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Cassidy Ochadleus

Charissa Kirby

Christie Scollon

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Cassidy Ochadleus, Charissa Kirby, and Dr. Christie Scollon

Department of Psychology, Western Washington University

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Awe is a self-transcendent emotion (Nelson-Coffey et al., 2019) which is typically elicited by natural environments which are perceptually vast and create a need for accommodation (Keltner & Haidt, 2003; Shiota et al., 2007). While awe is not always just experienced when viewing natural scenes (other things like people in positions of power or grand buildings can also create feelings of awe) the stimuli which best induce awe share those characteristics of vastness and a need for accommodation. Accommodation is the process by which existing cognitive schemes are adjusted to incorporate new information (Keltner and Haidt, 2003). The current study used this idea of accommodation as a theoretical background for how familiarity to the stimulus could impact the awe experienced from it. To date, no studies have examined the relation between awe, familiarity to the stimulus and accommodation. Of course, logically the more time people spend in a particular awe inducing scene the less need there will be for accommodation. In other words, more experience with a particular awe-inducing scene would give people a more developed cognitive schema which they could apply to the same stimulus in the future.

For this study we decided to use virtual reality images to experimentally manipulate awe as it immerses users completely in the environment. Virtual reality has been verified as a valid means of inducing awe in a controlled laboratory setting (Chirico et al., 2017; Nelson-Coffey et al., 2019; Quesnel & Riecke, 2018). Immersion in the stimulus acts as a moderator for awe (Chirico et al., 2017) and past research has suggested that because of this virtual reality is better for experimentally inducing awe than two-dimensional images. Additionally, while other studies have brought participants to awe inspiring nature scenes (Piff et al., 2015; Ballew & Omoto, 2018) this is not as controllable as virtual reality. Importantly, virtual reality allowed us to

experimentally manipulate familiarity, which would not have been possible by bringing participants to awe inspiring nature locations.

Overview

The current study used virtual reality images to experimentally manipulate familiarity and measure the effect it had on participants' experience of awe. We hypothesized that increased familiarity to the stimulus would decrease the intensity of awe. This is based on the idea that repeated exposure to awe inducing scenes would decrease the need for accommodation.

Method

Participants

The study was preregistered on OSF (https://osf.io/hsbgw). A sample of 53 undergraduate psychology students (30 female, 14 male, 8 non-binary, 1 other; age 18-57, M = 22.08, SD = 7.24) were recruited from Western Washington University to participate in this study. Subjects were recruited through the undergraduate Psychology subject pool (i.e., SONA) and were told that the study was on "emotional responses to virtual reality." Participants received course credit as an incentive for participation.

Using G*Power 3.1 (Faul et al., 2009), we conducted an a priori power analysis to determine the minimum number of subjects needed. Based on an estimated effect size of .40 with alpha set to .05 and power set to .80, the minimum number of subjects required was 52 in total (26 per condition). We aimed to collect data on 60 participants or until our a priori cut-off date.

The final sample size was N = 40 after removing a total of 13 subjects from the dataset. Three participants were trial runs to familiarize research assistants with the procedure. As such the trial participants were not included in the analysis. One participant was removed because the

virtual reality headset failed while they were viewing one of the awe scenes. The other nine subjects were removed because they were either too familiar with the unfamiliar condition (eight subjects) or too unfamiliar with the familiar condition (one subject), a threshold that was set before data collection and recorded in our preregistration (see Procedures for details).

Materials

The study used an HTC Vive virtual reality headset located in a lab on the Western Washington University campus. The participants each viewed three virtual reality images in total all from the Google Earth VR application. All the images were two-dimensional, 360-degree photos (see https://osf.io/hsbgw for original materials). Participants sat on an office chair (one capable of spinning around) in the center of the small room where they were able to view the images with the headset on. One of the images used was a picture of a flower garden from Fort Vancouver Garden in Vancouver, WA. This was a neutral image, not a true condition, and was used only to allow participants to adjust to the format and help the researcher adjust the headset before the participant viewed the first condition. As such, this location was chosen because, while it is pretty, it does not possess the qualities which make a scene inherently awe inducing. The image used for the awe-familiar condition was a picture of an old growth forest taken on a trail near Baker Lake in Bellingham, WA. The image used for the awe-unfamiliar condition was a picture of the Grand Canyon in Arizona. Both tall, old growth trees (Piff et al., 2015; Chirico et al., 2017) and the Grand Canyon are perceptually vast natural scenes that fit with established features of awe (Keltner & Haidt, 2003; Shiota et al. 2007). Participants viewed each condition image for the same amount of time, five minutes. The images were chosen specifically so participants familiarity with the scenes would differ based on the condition. All our participants were recruited from Western Washington University. As such most of them are from the Pacific

Northwest, so we determined that they shou ld be more familiar with tall trees from that area than the Grand Canyon, something we verified with a manipulation check.

Measures

Participants responded to an awe scale previously developed and used by Collado and Manrique (2019) to measure the intensity of awe experienced after viewing each condition (awe-familiar $\alpha = .63$; awe-unfamiliar $\alpha = .44$.) The scale consisted of 10 items meant to measure different aspects of awe (e.g., "This image makes me feel that I'm part of something much larger than myself." and "When I look at this image, it feels as if time stopped."). The measure uses a 7-point Likert-type scale items to measure awe experienced (1 = Strongly Disagree, 2 = Moderately Disagree, 3 = Somewhat Disagree, 4 = Neither Agree nor Disagree, 5 = Somewhat Agree, 6 = Moderately Agree, 7 = Strongly Agree). Higher scores on the scale indicate a greater intensity of awe experienced.

The study also included a manipulation check for familiarity to the stimulus. Subjects responded to two items ("How familiar are you with environments like the image you viewed?" and "I have spent a lot of time in environments that look like this.") intended to verify that they were more familiar with the familiar condition and less familiar with the unfamiliar condition (awe-familiar $\alpha = .88$; awe-unfamiliar $\alpha = .69$). The first item used a 7-point semantic differential scale (1 = Unfamiliar and 7 = Familiar) and the second item used a 7-point Likert-type scale to measure familiarity to the stimuli (1 = Strongly Disagree, 2 = Moderately Disagree, 3 = Somewhat Disagree, 4 = Neither Agree nor Disagree, 5 = Somewhat Agree, 6 = Moderately Agree, 7 = Strongly Agree). Higher scores on the items indicate more familiarity with the stimulus. Participants whose combined responses on these two items was 12 or higher for the awe-unfamiliar condition and 3 or lower for the awe-familiar condition were removed. This

threshold was set prior to data collection to ensure each condition would reflect the intended level of familiarity with the stimulus (see https://osf.io/hsbgw).

Procedure

The study used a within-groups design which allowed us to directly compare awe experienced by each individual across each condition. The awe conditions were counterbalanced to control for any possible order effects. Participants were randomly assigned to view either the awe-familiar condition first and the awe-unfamiliar condition second or the awe-unfamiliar condition first and the awe-familiar condition second. Each participant was randomly assigned to a condition order using a six-sided die with three blue sides and three red sides, where the blue side indicated participants would view the awe-familiar condition first and the red side indicated they would view the awe-unfamiliar condition first.

Participants came to the virtual reality lab on campus at Western Washington University, and after informed consent was obtained, they were asked to sit down on a chair in the center of the room. First, every participant viewed a neutral image of a garden with the VR headset for two minutes. The purpose of this was to give the researcher time to make sure the VR headset was on correctly and to give the participant time to adjust to the format. Additionally, participants were instructed beforehand to inform the researcher immediately if they felt any discomfort or nausea from the headset. Viewing this image first gave them time to see if they would experience discomfort before moving on to the conditions. None of the participants experienced any discomfort from the virtual reality environment. Before viewing each awe image, participants were instructed to "pay attention to the details of their surroundings and allow themselves to become absorbed in the experience." These instructions were intended to help control for the possibility that people may pay more attention and be generally more

absorbed in unfamiliar scenes. Absorption has been demonstrated to be a moderator of awe (Ballew & Omoto, 2018) so these instructions were given before each condition to maximize absorption. Next, participants viewed either the awe-familiar or the awe-unfamiliar image for five minutes with the VR headset before filling out a 10-item survey measuring the intensity of awe experienced and a two-item manipulation check measuring familiarity to the stimulus. Then, participants viewed whichever image they had not seen for five minutes with the VR headset before filling out the survey again as well as some demographics questions at the end. Finally, participants were thanked for their time and asked if they had any last questions.

Results

After removing outliers from the data set, we used a two-tailed paired samples t-test to compare participants' mean awe score in the awe-familiar condition to their mean awe score in the awe-unfamiliar condition. Results indicated that the intensity of awe experienced in the awe-unfamiliar (M = 4.6, SD = 0.63) condition was statistically significantly greater than the awe-familiar (M = 4.0, SD = 0.74) condition (t (39) = 5.69, $p < .001$). These results support our hypothesis that increased familiarity to an awe inducing stimulus would decrease the intensity of awe experienced.

We also ran an additional two-tailed paired samples t-test on ratings of familiarity. The results of our manipulation check suggest participants were indeed more familiar with the awe-familiar (M = 6.4, SD = 0.83) image than the awe-unfamiliar (M = 2.8, SD = 1.26) image (t (39) = 17.19, $p < .001$). This confirms that our experimental manipulation of familiarity was successful.

Discussion

The results of this study suggest that through experimental manipulation familiarity does diminish the intensity of awe experienced when looking at awe inspiring natural scenes. To the best of our knowledge, this is the first study to establish the effect of familiarity on the experience of awe. Because of the instructions given to participants before they viewed each condition, we can rule out absorption as a possible alternative explanation for the difference in awe experienced between the two conditions. By instructing participants to pay attention to all of the images and by counterbalancing the condition order, we controlled for any influence absorption or order may have had on participant's experience of awe.

Although we did not measure accommodation directly, the present findings have interesting implications for the notion that awe creates a need for accommodation. This study suggests that perhaps repeated exposer to an awe inducing stimulus lessens the need for accommodation over time by solidifying a person's existing cognitive schema for the stimulus. Future studies should measure accommodation to see if the results are mediated by accommodation.

Awe is a complex and important emotion. As such it is important to understand how it operates within us and what factors affect it. Past research has suggested that awe increase prosocial behavior in a variety of ways. In part this is due awe's ability to diminish one's sense of self and create feelings of being part of a larger whole, while generally shifting focus from the self to others, (Piff et al., 2015; Shiota et al., 2007; Perlin & Li, 2020; Nelson-Coffey et al., 2019). Additionally, there is research to suggest that awe slows the perception of time passing creating the illusion of having more time (Rudd et al., 2012). Future studies on awe and familiarity would benefit from measuring these potential mediators.

The effects of awe have been linked to increased helping behavior, generosity, support for ethical decisions, and prosocial values (Piff et al., 2015) as well as increased willingness to volunteer time (Rudd et al., 2012). A separate, but related, effect of awe which has been studied more recently by Keltner & Stancato (2021) suggests that it can also lessen certainty in ideological convictions and increase a sense of cohesion. Essentially, awe is incredibly beneficial for maintaining positive interpersonal relationships and making it easier to live together as members of a shared community.

There were several limitations to this study which should be discussed. First, given the timeframe of the study we were unable to do a pilot study with the images used in the study. A pilot study would have helped ensure the images chosen for the awe-familiar and awe-unfamiliar conditions are not inherently different in how awe inducing they are. This was omitted due to the limited amount of time we had to run the study. Also, most of our participant population is from the Pacific Northwest, so we assumed they were more familiar with the trees image than the Grand Canyon, which was confirmed by our manipulation check. Given this, a pilot study was not necessary to determine true differences in familiarity to our stimuli ahead of time. A second limitation to this study was that some participants thought they saw Bigfoot in the trees for the awe-familiar condition. Two of the participants mentioned that they saw Bigfoot afterwards. We believe this has to do in part with the participants being largely from Washington and the Pacific Northwest and because they were all psychology students themselves. It is possible that being psychology students they were looking for some trick or test. This should not have majorly impacted the results of the study but should be mentioned and considered for future research.

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