Does Absorption Moderate the Effect of Awe-Induction on Emotion of Awe, Time Perception, Perception of Vastness, and Accommodation Motivation?

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Abstract

The present study examined the relationship between awe-induction and awe emotion, perception of vastness, accommodation motivation, and time perception, and whether this relationship is moderated by trait absorption. Previous research found effects of awe-induction on outcome variables, but did not find a moderation effect of absorption on the relationship between awe-induction and outcome variables. Results remain unreliable due to insufficient awe-induction and sample size. Therefore, the current study uses stronger awe-induction methods and larger sample sizes when testing the hypothesis that absorption will moderate the relation between awe-induction and outcome variables, so that people higher in absorption will demonstrate stronger effects of awe-induction on awe emotion, perception of vastness, and accommodation motivation, and weaker effect of awe-induction on alterations in time perception. Canadian undergraduate students ($N = 293$) watched an awe or control video, after which they filled out questionnaires concerning outcome variables and absorption. Using *t*-tests and regression analyses, we found that awe-induction is related to the outcome variables and that absorption does not moderate these relationships. Future research should therefore consider intensifying awe-induction, using other moderating factors, and increasing sample size.

Keywords: awe-induction, trait absorption, emotion of awe, perception of vastness, accommodation motivation, time perception

Does Absorption Moderate the Effect of Awe-Induction on Emotion of Awe, Time Perception, Perception of Vastness, and Accommodation Motivation?

Being outside during a thunderstorm, being completely immersed in music with headphones on, or taking a walk in nature, allowing one to notice things that were left unnoticed before; these instances are all indicative of experiencing a sense of wonder, through being impressed by bright flashes and loud sounds, by the melodies and beats of the music, by the birds chirping and the orange light at sunrise. Equivalents of this experience were already elaborately described in the eighteenth century by Immanuel Kant, and ever since, attempts have been made to do so in a multitude of different ways by Charles Darwin, William James, Abraham Maslow, and so on, without ever having received proper definition until more recently in a paper of Keltner and Haidt (2003) that will be considered as a starting point recurrently referred to in the present report. It is awe.

What is so particular about this experience of awe? Awe affects a great range of emotions, skills, and experiences. Recent experimental research has found that when people experience awe, they enjoy enhanced well-being (Krause & Hayward, 2015) and increased meaning in life (Yuan, 2024), and exhibit more prosocial behaviors (Piff et al., 2015) and decreased acts of aggression (Yang et al., 2016). It may even affect the way we perceive our bodies (Van Elk et al., 2016) and can temporarily increase spiritual-type beliefs (Van Cappellen & Saroglou, 2012).

The first contemporary psychological description of *awe* was coined in a 2003 paper by Keltner and Haidt. They suggest that central to its experience are a cognitive appraisal and a motivational response, namely (1) the perception of vastness, and (2) *accommodation*, the latter of which entails mentally processing and integrating the received information by adjusting one's

mental schema. This is necessary because the vastness of what is perceived is so great that the mental representation may not fit into one's current mental schema. Therefore, in short, their definition of emotion of awe is an emotion that is experienced in the presence of something so vast that it requires cognitive accommodation (Keltner & Haidt, 2003).

Awe-Induction and Emotion of Awe, Alterations in Perception of Time and Vastness, and Accommodation Motivation

Having a closer look at these two dimensions of awe, we firstly find that *vastness* can either be *perceptual vastness*, so actually receiving sensory info, such as seeing a great mountain, or *conceptual vastness*, which entails simply being able to imagine something, hearing a grant idea, or meditating on eternity. Secondly, accommodation motivation is the second of the two aspects that constitute the definition of awe. The latter has rarely been addressed in awe literature so far (Chirico et al., 2016), and researchers have had trouble reaching a consensus on how to define or explain accommodation, which has resulted in a wide range of - sometimes unvalidated - operationalizations (Yaden et al., 2008).

In addition to the previously suggested factors of perception of vastness and accommodation motivation, Yaden et al. (2008) have proposed other experiential aspects of awe. One of these is time perception. Awe has been shown to temporarily change time perception (Rudd et al., 2012). More specifically, unlike flow, which tends to cause *downward time distortion*, or the sense that time is flying, awe may give the impression of *upward time distortion*, or the sense of time being slowed down. This may make people who are in a state of awe feel like they have more time available, and therefore, they experience less time pressure, increased willingness to spend the available time on helping others, preference of valuable experiences over materials, and increased overall satisfaction with life (Rudd et al., 2012). Their

hypothesis that time is perceived as slowing down when experiencing awe can be explained using two theories. First, the *extended-now theory* by Vohs and Schmeichel (2003) predicts that focusing on the here and now expands time perception, because with full attention, one can see things unfold step by step. This would be the case when experiencing awe. Second, *socioemotional selectivity theory* (SST) by Carstensen et al. (1999) suggests that this perceived increase in time may motivate people to find new knowledge to stimulate accommodation motivation. Thus, the combination of these theories suggest that the fact that awe emotion stimulates accommodation motivation is an indication that the mind has observed an increased amount of time as a consequence of awe-induction (Rudd et al., 2012).

Lastly, the *emotion of awe*, which is the subjective experience of awe, lies at the root of the other three outcome variables. Awe-induction was significantly correlated with the positive emotions of awe, wonder and astonishment (Yaden et al., 2008). Even though these are frequently studied outcome variables as a result of awe-induction, methodological flaws such as unreliable manipulations (e.g., thinking of an awe-inducing memory) point at a need for reliable awe-inducing stimuli that can be administered by researchers themselves (Van Elk, 2016).

The Role of Absorption

However, individual differences may play a role in who is more likely to experience awe-related outcomes in the presence of an awe elicitor. That is, effects of awe-inducing stimuli may differ per person. For example, Shiota et al. (2007) found that people scoring low on measures of *Need for Cognitive Closure*, which assess preference for continuity and predictability in surroundings and thereby, dislike of ambiguous situations, are more likely to experience awe than those who score higher on the measure. Another study investigated whether predispositions for awe vary across cultures and found that Japanese people are more likely to

experience negative aspects of awe than North Americans (Nakayama et al., 2020). Furthermore, previous research also found that individual differences in dreaming, imagination, and receptiveness to emotion-evoking stimuli may play a role in proneness to awe-induction. That is, there are individual differences in *absorption*, which is the tendency for being in an altered state of consciousness, by being completely absorbed in something (Van Elk, 2016; Ballew & Omoto, 2018). Van Elk hypothesized that absorption may moderate the effect of awe-induction on a small self when receiving awe-induction, so that people who score higher on absorption will perceive their body as being smaller. Absorption is hypothesized to moderate this, because people high in absorption are more sensitive to certain stimuli than people who are lower in absorption, which increases sensitivity to awe-induction. Awe may in turn cause the experience of a small self. Nevertheless, Van Elk could not find a clear moderation of absorption in the relationship between awe-induction and bodily perception, and he only found a small insignificant correlation between absorption and awe. However, Ballew and Omoto (2018) did find a significant association between awe and absorption. Thus, there are mixed findings on the relationship between awe and absorption and on the moderating effect of absorption.

Although Van Elk was unable to establish absorption as a moderator for the relationship between awe and small self, there have been some studies that showed absorption, or tendency to daydream and mind-wander, being related to time perception. One of these is Martarelli and Baillifard's (2024), who found that individuals who score low on absorption, therefore often letting their minds wander loosely instead of deliberately fantasizing, tend to have a slowed perception of time, and may therefore experience more boredom. Similarly, individuals scoring higher on absorption may be able to more actively design the objectively unchanged amount of time available, thereby making it seem like time goes by faster (Rutrecht et al., 2021). However,

as mentioned before, awe-induction may actually provide a sense of time slowing down. Why, then, does slowed time perception lead to the generally negative experience of boredom in one case, and is the expanded time perception a positive experience in another situation? It depends on the cause and consequent mechanisms that lead to upward time distortion, which would either allow for boredom, as is the case for low trait absorption scores, or consciously appreciating one's experiences rather than getting tired over the perceived increase of time, so that the available time can be used more effectively. The latter is the case for high awe scores (Rudd et al., 2012).

All in all, absorption's tendency to give the sensation of time speeding up may actually buffer awe-induction's sensation of time slowing down. Therefore, perception of time is an outcome variable that we will be looking at in our current research.

In addition, we will be looking at the two factors that constitute Keltner's definition of awe, namely perception of vastness and accommodation motivation. Firstly, perception of vastness may be influenced by higher scores on the absorption scale in a way that individuals who score higher on the absorption scale are more likely to perceive vastness after exposure to awe-inducing stimuli than those who score lower on the absorption scale. Secondly, people may experience increased need for accommodation after awe-induction when they score higher on trait absorption than those who score lower. After extensive research, we conclude that these two facets of awe are among the least researched in connection with trait absorption, even though they are strongly related to awe as a whole. I hypothesize that, based on the fact that research shows that absorption in some cases positively correlates with awe (Van Elk, 2015) and awe-induction positively correlates with perceived vastness and accommodation motivation (Yaden et al., 2008), trait absorption may increase perception of vastness and accommodation

motivation, or at least as a consequence of awe-induction. Therefore, we include the dependent variables of perception of vastness and accommodation motivation in our analysis.

Lastly, emotion of awe was one of the outcome variables in Van Elk's study (2016) on absorption moderating the effect of awe-induction on experience of awe. Although he found that absorption is related with emotion of awe, a moderating effect was not found. However, they had a relatively small sample size ($N = 89$), so a larger sample size is needed to test moderation to paint a clearer picture of the relationship. Furthermore, the awe-induction was done by instructing participants to think of a memory that would have evoked awe in them, rather than showing them awe-inducing videos in the moment. This is not the strongest method of inducing awe, since accuracy of memories and strength of awe-induction depend on type of memory and when it has taken place, and resulting emotional intensity may therefore differ per participant (Levine, 1997; Levine & Safer, 2002).

All in all, the experience of awe, consisting of the two dimensions of perception of vastness and accommodation motivation (Keltner & Haidt, 2003), has been repeatedly found to exert a multitude of positive effects on one's life, such as increased prosocial (Piff et al., 2015) and decreased aggressive behaviors (Yang et al., 2016), and enjoying enhanced well-being (Krause & Hayward, 2015) and increased meaning in life (Yuan, 2024) overall. Therefore, we are attempting to understand how we can enhance the effect of awe-induction as much as possible, and we do so by looking at the construct of absorption. Absorption has been found to be directly related to emotion of awe (Van Elk, 2016) and perception of time (Martarelli & Baillifard, 2024). However, there is a lack of research on the direct relationships between absorption and perception of vastness and accommodation motivation, and previous research on the relationship between awe and absorption did not find a significant correlation and has even

found mixed results (Van Elk, 2016; Ballew & Omoto, 2018). In addition, studies examining the moderating effect of absorption in the relationships between awe-induction and emotion of awe, perception of vastness, accommodation vastness, and time perception often lacked a sufficient sample size and powerful methods of awe-induction (Kaplan et al., 2016). Overall, the topics require a larger number of studies done on them with increased comprehensiveness.

To address these gaps, the aim of the present study is to examine whether absorption will enhance the effect that awe-inducing videos have on emotion of awe, perception of vastness, and accommodation motivation, and decrease the effect of awe-induction on time perception. Therefore, we presented a larger, more diverse group of participants with awe or neutral videos that allows for more generalizable findings and powerful methods of awe-induction as compared to previous research. In turn, we would let participants fill out measures of emotion of awe, perception of time, perception of vastness, accommodation motivation, and absorption.

More specifically, we first hypothesized (H1) that compared to control, participants receiving awe-induction will report greater emotion of awe, perceptions of vastness and accommodation motivation, and alterations in perceptions of time. Building on the first hypothesis, we hypothesized (H2) that trait absorption will moderate the relation between awe-induction and the four outcome variables, so that people higher in trait absorption will demonstrate stronger effects of awe-induction on emotion of awe, perceptions of vastness and accommodation motivation, but a weaker effect on alterations in time perception.

Methods

Participants

For the present study, we recruited Canadian undergraduate students, who received course credits for participation. A total of 293 participants took part, of whom 139 were assigned

to watch the neutral (control) video, and 154 to watch the awe (experimental) video. We obtained a group of participants of which 76.6% identified as female, 21.7% as male, and 1.7% as otherwise defined. The mean age was 18.76 (*SD* = 1.854) and the range was 17 to 35 years. Participants came from Canada (44.6%), Asia (38.8%), Europe (8.5%), Africa (5.3%), the United States (1.3%), South America (0.9%), and some were of mixed nationalities (0.6%).

Procedures

First, subjects watched one of the two videos: the awe-eliciting (experimental) video consisting of the overview effect, which moved from earth to the stars, or the neutral (control) video, consisting of instructions on building a patio enclosure with seating walls. After viewing the video, each participant completed the questionnaires on the amount of emotion of awe, perception of vastness, accommodation motivation, and alterations in their time perception they experienced, as well as on trait absorption.

Measures

To get an indication of the strength of awe-induction and the effect of absorption in this, we looked at four different outcome variables, namely the awe dimensions of emotion of awe, perception of time, perception of vastness, and accommodation motivation. To assess the time perception, perception of vastness, and accommodation motivation aspects of awe, we used the Awe Experience Scale (AWE-S; Yaden et al., 2008). It is a 6-factor structure that consists of 30 items in total.

Emotion of Awe

Emotion of awe was measured using the *Modified Differential Emotion Scale* (mDES), which measures the degree to which one has felt different emotions during the video (Fredrickson et al., 2003). More specifically, we use the cluster of awe, wonder, and

astonishment to conceptualize the emotion of awe. This is only one item, namely ‘’what is the most awe, wonder, or amazement you felt?’’, which is answered on a 5-point scale from 0 (*never/not at all*) to 4 (*often/extremely*).

Time Perception

Altered time perception was measured using the first subscale of the Awe Experience Scale (AWE-S; Yaden et al., 2008). Each of the 5 items was answered on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). An example item is ‘’I had the sense that a moment lasted longer than usual’’. Cronbach’s alpha was 0.921.

Perception of Vastness

Perception of vastness was measured using the fourth subscale (F4) of the Awe Experience Scale (AWE-S; Yaden et al., 2008). Each of the 5 items was answered on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). An example item is ‘’I felt the presence of something greater than myself’’ (Piff et al., 2015). Cronbach’s alpha is 0.959.

Accommodation Motivation

Accommodation motivation was measured using the sixth subscale (F6) of the Awe Experience Scale (AWE-S; Yaden et al., 2008). Each of the 5 items was answered on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). An example item is ‘’I felt challenged to mentally process what I was experiencing’’. Cronbach’s alpha is 0.901.

Absorption

Individual differences in absorption were measured using the Tellegen Absorption Scale. It consists of 34 items, each of which can be answered by ‘yes’ or ‘no’ (Tellegen & Atkinson, 1974). Example items are ‘’It is sometimes possible for me to be completely immersed in nature or in art and to feel as if my whole state of consciousness has somehow been temporarily

altered'', or a simple ''I can be deeply moved by a sunset''. The mean of trait absorption is 21.76 (*SD = 6.028*). Cronbach's alpha is 0.839.

Analytic Procedure

IBM Statistical package for the Social Sciences (SPSS) version 29.0.1 was used to handle data. Before data analysis, data for all scales and subscales were aggregated, and values for each predictor were centered. In this case, we performed this procedure on awe-induction and absorption. Furthermore, a *t*-test was performed on the Tellegen Absorption Scale to confirm equal scores between the groups, so that we have equal variances across groups that allow us to determine whether the observed differences in group means are actually attributable to the independent variables or due to differences in variances of groups.

Starting the data analysis, a *t*-test was performed to analyze the effect of the predictor awe-induction on emotion of awe, time perception, perception of vastness, and accommodation motivation and compare control group's mean scores on the outcome variables to those of the awe group. Thereby, we left out the moderator absorption as well as its interaction term (i.e., hypothesis 1). Next, we performed regression analyses, in which we first added the predictors awe-induction and absorption, the latter of which functions as a moderator, and the outcome variables. Afterward, we added the interaction term Awe-Induction x Absorption, on which we again performed a regression analysis, to describe the moderating effect of absorption in the relationship between awe-induction and emotion of awe, time perception, perception of vastness, and accommodation motivation (i.e., hypothesis 2).

Results

Cut-off times of the awe and control videos were established to ensure effective manipulation in our remotely conducted experiment. They indicate the amount of seconds that

the participants must have at least watched the videos for the awe-induction to be reasonably effective, which was two-thirds of each video. For the awe video, cut-off was 102 (of a total of 154) seconds; for the control video, cut-off was 223 (of a total of 338) seconds. Subjects who did not watch the videos until at least cut-off time were removed.

Moreover, subjects who did not pass at least one of the attention checks were also removed. The remaining 293 participants were then labeled according to condition (control = 0; experimental = 1), and means for scales and subscales were calculated.

A post hoc power analysis in GPower for an independent samples *t*-test for H1 showed that our current sample size ($N = 293$) allows for a power of 0.399 to detect a small effect size of 0.20, a power of 0.989 for a medium effect size of 0.50 and a power of 1.000 to detect a large effect size of 0.80.

Preliminary Analyses

Correlations between and descriptives of absorption and the four outcome variables were investigated to see whether and how they relate to each other. Outcomes are displayed in Table 1. Awe-induction is positively related to emotion of awe, perception of vastness, and accommodation motivation, and negatively related to time perception. Absorption is unrelated to awe-induction, awe emotion, perception of vastness, and accommodation motivation, but positively related to time perception.

Table 1

Correlation Table and Descriptives of Variables Absorption and Emotion of Awe, Perception of Vastness, Accommodation Motivation, and Time Perception for All Subjects Across Groups

	1	2	3	4	5
1. Absorption	-	0.058	0.062	0.081	0.156*

2. Emotion of Awe	0.058	-	0.682*	0.276*	0.015
3. Perception of Vastness	0.062	0.682*	-	0.401*	0.082
4. Accommodation Motivation	0.081	0.276*	0.401*	-	0.264*
5. Time Perception	0.156*	0.015	0.082	0.264*	-

Note. * $p < .05$.

An independent-samples *t*-test was run on the absorption scores to ensure equal means across control and awe groups. Levene's test indicated that variances across groups are equal ($F = 1.395$, $p = .239$). Based on these results and the small effect size ($d = 0.044$) that was found, we can state that there was no significant difference between group means (t (282) = .370, $p = .239$).

Awe-Induction and Emotion of Awe, Perception of Vastness, Accommodation Motivation, and Alterations in Time Perception

Hypothesis 1 proposed that awe-induction is positively associated with emotion of awe, perception of vastness, accommodation motivation, and alterations in time perception. To test this hypothesis, an independent-samples *t*-test was used to map out the differences in the outcome variables between the awe and control group. Levene's test indicated that variances across groups are equal for emotion of awe ($F = .002$; $p = .962$), accommodation motivation ($F = .065$; $p = .799$), and time perception ($F = .072$; $p = .788$), but not for perception of vastness ($F = 3.892$; $p = .049$). The latter suggests a violation of the equal variance assumption, so we do not assume equal variances in calculating the *t*-statistic.

The results showed that there were significant differences in emotion of awe between control ($M = 2.960$, $SD = 2.506$) and awe group ($M = 6.44$, $SD = 2.403$); t (291) = 12.096, $p < .001$, in perception of vastness between control ($M = 2.305$, $SD = 1.446$) and awe group ($M = 5.356$, $SD = 1.327$); t (281.086) = 18.753, $p = <.001$, in accommodation motivation between

control (M = 3.688, SD = 1.635) and awe group (M = 4.192, SD = 1.645); t (291) = 2.629, p = .009, and in time perception between control (M = 4.685, SD = 1.466) and awe group (M = 4.190, SD = 1.452); t (291) = -2.900, p = .004. Effect sizes were large for emotion of awe (d = 1.415) and perception of vastness (d = 2.204), but small for accommodation motivation (d = .308) and time perception (d = -.339). This finding implies that awe-induction has a significant effect on the outcome variables of emotion of awe, perception of vastness, accommodation motivation, and alterations in time perception. Although most of them are positively related, as was in line with our expectations, that was not the case for time perception, so that the awe condition had less alternation in time perception compared to control. This contrast with our previous speculations is something that will be further investigated.

Trait Absorption

Hypothesis 2 proposed that trait absorption moderates the relationship between awe-induction and awe emotion, perception of vastness, accommodation motivation, and alterations in time perception so that people scoring higher on trait absorption will experience stronger effects of awe-induction on awe emotion, perception of vastness, and accommodation motivation, but weaker effects on time perception.

Next, the predictors awe-induction and absorption were standardized. Then, a regression analysis of these predictors and the four outcome variables was performed. The interaction term Awe-Induction x Absorption was only included in the second step. This is done for each of the four outcome variables.

Emotion of Awe

Firstly, based on the results displayed in Table 2, absorption is unrelated to emotion of awe, and it does not moderate the effect of awe-induction on emotion of awe.

Table 2

Results of the Regression Analysis Predicting Emotion of Awe From Awe-Induction and Trait Absorption

						95% CI	
Step	Predictor	*b*	*SE*	ß	*p*	*LL*	*UL*
1	Awe-Induction	3.478	0.293	0.577	<0.001	2.902	4.054
	Absorption	0.035	0.024	0.071	0.148	-0.013	0.083
2	Awe-Induction	3.478	0.293	0.577	<0.001	2.901	4.055
	Absorption	0.038	0.038	0.077	0.313	-0.036	0.113
	Awe-Induction x Absorption	-0.005	0.049	-0.008	0.918	-0.102	0.092

Note. N = 293. CI = Confidence interval; LL = Lower limit; UP = Upper limit.

Perception of Vastness

Secondly, based on the results displayed in Table 3, absorption does not have a direct effect on perception of vastness, and it does not moderate the effect of awe-induction on perception of vastness.

Table 3

Results of the Regression Analysis Predicting Perception of Vastness From Awe-Induction and Trait Absorption

						95% CI	
Step	Predictor	*b*	*SE*	ß	*p*	*LL*	*UL*
1	Awe-Induction	3.009	0.165	0.736	0.001	2.685	3.333
	Absorption	0.027	0.014	0.079	0.052	0.000	0.054
2	Awe-Induction	3.009	0.165	0.736	0.001	2.685	3.333
	Absorption	0.031	0.021	0.092	0.142	-0.011	0.073

	Awe-Induction x Absorption	-0.008	0.028	-0.018	0.776	-0.063	0.047

Note. N = 293. CI = Confidence interval; LL = Lower limit; UP = Upper limit.

Accommodation Motivation

Thirdly, based on the results displayed in Table 4, absorption does not have a direct effect on accommodation motivation, and it does not moderate the effect of awe-induction on accommodation motivation.

Table 4

Results of the Regression Analysis Predicting Accommodation Motivation From Awe-Induction and Trait Absorption

						95% CI	
Step	Predictor	*b*	*SE*	ß	*p*	*LL*	*UL*
1	Awe-Induction	0.426	0.194	0.130	0.029	0.045	0.807
	Absorption	0.023	0.016	0.084	0.157	-0.009	0.054
2	Awe-Induction	0.425	0.194	0.129	0.029	0.044	0.806
	Absorption	0.006	0.025	0.021	0.818	-0.044	0.055
	Awe-Induction x Absorption	0.029	0.033	0.081	0.377	-0.035	0.093

Note. N = 293. CI = Confidence interval; LL = Lower limit; UP = Upper limit.

Time Perception

Lastly, based on the results displayed in Table 5, absorption had a positive direct effect on time perception. However, absorption does not moderate the effect of awe-induction on time perception.

Table 5

Results of the Regression Analysis Predicting Time Perception From Awe-Induction and Trait Absorption

Step	Predictor	*b*	*SE*	ß	*p*	95% CI	
						LL	*UL*
1	Awe-Induction	-0.527	0.172	-0.178	0.002	-0.865	-0.189
	Absorption	0.038	0.014	0.153	0.009	0.009	0.066
2	Awe-Induction	-0.527	0.172	-0.178	0.002	-0.865	-0.188
	Absorption	0.047	0.022	0.191	0.036	0.003	0.091
	Awe-Induction x Absorption	-0.016	0.029	-0.050	0.581	-0.073	0.041

Note. N = 293. CI = Confidence interval; LL = Lower limit; UP = Upper limit.

In conclusion, based on the results displayed in Table 2 to 5, we could not find support for the hypothesis that trait absorption moderates the relationship between the four outcome variables, meaning that people scoring higher in trait absorption will not demonstrate stronger effect of awe-induction on emotion of awe, perceptions of time, perceptions of vastness and accommodation motivation.

The direct inverse relationship between awe-induction and time perception, the latter of which is also the only outcome variable that is significantly positively related to absorption, is something to be further explored.

Discussion

The aim of the current study was to investigate whether the effect of awe-induction on perceptions of vastness, accommodation motivation, emotion of awe, and alterations in time perception was moderated by trait absorption. We found that there were significant differences between awe and control video group means of the four outcome variables, indicating that awe-induction may lead to significant increase in emotion of awe, perception of vastness, accommodation motivation, and alterations in time perception. However, there was no

significant interaction effect between awe-induction and absorption, suggesting that people who reported higher levels of absorption did not experience significantly greater effects on emotion of awe, perception of vastness, accommodation motivation, and smaller alterations in time perception. Since we already made use of a larger sample size and more powerful methods of awe-induction than previous research, this finding may be attributable to non-existent relationships between the variables in real environments, or perhaps an even stronger awe-induction or larger sample sizes are required to map out a possible moderating effect.

All in all, the findings of hypothesis 1 are similar to what has been found before: each of the outcome variables is related to awe-induction. Namely, the emotion of awe (Yaden et al., 2008), perception of vastness (Chirico et al., 2016), and accommodation motivation (Keltner & Haidt, 2003) were previously found to be strongly positively correlated with awe. Furthermore, Martarelli and Baillifard (2024) found an inverse correlation of awe-induction with time perception, which suggests that participants receiving awe-induction were likely to experience less alterations in time perception compared to control. These past findings are comparable to significance and effect sizes for the relationships of awe-induction with every outcome variable as was found in the present study.

Similarly, findings of the present study on the second hypothesis dealing with the question whether absorption moderates the relationship between awe-induction and the awe-related outcome variables are not much different from what has previously been found either. Research on absorption moderating the relationship between awe-induction and the outcome variables was scarce, and Van Elk (2016) failed to find a moderating effect. In our current study, we could not find moderating effects of absorption either. Even though we previously hypothesized that, with a larger sample size and more powerful awe-induction

compared to previous studies, a moderation effect would be more likely to occur, this was not the case.

Although no moderating effect of absorption on the relationship between awe-induction and the outcome variables was found, absorption was directly inversely related to time perception, suggesting that scoring higher on absorption is related to less alterations in time perception. This was found before by Martarelli and Baillifard (2024) and contrasts with the finding that awe was related to experiencing more alterations in time perception. They explain this by the finding that individuals scoring higher on absorption may be able to more actively design the amount of time available, thereby making it seem like time goes by faster (Rutrecht et al., 2021).

In conclusion, our findings align with previous research done on hypotheses 1 and 2. First, these similarities in findings regarding hypothesis 1 imply that there are significant correlations between awe-induction and emotion of awe, perception of vastness, accommodation motivation, and time perception across different methods of awe-induction, different sample sizes, and different populations. Therefore, generalizability is high. Second, the similarities in findings regarding hypothesis 2 imply that larger sample sizes may be required for future investigation of moderation of trait absorption in the relationship between awe-induction and emotion of awe, perception of vastness, accommodation motivation, and time perception. This is because moderating relationships generally require more data points than direct relationships to establish significance.

Implications

Theoretical Implications

Given the findings of the present study, the idea that absorption moderates the effects of awe-induction on the outcome variables requires more investigation. Theoretical reasoning pointed toward moderation through the idea that absorption would increase one's susceptibility or sensitivity to awe-inducing stimuli, thereby strengthening the effect of awe-induction on the emotion of awe, perception of vastness, and accommodation motivation, but weakening the effect on time perception (Van Elk, 2016). However, we found that this was not sufficient foundation for an actual effect.

A possible explanation is that absorption may buffer the effect of awe, as multiple studies have failed to find a moderating effect of absorption on awe-induction and its outcome variables (Van Elk, 2016; Ballew & Omoto, 2018). Perhaps the daydreaming aspect of absorption may predispose individuals to mind-wandering, thereby preventing one from being completely indulged in the awe-experience (Martarelli & Baillifard, 2024). As mentioned before, whereas absorption is positively related to time perception, with time speeding up being preoccupied with something completely (Martarelli & Baillifard, 2024), awe may slow down perception of time as a consequence of thorough appreciation of one's experiences (Van Elk, 2016). This points at two different mechanisms being at play, which may inhibit each other's effects on the outcome variable of time perception.

Another possible explanation could be that absorption may be a mediating, rather than a moderating factor in the relationship between awe-induction and the outcome variables (Ballew & Omoto, 2018). This suggests that absorption would be required for awe-induction to evoke awe, rather than influence an existing relationship between awe-induction and awe.

Therefore, future research may benefit more from discovering possible reasons why absorption may not be a moderator. This can be done by investigating the buffering effects of

absorption and examining a possible mediating, rather than a moderating effect (Ballew & Omoto, 2018). For this it is crucial to have a sufficiently large and diverse sample, since some people may benefit more from certain predictors than others.

Practical Implications

Nevertheless, practical implications of our findings may capitalize on awe's significant relationship with time perception. More specifically, being able to mentally slow down, doing more in an objectively unchanged amount of time, and reducing time pressure and thereby stress are the beneficial mechanisms at play. One could consider implementing awe-inducing activities at the start of a working or school day to increase perceived availability of time with reduced amounts of stress. This would also increase productivity or enjoyment in performing tasks, altruistic actions, and ultimately, overall life satisfaction (Rudd et al., 2012). An awe-inducing activity that is generally easy to implement is walking through nature (Ballew & Omoto, 2018).

However, effectiveness of these implementations may differ per population, since the used sample was lacking in size and diversity. Nevertheless, as suggested by previous research, awe will have a multitude of positive effects on daily life, each of which essentially contributes to well-being (Krause & Hayward, 2015) and meaning in life (Yuan, 2024).

Limitations and Future Directions

Sample Size and Diversity

The current study capitalized on its sample size of 293 participants. Although they were all undergraduate students in Canada, they came from a wide range of countries from all over the world. In addition, their age range was not narrow, spanning from 17 to 35 years. Regardless of its seemingly monotonous nature, our sample appears to go beyond the narrow WEIRD sample. This allows for some generalization.

However, for future research, it may be valuable to sample a larger group from a population more diverse in age, education level, and geographic location than the current one. This may increase generalizability of our findings, which allows for better considerations of practical implementations. For example, in considering whether a walk in nature would support preschool children in the United States in making new friends, or whether it would improve the well-being of elderly in nursing homes in Southern Asia.

Awe-Induction

Similarly, the current method of awe-induction is more powerful than is used in many previous studies that included evoking experiences of awe. For example, Van Elk (2016) elicited awe in participants by requesting them to recall awe-inducing memories. Although the exact effect size is unknown, this has repeatedly been suggested not to be a powerful method of awe-induction, since accuracy of memories and strength of awe-induction depend on type of memory and timeframe. The resulting emotional intensity may therefore differ per participant and may generally be weaker than other methods of awe-induction, such as writing down awe-inducing memories and showing awe-eliciting videos (Kaplan et al., 2016). In the present study, awe-inducing effects of the latter method could be checked for individual manipulation strength as well as for consistency between participants. This allows for more powerful awe-induction. We indeed found that two out of the four awe-related outcome variables, namely emotion of awe ($r = .578$, $p < .001$) and perception of vastness ($r = .741$, $p < .001$) were more strongly correlated with awe-induction and with higher significance than was the case in Van Elk's (2016) study ($r = .230$, $p < .01$; $r = .300$, $p < .01$).

In addition, the strength of awe-induction may depend on the content of awe-induction. For instance, in an attempt to increase awe by letting participants take a walk through the local

arboretum, Ballew and Omoto (2018) found an effect size of 0.43. The present study, on the other hand, utilized videos displaying an overview effect to evoke awe. This seemingly less immersive and realistic experience than Ballew and Omoto's (2018) actually had a stronger effect size, namely 1.415. This may be attributed to the content of the experience; whereas participants in the more immersive awe-induction experience saw an arboretum, participants in our study saw an overview effect that capitalized on the vastness of the galaxy.

However, although improvements have been made, lack of strength of awe-induction remains a limitation of previous as well as current research (Silvia et al., 2015). We have found that our awe-induction was more effective than other studies' (Van Elk, 2016; Ballew and Omoto, 2018), which may be attributable to use of the overview effect in our awe videos. In contrast, other studies have capitalized on their more immersive, realistic awe-experience (Ballew and Omoto, 2018). For instance, by making participants walk through a garden. The lack of immersiveness of the awe-inducing experience is a possible reason for finding our current null results for the moderation of trait absorption in the relationship between awe-induction and the outcome variables.

Therefore, one way in which awe could be more powerfully elicited, optimizing not only the content, as we already did, but also the immersiveness of awe-induction, is through Virtual Reality (VR). Chirico et al. (2016) suggest that VR has three benefits for strengthening awe-induction. First, VR is more realistic and immersive, and therefore possibly more effective than other formerly suggested methods of awe-induction, because it can induce a sense of being in the recreated situation. Second, VR has the benefit of presenting previously unattainable stimuli, such as natural phenomena, or complex stimuli that target specific dimensions of awe. Third, VR allows for tracking behavioral and physiological responses in more detail so that a

more comprehensive assessment of emotional reaction can be captured. Some challenges that may be encountered by using VR for awe-induction include overly expensive equipment, motion sickness, and high-risk emotional virtual environments. However, to minimize these drawbacks, new affordable VR solutions are already on the market (e.g., Samsung Gear VR and Google Cardboard), use of VR could be limited to shorter periods of time, and adequate informed consent information and if necessary, debriefing could be provided. In the end, benefits and costs should be weighed carefully.

All in all, although its methods of induction and exact effects remain disputed, we know that awe significantly affects well-being, meaning in life, spiritual-type beliefs, prosocial behaviors, and even bodily perceptions, whether these relationships are reinforced through absorption or not. Hence, it would be of great value to societal quality of life to consider how we continue and even strengthen awe's effects by discovering what contributes to them. In the end, if there is one thing we know about awe, it is that it has exerted its one-of-a-kind powers on human emotional experience throughout centuries, and that it would only be appropriate to capitalize on this valuable property.

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