

Virtual Reality Nature and Spirituality: A Gateway to Awe

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Abstract

Background: This study focused on how spiritual and non-spiritual individuals differ in responses to awe evoked by virtual reality (VR) nature. Awe, often linked to spiritual and peak experiences, consists of two aspects: the need for accommodation and vastness. Given that nature frequently triggers awe and spiritual experiences, this study investigated whether spirituality affects the intensity of awe in VR environments.

Methods: Therefore, this study had recorded participants intensity of spirituality and had them undergo two VR nature environments, one to induce awe, and the other to inhibit awe. Awe, assessed after each environment, and spirituality was further tested.

Results: The final sample consisted of 40 participants, with 24 tested as high in spirituality and 16 as low spirituality. The first hypothesis was that people scoring high in spirituality would experience more awe, according to the results, this hypothesis was accepted. The second hypothesis assessed whether spirituality could moderate the amount of awe experiences in VR nature environments, results showed that this hypothesis must be rejected.

Conclusion: These results were consistent with research informing that spirituality is a perspective aspect of awe. This was in line with previous studies suggesting that spirituality is a consistent facet and personality trait, which was prevalent regardless of the virtual reality environment. Moreover, these results hold value to the application of awe to VR-based therapies, and the involvement of spirituality. These results give future directions into applications of VR nature and suggestions when representing spirituality.

Keywords: Virtual Reality (VR), Nature, Awe, Spirituality

Table of contents

1. Introduction.....	5
<i>1.1 Nature, spirituality, and transpersonal ecopsychology.....</i>	<i>5</i>
<i>1.2 Spiritual experiences and awe.....</i>	<i>7</i>
<i>1.3 Application of nature in VR to elicit awe</i>	<i>8</i>
<i>1.3.1 Replication of awe in virtual reality.....</i>	<i>9</i>
<i>1.4 Aim of the current experiment.....</i>	<i>10</i>
2. Methods.....	11
<i>2.1 Study design.....</i>	<i>11</i>
<i>2.2 Participants.....</i>	<i>11</i>
<i>2.3 Materials</i>	<i>12</i>
<i>2.3.1 Equipment.....</i>	<i>12</i>
<i>2.3.2 The Spirituality Scale.....</i>	<i>14</i>
<i>2.3.3 The Awe Experience Scale.....</i>	<i>15</i>
<i>2.4 Procedure.....</i>	<i>15</i>
<i>2.5 Data analysis.....</i>	<i>16</i>
3. Results.....	18
<i>3.1 Descriptive statistics.....</i>	<i>18</i>
<i>3.2 Parametric assumptions</i>	<i>19</i>
<i>3.3 H1: High-spiritual individuals experience awe more intensely in VR nature scenes than low-spiritual individuals.</i>	<i>20</i>
<i>3.4 H2: Spirituality moderates the intensity of awe in different VR nature environments </i>	<i>22</i>
<i>3.5 Post hoc analysis.....</i>	<i>22</i>
4. Discussion.....	24
<i>4.1 Research question.....</i>	<i>24</i>
<i>4.2 Spirituality and awe.....</i>	<i>24</i>
<i>4.3 Spirituality as a moderator.....</i>	<i>25</i>
<i>4.4 Gender and Spirituality.....</i>	<i>26</i>
<i>4.5 Strengths and limitations</i>	<i>26</i>
<i>4.6 Implications</i>	<i>27</i>
<i>4.7 Future research.....</i>	<i>28</i>
<i>4.8 Conclusion.....</i>	<i>28</i>
References.....	29
Appendix A: Use of AI Tools	35
Appendix B: Informed Consent.....	36

Appendix C: Demographic Questions.....	37
Appendix D: Spirituality Scale (SS)	38
Appendix E: AWE-S Factor Items.....	40
Appendix F: R Code for Parametric Assumptions.....	42
Appendix G: R Code for Lmer Test.....	44
Appendix H: R Code for Graphs.....	45

1. Virtual Reality Nature and Spirituality: A Gateway to Awe

Peak experiences are moments in which one experiences harmony and ecstasy within one's surroundings (Wulff & Maslow, 1965). Peak experiences, such as awe, have often been related to spiritual experiences (Büssing, 2021; Davis, 1998). While awe has shown to be experienced through having a sense of vastness and having the need to accommodate something extraordinary mentally (Keltner & Haidt, 2003). These conditions, which are often evoked by nature, provide sensations of wonder and insignificance (Allen, 2018; Keltner & Haidt, 2003). Although, studies evoking awe in nature have suggested that the emotion may be related to the spiritual experience (Allen, 2018; Büssing, 2021; Keltner & Haidt, 2003). The concept of transpersonal ecopsychology may further support this whereas nature and the spiritual experience are claimed to be intertwined (Davis, 2013). Moreover, this concept advocates the appreciation and conservation of nature in efforts to preserve the benefits spiritual individuals receive (Strumse, 2007). Understanding the connection between nature and spirituality is useful for understanding human behaviour and investigating experiencing awe in nature offers insights into the impact of spiritual beliefs on well-being (Luhrmann et al., 2013; Pargament, 2002; Van Cappellen et al., 2016). Virtual reality (VR) has been able to recreate awe-inducing nature experiences, allowing for the benefits of nature to be more accessible, which may be utilised to fill the gap in spiritual devotion, awe, and nature (Büssing, 2021; Keltner & Haidt, 2003; Yeo et al., 2020).

1.1 Nature, spirituality, and transpersonal ecopsychology

Nature has proven to express beneficial psychological outcomes such as reduced anxiety and stress, caused emotion restoration, improved well-being, and relieved symptoms of depression (Brancato et al., 2022; Browning et al., 2019; Liu et al., 2023; Reese et al., 2022). Therapies such as nature-based therapy (NBT) and shinrin-yoku are designed to utilise these positive aspects by exposing individuals to natural environments (Naor & Mayseless, 2019;

Reese et al., 2022). These forms of therapy are a product of ecopsychology, a field that explores the relationships between humans and nature (Strumse, 2007).

Spirituality, a complex construct, can be defined as a subjective perspective dependent on one's religion and culture, these aspects influence spirituality by altering how one experiences: meaning and purpose in life, relationships with others, and appreciation for natural environments (Delaney, 2005). Often, spirituality is a prominent aspect of many ecopsychological frameworks (Kamitsis & Francis, 2013). Davis (1998) describes transpersonal psychology which is the result of spiritual concepts integrated into concepts of ecopsychology. Transpersonal ecopsychology applies psychology and ecology, emphasising that humans are spiritually connected to nature (Davis, 2013). This field explores how this interconnectedness can be applied to elicit personal growth and increase well-being interdependent on one's relationship with the environment (Davis, 1998; Kamitsis & Francis, 2013). Therefore, applying concepts of transpersonal ecopsychology may help better understand the relationship between humans, nature, and spirituality.

However, to apply this concept it must be investigated how transpersonal ecopsychology is apparent in natural environments. Transpersonal aspects of nature experiences are comprised of peak experiences, wilderness experiences, and flow (Davis, 1998). Peak experiences are short, yet outstanding moments that often leave the feeling of euphoria. While wilderness experiences involve adventure and natural surroundings. Lastly, flow is characterised by total immersion within an activity. According to transpersonal ecopsychology, all three of these aspects are involved with experiencing spirituality in natural environments (Davis, 1998). These aspects of nature experiences help us to understand the connection of how one experiences spirituality.

The application of these spiritual characteristics has been investigated in nature experiences (Kamitsis & Francis, 2013; Naor & Mayseless, 2019; Ryff, 2021). Previous studies have shown that spirituality significantly mediates the relationship between nature exposure and well-being as well as connectedness to nature and well-being (Kamitsis & Francis, 2013). Involving spirituality in immersive nature therapies such as NBT has been shown to have positive outcomes (Naor & Mayseless, 2019). Therefore, spiritual individuals may experience more favourable outcomes in the therapeutic benefits of nature therapies.

1.2 Spiritual experiences and awe

To experience the complex emotion of awe, authors Keltner and Haidt (2003) suggest two aspects of perceived vastness and need for accommodation must be experienced. Perceived vastness originates from the sensation of observing something grand and impressive; something so perplexing and complex that it takes time for the mind to grasp the scale of it (Chirico et al., 2018; Keltner & Haidt, 2003). The need for accommodation arises when a stimulus is beyond an individual's known sense of reasoning (Chirico et al., 2018; Keltner & Haidt, 2003). Awe is often described as an unambiguous emotion, with both positive aspects such as amazement and negative aspects such as fright or insignificance (Haidt, 2003; Lazarus, 1991).

Due to the complex nature of awe and its benefits, it has been an insightful area of study (Chirico et al., 2018). For example, authors mention that experiencing awe may allow individuals to reorganise mental structures and enhance personal awareness (Chirico et al., 2018; Shiota et al., 2007). The ability to replicate this emotion systematically has the potential to strengthen therapeutic practices to improve patient outcomes by creating transformative experiences which may revise personal values and feelings (Chirico et al., 2018; Keltner & Haidt, 2003; Shiota et al., 2007). In this study, the awe will be elicited using VR nature environments.

In addition, previous research has related nature to be a common source of awe due to the wonder and beauty experienced when in natural environments (Büssing, 2021).

Experiencing the unique or novel aspects of nature often elicits the benefits of awe (Allen, 2018; Büssing, 2021; Joye & Verpooten, 2013). Awe experienced in nature has shown to be emotionally impactful and beneficial for well-being (Büssing, 2021). This is achieved by reducing stress and improving mindfulness (Brancato et al., 2022; Büssing, 2021; Liu et al., 2023). Therefore, exposure to nature appears to be an effective method to elicit awe and the benefits derived from it.

Spirituality has been shown to mediate engagement in nature and well-being and potentially awe (Büssing, 2021; Kamitsis & Francis, 2013). Research indicates that individuals reporting lower levels of awe also tended to engage less in meditation and prayer, whereas those reporting higher levels of awe demonstrated greater involvement in meditation and prayer activities (Büssing, 2021). This study expresses the experience of awe through spirituality provides a deeper understanding of one's beliefs, leading to feelings of interconnectedness, transcendence, prosocial behaviour, and a greater meaning in life (Büssing, 2021; Van Cappellen & Saroglou, 2011). Therefore incorporating spirituality when investigating awe in natural environments may be a key factor worthy of investigation.

1.3 Application of nature in VR to elicit awe

Despite the evidence that awe provides psychological and physiological benefits, accessing natural environments is not always possible (Büssing, 2021; World Health Organization, 2021; Chiang et al., 2017; Liu et al., 2023). Factors such as physical impairment, age, and time constraints may lead individuals to have less natural exposure (Brancato et al., 2022; Liu et al., 2023). To address these limitations, VR may be an effective medium to expose these individuals to nature-induced awe (Brancato et al., 2022; Chan et al., 2023).

1.3.1 Replication of awe in virtual reality

VR can replicate nature scenes that elicit awe and have benefits although it requires instructions to do so. VRs' immersive features, allow users to experience psychological benefits such as reduced stress, increased relaxation, improved mental well-being, and prompt motivation (Brancato et al., 2022; Browning et al., 2019; Chan et al., 2023; Frost et al., 2022; Leung et al., 2022; Reese et al., 2022). These benefits can be achieved by using 360° nature scenes to immerse users in five-minute videos of water and forest scenes (Barton & Pretty, 2010; Brancato et al., 2022; Chiang et al., 2017; Leung et al., 2022; Liszto et al., 2018; Liu et al., 2023; Yeo et al., 2020). These nature scenes must be selected based on a predetermined framework of how to elicit awe (Büssing, 2021).

Moreover, researchers have identified natural scenes capable of eliciting awe-evoking reactions in VR by manipulating the two aspects of awe, the need for accommodation and perceived vastness (Büssing, 2021). Frameworks of these VR nature environments will be further used to develop awe-evoking and neutral environments for this study. VR environments that evoke awe have been shown to follow a narrative of typically walking along a path while revealing moving stimuli and panoramas (Brancato et al., 2022; Chiang et al., 2017; Chirico et al., 2018; Ochsleus et al., 2023). The stimuli create a need for accommodation while panoramas create vastness (Liu et al., 2023). Conversely, neutral VR environments designed to maintain a non-emotional, neutral state are done by making the scenes easily observable (Chirico et al., 2018; Frost et al., 2022). Such environments contain features such as open areas with minimal natural elements and no expansive views or features requiring prolonged observation, such as animals or moving leaves, thereby preventing the need for accommodation (Chirico et al., 2018). This framework will be further used to create awe-inducing and mundane nature environments.

1.4 Aim of the current experiment

This study aims to use the emotion of awe to further quantify peak experiences in spirituality to understand human relationships with the environment. Designing VR environments to elicit awe and measuring the differences between spiritual and non-spiritual individuals, may contribute to a deeper understanding of awe, nature, spirituality, and the relationship between them (Chirico et al., 2018; Frost et al., 2022).

This paper aims to offer the benefits of applying VR to show a link between awe, nature, and spirituality. To begin, this study may be able to replicate the link by Büssing (2021) that nature, awe, and spirituality are connected. Moreover, this may be able to be done on VR, which would yield benefits in improving accessibility to natural environments (Brancato et al., 2022; Liu et al., 2023). This may also be valuable to apply theories of transpersonal ecopsychology, insisting there is a connection between the three elements. This insight may facilitate interventions such as eco-therapy or promote sustainable actions (Davis, 1998; Kamitsis & Francis, 2013; Naor & Mayseless, 2019).

While studies have suggested that awe is linked to nature and spirituality moderates nature exposure and well-being, we lack evidence as to whether there may be a connection between the awe in types of VR nature environments and spirituality (Allen, 2018; Van Cappellen & Saroglou, 2011). Accordingly, this study will investigate: *How do spiritual individuals and non-spiritual individuals differ in their responses to induced awe through VR nature experiences?* Correspondingly, hypotheses will further include:

H1: *The intensity of awe experienced in response to VR nature environments will be significantly higher among spiritually affiliated individuals than those who are not spiritually affiliated.*

H2: *Spirituality moderates the intensity of awe in different VR nature environments.*

2. Methods

2.1 Study design

A within-subject design was selected for this study to ensure both nature environments received equal representation of the spiritual and non-spiritual groups. This design also included counterbalancing of the VR videos to mitigate order effects. Furthermore, the use of the self-report questionnaires aided in the ability to compare both environments and groups quantitatively. Standardisation of the testing environment and self-report questionnaires allowed consistency and reliability within the VR environment and testing experience.

2.2 Participants

For this study, participants must have been fluent in English to be included. However, individuals who had been susceptible to motion sickness and light sensitivity were excluded. Moreover, the sampling methods of convenience, opportunity, and voluntary were used to collect participants. Recruitment strategies included reaching out to the researchers' acquaintances and approaching students on the University of Twente campus and requesting participation. Other methods consisted of offering psychology students at the University of Twente research participation credits and raising awareness of the study by messaging information through targeted WhatsApp groups including University of Twente students seeking participation opportunities.

The final sample consisted of 40 participants between the ages range of 18-25. Most participants were female (55%) and of German nationality (40%) (see Table 1). All participants gave informed consent, which clarified their right to withdraw from the study at any time. The informed consent had been approved by the ethics committee of the BMS at the University of Twente under request number 240265.

Table 1*Demographics of Participants (N = 40)*

Variable	n	%
Gender		
Female	22	55
Male	18	45
Nationality		
German	16	40
Dutch	11	27.5
Other European country	9	22.5
Country outside Europe	4	10

2.3 Materials

2.3.1 Equipment

This experiment was conducted in a silent room free from distractions to ensure participant focus, using a desk with an HP ZI G9 tower desktop PC and swivel desk chair to ensure comfort. On this PC, Qualtrics, an online survey tool, was used to administer a questionnaire. This questionnaire held informed consent (see Appendix B), demographic questions (see Appendix C), The Spirituality Scale, and The Awe Experience Scale. The Spirituality Scale and Awe Experience Scale will be mentioned later in further detail.

An Oculus 2 headset was used to expose participants to two five-minute 6K 360° videos in VR. One video was to evoke awe while the other was neutral. For the neutral environment, a video by VR Small World (2020) of a Korean park was chosen (see Figure 1). In contrast, the awe-evoking environment was a video by City Walks (2020) of a hike in

Switzerland (see Figure 2). Both videos follow the respective characteristics of awe-evoking and neutral, non-awe-evoking environments, as described by Chirico et al. (2018).

Figure 1

Neutral Virtual Reality Environment



Note. This is a screenshot of the neutral environment taken from the YouTube video by VR Small World (2020).

Figure 2

Awe-Evoking Virtual Reality Environment



Note. This is a screenshot of the awe environment taken from the YouTube video by City Walks (2020).

2.3.2 *The Spirituality Scale*

Developed by Delaney (2003), The Spirituality Scale (SS) was applied in the questionnaire to measure participants' spiritual level. In this study, the total score for each participant on the SS was computed by calculating the 1-7 Likert scale ranged from 1, strongly disagree to 7, strongly agree. Responses ranged from 23 to 161 across the 23 items (see Appendix D).

Delaney (2003) categorised SS scored into four groups: very low, low, moderate, and very high (see Table 2). For this study, the four groups were adjusted into two groups: low and high scores. This adjustment to the scoring seen in Table 2, allows for analysis of spiritual tendencies within the participant cohort.

Table 2

Spirituality Score Classification

	Low Spirituality		High Spirituality	
	Very Low	Low	Moderate	Very High
Total Score	23 - 70	71 - 106	107 - 137	138 - 161

Note. Adapted from *The Spirituality Scale: development and psychometric testing of a holistic instrument to assess the human spiritual dimension* by C. Delaney, 2005. Copyright 2005 by Journal of Holistic Nursing.

Developed to capture diverse aspects of spirituality, the SS encompasses factors representative of human spirituality: self-discovery, relationships, and eco-awareness (Delaney, 2003). Examples of items of self-discovery are, "I find meaning in my life experiences" and, "I am happy about the person I have become". Items for the relationships factor included, "I believe all living creatures deserve respect" and, "I am able to receive love from others". The final factor, eco-awareness had the closest ties to spirituality with items such as "I use silence to get in touch with myself" and, "My faith in a Higher

Power/Universal Intelligence helps me cope with challenges in my life”. Through rigorous refinement and evaluation of its psychometric characteristics, the SS suggests to be a reliable and valid questionnaire capable of measuring the various characteristics of spirituality (Delaney, 2003; Edwards, 2012).

2.3.3 The Awe Experience Scale

Awe in the neutral and awe-evoking environments was measured used the Awe Experience Scale (AWE-S). The scale includes 30 items rated on a 1-7 Likert scale which ranged from 1, strongly disagree to 7, strongly agree; the minimum score is 30 while the maximum score is 210. The AWE-S allowed a quantitative measure to assess the emotion of awe following both the neutral and awe environments.

The AWE-S consists of five sub-scales: time, self-diminishment, connectedness, vastness, physical sensations and need for accommodation. Each subscale included five items; time included items such as “I sensed things momentarily slow down”. While vastness included items such as “I felt that I was in the presence of something grand”. Other items and corresponding factors can be seen in Appendix E. This test was further selected due to its proven high content validity, internal reliability, and test-retest reliability, making it an ideal scale for this study (Yaden et al., 2019).

2.4 Procedure

The collection consisted of three sequential blocks. All Qualtrics surveys were administered on the HP desktop PC. The initial block encompassed informed consent, demographic questions (gender, age, and nationality), and the SS (Delaney, 2005; Nisbet & Zelenski, 2013). The informed consent withheld that the study was measuring spirituality to avoid potential biases from participants. After the participants completed the first block, the questionnaire instructed the subject to call the student researcher to come to them.

At the onset of the second and third blocks, the student researchers presented participants with the Oculus 2 headset to view one of two five-minute, 6K 360-degree videos. The two nature environment videos were randomly alternated between participants to counterbalance order effects. 32 participants experienced the neutral environment first following the awe-evoking environment, and another 8 experienced the opposite. Before using the VR headset, participants were given clear instructions to report any discomfort or technical issues. While using the VR headset, participants sat in the swivel desk chairs to experience the 360-degree effect and mitigate motion sickness. Following each five-minute video, participants were requested to remove the headset and the student researcher asked the participant to resume answering the AWE-S. This process was repeated for block three, only with the participant watching the second video condition.

Upon completing the third survey block, participants received a debriefing. The debriefing informed participants that spirituality was a point of investigation. Following this, participants were asked to re-confirm participation knowing that a score of their spirituality would be calculated. After each participant had left, the experiment environment was ventilated, and the VR headset was sanitized using alcohol wipes.

2.5 Data analysis

To assess individuals' levels of spirituality and their experiences of awe, an in-depth analysis of the survey results was conducted. This data was taken from Qualtrics and downloaded as an Excel file. In Excel, data wrangling was used to properly label and order the data for analysis in RStudio. Before conducting analysis, parametric assumptions: normality of residuals, homoscedasticity, and linearity were assessed. To evaluate the parametric assumption normality and linearity, the Shapiro-Wilk Normality Test was conducted to test normality, a non-significant score will show this assumption has been met. Moreover, the heteroscedasticity will be visualized using the Breusch-Pagen Test while a linear relationship

will be required to ensure there are no issues with skew or kurtosis. The packages and codes used in RStudio can be seen in Appendix F. Provided these assumptions were met, the AWE-S scores and factor scores between participants scoring low and high spirituality were then compared for each environment.

An analysis of variance (ANOVA) was conducted to examine the overall significance of the linear regression model predicting the dependent variable awe from the predictors' group (high vs. low spirituality) and VR nature environment (neutral vs. awe-evoking). Using the "lmerMod" function in RStudio, the intensity of awe experienced was assessed for each VR nature environment and spiritual group (see Appendix G). Following, to visualise this interaction, the R script in Appendix H was used to illustrate the ANOVA model by using an interaction plot and bar graph.

3. Results

3.1 Descriptive statistics

The final sample included a total of 40 participants, 26 of which scored above 107 in the SS, classifying them in the high spiritual group. Conversely, 14 participants scored 106 or fewer points, showing low spirituality. Further descriptives of the neutral and awe environments on spirituality and the awe subscales can be seen in Table 3.

Table 3

Mean and Standard Deviation of Total AWE-S Score and Subscales of Spirituality and VR Nature Environment

Variable	Neutral Environment		Awe Environment	
	High Spiritual (N=26)	Low Spiritual (N=14)	High Spiritual (N=26)	Low Spiritual (N=14)
Awe (Total)	<i>M</i> = 111.53 <i>SD</i> = 26.21	<i>M</i> = 82.50 <i>SD</i> = 31.10	<i>M</i> = 136.92 <i>SD</i> = 29.61	<i>M</i> = 107.57 <i>SD</i> = 29.87
Time	<i>M</i> = 24.88 <i>SD</i> = 4.99	<i>M</i> = 23.57 <i>SD</i> = 6.49	<i>M</i> = 26.08 <i>SD</i> = 4.13	<i>M</i> = 24.50 <i>SD</i> = 6.63
Self-Diminishment	<i>M</i> = 18.31 <i>SD</i> = 5.97	<i>M</i> = 15.43 <i>SD</i> = 7.99	<i>M</i> = 23.15 <i>SD</i> = 6.55	<i>M</i> = 20.64 <i>SD</i> = 4.73
Connectedness	<i>M</i> = 19.73 <i>SD</i> = 5.49	<i>M</i> = 13.50 <i>SD</i> = 6.55	<i>M</i> = 21.54 <i>SD</i> = 6.94	<i>M</i> = 14.07 <i>SD</i> = 6.33
Vastness	<i>M</i> = 17.73 <i>SD</i> = 6.79	<i>M</i> = 11.71 <i>SD</i> = 6.66	<i>M</i> = 26.62 <i>SD</i> = 7.43	<i>M</i> = 21.86 <i>SD</i> = 7.51
Physical Sensations	<i>M</i> = 18.62 <i>SD</i> = 4.34	<i>M</i> = 8.00 <i>SD</i> = 4.35	<i>M</i> = 18.65 <i>SD</i> = 6.84	<i>M</i> = 10.36 <i>SD</i> = 4.73

Need for	$M = 18.50$	$M = 11.14$	$M = 20.88$	$M = 16.14$
accommodation	$SD = 5.97$	$SD = 5.72$	$SD = 7.26$	$SD = 5.92$

3.2 Parametric assumptions

The Shapiro-Wilk test was conducted to assess the normality of the residuals. The results showed that the residuals were normally distributed ($W = 0.985$, $p = 0.466$) (see Figure 3). Homoscedasticity was evaluated using the standardized Breusch-Pagan test. The test results were not significant, indicating that the assumption of homoscedasticity and linearity was met ($BP = 0.458$, $df = 2$, $p = 0.795$) (see Figure 4).

Figure 3

Q-Q Plot of the Residuals in AWE-S Scores by Group and VR Environment

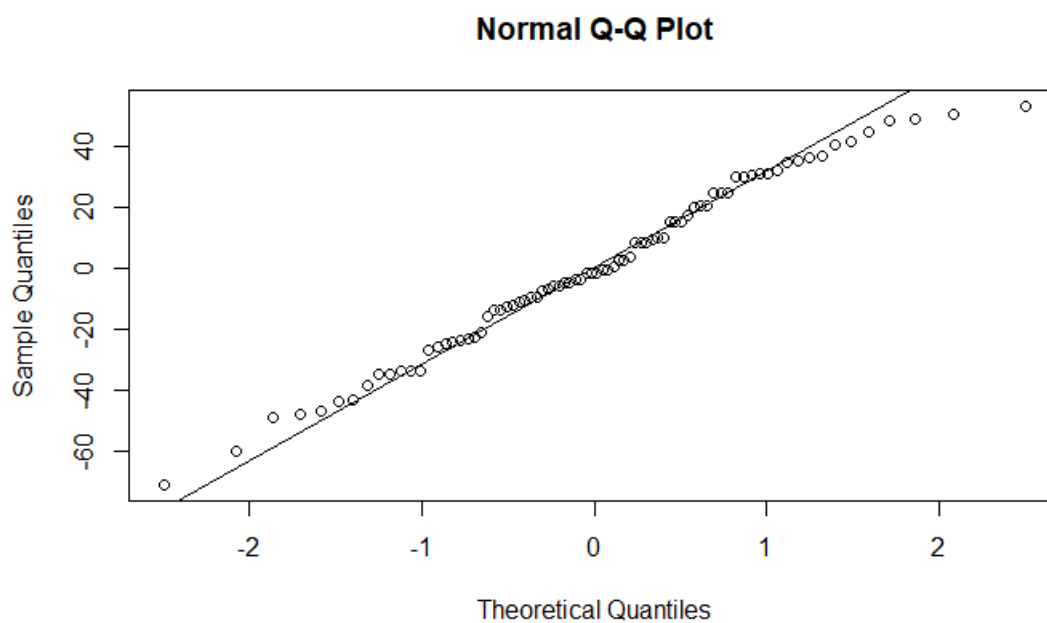
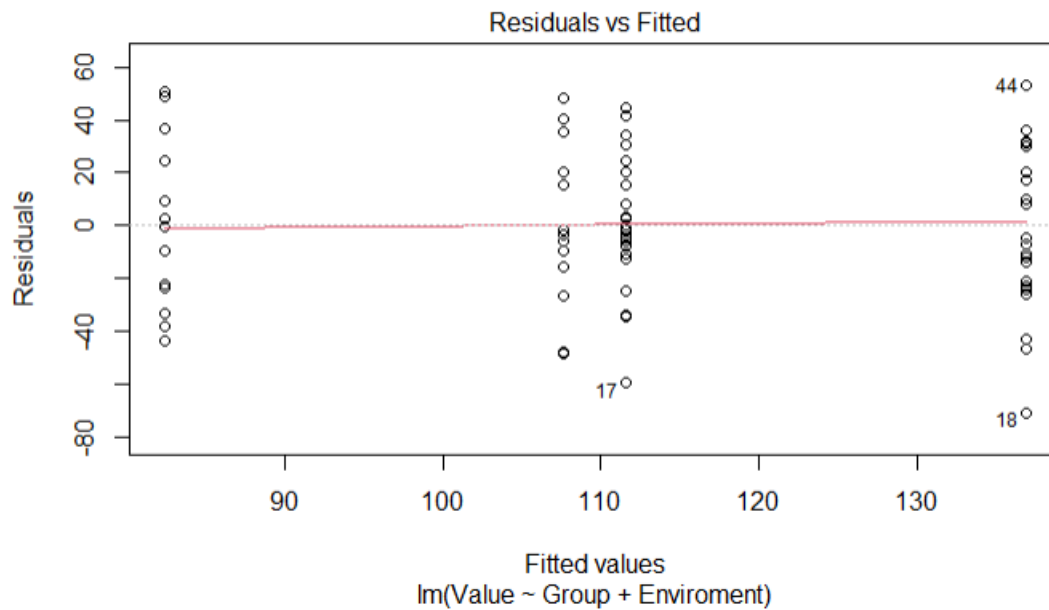


Figure 4

Residuals vs Fitted Plot of AWE-S Scores by Group and VR Environment



Note. Value = AWE-S score. Group = Low/High Spirituality Groups. Environment = Neutral/Awe-Evoking VR Nature Environments.

3.3 H1: High-spiritual individuals experience awe more intensely in VR nature scenes than low-spiritual individuals.

The ANOVA model evaluated the significance of the linear regression model predicting awe on the predictors of spirituality group and type of VR environment. The results showed that the overall model was statistically significant ($F(3, 76) = 11.33, p < 0.001$) (see Table 4). This model accounted for a significant proportion of the variance in AWE-S scores, $R^2 = .309$, adjusted $R^2 = .282$. An interaction plot difference in AWE-S scores, spirituality group, and environment can be seen in Figure 5.

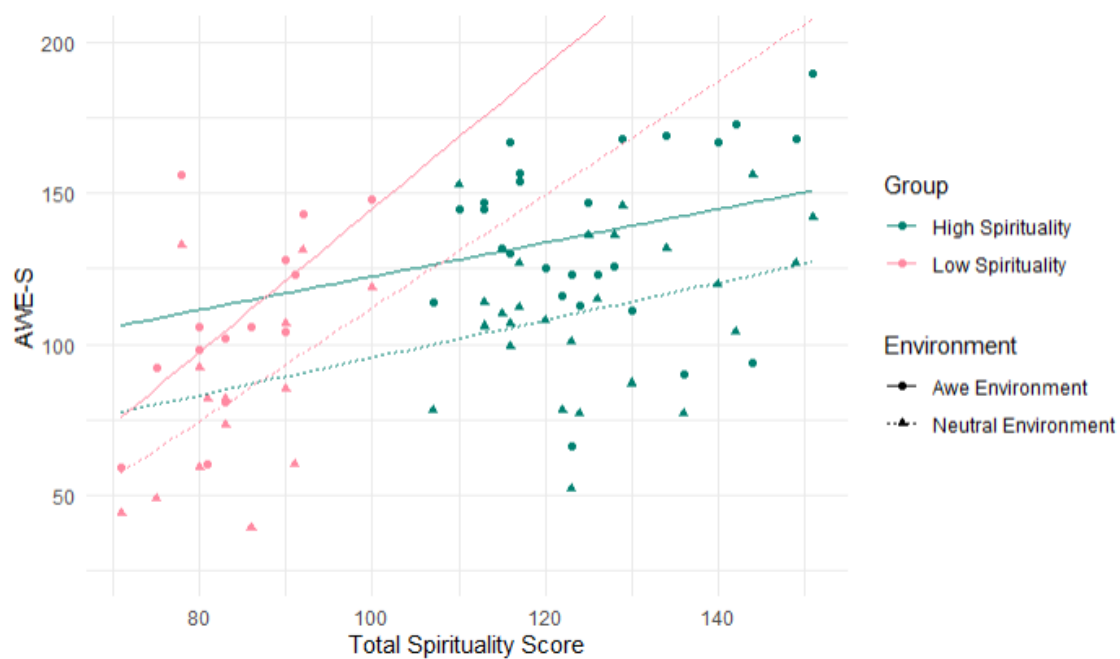
Table 4*2 Factor ANOVA of Spiritual Group and VR Nature Environment*

Variable	Df	Sum Sq	Mean Sq	F-value	p-value	
Spiritual Group	1	15513	1552.8	18.63	<0.001	***
VR Nature Environment	1	12777	12776.5	15.35	<0.001	***
Spiritual Group: VR Nature Environment	1	0	0.4	0.0005	0.981	
Residuals	76	63267	832.5			

Note. *** $p < .001$

Figure 5

Interaction plot of AWE-S vs. Spirituality Score with Estimated Lines by Spiritual Group and Environment

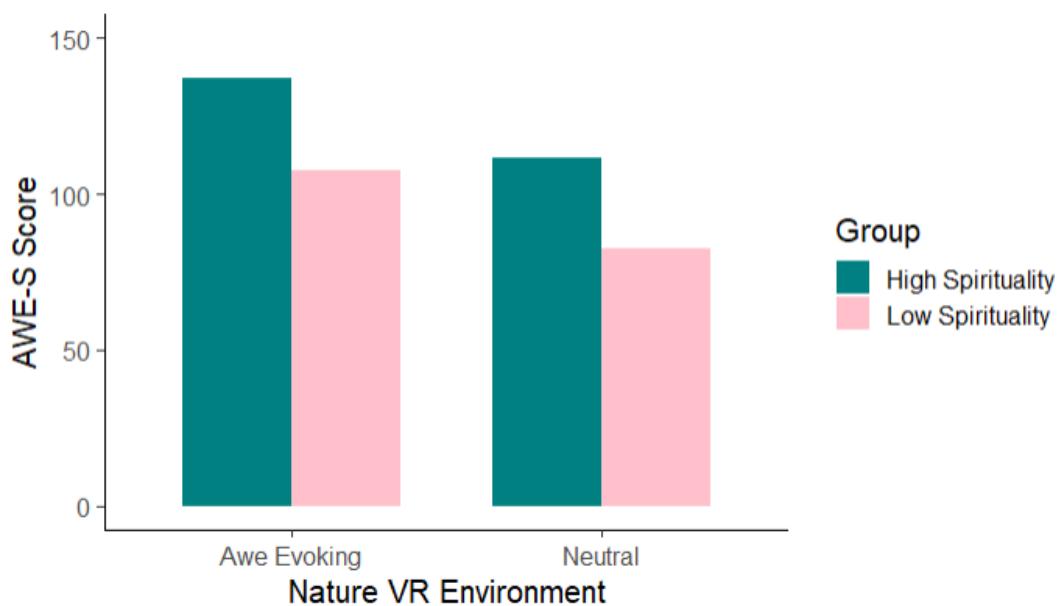


The model revealed significant differences between the spiritual group and VR environment on the AWE-S score. Specifically, participants in the low spirituality group had

significantly lower values compared to those in the high spirituality group ($\beta = -29.35$, $SE = 9.56$, $t(76) = -3.07$, $p = .003$). Additionally, participants in the neutral VR environment condition ($\beta = -25.38$, $SE = 8.00$, $t(76) = -3.17$, $p = .002$) had significantly lower values compared with those in the awe-evoking VR environment. This pattern in the spiritual groups and environments is illustrated in Figure 6.

Figure 6

AWE-S for high and low spiritual groups in awe and neutral environment



3.4 H2: Spirituality moderates the intensity of awe in different VR nature environments.

As shown in the last analysis, the interaction of spirituality and the VR nature environment was not significant ($F(1, 76) = 0.0005$, $p = 0.981$). Indicating that the relationship between the spiritual group and VR nature environment on the awe scores was not moderated by the interaction of these two factors (see Table 4).

3.5 Post hoc analysis

An ANOVA analysis revealed a significant linear relationship between demographics and AWE-S score ($F(23, 56) = 2.94$, $p < 0.001$). Nationality revealed no significant effect on

the AWE-S score (all $p > 0.05$). Although, there was a significant interaction effect between the spirituality group and gender ($F(1, 56) = 11.42, p = 0.001$). The means and standard deviation of each gender can be seen in Table 5.

Table 5

AWE-S Mean for each Spiritual Group and Gender

Variable	Male		Female	
	High Spiritual ($N=12$)	Low Spiritual ($N=10$)	High Spiritual ($N=14$)	Low Spiritual ($N=4$)
AWE-S	$M = 115.12$	$M = 101.80$	$M = 132.04$	$M = 78.13$
	$SD = 33.06$	$SD = 32.03$	$SD = 26.27$	$SD = 29.98$

Further investigation of the gender differences revealed males exhibited significantly lower AWE-S scores compared with females ($\beta = -16.911, SE = 8.391, t = -2.015, p = .047$). Additionally, there was a significant interaction in gender belonging to the low spiritual men who scored higher in spirituality than low spiritual women ($\beta = 40.586, SE = 15.153, t = 2.678, p = .009$).

4. Discussion

4.1 Research question

This study aimed to answer the research question: *How do spiritual individuals and non-spiritual individuals differ in their responses to induced awe through VR nature experiences?*

Results suggest that there is a significant difference in awe evoked by VR nature scenes for high and low spiritual individuals. This is in line with the studies showing that VR nature environments can elicit awe (Chirico et al., 2018).

These results support the conclusion that awe is a perspective of spirituality and that spirituality can impact the engagement of nature (Kamitsis & Francis, 2013). As the data indicates, high and low spirituality scores had been able to coincide with the intensity of awe experienced within the awe environment. This is in line with Büssing (2021) and transpersonal ecopsychology that emotionally touching experiences, such as awe, may be interconnected with spirituality (Davis, 2013).

4.2 Spirituality and awe

The first hypothesis evaluated if highly spiritual individuals experience more awe in VR nature environments compared to low spiritual individuals. The results display that this hypothesis can be accepted. Awe was shown to be experienced more intensely in both VR nature environments for the highly spiritual group compared to the low spiritual group.

This occurrence may be due to the spiritual individual's increased engagement to peak experiences such as the emotion of awe (Davis, 2013). Keltner and Haidt (2003) support this motion as they describe awe to be a peak experience, aligning with Davis's (1998) view on the transpersonal nature of awe in experiences with nature. These authors further support the findings of this research as it ties the intensity of awe to spiritual experiences.

Wulff and Maslow (1965) additionally support this connection, providing a larger context of how spiritual experiences relate to self-actualization. Both spirituality and self-actualization have similarities such as a deepened awareness of and appreciation of life, a connection to others and the environment, and a strong sense of personal fulfillment (Davis, 1998; Keltner & Haidt, 2003). These overlapping qualities suggest an interrelationship between self-actualization and the spiritual experience. Therefore, providing an understanding of why awe intensity would change depending on the spirituality of an individual. Indicating that the heightened sense of awe in spiritual individuals may be a result of a predisposition to feel peak experiences more intensely than non-spiritual individuals.

4.3 Spirituality as a moderator

The second hypothesis assessed whether spirituality would moderate the relationship of awe intensity experienced in VR nature environments. This hypothesis was rejected according to the results. Spirituality and VR environments have been shown to independently influence awe; however, these factors did not display an interacting relationship. Those who were spiritual consistently expressed more awe in both nature conditions than the non-spiritual subjects, not only in the awe environment. These results suggest differences in nature-induced awe experiences may not translate into differences among spirituality groups.

Given the connection between spirituality, awe experiences, and perceptions of nature, this may be explained that spirituality is deeply intertwined with both awe intensity and nature experiences. Büssing (2021) elaborates that spirituality appears to be embedded within the awe-nature relationship, influencing beliefs regardless of variations in VR nature-induced awe. This explanation may clarify as to why no significant differences were seen in the moderation of spirituality on awe intensity in VR nature environments.

4.4 Gender and Spirituality

The results have shown that gender and spirituality impact awe experience, it is pronounced in low-spiritual males. These findings are consistent with previous research indicating that gender influences the spirituality and awe experienced in VR nature environments (Büssing, 2021). This may be because women tend to show a greater likelihood of resorting to spirituality as a coping mechanism compared to men (Rassoulilian et al., 2021).

4.5 Strengths and limitations

This research displayed several key strengths such as the use of validated and reliable surveys such as the AWE-S and the SS (Delaney, 2003; Yaden et al., 2019). Moreover, results displayed construct validity as it was able to successfully replicate the awe in natural environments as depicted by Chirico et al. (2018). This study also benefited from a controlled environment, which ensured minimal distractions and equal settings for each participant (Barton & Pretty, 2010). Moreover, the use of student participation points provided an incentive for engagement and motivation to participate (Abdelazeem et al., 2022). The combination of these points improved the quality of the data collected.

Despite these strengths, this study has points for further improvement. For example, the imbalance of spirituality levels within the sample. This imbalance might be attributed to the adjustment of the original SS. Therefore, only including participants who rated “very high” or “very low” in the SS may provide more extreme results.

The sampling methods may have affected the results, as all participants were voluntary technical university students. As activities like charitable involvement, which is a characteristic of spirituality, may have attracted more spiritual individuals (Bryant, 2007). Moreover the sample was collected at a technical university, this might have resulted in a higher-than-average population of low-spiritual men as studies show that spirituality in

college-aged men negatively impacts academic performance (Bryant, 2007). Therefore, including randomly selected participants may provide a less spiritual sample and sampling men from non-technical educational backgrounds may reveal higher spiritual men.

Regarding the VR equipment, Wi-Fi connection was unstable which led to some participants experiencing lower-resolution videos, potentially affecting the immersive experience. Assuring that the videos are being presented with a stable internet connection may lead to a more immersive VR experience.

4.6 Implications

This research emphasises the role of awe and its interrelationships with nature and spirituality. This connection supports transpersonal ecopsychology, which can be used to promote sustainable actions (Davis, 2013; Kamitsis & Francis, 2013; Thoma et al., 2021). Moreover, it shows that awe can be measured through VR natural environments; which aids in understanding the psychological benefits and potential therapeutic applications of experiencing awe in nature (Büssing, 2021; Van Cappellen & Saroglou, 2011). Additionally allowing an accessible method to experience awe in natural environments (Brancato et al., 2022; Browning et al., 2019; Chan et al., 2023; Yeo et al., 2020).

This study's findings are particularly valuable to transpersonal ecopsychology, which integrates spirituality and nature for therapeutic interventions (Davis, 2013; Naor & Mayseless, 2019; Strumse, 2007). These results highlight the interconnectedness of spirituality and nature, thereby supporting transpersonal ecopsychology and enhancing the understanding of emotion perception within a broader ecological and spiritual context (Davis, 1998).

4.7 Future research

Future studies may benefit from accounting for multiple factors when collecting a sample of spiritual individuals. For example, the sample should include those of diverse educational backgrounds and not rely on volunteer participants (Bryant, 2007). Lastly, the SS may lead to more valid results by excluding participants who scored “moderate”, only including those with extreme results (Delaney, 2005). Moreover, accounting for these aspects when determining spirituality may yield a more diverse sample in future studies.

With consideration of these findings, future studies could focus on what types of awe-inducing VR nature scenes would be the most effective at eliciting awe. As for this study, only one awe-inducing natural environment was assessed. Different awe-evoking VR nature scenes could be examined as they may indicate a key factor in the design of VR-based interventions aimed at enhancing awe and spirituality.

4.8 Conclusion

Findings of this study have shown that highly spiritual individuals experienced more awe than lowly spiritual individuals; moreover, environments designed to induce awe revealed to do so for both groups. This assessment implies that awe-evoking VR nature environments may be an effective method to make awe accessible as well as provide an understanding of the interconnection of awe and spirituality. This research successfully replicated awe; however, limitations of technical issues and sampling could benefit future data.

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Appendix A

Use of AI Tools

During the preparation of this work, I used EndNote to manage citations, Grammarly to improve sentence structure/clarity, Microsoft Word to check spelling/grammar/punctuation, and Chat GPT to troubleshoot code in RStudio. After using these tools, I thoroughly reviewed and edited the document and code as needed, taking full responsibility for the final outcome.

Appendix B

Informed Consent

A Quest for Well-being in Virtual Reality Nature: Informed Consent

Purpose of the Research:

The purpose of this research study is to investigate the impact of virtual reality (VR) nature exposure on wellbeing among university students. Also factors like spirituality, awe and nature connectedness are being explored within this context. By participating, you will contribute to advancing our understanding of how virtual nature experiences in interplay with the previously mentioned factors may affect individuals' wellbeing.

Risks of Participating:

Participation in this research project may provide you with the opportunity to explore innovative methods of experiencing nature through VR technology. However, it is important to note that there may be minimal risks associated with VR use, such as motion sickness or discomfort. Additionally, please be informed that this research project has been reviewed and approved by the BMS Ethics Committee of the University of Twente.

Procedures for Withdrawal:

You have the right to withdraw from the study at any time without penalty or consequences. If you choose to withdraw, you may do so by contacting the researcher directly using the provided contact details or directly addressing the researchers while the experiment is being conducted.

Processing of Personal Information:

Any personal information collected during this study will be kept confidential and used solely for research purposes. Your data will be anonymized to protect your privacy. You have the right to request access to, rectification, or erasure of your personal data at any time.

Usage and Safeguarding of Data:

Research data will be used exclusively for research purposes and will be stored securely. Personal information will be safeguarded. Data may be archived and reused for future research endeavours, following ethical guidelines and procedures.

Retention Period for Research Data:

The research data will be retained for a specified period, after which it may be securely disposed of. The criteria for determining the retention period will adhere to ethical standards and legal requirements.

Contact Information:

For any questions, concerns, or to request withdrawal from the study, please contact: Audrey Hernandez (a.a.hernandez@student.utwente.nl) or Milan Karam Menkhaus (m.k.menkhaus@student.utwente.nl)

For inquiries or complaints regarding ethical considerations, please contact the BMS Ethics Committee: ethicscommittee-hss@utwente.nl [Contact Information for BMS Ethics Committee/domain Humanities & Social Sciences]

Appendix C
Demographic Questions

Question	Answer Options
Gender	Female, Male, Other, I prefer not to say
Age	17 and younger, 18-25, 26-35, 36-45, 46-55, 55 and older, I prefer not to say
Nationality	German, Dutch, Other European country, Other country outside Europe, I prefer not to say

Note. Participants were required to select one option for each of the three demographic questions.

Appendix D
Spirituality Scale (SS)

1. I find meaning in my life experiences.
2. I have a sense of purpose.
3. I am happy about the person I have become.
4. I see the sacredness of everyday life.
5. I believe that all living creatures deserve respect.
6. I value maintaining and nurturing my relationships with others.
7. I believe that nature should be respected.
8. I am able to receive love from others.
9. I strive to correct the excesses in my own lifestyle patterns/practices.
10. I respect the diversity of people.
11. I meditate to gain access to my inner spirit.
12. I live in harmony with nature.
13. I believe there is a connection between all things that I cannot see but can sense.
14. My life is a process of becoming.
15. I believe in a Higher Power/Universal Intelligence.
16. The earth is sacred.
17. I have a relationship with a Higher Power/Universal Intelligence.
18. My spirituality gives me inner strength.
19. My faith in a Higher Power/Universal Intelligence helps me cope with challenges in my life.

20. Prayer is an integral part of my spiritual nature.
21. I often take time to assess my life choices as a way of living my spirituality.
22. I use silence to get in touch with myself.
23. At times, I feel at one with the universe.
24. My faith in a higher power/universal intelligence helps me cope during challenges in my life.

Appendix E
AWE-S Factor Items

Factor	Item
Time	1. I sensed things momentarily slow down. 2. I noticed time slowing. 3. I felt my sense of time change. 4. I experienced the passage of time differently. 5. I had the sense that a moment lasted longer than usual.
Self-diminishment	6. I felt that my sense of self was diminished. 7. I felt my sense of self shrink. 8. I experienced a reduced sense of self. 9. I felt my sense of self become somehow smaller. 10. I felt small compared to everything else.
Connectedness	11. I had the sense of being connected to everything. 12. I felt a sense of communion with all living things. 13. I experienced a sense of oneness with all things. 14. I felt closely connected to humanity. 15. I experienced a sense of oneness with all things.
Vastness	16. I felt that I was in the presence of something grand. 17. I experienced something greater than myself. 18. I felt in the presence of greatness.

	19. I perceived something that was much larger than me.
	20. I perceived vastness.
Physical sensations	21. I felt my jaw drop.
	22. I had goosebumps.
	23. I had chills.
	24. I gasped.
	25. I felt my eyes widen
Need for accommodation	26. I felt challenged to mentally process what I was experiencing.
	27. I found it hard to comprehend the experience in full.
	28. I felt challenged to understand the experience.
	29. I struggled to take in all that I was experiencing at once.
	30. I tried to understand the magnitude of what I was experiencing

Appendix F

R Code for Parametric Assumptions

```
....

#packages required for parametric assumption tests
library(stats)
library(lmtest)
library(car)
....
....

# Fit a linear regression model
para.test <- lm(Value ~ Group + Enviroment, data = long_Awe_paratest)

# Shapiro-Wilk Test for normality
shapiro.test(residuals(para.test))
qqnorm(residuals(para.test))
qqline(residuals(para.test))

# Breusch-Pagan test for homoscedasticity
bptest(para.test)

# Plots for homoscedasticity
plot(para.test, which = 1) # Residuals vs Fitted
plot(para.test, which = 3) # Scale-Location plot

# Levene's Test for Homogeneity of Variances
leveneTest(Value ~ Group * Variable, data = long_Awe_sub)

# Breusch-Pagan Test
bptest(para.test)

#test for multicollinearity
#pearson correlation table
predictors <- long_Awe_paratest[, c("TotalSS", "Value")]
```

```
correlation_table <- cor(predictors)
print(correlation_table)
#tolerance values
summary_para <- summary(para.test)
rsquared <- summary_para$r.squared
tolerance_values <- 1 - rsquared
print(tolerance_values)
# variance inflaction factor (VIF)
vif_result <- vif(para.test)
print(vif_result)
` ``
```

Appendix G

R Code for Lmer Test

```
....  
  
#packages required for data transformation  
library(dplyr)  
library(tidyr)  
....  
....  
  
#Package required for linear model analysis  
library(stats)  
....  
....  
  
#analysis of factor significance  
Awe_sub_model = lm(Value ~ Group * Variable, data = long_Awe_sub)  
summary(Awe_sub_model)  
anova(Awe_sub_model)  
....
```

Appendix H

R Code for Graphs

```

...

#packages required for graphs
library(dplyr)
library(tidyr)
library(ggplot2)
...
...

#scatterplots
Awe_whole <- SpiritAwe %>%
  dplyr::select(Subject, Group, TotalSS, `Neutral Environment`, `Awe
Environment`)
long_Awe_whole <- Awe_whole %>%
  pivot_longer(cols = -c(Subject, Group, TotalSS), names_to = "Variable",
values_to = "Value", values_drop_na = TRUE)
means_per_group <- long_Awe_whole %>%
  group_by(Group, Variable) %>%
  summarise(mean_Value = mean(Value), .groups = 'drop')
models <- long_Awe_whole %>%
  group_by(Group, Variable) %>%
  do(model = lm(Value ~ TotalSS, data = .))
fitted_lines <- models %>%
  do(data.frame(Group = .$Group, Variable = .$Variable, TotalSS =
seq(min(long_Awe_whole$TotalSS), max(long_Awe_whole$TotalSS), length.out =
50),
      Value = predict(.$model, newdata = data.frame(TotalSS =
seq(min(long_Awe_whole$TotalSS), max(long_Awe_whole$TotalSS), length.out =
50))))))
ggplot(long_Awe_whole, aes(x = TotalSS, y = Value, color = Group)) +

```

```

geom_point(aes(shape = Variable), alpha = 2) +
geom_line(data = fitted_lines, aes(x = TotalSS, y = Value, color = Group,
linetype = Variable)) +
labs(x = "Total Spirituality Score", y = "AWE-S", color = "Group", shape
= "Environment", linetype = "Environment") +
theme_minimal() +
ggtitle("Interaction plot of AWE-S vs. Spirituality Score with Estimated
Lines") +
scale_color_manual(values = c('#008070', '#FF89A1'), name = "Group") + #
Use scale_color_manual for color aesthetic
coord_cartesian(ylim = c(25, 200))
#bar graphs
# Define the desired order of the "Variable"
variable_order <- c("time", "self-diminishment", "connectedness",
"vastness", "physical sensations", "need for accommodation")
# Convert the "Variable" column to a factor with the specified order
long_Awe_sub.blk.df$variable_order <- factor(long_Awe_sub.blk.df$Variable,
levels = variable_order)
# Create the plot
plot2.long_Awe_sub.blk <- ggplot(long_Awe_sub.blk.df, aes(x =
variable_order, y = fit, fill = Group)) +
geom_ribbon(aes(ymin = 0, ymax = 25, fill = Group), alpha = 0.5) +
geom_bar(stat = "identity", position = "dodge", width = 0.7) +
ylab("AWE-S Score") +
xlab("AWE-S Factor") +
ggtitle("Neutral VR Environment and AWE-S Factors") +
scale_fill_manual(values = c('#008080', '#FFC0CB'), name = "Group") +
theme_classic(base_size = 23)
# Print the plot
print(plot2.long_Awe_sub.blk)
...

```