First-Person Perspective Induces Stronger Feelings of Awe and Presence Compared to Third-Person Perspective in Virtual Reality

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ABSTRACT

Awe is a complex emotion described as a perception of vastness and a need for accommodation to integrate new, overwhelming experiences. Virtual Reality (VR) has recently gained attention as a convenient means to facilitate experiences of awe. In VR, a first-person perspective might increase awe due to its immersive nature, while a third-person perspective might enhance the perception of vastness. However, the impact of VR perspectives on experiencing awe has not been thoroughly examined. We created two types of VR scenes: one with elements designed to induce high awe, such as a snowy mountain, and a low awe scene without such elements. We compared first-person and third-person perspectives in each scene. Forty-two participants explored the VR scenes, with their physiological responses captured by electrocardiogram (ECG) and face tracking (FT). Subsequently, participants self-reported their experience of awe (AWE-S) and presence (IPQ) within VR. The results revealed that the first-person perspective induced stronger feelings of awe and presence than the third-person perspective. The findings of this study provide useful guidelines for designing VR content that enhances emotional experiences.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; *Empirical studies in collaborative and social computing*.

KEYWORDS

Awe, Virtual reality, Perspective, Emotion

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1 INTRODUCTION

Awe is a complex emotion characterized by wonder and amazement, often triggered by perceptual or conceptual vast stimuli [1, 2]. The core of the awe experience involves the perception of vastness and the mental attempt to accommodate this vastness within one's existing mental schema [1]. Stimuli that can induce awe include majestic and dramatic natural landscapes [3], tall trees in forests [4], and powerful music [5]. Awe plays a significant role in enhancing our lives, leading to a variety of positive effects such as an increase in patience and altruistic behavior [6], reduction of stress [7], and an increase in well-being [8].

In recent years, the emotion of awe has garnered considerable scientific interest across various fields such as psychology, neuroscience, and sociology [9, 10]. The main challenge in studying awe is the limited access to stimuli that can reliably induce this emotion. Virtual Reality (VR) technology is gaining recognition as a means to safely and accessibly induce the emotion of awe [11–13]. VR can effectively recreate vast and overwhelming worlds that are difficult to experience in reality, providing the grandeur and novelty needed to induce awe. Additionally, VR allows users to experience awe in a safe and controlled environment by virtually experiencing situations that would be dangerous in the real world (e.g., the summit of a snowy mountain). In this way, VR technology is recognized as an effective means of inducing awe.

Immersion is critical for awe experiences in VR, with more immersive media eliciting stronger awe responses [4]. VR perspectives significantly affect users' sense of embodiment and spatial awareness, both crucial for immersion [14]. Therefore, this study examines how first-person and third-person perspectives affect the experience of awe and provides VR design guidelines to evoke this emotion. Specifically, using a first-person perspective enhances the sense of immersion, thereby intensifying the awe experience. Enhancing awe experiences is good for designing awe-eliciting VR in domains like art and architecture, where emotional engagement is desirable. Well-being improvement is also fostered by feeling awed and as part of something greater than oneself.

The main contributions of this study are:

- The first-person perspective was more effective than the third-person perspective in eliciting a sense of awe by enhancing feelings of connection and physical sensations associated with awe experiences.
- The snowy mountain scene we created as a High Awe scene was confirmed more effective in eliciting awe than our corridor scene,

created as a Low Awe scene. Particularly in terms of evoking a sense of vastness and physical sensations.
- Awe-related spontaneous facial expressions were subtle, in contrast to previous work on awe-related posed facial expressions.
- The perspective did not significantly affect changes in heart rate.
- The emotional intensity of awe experiences is potentially driven by awe-inducing content, rather than a specific perspective.

2 RELATED WORK

2.1 Awe Induced through VR

Previously, three advantages of using VR to induce awe were identified [11]. First, it can provide immersive experiences anywhere; second, it enables astonishing experiences that are not only possible in reality but also those that are impossible in reality; and third, it facilitates the real-time collection of physiological data during awe experiences. A follow-up study comparing awe and presence found that VR significantly enhances feelings of awe and presence compared to 2D videos [4]. Furthermore, scenarios with vast elements, such as mountains, are particularly effective in eliciting awe. The graphical fidelity of VR platforms also plays a crucial role in enhancing the realism and immersiveness of the experience, contributing to the awe-inducing potential of VR [15]. Additionally, sensations like flying in VR can amplify awe by enhancing perceptions of vastness and cognitive accommodation [12]. While these studies contribute to our understanding of awe experiences through VR, further research is needed to explore how different perspectives within VR can affect the awe experience.

2.2 First-Person and Third-Person Perspectives

The choice of perspective in VR greatly affects the user experience. When comparing the effects of different perspectives on user performance, the first-person perspective (1pp) significantly enhanced the sense of embodiment. In contrast, the third-person perspective (3pp) offered advantages in spatial perception [14]. Moreover, 1pp tends to produce a stronger sense of body ownership and self-location, critical embodiment components, compared to 3pp [16]. The sense of embodiment in VR can affect a user's emotional and cognitive experiences, enhance the sense of presence, and intensify the emotional impact of VR experiences [17]. Other research found that while 1pp provided a higher sense of presence [18], 3pp offers a broader view that can reduce simulator sickness and improve spatial awareness and orientation [19].

In the context of awe elicitation in VR, the literature predominantly discusses experiences designed from a 1pp. Studies have emphasized the role of 1pp in enhancing immersive and awe-inducing experiences, suggesting that this perspective may be particularly effective in eliciting emotional responses such as awe [4, 12, 20].

While these studies highlight the influence of VR perspectives on embodiment, presence, and emotional responses, further research is required to directly compare 1pp and 3pp to determine their specific effects on the experience of awe in VR.

2.3 Self-Report Measures of Awe

Several methods exist to measure awe, including questionnaires and observational techniques. Among self-report methods, questionnaires are the most commonly used. The Dispositional Positive Emotion Scale (DPES) [21] is one example that measures various positive emotions, including awe [22]. The Awe Experience Scale (Awe-S) [23], is specifically designed to comprehensively measure the emotion of awe into six factors: changes in time perception, self-loss, connection, perception of vastness, physical sensations, and the need for accommodation. Each factor is assessed with five items, totaling 30 questions. This scale is also validated in Japanese, maintaining the original's six-factor structure [24]. We opted to use the Awe-S due to its comprehensive measurement of multiple dimensions of awe, such as time perception, self-loss, and connection. These dimensions were expected to be particularly relevant in VR environments where camera perspectives might influence users' experiences and perceptions of awe-inspiring content.

2.4 Physiological and Behavioral Measurement Methods for Awe

As with other emotions, physiological responses co-occur with the experience of awe. One such response is the occurrence of goosebumps. Specifically, people whose goosebumps were detected using a recording instrument showed significantly higher ratings of awe than those who did not experience goosebumps [12]. Additionally, previous research compared heart rate changes while watching neutral and awe-inducing videos, showing a significant decrease in heart rate while watching awe-inducing videos compared to neutral ones [25]. Responses also include facial expressions such as widened eyes, raised inner eyebrows, and a slightly lowered jaw and mouth, which were voluntarily expressed during the recall of awe [26]. However, as the elicitation relied on recalling past experiences, it remains unclear whether participants would naturally exhibit these expressions without prompting to communicate awe.

3 RESEARCH QUESTIONS

This study aims to bridge these gaps by investigating how 1pp and 3pp perspectives in VR influence the perception of awe. We developed a VR application with both perspectives. We evaluated participants' awe experiences through self-reporting and physiological and behavioral responses. We aim to investigate the following research questions, each supported by specific hypotheses:

RQ1: How does the choice of perspective (1pp vs. 3pp) in VR influence the subjective experience of awe?

H1: There is a difference in awe between 1pp and 3pp. We hypothesize that 1pp elicits more awe than 3pp – **(H1-1)** because 1pp enhances the sense of presence in VR [27]. Conversely, we also hypothesize that 3pp elicits more awe than 1pp – **(H1-2)**, because a 3pp improves spatial cognition and allows one to compare one's smallness with the vastness of the landscape [14]. This contradictory hypothesis needs further investigation.

RQ2: How do different scene types and perspectives in VR influence the physiological and expressive responses associated with awe?

H2: Feeling awe relates to a heart rate reduction.

H3: Feeling awe relates to an increase in goosebumps.

H4: Feeling awe relates to widened eyes.

H5: Feeling awe relates to a slightly dropped jaw.

H6: Feeling awe relates to raising the inner eyebrows.

H7: The type of perspective (1pp vs. 3pp) interacts with each dependent variable (heart rate, goosebumps, gaze, mouth opening, and eyebrows tilting).

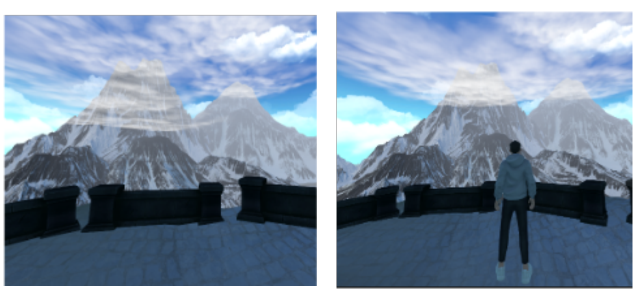
RQ3: How do different types of scenes (high awe vs. low awe) in VR affect the perception of awe?

H8: A high awe scene (a snowy mountain scene) elicits more awe than a low awe scene (a corridor scene enclosed by walls).

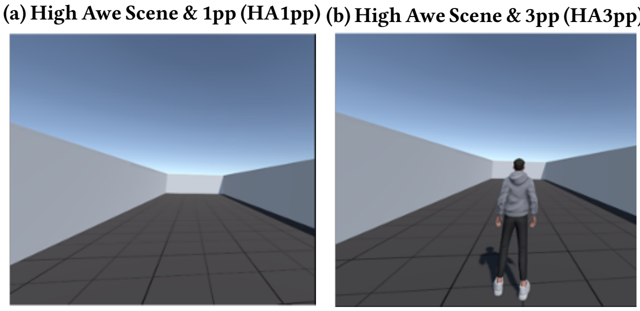
4 METHOD

4.1 Participants

We calculated the required total sample size assuming an alpha error probability of 0.05 and a desired test power of 0.95 and given an expected effect size of $\eta^2 = 0.22$ (converted from ($r = 0.31$) [27]). This calculation was performed using the function `pwrss.f.rmanova` tailored for within-subjects effects. The computed necessary sample size to achieve the desired power was 17 participants. However, considering potential dropouts due to cyber sickness and to balance different nationalities, we ultimately recruited 42 participants (20 Japanese and 22 Germans; 28 men and 14 women; aged between 18 and 54). Due to a connectivity issue, data from one participant was excluded from the analysis (German female). Ethical approval was granted by our local institution (2023-I-5). Before starting the experiment, participants were provided with detailed information about the study and were asked to sign an informed consent form. The code and anonymized data are available in OSF (https://osf.io/azq6xf).



(a) High Awe Scene & 1pp (HA1pp) **(b) High Awe Scene & 3pp (HA3pp)**



(c) Low Awe Scene & 1pp (LA1pp) **(d) Low Awe Scene & 3pp (LA3pp)**

Figure 1: Conditions used in the experiment

4.2 Experiment Design

A 2×2 within-subjects design was used with two independent variables: VR perspective (first-person [1pp] and third-person [3pp], counterbalanced across blocks) and scene type (high awe [HA] and low awe [LA], counterbalanced within blocks). Self-reports of awe and presence in VR, electrocardiogram (ECG), and face tracking were measured as dependent variables. Participants did not undergo practice trials before the experiment to avoid altering their natural reactions, as familiarity with the tasks could influence their initial responses.

4.3 Stimuli

4.3.1 VR Scenes. We created two distinct VR scenes: a low awe scene (hereafter referred to as LA) and a high awe scene (hereafter referred to as HA). We chose a snowy mountain for the HA, as prior studies have shown the effectiveness of vast, nature-based stimuli like mountains in eliciting awe [1, 20]. This scene emphasized vastness, a key component for awe, by having participants walk through a narrow path with limited visibility before revealing a wide mountain view (Figure 1a and 1b). This design was inspired by Burke's concept of the sublime [28], where such spatial transitions can intensify the emotional impact of the experience. The LA was designed to contrast with the awe-inducing scene, following the description of a physically closed environment that is perceivable at a glance [20]. The focus was on removing elements of vastness rather than to replicate a real location. The scene merely showed a simple textured ground plane surrounded by plain walls (3m × 98m × 2.5m) (Figures 1c and 1d). These scene and VR perspective combinations created four experimental conditions: High Awe Scene & First-Person Perspective (HA1pp), High Awe Scene & Third-Person Perspective (HA3pp), Low Awe Scene & First-Person Perspective (LA1pp), and Low Awe Scene & Third-Person Perspective (LA3pp).

4.3.2 VR Perspectives. In our 3pp implementation, we selected a fixed camera system to suppress discomfort associated with complex camera movements. This implementation positioned the camera behind the avatar at a distance of 3 m and a height of 1.6 m. The camera maintains a constant relative position to the avatar, ensuring a stable view. The camera's orientation is linked to the user's head movements, allowing for intuitive control. When a participant faces forward, the avatar's back is visible, but as the participant turns their head to the side or looks backward, the avatar disappears from view.

4.4 Measurements

Self-report data was collected using the open-source LimeSurvey[1] on an iPad. The Awe Experience Scale (Awe-S) [23] was employed to assess participants' experiences of awe. The Awe-S was measured using a 7-point Likert scale. The Igroup Presence Questionnaire (IPQ) [29] was used to measure the influence of 1pp and 3pp perspectives on the sense of presence in VR. The IPQ was measured using a 7-point Likert scale. All participants completed a demographic questionnaire assessing age, gender, nationality, dominant hand, previous VR experience, and general well-being (see supplementary materials). The self-report data used the Japanese version in Japan

[1] http://www.limesurvey.org

and the English version in Germany, considering the average English proficiency of each population. Heart rate (HR) was recorded by a Shimmer3 ECG Unit[2]. Facial tracking data was recorded using the Meta Movement SDK for Unity [30], utilized by a Meta Quest Pro. This SDK employs the headset's built-in cameras to capture images of the user's face in real time to estimate facial movements. The tracking output ranges from zero (no facial movement) to one (maximum facial displacement).

4.5 Experimental Setup and Content

Participants were seated on a regular chair and equipped with a Meta Quest Pro (Refresh Rate: 90Hz, Resolution: 1800 × 1920 pixels per eye). The VR scenes were implemented using Unity 2021.3.6f1. Avatars matching the self-reported gender of participants were selected from the Ready Player Me library [31].

4.6 Procedure

Participants first viewed a black screen in the Head-Mounted Display (HMD) for 30 seconds to provide a baseline and minimize any residual effects from the previous VR scene. They then explored the VR scene freely for one and a half minutes in each condition. Participants navigated the VR environment using the hand controllers to move and visually explore the virtual scene by turning their heads. Afterward, participants removed the HMD and completed the questionnaires on an iPad. The total duration of the experiment was about one hour.

5 ANALYSIS AND RESULTS

5.1 Confirmatory Factor Analysis

Confirmatory factor analysis was performed to verify the factor structure of the previously reported Awe-S results [23, 24] under the four conditions of this study. Four Awe-S factors – *Changes in Time Perception*, *Self-loss*, *connection*, and *Perception of Vastness* – were decomposed similarly to the original study. However, items classified under *Physical Sensations* and *Need for Accommodation* in the original study were categorized under *Perception of Vastness* in this study. Consequently, the factors *Physical Sensations* and *Need for Accommodation* could not be classified as in the original study. Despite the discrepancies in our sample's Awe-S factors, we decided to rely on the factors from the original study [23, 24] for the subsequent analyses, given their larger sample size. The results of this analysis are illustrated in the supplementary materials.

5.2 Awe-S

The average scores for each participant were calculated for the total score of Awe-S and for each factor [23]. A general linear mixed model, fitted with a Gamma distribution to match the Awe-S scores' distribution, evaluated the interaction effects between perspective and VR scene on Awe-S scores, using factors from Yaden et al [23]. Subsequent pairwise comparisons were conducted using estimated marginal means (EMMs) with p value adjustment performed using the Tukey method for comparing a family of four estimates. There were no significant differences in AWE-S scores between Japanese and Germans (t = 0.99, p = 0.323). Thus, we did not further analyze nationality differences.

5.2.1 Overall Awe-S Score. The main effects of the overall Awe-S score showed that the snowy mountain environment designed to induce HA indeed received higher overall awe ratings ($M = 3.48, SD = 1.15$) compared to LA ($M = 2.56, SD = 0.98, \hat{\beta} = 0.11, SE = 0.01, t = 7.74, p < 0.01$), confirming **H8**. The 1pp also resulted in significantly higher overall awe ratings ($M = 3.16, SD = 1.21$) compared to the 3pp ($M = 2.88, SD = 1.09, \hat{\beta} = 0.04, SE = 0.01, t = 3.10, p < 0.01$), thus confirming **H1**. There was no significant interaction between perspective and VR scene conditions ($\hat{\beta} = -0.03, SE = 0.02, t = -1.28, p = 0.20$). Furthermore, pairwise comparisons of the Awe-S total scores across HA1pp ($M = 3.73, SD = 1.15$), HA3pp ($M = 3.23, SD = 1.09$), LA1pp ($M = 2.58, SD = 0.99$), and LA3pp ($M = 2.53, SD = 0.99$) conditions revealed significant differences except between LA1pp vs. LA3pp (see Table 1).

The following results were obtained for each Awe-S factor:

Changes in Time Perception. No significant differences were observed in the main effects of VR scene conditions. The HA ($M = 3.71, SD = 1.46$) did not show any significant effect on time perception compared to the LA ($M = 3.85, SD = 1.64, \hat{\beta} = -0.01, SE = 0.02, t = -0.52, p = 0.61$). Similarly, the 1pp ($M = 3.96, SD = 1.61$) did not show any significant effect on time perception compared to the 3pp ($M = 3.61, SD = 1.47, \hat{\beta} = 0.02, SE = 0.02, t = 1.24, p = 0.22$). Moreover, there was no significant interaction between perspective and VR scene conditions ($\hat{\beta} < -0.01, SE = 0.03, t = -0.09, p = 0.93$).

Self-loss. The main effect of the VR scene condition was significant, showing that participants experienced a higher degree of self-loss in the HA condition ($M = 3.66, SD = 1.59$) compared to the LA ($M = 2.82, SD = 1.46, \hat{\beta} = 0.08, SE = 0.02, t = 3.87, p < 0.01$). However, the 1pp ($M = 3.39, SD = 1.63$) did not show any significant effect on self-loss compared to the 3pp ($M = 3.08, SD = 1.51, \hat{\beta} = 0.03, SE = 0.02, t = 1.68, p = 0.09$), confirming no significant differences in the main effects of perspective conditions. Moreover, there was no significant interaction between perspective and VR scene conditions ($\hat{\beta} = -0.02, SE = 0.03, t = -0.54, p = 0.59$). Furthermore, pairwise comparisons of the factor *Self-loss* across the HA1pp ($M = 3.90, SD = 1.66$), HA3pp ($M = 3.42, SD = 1.49$), LA1pp ($M = 2.88, SD = 1.44$), and LA3pp ($M = 2.75, SD = 1.48$) conditions revealed significant differences between HA1pp vs. LA1pp, HA1pp vs. LA3pp, and HA3pp vs. LA3pp (see Table 1).

Connection. Significant main effects were found in the VR scene conditions. The HA ($M = 2.93, SD = 1.48$) showed significantly higher feelings of connection compared to the LA ($M = 1.93, SD = 1.15, \hat{\beta} = 0.18, SE = 0.03, t = 5.55, p < 0.01$). Similarly, the 1pp ($M = 2.54, SD = 1.46$) showed significantly higher connection compared to the 3pp ($M = 2.32, SD = 1.36, \hat{\beta} = 0.05, SE = 0.03, t = 2.12, p = 0.03$). Moreover, there was no significant interaction between perspective and VR scene conditions ($\hat{\beta} = -0.06, SE = 0.05, t = -1.36, p = 0.17$). Furthermore, pairwise comparisons of the factor *Connection* across the HA1pp ($M = 3.19, SD = 1.51$),

[2]https://shimmersensing.com

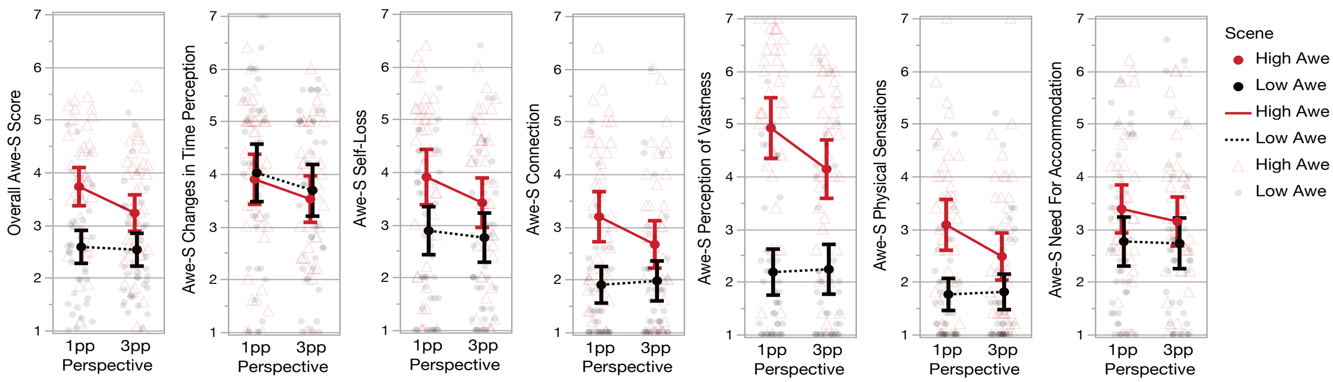


Figure 2: Depicted are means and 95% confidence intervals for the overall Awe-S score and its subscales. Data for HA is depicted in red, whereas LA is depicted in black. Individual participant responses are indicated by light red triangles for HA, and light gray dots for LA.

HA3pp ($M = 2.66, SD = 1.43$), LA1pp ($M = 1.90, SD = 1.10$), and LA3pp ($M = 1.97, SD = 1.20$) conditions revealed significant differences between HA1pp vs. LA1pp, HA1pp vs. LA3pp, HA3pp vs. LA1pp, as well as HA3pp vs. LA3pp (see Table 1).

Perception of Vastness. In the mountain scene (HA condition), participants crossed the threshold between narrow and vast areas after a median of 40 seconds and remained in the vast section for a median of 50 seconds. Significant main effects in the VR scene conditions were observed. The HA ($M = 4.53, SD = 1.82$) showed a significantly greater perception of vastness compared to the LA ($M = 2.21, SD = 1.43, \hat{\beta} = 0.23, SE = 0.03, t = 7.31, p < 0.01$). However, the main effects of the perspective condition were not significant, with 1pp ($M = 3.55, SD = 2.12$) not significantly different from 3pp ($M = 3.19, SD = 1.89, \hat{\beta} = 0.03, SE = 0.02, t = 1.75, p = 0.08$). Additionally, the interaction between perspective and VR scene conditions was not significant ($\hat{\beta} = -0.04, SE = 0.04, t = -0.85, p = 0.40$). Furthermore, pairwise comparisons of the factor *Perception of Vastness* across the HA1pp ($M = 4.92, SD = 1.82$), HA3pp ($M = 4.14, SD = 1.76$), LA1pp ($M = 2.18, SD = 1.38$), and LA3pp ($M = 2.23, SD = 1.50$) conditions revealed significant differences between HA1pp vs. LA1pp, HA1pp vs. LA3pp, HA3pp vs. LA1pp, as well as HA3pp vs. LA3pp (see Table 1).

Physical Sensations. Significant main effects were observed in both the VR scene and perspective conditions. The HA ($M = 2.78, SD = 1.50$) showed significantly more intense sensations compared to the LA ($M = 1.78, SD = 1.01, \hat{\beta} = 0.20, SE = 0.03, t = 7.06, p < 0.01$). Similarly, the 1pp ($M = 2.42, SD = 1.43$) showed significantly stronger physical sensations compared to the 3pp ($M = 2.14, SD = 1.29, \hat{\beta} = 0.06, SE = 0.02, t = 2.78, p < 0.01$). However, the interaction effect between perspective and VR scene conditions was not significant ($\hat{\beta} = -0.07, SE = 0.04, t = -1.71, p = 0.09$). Furthermore, pairwise comparisons of the factor *Physical Sensations* across the HA1pp ($M = 3.08, SD = 1.53$), HA3pp ($M = 2.48, SD = 1.42$), LA1pp ($M = 1.76, SD = 0.96$), and LA3pp ($M = 1.81, SD = 1.07$) conditions revealed significant differences between HA1pp vs. HA3pp, HA1pp vs. LA1pp, HA1pp vs. LA3pp, HA3pp vs. LA1pp, as well as HA3pp vs. LA3pp (see Table 1).

Need for Accommodation. Significant main effects were observed in the VR scene conditions. The HA ($M = 3.26, SD = 1.46$) indicated a significantly greater need for accommodation compared to the LA ($M = 2.74, SD = 1.49, \hat{\beta} = 0.05, SE = 0.02, t = 3.25, p < 0.01$). However, the main effects of the perspective condition were not significant, with 1pp ($M = 3.07, SD = 1.48$) not significantly different from 3pp ($M = 2.93, SD = 1.51, \hat{\beta} = 0.02, SE = 0.02, t = 1.15, p = 0.25$). Additionally, the interaction between perspective and VR scene conditions was not significant ($\hat{\beta} = -0.01, SE = 0.02, t = -0.55, p = 0.59$). Furthermore, pairwise comparisons of the factor *Need for Accommodation* across the HA1pp ($M = 3.38, SD = 1.44$), HA3pp ($M = 3.14, SD = 1.47$), LA1pp ($M = 2.76, SD = 1.47$), and LA3pp ($M = 2.73, SD = 1.53$) conditions revealed significant differences between HA1pp vs. LA1pp, as well as HA1pp vs. LA3pp (see Table 1).

Table 1: Pairwise comparisons per condition for the Awe-S ratings
Statistically significant differences in bold. ES denotes Effect Size.

	A1pp vs. A3pp		A1pp vs. N1pp		A1pp vs. N3pp		A3pp vs. N1pp		A3pp vs. N3pp		N1pp vs. N3pp	
	ES	p	ES	p	ES	p	ES	p	ES	p	ES	p
Overall Awe-S Score	**-0.15**	**0.01**	**-0.44**	**<.01**	**-0.47**	**<.01**	**-0.29**	**<.01**	**-0.32**	**<.01**	-0.03	0.97
Changes in Time Perception	-0.07	0.57	0.02	0.98	-0.04	0.89	0.09	0.33	0.03	0.94	-0.06	0.69
Self-loss	-0.08	0.28	**-0.21**	**<.01**	**-0.25**	**<.01**	-0.13	0.10	**-0.17**	**0.02**	-0.04	0.92
Connectedness	-0.12	0.16	**-0.42**	**<.01**	**-0.38**	**<.01**	**-0.31**	**<.01**	**-0.27**	**<.01**	0.04	0.97
Perception of Vastness	-0.07	0.29	**-0.50**	**<.01**	**-0.48**	**<.01**	**-0.43**	**<.01**	**-0.41**	**<.01**	-0.02	0.99
Physical Sensations	**-0.17**	**0.01**	**-0.56**	**<.01**	**-0.53**	**<.01**	**-0.40**	**<.01**	**-0.36**	**<.01**	0.04	0.98
Need for Accommodation	-0.06	0.61	**-0.17**	**<.01**	**-0.18**	**<.01**	-0.11	0.13	-0.13	0.08	-0.01	1.00

5.3 Effect of Nationality

While the main focus of this study was to explore the impact of VR perspective on the experience of awe, we also used generalized linear mixed models to examine the effect of nationality on participants from Japan and Germany. The results indicated no significant differences in measures of awe due to nationality: Overall Awe-S Score ($\hat{\beta} = 0.05, SE = 0.05, t = 0.99, p = 0.32$), Changes in Time Perception ($\hat{\beta} = -0.01, SE = 0.05, t = -0.26, p = 0.80$), Self-loss ($\hat{\beta} = 0.12, SE = 0.08, t = 1.56, p = 0.12$), Connection ($\hat{\beta} = 0.07, SE = 0.07, t = 1.00, p = 0.32$), Perception of Vastness ($\hat{\beta} = 0.01, SE = 0.05, t = 0.29, p = 0.77$), Physical Sensations ($\hat{\beta} = 0.02, SE = 0.09, t = 0.26, p = 0.80$), and Need for Accommodation ($\hat{\beta} = 0.07, SE = 0.09, t = 0.71, p = 0.48$). These findings suggest that nationality did not significantly influence the participants' experience of awe in this study.

5.4 IPQ

We first assessed the internal consistency of the IPQ subscales using Cronbach's alpha. The results showed high internal consistency for all subscales: Spatial Presence ($\alpha = 0.803$), Involvement ($\alpha = 0.798$), and Realism ($\alpha = 0.838$). The IPQ showed a non-normal distribution ($\mathrm{IPQ}: W = 0.98, p < 0.01; \mathrm{SpacePresence}: W = 0.96, p < 0.01; \mathrm{Involvement}: W = 0.97, p < 0.01; \mathrm{Realism}: W = 0.94, p < 0.01$) as tested with the Saphiro-Wilk test for normality. Therefore, a non-parametric repeated measures ANOVA using the Aligned Rank Transform (ART) was conducted [32].

5.4.1 Overall IPQ score. There were significant main effects of both the VR scene and perspective conditions. The HA ($M = 3.08, SD = 0.61$) and the LA ($M = 2.74, SD = 0.62$) showed significant differences ($F(1, 120) = 29.21, p < 0.01$). Similarly, the 1pp ($M = 3.07, SD = 0.54$) and 3pp ($M = 2.75, SD = 0.68$) conditions showed significant differences ($F(1, 120) = 22.43, p < 0.01$). However, the interaction effect between perspective (1pp and 3pp) and VR scene (HA and LA) conditions was not significant ($F(1, 120) = 0.16, p = 0.69$).

5.4.2 Spatial Presence score. The 1pp ($M = 3.45, SD = 0.75$) and 3pp ($M = 2.91, SD = 1.06$) conditions showed significant differences in their Spatial Presence scores ($F(1, 120) = 15.85, p < 0.01$), indicating that the perspective condition influenced the Spatial Presence scores. However, the HA ($M = 3.37, SD = 0.88$) and LA conditions ($M = 3.09, SD = 1.02$) did not show significant differences in their Spatial Presence scores ($F(1, 120) = 3.53, p = 0.06$). Furthermore, the interaction effect between perspective (1pp and 3pp) and VR scene (HA and LA) conditions was not significant ($F(1, 120) < 0.01, p = 0.97$).

5.4.3 Involvement score. Significant main effects were observed in both the VR scene and perspective conditions. The HA involvement scores ($M = 3.54, SD = 0.70$) were significantly higher than in the LA ($M = 3.05, SD = 0.73, F(1, 120) = 31.19, p < 0.01$). Similarly, the 1pp ($M = 3.38, SD = 0.73$) conditions were significantly higher than the 3pp ones ($M = 3.21, SD = 0.78, F(1, 120) = 4.31, p = 0.04$). However, the interaction effect between perspective (1pp and 3pp) and VR scene (HA and LA) conditions was not significant ($F(1, 120) = 0.13, p = 0.72$).

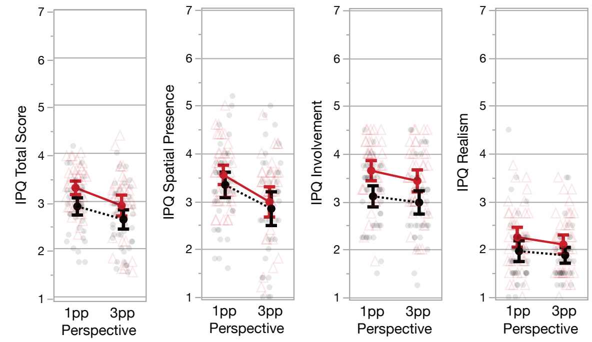
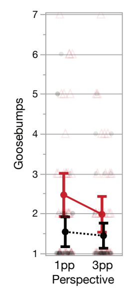


Figure 3: Results of the IPQ score



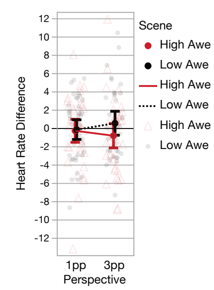


Figure 4: Goosebumps **Figure 5: BPM**

5.4.4 Realism score. There were significant main effects observed in the VR scene conditions, suggesting that the HA scene was more realistic than the LA one ($M_{HA} = 2.17, SD_{HA} = 0.65, M_{LA} = 1.91, SD_{LA} = 0.61, F(1, 120) = 22.429, p < 0.01$). However, the main effects of the perspective condition were not significant ($M_{1pp} = 2.10, SD_{1pp} = 0.68, M_{3pp} = 1.98, SD_{3pp} = 0.59, F(1, 120) = 2.53, p = 0.11$). Furthermore, the interaction effect was not significant ($F(1, 120) = 0.71, p = 0.40$).

5.5 Self-reported Goosebumps

The Awe-S Goosebumps score showed a non-normal distribution ($W = 0.67, p < 0.01$), leading to a non-parametric ANOVA via ART. Significant effects were noted in VR scene and perspective conditions, with higher Goosebumps scores in HA ($M_{\mathrm{HA}} = 2.22, SD_{\mathrm{HA}} = 1.59$) compared to LA ($M_{\mathrm{LA}} = 1.49, SD_{\mathrm{LA}} = 1.09$), $F_{scene}(1, 120) = 40.33$, $p_{scene} < 0.01$. Similarly, 1pp ($M_{1pp} = 2.00, SD_{1pp} = 1.54$) showed higher scores than 3pp ($M_{3pp} = 1.71$, $SD_{3pp} = 1.25$), $F_{perspective}(1, 120) = 11.83$, $p_{perspective} < 0.01$. An interaction effect ($F(1, 120) = 8.01, p < 0.01$) and pairwise comparisons using Wilcoxon tests adjusted by Hochberg method showed significant differences in HA1pp vs. LA1pp ($W = 1155, p_{\mathrm{adj}} < 0.01$), and HA1pp vs. LA3pp ($W = 1184, p_{\mathrm{adj}} < 0.01$), with no significant differences in other comparisons (HA1pp vs. HA3pp, HA3pp vs. LA1pp, HA3pp vs. LA3pp, LA1pp vs. LA3pp).

5.6 Heart Rate

To assess changes in heart rate in VR, differences in BPM before and after the experiment were analyzed, showing a normal distribution confirmed by the Shapiro-Wilk test ($W = 0.99, p = 0.40$). A repeated measures ANOVA found no significant differences in

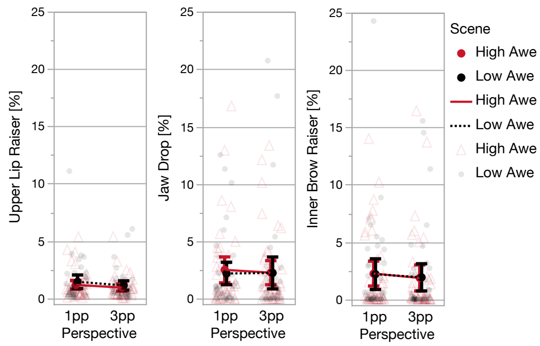


Figure 6: Results of the Face data

heart rate changes between HA and LA ($M_{\text{HA}} = -0.57, SD_{\text{HA}} = 3.97, M_{\text{LA}} = 0.15, SD_{\text{LA}} = 3.65, \hat{\beta} = 0.02, SE = 0.75, t = 0.02, p = 0.98$) or between 1pp and 3pp ($M_{1pp} = -0.30, SD_{1pp} = 3.65, M_{3pp} = -0.12, SD_{3pp} = 4.00, \hat{\beta} = -0.54, SE = 0.75, t = -0.72, p = 0.47$). There was also no significant interaction between scene type and perspective ($\hat{\beta} = 1.42, SE = 1.06, t = 1.34, p = 0.18$), indicating that perspective did not affect heart rate responses to scene type.

5.7 Facial Tracking

We collected data on Inner Brow Raiser Left (BRL), Inner Brow Raiser Right (BRR), Upper Lid Raiser Left (URL), Upper Lid Raiser Right (URR), and Jaw Drop (JD) during the last 30 seconds of VR exploration. These were chosen because expressions were subtle and only visible in the final 30 seconds of the awe-inducing scene. After applying a low-pass filter to remove noise, averages for each facial movement (BRL, BRR, JD, URL, URR) were calculated for each participant. These were then used to compute Inner Brow Raiser (BR) and Upper Lid Raiser (UR) metrics. UR, JD, and BR showed a non-normal distribution($UR : W = 0.61, p < 0.01; JD : W = 0.65, p < 0.01; Involvement : W = 0.97, p < 0.01; Realism : W = 0.94, p < 0.01$) Thus, we used a non-parametric repeated measures ANOVA with ART.

5.7.1 UpperLidRaiser. Perspective showed significant main effects. 1pp ($M = 0.022, SD = 0.038$) and 3pp ($M = 0.019, SD = 0.037$) had significant differences in Upper Lid Raiser scores ($F(1, 120) = 6.09, p = 0.015$). However, the HA ($M = 0.020, SD = 0.035$) and LA ($M = 0.021, SD = 0.040$) did not show significant differences ($F(1, 120) = 0.22, p = 0.64$). There was no significant interaction between perspective and VR scene ($F(1, 120) = 0.36, p = 0.55$).

5.7.2 JawDrop. Perspective did not significantly affect Jaw Drop scores ($F(1, 120) = 1.73, p = 0.19$). Scene also had no significant main effect on Jaw Drop scores ($F(1, 120) = 0.76, p = 0.38$). No significant interaction effect between Perspective and Scene was found ($F(1, 120) < 0.01, p = 0.97$).

5.7.3 InnerBrowRaiser. Perspective did not significantly affect InnerBrowRaiser scores ($F(1, 120) = 2.74, p = 0.10$). Scene also had no significant main effect ($F(1, 120) = 0.89, p = 0.35$). There was no significant interaction between Perspective and Scene ($F(1, 120) = 0.11, p = 0.74$).

6 DISCUSSION

6.1 Perspective and Awe Experience (RQ1)

H1 is supported by the findings that participants felt a stronger sense of awe in 1pp compared to 3pp. Awe-S results showed factors like Connection and Physical Sensations were significantly higher in 1pp. This suggests that the immersive nature of 1pp enhances feelings of embodiment and connection, eliciting stronger emotional responses such as awe. While previous research [14] found 3pp could offer advantages in spatial perception and awareness, our study did not find significant differences in the Perception of Vastness factor between 1pp and 3pp. This contradicts H1-2's assumption that 3pp might elicit more awe by allowing better comparisons of one's own smallness with the landscape's vastness.

IPQ results further emphasize the importance of presence, with HA1pp scoring significantly higher than other conditions, including HA3pp. These findings suggest that the immersive qualities of presence, embodiment, and connection are more effective in inducing awe than spatial awareness alone. Despite 3pp being less effective in this study, it may still be useful for certain awe experiences, especially when narrative or sensory elements [20, 33] are incorporated to offset reduced embodiment. Additionally, 3pp may benefit users prone to simulator sickness or discomfort in immersive environments [19]. However, our study emphasizes that the sense of presence in 1pp is crucial to evoke strong emotional responses of awe, especially spatial presence and involvement.

6.2 Physiological and Expressive Responses to Awe (RQ2)

H2 suggested that awe-inducing content would decrease heart rate [25]. Contrary to expectations, our analysis showed no significant heart rate differences across conditions. Several factors could account for this unexpected outcome. First, the variability in awe experiences, as awe can be elicited by various stimuli, not all of which may lead to heart rate reduction [1, 11]. Second, individual differences in the subjective experience of awe and physiological responses to it could influence heart rate responses [9]. Third, the immersive and dynamic nature of the VR environment itself may have introduced additional physiological responses or arousal levels that could potentially mask or counteract the expected heart rate reduction associated with awe [34]. Our findings partially support **H3**, which predicted a relationship between awe and goosebumps. Participants in HA1pp reported more goosebumps compared to LA1pp and LA3pp suggesting goosebumps indicate awe intensity, aligning with [12]. This suggests that goosebumps could potentially indicate the intensity of awe. However, this contradicts studies that found no physiological evidence of piloerection in response to awe [35]. A potential explanation is that we used self-reported goosebumps while previous work measured them physically.

Interestingly, no significant differences were found between HA1pp and HA3pp, implying perspective may not influence goosebumps in awe experiences. The absence of significant differences between the two low awe conditions (LA1pp vs. LA3pp) further supports the specificity of awe in eliciting physiological reactions like goosebumps.

Our analysis of **H4**, **H5**, and **H6** revealed a significant main effect of Perspective on the UpperLidRaiser score, indicating that the perspective condition influenced this particular facial expression associated with awe. However, no significant main or interaction effects were found for JawDrop and InnerBrowRaiser scores, suggesting that perspective and scene did not significantly influence these expressions. Several factors could explain this. First, variability in individual responses to awe-inducing stimuli might have contributed to the lack of significant effects for JawDrop and InnerBrowRaiser, as previous research has shown a wide range of reactions to awe [4, 36]. Second, our VR setup and measurement tools might not have been sensitive enough to detect subtle facial changes. This study is one of the first to empirically validate specific facial expressions associated with awe using sensing data. The absence of prior empirical investigations into these expressions means that the findings reported by **(author?)** [26], which characterized awe through widened eyes, raised inner brows, and a slightly dropped jaw and mouth, remain tentative. In particular, because the expressions they elicited were posed facial expressions.

H7 assumed that perspective type (1pp vs. 3pp) would interact with physiological responses during awe experiences. However, our findings indicated no significant interactions between perspective type and physiological measures, suggesting the immersive quality of the perspective does not significantly influence these responses in VR. The higher self-reported goosebumps in the HA1pp condition compared to low awe conditions did not differ significantly between HA1pp and HA3pp or between the two low awe conditions. This implies the awe experience itself triggers distinct goosebumps, but perspective does not alter their intensity. The lack of significant differences in heart rate and facial expressions suggests perspective type's physiological impact may not be as pronounced as assumed, driven mainly by the emotional intensity of awe-inducing stimuli [36]. This invites further investigation into VR elements influencing physiological responses.

6.3 Impact of Scene Type on Awe (RQ3)

As hypothesized in **H8**, our findings confirm that the high awe scene induced greater awe than the low awe scene. These results highlight the importance of environmental content in VR for eliciting awe, particularly elements that evoke vastness and beauty [20, 37].

The significant main effects were observed for the awe-inducing scene across various Awe-S factors, particularly *Perception of Vastness* and *Physical Sensations*.

The snowy mountain scene's design, transitioning from a narrow path to an expansive view, may have contributed to these effects by altering the user's sense of scale and space.

This transition, aligning with Burke's theory of the sublime [28], suggests that dramatic spatial changes can intensify emotional responses, particularly awe. In contrast, the low awe scene's lack of such elements did not similarly engage awe responses, emphasizing the importance of engaging environmental design. However, the less pronounced effects on *Changes in Time Perception* and *Need for Accommodation* indicate that cognitive aspects of awe may be influenced by triggers beyond the visual and spatial characteristics provided by the scene. This is consistent with research suggesting that awe involves a complex interplay between sensory experiences and cognitive processes [1, 26]. The significant main effects on IPQ scores further validate the effectiveness of the awe scene in enhancing presence and involvement in VR, despite no significant physiological changes observed across conditions. These findings underscore the importance of carefully designed VR environments to evoke awe, pointing to the need for exploring beyond visual and spatial characteristics to elicit a comprehensive awe response.

6.4 Limitations and Future Work

Our study has several limitations. First, the scores from the Awe-S and IPQ did not reach extreme values in the measuring scales, suggesting that the VR experience might not have elicited full immersion, realism, or deep emotions. This indicates a need for further enhancement in the VR quality. While previous research supports the effectiveness of natural stimuli like forests and waterfalls [1, 20], our corridor scene's simplicity may have engaged cognitive processes differently than expected. Facial data collection methods also limited us. VR headsets might not fully capture facial dynamics, and our tracking technology might miss subtle awe expressions. We did not account for individual differences like personality, and our sample mainly consisted of university students. Future research should explore more varied awe-inducing scenarios, including multiple neutral scenes or gradual introductions to awe-inducing elements.

6.5 Design guidelines

Using 1pp enhanced the sense of presence, connectedness, perception of vastness, and physical sensations, leading to stronger feelings of awe (medium to large effect). It also increased awe ratings in the same mountain scene (small to medium effect). Therefore, VR designers should focus on using 1pp, especially when seeking to evoke awe in VR. Adding features that boost the perception of vastness and scale can also improve the experience of awe.

7 CONCLUSION

This study revealed that the choice of perspective and scene in VR-induced awe experiences significantly affects the extent to which participants feel awe. It was confirmed that 1pp induces a stronger sense of awe compared to 3pp. Interestingly, spontaneous facial expressions traditionally associated with awe were subtle, in contrast to previous work on posed facial expressions related to awe. These findings highlight the need for further investigation into the reliability of physiological correlates, such as facial expressions and goosebumps, as indicators of spontaneous awe experiences across diverse contexts and individuals. Future research should explore the potential variability in the physiological manifestations of awe.

The unique experiences offered by VR have great potential for promoting well-being, reducing stress, and fostering inspiration through awe. By creating landscapes which are not easily accessible in reality, VR can provide opportunities for new knowledge and transformative experiences.

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