Space" condition pre-experiment



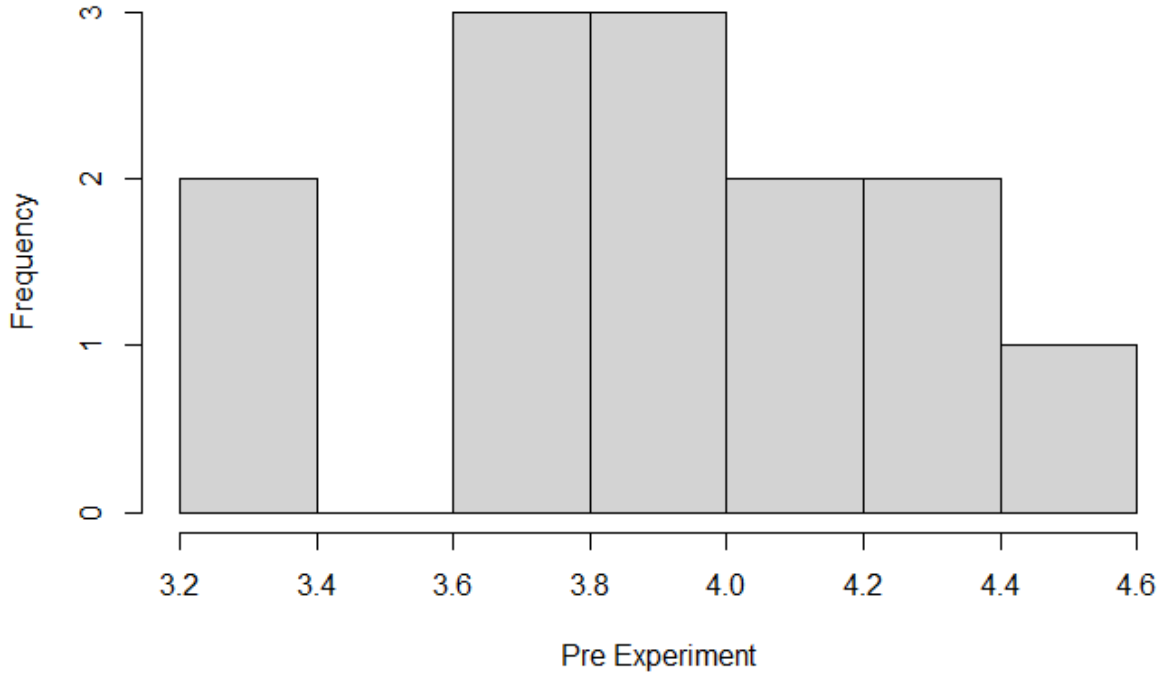
Appendix E

Distribution of social well-being scores in "Humanmade structures" condition.



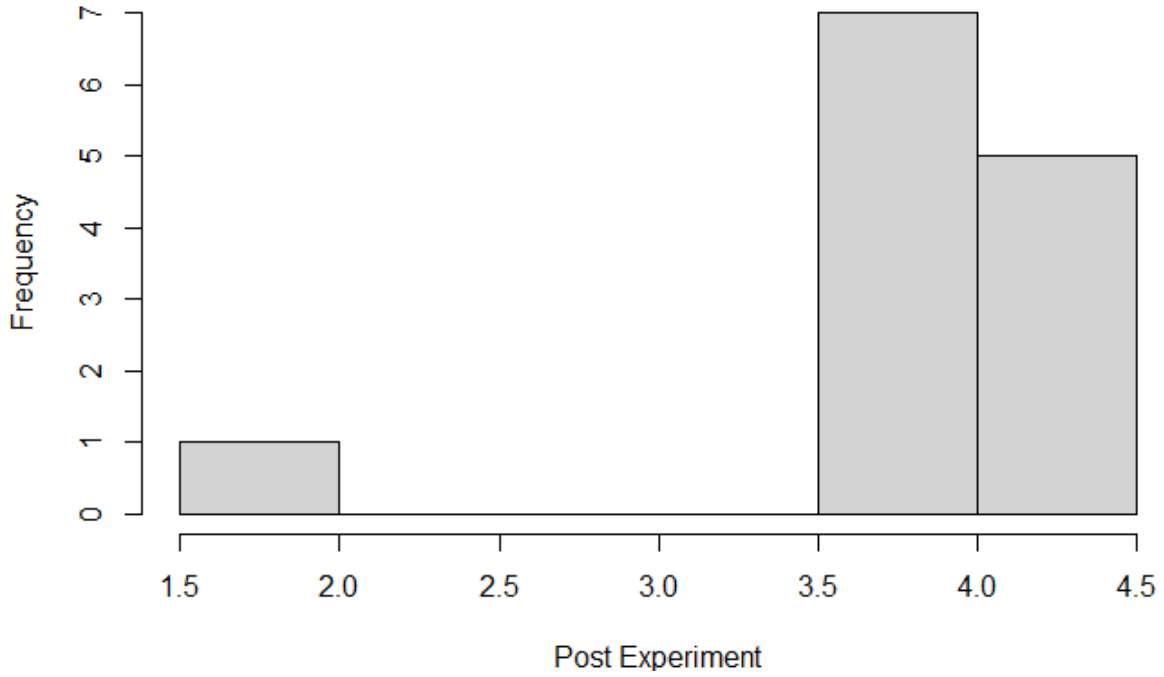
Appendix F

Histogram of social well-being scores in "Humanmade structures" condition pre-experiment.



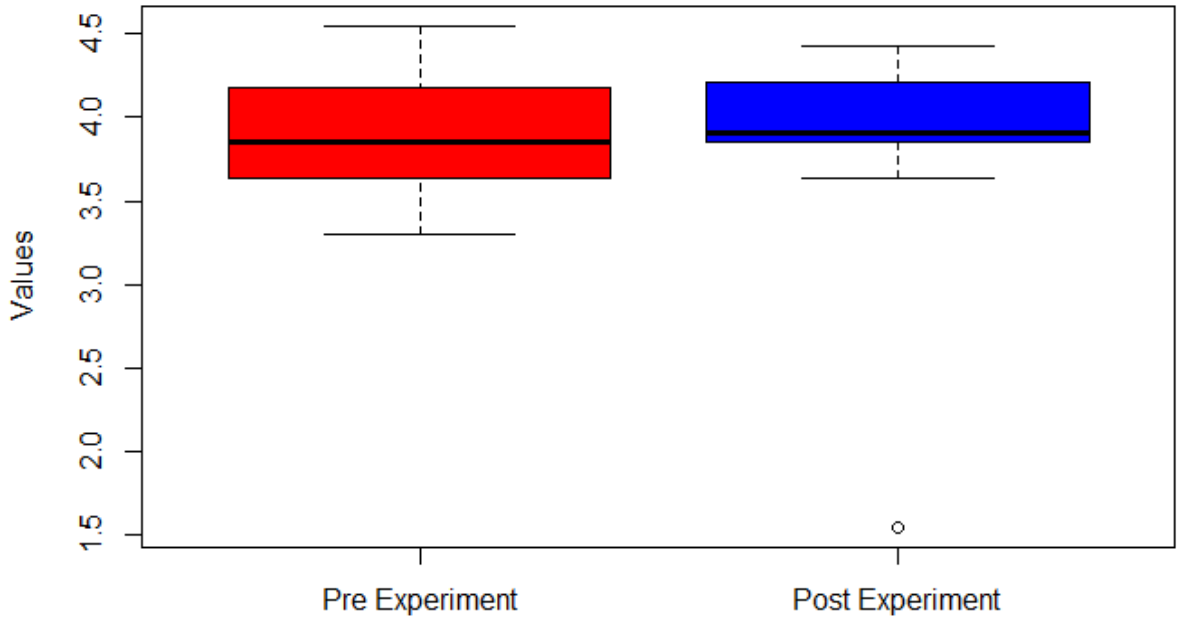
Appendix G

Histogram of social well-being scores in "Humanmade structures" condition post-experiment.



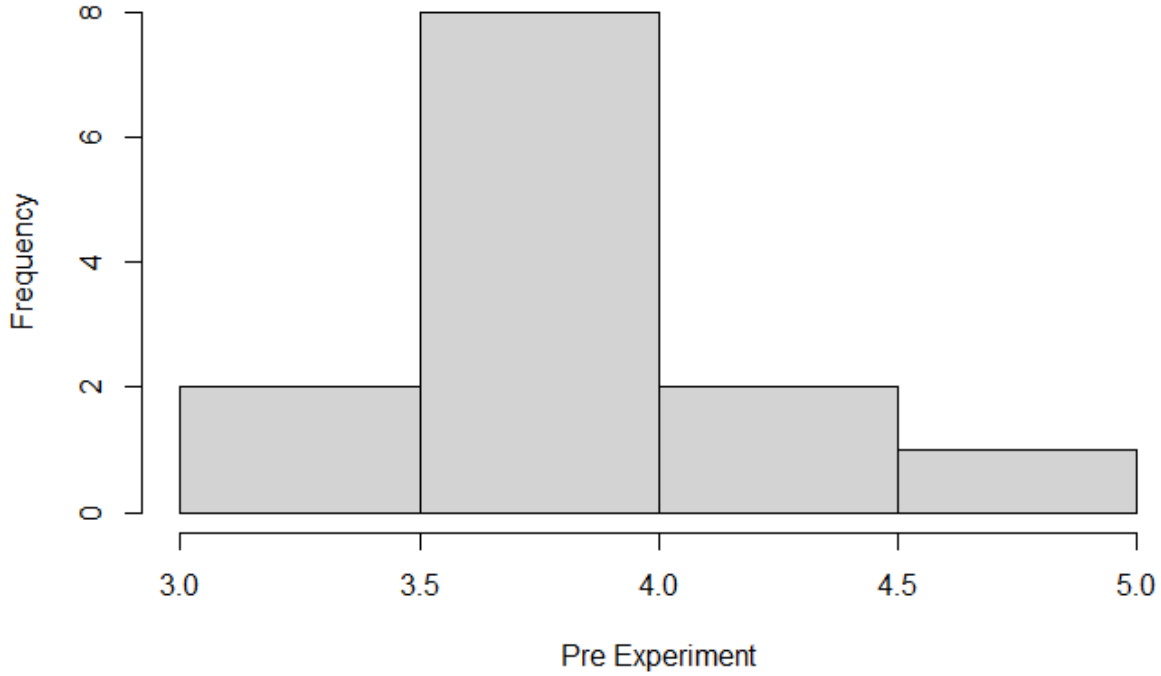
Appendix H

Distribution of social well-being scores in "Nature" condition.



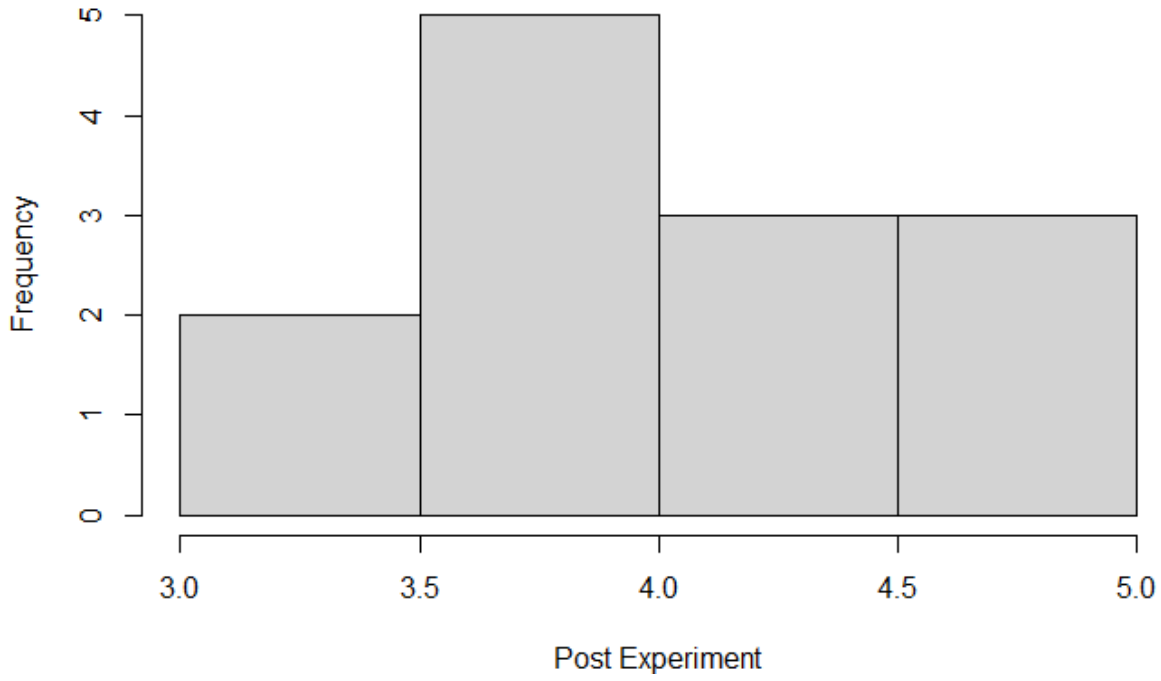
Appendix I

Histogram of social well-being scores in "Nature" condition pre-experiment



Appendix J

Histogram of social well-being scores in "Nature" condition post-experiment



Appendix K

Informed Consent Form

Informed Consent

Title of the Study: Understanding the Influence of Awe in Virtual Reality on Well-being.
Principal Investigators: Jessica Erlich, Christopher Keller

Welcome!

You are invited to participate in a research study that aims to investigate the influence of different virtual environments on the experience of awe and social well-being. Before you decide to participate, it is essential that you understand the nature of the study, the procedures involved, and the potential risks and benefits associated with your participation.

The purpose of this study is to examine how exposure to different virtual environments influences the experience of awe and social well-being. Awe is a powerful emotion which we get in the presence of something vast that challenges our understanding of the world, like looking up at millions of stars in the night sky or marvelling at the birth of a child. Current research suggests that experiences of awe may relate to social well-being. We are therefore aiming to explore factors that influence how strongly awe is experienced and how different awe experiences impact social well-being. Your participation will involve engaging in a virtual reality (VR) experience and completing two questionnaires before and after the VR session. The whole experiment will take approximately 30 minutes to complete.

Procedures:

1. You will be asked to read and sign this informed consent form before participating in the study.
2. You will engage in a virtual reality (VR) experience designed to induce awe.
3. Before and after the VR session, you will be required to complete a questionnaire that assesses your experience of awe and social well-being.

Risks

This research has been reviewed and approved by the BMS Ethics Committee/domain Humanities & Social Sciences. Participating in this study involves minimal risks. Some individuals may experience discomfort or motion sickness during VR exposure. You have the right to withdraw the experiment at any time if you feel uncomfortable without negative consequences or the duty of providing reasons.

Benefits

The potential benefits of this study include contributing to the understanding of how different virtual environments influence the experience of awe and social well-being,

which may have implications for future research and the development of VR applications. The experience of awe also induces positive benefits for your well being according to research.

Confidentiality:
Your participation in this study is confidential. Your personal information will be anonymized and kept confidential. Only the principal investigators and supervisor team will have access to the data. It will be stored on password-protected Computers and deleted after it has been analyzed for the sake of answering the Research questions.

Contact Information:
If you have any questions about the study or your participation, please contact:
Jessica Erlich j.erlich@student.utwente.nl +4917658862059
Christopher Keller c.keller@studetn.utwente.nl +491715714919

For more specific questions you can also contact the supervisors of this study:
Lina Bareisyte l.b.bareisyte@utwente.nl
Anneke Sools a.m.sools@utwente.nl

Agreement:
I have read and understood the information provided in this consent form. I voluntarily agree to participate in the study.