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ORIGINAL RESEARCH REPORT

'Standing in Awe': The Effects of Awe on Body Perception and the Relation with Absorption

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The experience of awe is typically elicited in response to perceptually vast stimuli and is often characterized by feeling small and insignificant. In the present series of studies we aimed (1) to determine the effects of awe on body perception and (2) to elucidate the role of the personality trait of 'absorption' (i.e. the tendency to get fully immersed in one's experiences) in relation to the feeling of awe. Across 4 different studies, involving both lab-based and field experiments, we found that feelings of awe are associated with smaller body size estimates. We also found that absorption is a strong predictor of feelings of awe: people scoring high on absorption tended to report overall stronger feelings of awe – irrespective of the experimental manipulation. In addition, experimentally manipulating absorption, by instructing participants to get fully absorbed in an external stimulus resulted in stronger feelings of awe. Thereby these findings illustrate that two key features underlying the experience of awe are changes in the perception of one's body and a tendency to get absorbed in internal or external stimuli.

Keywords: awe; wonder; absorption; body perception; dispositional awe; individual differences

1. Introduction

Awe is a complex emotion that is characterized by feelings of intense pleasure, surprise, connectedness and vastness but also by feelings of fear and uncertainty. It is an emotion one may feel at the verge of a massive cliff, enjoying the dangerous yet beautiful, breathtaking view. But it is also an experience that may be elicited when seeing the birth of a child, or when viewing a beautiful work of art. Feelings of awe are triggered by a wide range of phenomena and circumstances, such as natural beauty, impressive art, divine epiphanies or the vastness of space. As many famous scientists have noted, ranging from William James to Albert Einstein and from Paul Tillich to Richard Dawkins, the experience of awe may be considered a basic and intense emotional state that drives scientific achievements, the creation of great works of art and religious movements alike [1]. In turn, people are strongly motivated to actively seek experiences of awe and this motivation may underlie a wide range of human activities [2], such as traveling, visiting concerts and museums or reading literature.

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Continental philosophers like Immanuel Kant and Arthur Schopenhauer already referred to the experience of the sublime, which can be evoked by overpowering nature, such as mountains or waterfalls and which bears close similarities with feelings of awe. They contrasted the sublime with the experience of beauty, indicating that the sublime is experienced as boundlessness that can eventually overwhelm or even destroy the observer [3, 4]. Interestingly, the last decade has seen a renewed interest in the topic of positive emotions [5] and in studying both the causes and consequences of awe specifically. For instance, several studies have focused on the elicitors of awe [6] and on individual differences in the experience of awe [7, 8]. Other studies have established the effects of awe on time perception [9], feelings of uncertainty and agency detection [10], spiritual intentions [2, 11] and perceptions of the self [8]. Interestingly, the experience of awe has also been associated with several beneficial effects, such enhanced prosocial behavior [8, 12, 13], enhanced generosity and helping behavior [13, 14] and moral care [12].

Thus awe is a powerful emotion that people actively seek and experiencing awe has many beneficial effects. The aim of the present series of studies was twofold. First, we aimed to obtain more insight in the effects of awe on body perception. Previous studies have suggested that the feeling of 'being small and insignificant' may be a key feature of the experience of awe, but so far no study has directly investigated whether feelings of awe are literally accompanied by changes in perceived body size. Second,

building on recent findings indicating that individual differences in the personality trait of absorption (i.e. the tendency to get fully immersed in one's experiences) may predispose people to have self-transcendent experiences [15–17], here we investigated the relation between absorption and the experience of awe. That is, we hypothesized that a tendency to get immersed in external stimuli may predispose people to experience awe. We will first present a state-of-the-art overview of research on awe. Next, we will turn to the two topics that are central in this paper, namely body perception and the personality trait of absorption. This will lead to the two research questions that are central to the studies that we conducted, namely: (1) 'What are the effects of awe on body perception?' And: (2) 'Does the personality trait of 'absorption' predispose people to experience awe?'. Next, we present two pretests (see: **Supplementary Material Online**) and four different experiments, involving both lab-based and field studies, and using different experimental designs and stimuli to elicit feelings of awe to test our hypotheses regarding the relation between awe, body perception and absorption.

A key feature of the experience of awe is the feeling that one is confronted with something that is greater than the self [6, 8]. In their seminal paper, Keltner and Haidt [18] argue that awe is an emotional response to perceptually vast stimuli that overwhelm current mental structures, resulting in a need for accommodation to reconstruct one's mental schemas and to accommodate the experience. Perceived vastness may be triggered through the confrontation with vast objects – both symbolically (e.g., when reflecting on the fact that humans visited the moon) and literally (e.g., when viewing a mountain vista). Awe is typically elicited by perceptually vast objects, such as forests, mountains, waterfalls, and skyscrapers [6]. The perception of vast objects may also trigger the subjective experience of feeling small and insignificant [6]. For instance, it has been found that participants who recalled an experience of awe reported feeling smaller relative to the environment, as measured through self-report questionnaires [7]. People who watched the Earth from space by using a virtual reality (VR) simulation reported feelings of awe and feeling small and insignificant in the face of the vast and incomprehensible universe [19, 20]. In addition, in a recent study experimentally induced feelings of awe resulted in higher ratings on the "small-self-scale," consisting of items like *'I feel small or insignificant'* and *'I feel the presence of something greater than myself'* [8].

Thus, several studies have found that feelings of awe are associated with a changed perception of the self [6, 8, 13]. However, these studies strongly relied on self-report measures, such as subjective reports and scales assessing self-perception. Although these measures provide interesting and tentative insight in the relation between awe and self-perception, a potential problem is that this method may be highly sensitive to demand characteristics. More importantly, the observed relation between awe and the small self [8] may actually be explained by a conceptual overlap in the items used to measure both awe (i.e. 'I experienced awe') and the small self (i.e. 'I felt the presence of something greater than the self.'). This problem is also known as the common method bias, in which the variance in the dependent measures is to some extent caused by the use of the same measurement tool (i.e. self-report questionnaires; cf. [21]). Different measures may be needed in order to avoid these potential confounds and to establish whether the experience of awe is truly related to literally perceiving oneself to be smaller. In addition, whereas previous studies have investigated whether the experience of awe is associated with changes in the perception of the 'self' at a relatively abstract level, so far no study has directly investigated whether awe experiences are accompanied by changes in the perception of one's body, such that participants tend to underestimate their body size with respect to the environment. Following the notion that the experience of the self is directly related to the experience of one's body [22] and that self-transcendent experiences may be characterized by changes in body-perception [23–25], in the present study we set out to investigate whether awe directly affects body perception.

In the cognitive psychology and cognitive neuroscience literature, several measures have been proposed to study perception of the body. For instance, studies on tool use and effects of handedness have used distance estimation tasks [26] or body part length estimation tasks [27], to investigate whether tool use results in a differential perception of the body. In a recent study an object size estimation task has been used to study the effects of body posture [28]: participants were required to estimate the size of well-known objects such as the Eiffel tower or the wall of China. A body-specific effect on object-size estimation was observed, reflecting that participants tended to underestimate the size of objects when leaning to the left, which was related to the implicit activation of the 'mental number line' making small numbers easier accessible (for similar effects, see: [29, 30]. Thus, in our experiments we introduced a body size estimation task (Study 1), an object size estimation task (Study 2 and 3) and a distance perception task (Study 4) to measure effects of awe on the perception of one's body. In addition, we developed a novel body perception task, partly inspired by social psychological measures of the perception of the self in relation to others [31]. In this task participants were presented with a graphical representation of the experimental environment and their body and they were required to indicate the perceived size of their own body with respect to the environment (see **Figures 1** and **2**). By using these novel measures we investigated whether feelings of awe result in changes in the perception of one's body with respect to the environment and also whether these changes in turn may have an effect on object and distance estimation (i.e. if one perceives oneself to be smaller, this may result in an overestimation of object size and distance; e.g. [32]).

Next to investigating the effects of awe on body perception, across the different studies reported here, we also assessed the role of individual personality differences in the

experience of awe. Previous studies on awe have suggested that large individual differences exist in dispositional awe, as measured with the dispositional positive emotions scale (e.g. 'I often feel awe'; cf. [33]): higher scores on the dispositional awe scale are related to a higher frequency and stronger intensity of naturally occurring awe-related experiences [6]. However, yet it is unclear whether other and more general personality traits predispose people to the experience of experimentally induced awe.

Absorption refers to the tendency to become completely engaged in one's subjective thoughts or experiences. The Tellegen absorption scale has been proposed as a measure to capture individual differences in the personality trait of 'absorption' [35]. The original absorption scale consists of 34 items, which are related to imaginative involvement (e.g. *'If I wish, I can imagine (or daydream) some things so vividly that they hold my attention in the way a good movie or story does'*), responses to engaging stimuli (e.g. *'I can be deeply moved by a sunset'*) and powerful imagination (e.g. *'If I wish, I can imagine that my body is so heavy that I could not move it if I wanted to'*) among other things. Of interest to the present study, in recent studies it was found that participants scoring high on absorption were more prone to reporting supernatural experiences in a religious context (e.g., hearing God's voice; [16]) and to report having had an experimentally induced spiritual experience [17]. A recent study reported mixed evidence for the relation between absorption and awe [15]: by using a VR space manipulation, for participants who reported feelings of awe and wonder, both positive and negative correlations with the Tellegen absorption scale were reported. However, the number of participants that was tested in that study was relatively low, thereby limiting the conclusions regarding the relation between absorption and awe. The present study builds on and extends these findings by investigating whether the personality trait of absorption functions as a potential moderator of the experience of awe, such that people scoring high on absorption more readily report awe in response to beautiful nature scenery than people scoring low on absorption.

Thus, the aim of the present research was twofold: first, we investigated the effects of awe on body size perception, using different and novel measures of body perception. We expected that induced feelings of awe would result in an underestimation of one's own body size and an overestimation of the size of objects and of distance. Second, across different studies we investigated the effect of absorption as potential moderator on the experience of awe. Using both within- and between-subjects designs, and by using both online, lab-based and field studies, participants were exposed to an awe or a control condition and next they engaged in different body perception tasks and reported feelings of awe. In addition, in study 2 we explicitly manipulated absorption to investigate effects of absorption on awe, by instructing participants to get absorbed in an awe-inducing video or to watch the same video with an analytical mind-set. Across all studies absorption was measured using the Tellegen-absorption scale (1974) and included as an individual difference measure.

2. Study 1

In the first study we manipulated feelings of awe by presenting participants either with an awe-inducing video, a positive control video or a neutral control video. We investigated the effects of awe on body perception through the use of an explicit body size perception task, in which participants were required to estimate the perceived height and width of their body [27]. This task was administered both before and after the video-manipulation, as this allowed us to control for individual biases in body size estimation (i.e. participants systematically over- or underestimating the size of their body). We hypothesized that participants in the awe condition compared to the positive and the neutral control condition, would underestimate the size of their body, which should be reflected in smaller size estimates in the post- compared to the pre-test for this group. In addition, we hypothesized that absorption could act as a potential moderator on the effects of our experimental manipulation on awe and on the effects of awe on body size perception. We expected that the difference in perceived awe between our experimental and control condition would be most pronounced for participants scoring high on absorption. In addition, we expected that participants scoring high on absorption would be characterized by the strongest effects of awe on body perception.

2.1 Method

2.1.1 Participants

Eighty-nine participants (58 women; mean age = 22.3 years, *SD* = 3.8) were randomly assigned to a between-subjects design consisting of 3 conditions (awe, positive control, and neutral control). Five additional participants were tested but their data was excluded, because they did not follow the instructions to click the link that would have taken them to the video, but went directly to the dependent measures.[1] A power-analysis suggested that to achieve 80% power to detect a small effect size as observed in previous studies investigating effects of awe on behavior ($\eta^2 = .10$; cf. [9, 10]), at least 84 participants should be tested (i.e. based on a repeated measures ANOVA with an additional between-subjects factor). This criterion was met in all studies employing similar between-subjects designs. All studies were conducted at the University of Amsterdam, the Netherlands – except for Study 4, which was conducted as a field study. All participants gave written informed consent prior to participation and they received a financial remuneration or course credits for their participation. All studies were approved by the local ethics committee at the Psychology Department of the University of Amsterdam, the Netherlands.

2.1.2 Stimuli

In two pre-tests we assessed the awe-inducing properties of both novel video-stimuli and video-stimuli that have been used in previous studies on awe (see: **Supplementary Material Online**). Based on these pre-tests we selected an awe-eliciting video, which consisted of a trailer for a BBC Planet Earth documentary (for similar experimental manipulation, see: [8, 10]. The video pic-

tured panoramic views of nature, mostly consisting of vast objects such as mountains, waterfalls, oceans, and valleys, and partly slow-motioned scenes of animals. In the positive control condition, participants viewed a video of cute animals (e.g., dogs, cats), and in the neutral control condition, participants viewed a video taken from a car on the motorway. The positive control condition was included to ensure that any effects we might find would not be due only to the positive valence of awe. All videos were approximately four and a half minutes long, and had the same background music (Sigur Rós – Hoppípolla).

2.1.3 Experimental Procedure

A between-subjects design was used in the first study and participants were randomly assigned to one of three conditions (awe condition: N = 28; positive control condition: N = 28; neutral control condition: N = 33).[2] At the beginning of the experiment, the experimenter asked participants to estimate their body height and width (with arms extended). The experimenter was standing in front of the wall of the cubicle and increased the distance from a point of reference, perpendicular to the dimension being measured (for similar method, see: [27]). More specifically: when estimating their *body height*, the experimenter asked the participants to match a point on the wall with respect to the corner of the room; when estimating their *body width*, they were required to match a point with respect to the floor of the room. This was done in order to prevent participants from directly matching their body height to the observed height on the opposite wall and vice versa for body width. Participants indicated to the experimenter when this distance matched their height or width. Thus, the experimenter asked participants to estimate either the body width or height and next the experimenter moved her arm position from a starting position on the wall or floor away until the participant said that the distance between the starting point and the reference point matched their body width / height.[3]

After watching the video, participants again estimated their height and width, and the experimenter measured participants' actual height and width. Participants then continued with completing 8 items related to the experience of awe (Cronbach's α = .83; See Appendix 1), which were combined in a mean 'awe score' as a manipulation check. As the literal translation of 'awe' in Dutch (i.e. 'ontzag') is somewhat out-of-use in ordinary language use, we also included different related questions to the full experience of awe. Participants rated on a 5-point Likert scale (1 = not at all, 5 = very much) to what extent the video induced feelings of awe, oneness, connectedness, beauty, aesthetic experience, being impressed, self-transcendence and loss of space and time. Finally participants completed the Tellegen Absorption scale consisting of 34 items that were rated by using a dichotomous response ('yes' or 'no'; *Cronbach's* α = .86; [35]) and were asked about their subjective beliefs about the true purpose of the experiment using an open-ended question. Participants then received their reward and were debriefed regarding the purpose of the experiment.

2.2 Results

Participants in the experimental condition scored higher on the manipulation check items related to the experience of awe than those in the control conditions, $F(2,86) = 5.6$, $p = .005$, $\eta^2 = .12$ (see **Table 1**). Post-hoc independent t-tests showed a significant difference in awe ratings between the experimental condition and the positive control condition, $t(54) = 2.8$, $p = .007$, and between the awe condition and the neutral control condition, $t(59) = 3.1$, $p = .003$, but no difference between the positive and neutral control condition, $t(59) = .66$, $p = .51$.

To investigate the relation between absorption and the experience of awe, we included participants' score on the Tellegen Absorption scale as a covariate using an ANCOVA.[4] The interaction between Condition and Absorption was not significant, $F(2, 83) = 1.3$, $p = .27$, $\eta^2 = .03$. A main effect of Condition, $F(2, 83) = 3.7$, $p = .03$, $\eta^2 = .08$, reflected that participants experienced more awe in the awe condition compared to the positive control and the neutral condition. In addition, a main effect of Absorption was found, $F(1, 83) = 9.6$, $p = .003$, $\eta^2 = .10$, reflecting that participants scoring high on absorption overall experienced stronger feelings of awe (i.e. the correlation between feelings of Awe and Absorption was positive, Pearson's $r = .38$, $p < .001$). We note that this was contrary to our initial hypothesis, as we predicted that absorption would function as a moderator of our awe manipulation.

The data from the body width / height estimation task was analyzed by means of a repeated measures ANOVA with Time (Pre vs. Post-test) as a within-subjects factor and Condition (Experimental, Positive Control, Neutral

	Experimental Video (BBC Nature)	Positive Control Video (Cute Animals)	Neutral Control Video (Motorway)
Awe Ratings	3.5 (.65)	3.1 (.65)	2.9 (.89)
Body Height Pre	.88 (.02)	.87 (.02)	.85 (.02)
Body Height Post	.88 (.02)	.88 (.02)	.88 (.02)
Body Width Pre	.88 (.02)	.88 (.02)	.86 (.02)
Body Width Post	.88 (.02)	.87 (.02)	.86 (.02)

Table 1: Feelings of Awe for the different videos and performance on the body height / width estimation task in Study 1. Standard errors are between brackets.

Control) as a between-subjects factor. Prior to analysis we rescaled the body width / height estimation data, according to the participants' actual height and width, such that a value of '1' reflects an accurate body size estimation, values smaller than '1' reflect an underestimation of body size, and values bigger than '1' reflect an overestimation of body size). As can be seen in **Table 1** in general participants tended to underestimate the size of their body and this may have been related to the experimental procedure that was used, in which the experimenter slowly increased the height / width until participants indicated that the indicated height /width matched their real body size. Thus, future studies using explicit measures on body size perception should vary the estimation procedure, by both increasing and decreasing the size estimates. For perceived *body height*, the main effect of Time was not significant, $F(1, 86) = 2.8$, $p = .10$, $\eta^2 = .03$, and the interaction between Time and Condition was also not significant, $F(2, 86) = 2.4$, $p = .10$, $\eta^2 = .05$ (see **Table 1**). Similarly, for perceived body width, no significant effects were observed, $F < 1$, *ns*.

Including absorption as an additional covariate in the analysis of body width / height estimates resulted in a significant interaction between Time and Absorption for perceived body height, $F(1, 83) = 4.7$, $p = .033$, $\eta^2 = .05$. This interaction reflected that participants scoring low on absorption tended to underestimate their body height more strongly in the pre-test (mean = .85, SE = .01) compared to the post-test (mean = .87, SE = .01), compared to participants scoring high on absorption (Pre-test mean = .88, SE = .02; Post-test mean = .89, SE = .02). However, given the relatively small differences these findings should be interpreted with caution. For perceived body width, inclusion of Absorption as covariate did not result in significant effects ($F < 1$, ns). Finally, we investigated exploratively whether awe was related to perceived body size: however the correlations between self-reported awe and the body width / height estimates were not significant.

2.3 Discussion

In the first study we found that our experimental manipulation induced feelings of awe, thereby replicating previous studies using similar experimental stimuli [8, 10]. We note that many participants were actually aware of the purpose of our study (see also below) and accordingly it remains unclear to what extent the effects on our manipulation check items truly reflected that our manipulation was successful or were related to socially desirable responding. Still, informal observations and subjective reports indicate that many people perceived the awe video to be quite overwhelming and transiently experienced strong feelings of awe and wonder. Contrary to our initial hypothesis, we did not find a moderation effect of absorption on our experimental manipulation of awe. Instead, we found that participants scoring high on absorption overall reported stronger feelings of awe compared to participants scoring low on absorption. In addition, contrary to what we expected, no effect of awe on body perception was observed: there was no main effect of awe on the body size perception task.

3. Study 2

In Study 1 we used a body width / height estimation task, by asking participants to indicate the perceived width and height of their body. However, this measure may have been suboptimal to capture effects of awe on body perception, as it required the active involvement of the experimenter, which could thereby interfere with any potential effects of the awe-manipulation. Another disadvantage of this method is that the relation between the independent and the dependent measure may have been quite transparent for participants. In response to the open question about the purpose of the study, 35 participants (40%) reported that the study was likely about the relation between emotion and body / self-perception.[5] Thus, in a second study we introduced a different measure of body perception, by asking participants to rate their body size with respect to the experimental room on a scale and to conduct an object size estimation task [28]. We expected that induced feelings of awe would result in an underestimation of one's own body and an overestimation of the size of objects.

Next to using a different measure of body perception, in the second study we aimed to more directly assess the role of absorption in the experience of awe. To this end, we explicitly manipulated absorption by instructing participants to get fully absorbed in the video or to watch the video with an analytical mindset. Similar manipulations to present the same stimuli under different attentional modes have been used successfully in research on music perception, for instance [36]. We manipulated the absorption vs. control instruction using a within-subjects manipulation, because within-subjects designs have higher statistical power [37], thereby potentially reducing the required number of participants to show an effect of awe. Thus, in the second study we used the same awe-inducing video as in Study 1, but in different blocks participants were instructed to either get fully absorbed in the video or to watch the video with an analytical mindset, by counting the number of perspective changes that occurred.

We hypothesized that participants would experience stronger feelings of awe in the absorption condition compared to the control condition. In addition, we expected that participants would tend to underestimate the size of their body and overestimate the size of objects in the absorption compared to the control condition. Finally, we hypothesized that absorption could function as a potential moderator of these effects, such that participants scoring high on absorption would show the strongest effects of our experimental manipulation.

3.1 Method

3.1.1 Participants

In Study 2 forty-seven participants (32 women; mean age = 22.7 years, *SD* = 6.0) were tested, using a within-subjects design (absorption condition vs. control condition). Fifteen additional participants were tested but their data was excluded, because they did not watch the video and / or they did not complete all dependent measures that were included in the experiment. One additional participant was excluded from analysis, because in the

control condition he / she only reported 3 perspective changes (see below).

3.1.2 Experimental Procedure

In the second study we used the same experimental video as in the first experiment. Participants watched a 4.5-minute trailer for a BBC Planet Earth documentary twice with two different instructions. In the *absorption condition* participants received the following instruction: *'Please relax while watching the video and get absorbed in the images and music that you will see.'* In the *control condition* participants received the following instruction: *'Please note: while watching the video, you are required to count the number of perspective / camera changes. After having watched the video, you will be asked how many times the perspective changed'*. Thus, participants always watched the same awe-inducing video and instruction was used as a repeated within-subjects manipulation (block order was counterbalanced between participants). At the end of the control condition, participants were first asked how many perspective changes they observed.

Following both the absorption and the control condition, first an *object size estimation task* was conducted (for similar task, see: [28]). The rationale for including an object size estimation task was to avoid participants from hypothesis guessing: the implicit assumption underlying the object size estimation task is that due to the awe-manipulation, participants would perceive themselves as smaller and as a consequence they may be tended to overestimate the size of external objects. Participants were required to give a size estimation on five questions regarding the size of different objects (i.e. 'What is the height of the Eiffel tower in meters?'; 'What is the length of the Erasmus Bridge in meters?'; 'How many floors had the World Trade Center in New York?'; 'How tall is the longest person in the world in meters?'; 'What is the length of the Chinese wall in meters?'). For the analysis, the individual size estimates were z-transformed because the distribution of the height estimates was strongly skewed (for similar procedure, see [28]). For each participant an average size estimate was calculated separately for the absorption condition (Cronbach's α of 5 combined items = .65) and the control condition (Cronbach's α of 5 combined items = .66). The size estimates of both conditions were highly correlated, $r = .983$, $p < .001$.

Participants also completed a *body size estimation task*. They were presented with an abstract graphical representation of their body and the experimental cubicle (see **Figure 1**). The dimensions of the graphical representation of the room (dimensions: 153 x 250 pixels) closely matched the size of the cubicle (153 x 238 cm) in which the study was conducted. Participants received the following instruction: *'Imagine seeing yourself from above in the room in which you are located. Which picture do you think does best depict the size of your body with respect to the room, while watching the video?'* Thus, participants were asked to give a body size estimate based on a 7-point Likert-scale (1 = body perceived as small with respect to the room; 7 = body perceived as large with respect to the experimental room).

Next, participants completed the same 8 items to measure feelings of awe as used in the first study as a manipulation check (Experimental Condition: Cronbach's a = .86; Control Condition: Cronbach's a = .90). Finally, participants completed the Tellegen Absorption scale, which consisted of 34 items that were completed on a 4-point Likert scale (1 = I don't agree at all, 4 = I strongly agree; Cronbach's a = .94). We note that this experiment was part of a larger research project, in which the relation between the Tellegen absorption scale and visual / mental imagery was tested by using additional experimental tasks.[6] The outcomes of this project will be reported elsewhere.

3.2 Results

The mean number of perspective changes that was reported in the control condition was 64.6 (SD = 7.1, range = 36–74), which is quite close to the actual number of perspective changes in the video (66). This finding indicates that most participants were able to accurately follow the instruction in the control condition.

The awe ratings were analyzed using a repeated measures ANOVA with Condition (Absorption vs. Control) as a within-subjects factor and block-order (Absorption Condition in 1st vs. 2nd block) as a between-subjects factor. A main effect of Condition, $F(1, 45) = 13.2$, $p = .001$, $\eta^2 = 23$, confirmed that participants experienced stronger feelings of awe in the absorption condition compared to the control condition (see **Table 2**). In addition, an interaction between Condition and block-order was found, $F(1, 45) = 11.1$, $p = .002$, $\eta^2 = .20$. Post-hoc analyses indicated that participants who conducted the absorption condition in the first block, experienced more awe in the absorption (mean = 3.9, SE = .15) compared to the control condition (mean = 3.2, SE = .17), $F(1,26) = 19.5$, $p < .001$, $\eta^2 = 43$.

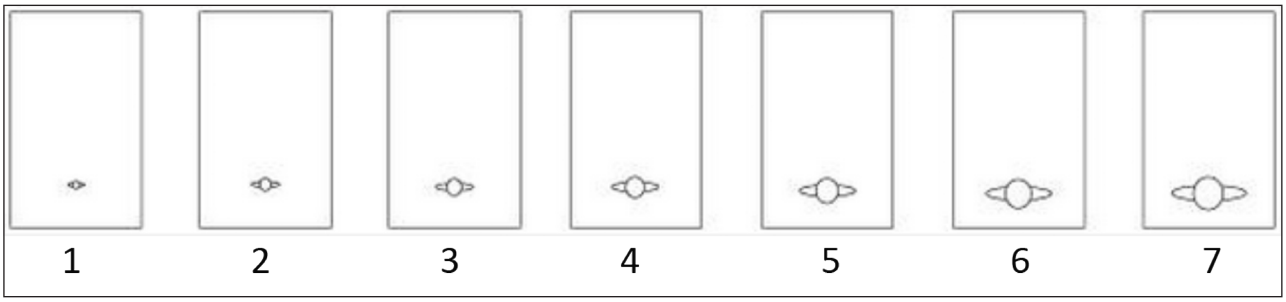

Figure 1: Body size estimation task as used in Pre-test 1 and Study 2 and 3. Participants were presented with an abstract graphical presentation of their body in the experimental cubicle, as viewed from above.

	Absorption Condition	Control Condition
Awe Ratings	3.8 (.11)	3.3 (.13)
Object Size Estimation	5.3 (.13)	5.4 (.13)
Body Size Estimation	3.6 (.24)	3.9 (.23)

Table 2: Feelings of Awe, Object Size Estimation and Body Size Estimation measures as a function of condition (Absorption vs. Control condition) in Study 2. Standard errors are presented between brackets.

In contrast, for participants who started with the control condition, no difference was observed in the awe ratings between the absorption (mean = 3.6, SE = .18) and the control condition (mean = 3.6, SE = .21; $F < 1$, ns), potentially reflecting an effect of familiarity on feelings of awe.

Including the trait 'absorption' as covariate in the analysis revealed a main effect of absorption, $F(1, 43) = 21.5$, $p < .001$, $\eta^2 = .33$, reflecting that participants scoring high on the Tellegen absorption scale reported overall higher feelings of awe (i.e. the correlation between feelings of awe and absorption was positive; Pearson's $r = .58$, $p < .001$ for the Absorption Condition and Pearson's $r = .45$, $p < .001$ for the Control Condition). The interaction between absorption and Condition was not significant ($F < 1$, ns).

For the object size estimation task, the effect of Condition was not significant ($F(1,46) = 1.4$, $p = .25$, *ns*). Also the interaction between Condition and block-order was not significant ($F(1, 45) = 3.0$, *ns*). Including absorption as covariate in the analysis did not show significant interactions ($F(1, 43) < 1$, *ns*). Only a marginally significant main effect of Absorption was found, $F(1, 43) = 3.6$, $p = .066$, $\eta^2 = .07$, reflecting that participants scoring high on absorption tended to report larger object sizes as compared to participants scoring low on absorption (although the correlations between absorption and the height-estimates were non-significant; $r = .23$, $p = .12$ for the Absorption Condition and $r = .21$, $p = .15$ for the Control Condition).

For the body size estimation task, the effect of Condition was only marginally significant, $F(1, 45) = 3.1$, $p = .083$, $\eta^2 = .065$, reflecting that participants tended to perceive their body as smaller in the absorption (mean = 3.6, SE = .24) as compared to the control condition (mean = 3.9, SE = .23). The effects of block-order on body size estimation were not significant ($F < 1$, ns). Including absorption as covariate in the analysis did not reveal significant effects ($F < 1$). The correlation between self-reported awe and perceived body size was in the expected direction for both the experimental and the control condition ($r = -.194$ and $r = -.215$), but not significant ($p > .073$).

3.3 Discussion

In the second study we found that experimentally manipulating absorption resulted in differential feelings of awe: participants reported stronger feelings of awe when instructed to get absorbed in the video compared to when watching the video with an analytical mind-set. In the second study we did not find evidence for a moderating effect of the personality trait 'absorption' on our awe manipulation. Instead, similar to the first study, we found a relation between the trait absorption and awe: participants scoring high on the Tellegen absorption scale tended to report overall higher feelings of awe than participants scoring low on this scale. These findings indicate that the trait of absorption is strongly related to feelings of awe: a tendency to get absorbed in external stimuli may predispose people to experiencing awe and the second study shows that this tendency can also be manipulated experimentally. We note that our absorption / perspective manipulation respectively increased (mean awe rating = 3.8) and decreased feelings of awe (mean =3.3) compared to the previous study (mean awe rating = 3.5) in which the instructions regarding the video were left implicit.[7] This indicates that feelings of awe can also be actively suppressed when participants are instructed to be in a different mind-set when being exposed to awe-related stimuli. Although the effects of awe on body perception were in the expected direction, with participants feeling smaller in the awe compared to the control condition, these effects were only marginally significant.

4. Study 3

The absence of a more pronounced effect of awe on body perception may be related to the repeated measures design that was used in Study 2. Only when participants were first allowed to get absorbed in the video, they reported lower feelings of awe when watching the video for the second time and while attending to the number of perspective changes. In addition, the measures of body size estimation were also repeated over participants, thereby introducing learning or practice-related effects [37]. Thus, although the effects in Study 2 were in the expected direction, the repeated presentation of the same stimuli and measures may have introduced additional confounds, thereby potentially overshadowing any potential effect of awe on body perception. To this end, we decided to conduct a third study, using the same between-subjects design to induce feelings of awe as used in Study 1, while keeping the same measures of body size perception that were used in Study 2.

We hypothesized that participants would experience stronger feelings of awe in the experimental compared to the positive control and the neutral control condition. We also expected that the experimental condition would result in smaller body size estimates compared to the control conditions, as measured both using the body size estimation task and the object size estimation task. Finally, based the results of Study 1 and 2 and expected to replicate the observed relation between absorption and self-reported awe.

4.1 Method

4.1.1 Participants

In Study 3 hundred-and-five participants (77 women; mean age = 22.7 years, SD = 6.0) were randomly assigned to a between-subjects design consisting of three conditions (awe, positive control, and neutral control). Twenty-two additional participants were tested but their data was excluded, because they did not watch the video or they failed to pay attention to an attention check item that was included in the study.

4.1.2 Stimuli and experimental procedure

In the third study a similar between-subjects design was used as in the first study, in which different groups of participants were presented with an awe video (N = 36), a positive control video (N = 34) or a neutral control video (N = 35). Following each video participants completed the same object size estimation task as used in Study 2 [28], by providing size estimates in response to 5 different questions. Again, the size-estimates were strongly skewed and therefore a z-transformation was applied and for each participant the average size estimate was calculated. However, due to large individual variability in the size estimates and the fact that participants often reported weird size estimates (e.g. confusing centimeter with meter; providing highly inaccurate estimates), the object size estimate data could not be used (Cronbach's a of 5 combined items = .14) and is not reported in the results section.

In addition, participants completed the same body size estimation task as used in Study 2, by indicating the perceived size of their body with respect to the experimental room. Next, participants completed the same 8 awe manipulation check items as used in the first two studies (Cronbach's a = .97). Participants also completed a shortened version of the Tellegen absorption scale, consisting of 15 items (corresponding to the following items from the original scale: 3, 4, 7, 8, 9, 10, 12, 14, 16, 19, 21, 24, 25, 28, 31)[8] using a 4-point Likert scale (Cronbach's a = 83). The rationale for using a shortened version of the absorption scale was to save time, as previous research had shown that the shortened version had similar psychometric properties as the extended version (van Elk & Lindeman, in prep.). Similar to the second study, this experiment was conducted as part of a larger research project and additional measures and tasks were included prior and following the measures described in this study.[9]

4.2 Results

A main effect of Condition on feelings of awe was observed, $F(2, 102) = 33.0$, $p < .001$, $\eta^2 = .39$; see **Table 3**). Participants tended to perceive more awe in the awe condition compared to the positive control condition, $t(68) = 8.6$, $p < .001$, and compared to the neutral control condition, $t(69) = 4.4$, $p < .001$. In addition, participants reported stronger feelings of awe in the neutral control condition compared to the positive control condition, $t(67) = -3.3$, $p = .001$.

When absorption was included as covariate in the analysis, the interaction between Condition and Absorption was not significant ($F(2, 99) < 1$, ns). Only a main effect of Absorption was found, $F(1, 99) = 26.3$, $p < .001$, $\eta^2 = .21$, reflecting that participants scoring high on absorption reported stronger feelings of awe (i.e. the correlation between Absorption and Awe was $r = .40$, $p < .001$).

For the body size estimation task, a main effect of Condition was found $F(2, 102) = 4.3$, $p = .017$, $\eta^2 = .08$ (see **Table 3**). Participants tended to perceive their body as smaller in the experimental condition compared to the positive control condition, $t(68) = -2.6$, $p = .011$, and compared to the neutral control condition, $t(69) = -1.9$, $p = .059$.

Including absorption as covariate in the analysis of the body size estimation task, did reveal a significant interaction between Condition and Absorption, $F(2, 99) = 4.0$, $p = .021$, $\eta^2 = .08$. To interpret this interaction, we performed two ANOVAs with z-transformed Absorption (1SD above or below the mean), dummy coded condition (1 = awe; 2 = positive control; 3 = neutral control), and their interaction as the independent variables. The analysis revealed that participants scoring high on absorption tended to report smaller body size estimates in the experimental condition compared to the neutral control condition, $B = -.1$, $SE = .6$, $t = -1.7$, $p = .087$, and larger body size estimates in the positive control condition compared to the neutral control condition, $B = 1.5$, $SE = .6$, $t = 2.5$, $p = .015$. For participants scoring low on absorption, the body size estimates did not differ between conditions ($t < 1.0$, ns). Finally, a significant correlation was observed between self-reported awe and perceived body size, $r = -.245$, $p = .012$.

4.3 Discussion

Study 3 replicates and extends findings from the previous studies: participants reported stronger feelings of awe in the experimental compared to the control condition and participants scoring high compared to low on absorption overall reported stronger feelings of awe. In the third study we also found that awe affected body size perception: participants perceived their body as smaller in the awe condition compared to the control conditions and this effect was most pronounced for participants scoring high on absorption.

	Experimental Video (BBC Nature)	Positive Control Video (Cute Animals)	Neutral Control Video (Motorway)
Awe Ratings	3.5 (.13)	2.1 (.13)	2.6 (.13)
Body Size Estimation	3.6 (.29)	4.8 (.30)	4.4 (.30)

Table 3: Feelings of Awe and Body Size Estimation measures as a function of Condition (Awe, Positive Control vs. Neutral Control). Standard errors are between brackets.

5. Study 4

In the first three studies the same awe-inducing video was used as in previous studies [8–10], which is a relatively artificial method to induce feelings of awe and wonder. An important question is to what extent the observed relation between absorption and awe (in Studies 1 – 3) and between awe and body perception (i.e. as observed in Pre-test 1 (see: **Supplementary Material Online**) and in Study 2 (marginal) and 3) extends to a more naturalistic environment. In a fourth study we relied on the natural variability in self-reported awe in visitors of a video installation in the oldest church of the city of Amsterdam, the Netherlands. Visitors were asked to rate their feelings of awe in response to the visit and we included similar measures of absorption as used in the previous studies. Thereby we aimed to replicate the observed relation between awe and absorption to a more naturalistic setting and a more general population. In addition, by asking participants to estimate their body size prior and following the visit, we could investigate whether the exhibition would affect body size perception, resulting in smaller body size estimates following the visit.

5.1 Method

5.1.1 Experimental Setting

Study 4 was conducted as a field experiment at the Oude Kerk in Amsterdam (http://www.oudekerk.nl/en/) in March 2015 in association with the exhibition of the visual artist Tony Oursler (http://www.tonyoursler.com/). The exhibition was custom-made for the Oude Kerk and consisted of installations and video projections integrated with the interior of the church. The study booth was located at the main entrance of the church and visitors of the exhibition were invited to participate in a study of the University of Amsterdam on 'awe and creativity'. The study consisted of two parts: prior to their visit participants completed a number of tasks and questionnaires of approximately 10 minutes and at the end of their visit they returned to complete the second part of the study. Participants received a voucher for their participation in the study that could be used at the museum restaurant for a free coffee or drink.

5.1.2 Participants

In total data from 113 participants (63 women; mean age = 45.6 years, SD = 17.0) was included in the analysis of Study 4. Initially 132 visitors participated in the experiment, but data from 19 participants were excluded due to missing data (e.g. not returning after the visit for the second part of the study). Participants came from a wide range of different countries and cultural backgrounds: 36 participants were Dutch, 61 came from other European countries, 9 from North America, 3 from South American countries, 2 from Asia, 1 from Russia and 1 from South Africa. The experiment was conducted in Dutch (for Dutch visitors) or in English (for foreign visitors). Prior to analysis, responses to open-ended questions were translated back to Dutch.

5.1.3 Stimuli, materials and experimental procedure

The experimental design consisted of a pre-test, followed by a visit of the exhibition, and at the end of the visit the post-test was conducted. In the pre-test participants completed a shortened version of the absorption scale consisting of 15 items using a 4-point Likert scale (Cronbach's a = .90). The following items of the original absorption scale were included: items 3, 4, 7, 8, 9, 10, 12, 14, 16, 19, 21, 24, 25, 28, 31. Participants were required to indicate their approximate level of education (1 = no education, 2 = primary education, 3 = secondary education, 4 = higher education).

In both the pre- and the post-test a body size estimation task and a psychological distance task [38] were conducted. In the body size estimation task participants were presented with a visual representation of the main entrance of the church and were required to indicate which picture best represented the perceived size of their body (see **Figure 2**). For the psychological distance task,

Figure 2: Body size estimation task used in Study 4. Participants were presented with a graphical representation of the main entrance of the church and were required to indicate which figure best represented the perceived size of their body.

participants were required to indicate the approximate distance from Amsterdam to Paris and from Amsterdam to Berlin (0 = less than 200 km, 1 = 200–400 km, 3 = 400–600 km, 4 = 600–800 km, 5 = 800–1000 km, 6 = more than 1000 km; questions were presented in a counterbalanced order across participants). The rationale for including the psychological distance estimation task was similar to the height estimation task that was used in studies 2 and 3: we hypothesized that the experience of awe would be accompanied by feeling small and insignificant, which would in turn result in an overestimation of the distance between cities. In the post-test participants' feelings of awe were tested using the same 8 items as used in studies 1–3 (Cronbach's a = .93). This study was part of a larger research project on the effects of awe and art expertise on creativity. Therefore, in addition several other measures were included in the study, namely: the openness to experience scale, a measure of art expertise, and a creativity task, which will all be reported elsewhere (Specker et al., unpublished findings available at: www.relcog.com), as the focus of this paper is primarily on the effects of absorption on awe and body perception.

5.2 Results

In the present study a quasi-experimental design was used, including a pre- and a post-test, and feelings of awe were only assessed following the visit. In a first analysis, we investigated the extent to which the score on the absorption scale (measured pre-visit) predicted perceived awe (post-visit). A hierarchical multiple regression analysis was conducted. **Table 4** shows the outcome of the hierarchical linear regression. Because of the heterogeneous sample that was tested in the fourth study, in the first step demographic variables were included as predictors and the resulting model was marginally significant, $F(3, 107) = 2.2$, mean square error (MSE) = 306.5, $p = .087$, $R2 = .06$. Age was a significant predictor variable, $t = -2.0$, $p = .047$): with increased age, participants tended to report lower feelings of awe. In the second step, it was found that including the Tellegen absorption scale increased the fit of the model: $F(4, 106) = 3.5$, mean square error (MSE) = 449.2, $p = .01$, $R2 = .12$. Absorption was a significant predictor of awe, $t = 2.6$, $p = .011$: participants scoring high on the absorption scale tended to report stronger feelings of awe.

	B	SE	β	p
Constant	30.04	15.01		.048
Gender	3.22	2.24	.14	.154
Age	–.14	.07	–.20	.047
Education	–.463	3.35	–.01	.890
Constant	16.88	15.47		.278
Gender	2.90	2.19	.12	.188
Age	–.12	.07	–.17	.082
Education	.28	3.28	–.01	.932
Absorption	3.57	1.38	.24	.011

Table 4: Linear model of predictors of perceived awe in Study 4. Absorption = mean score on the Tellegen Absorption scale.

Next, we investigated the extent to which perceived body size was related to self-reported awe. A repeated measures ANOVA was conducted with Pre vs. Post-test as a within-subjects factor, perceived awe as covariate and perceived body size as dependent variable. Perceived body size did not differ between the pre- and the post-test ($F = 1.1$, ns) and the interaction between Pre vs. Post and perceived awe was not significant, $F(1, 110) = 2.8$, $p = .098$, $\eta^2 = .025$. A trend was observed for a main effect of perceived awe on body size, $F(1, 110) = 3.6$, $p = .060$, $\eta^2 = .032$. This finding indicates that participants reporting overall higher feelings of awe tended to perceive their body as smaller compared to participants reporting lower feelings of awe (i.e. there was a negative correlation between feelings of awe and body size perception; Pre-test: $r = -.23$, $p = .015$; Post-test: $r = -.11$, $p = .23$).[10] When absorption was included as covariate in the analysis, no significant effects were observed ($F < 1$, *ns*). For psychological distance, no difference was found between the pre- and the post-test, irrespective of whether feelings of awe were included as covariate in the analysis ($F < 1$). Also, when absorption was included as covariate in the analysis, no significant effects were observed ($F < 1$, *ns*).

5.3 Discussion

In the fourth study we relied on the natural variability in feelings of awe in visitors of an exhibition in a church in Amsterdam. We found that the trait absorption was a significant predictor of feelings of awe, thereby extending the findings from our previous studies to a more ecologically valid setting. In addition, the participants in study 4 came from a wide range of different cultural backgrounds thereby also controlling for the potential confound that the observed relation between awe and wonder in our lab-based studies was limited to the so-called WEIRD population of highly educated female psychology students [39]. Although the effect of awe on body size perception was not significant, the pattern was in the same direction as observed in previous studies: a negative relation was found between awe and perceived body size, indicating that stronger feelings of awe were associated with smaller body size estimates.

6. Meta-analysis on the relation between awe and body size

In two studies (Study 2 and 4) the effects of awe on body size perception were in the expected direction but only marginally significant and only in one study (Study 3) we found a direct and significant effect of awe on body perception. Our studies involved between-subjects designs (Study 1 and 3), a within-subjects design (Study 2) and an individual difference approach (Study 4). In addition, different dependent measures of body size estimation were used including a body width / height estimation task (Study 1) and a body size estimation task involving a pictorial representation of the participant's body with respect to the environment (Study 2–4). In order to determine the

robustness of the relation between the experience of awe and body perception and given the diversity of designs and measures we conducted two additional meta-analyses.

In a first meta-analysis we investigated whether our experimental manipulation of awe affected perceived awe and body size perception by including the body size estimation data from Study 1 – 3.[11] As expected, the experimental conditions induced stronger feelings of awe (mean = 3.6) compared to the control conditions (mean = 2.8 for both conditions), $F(2,238) = 28.6$, $p < .001$, $\eta^2 = .19$. However, the experimental manipulation of awe did not have an effect on perceived body size, $F(2, 238) = 1.1$, $p = .35$.

In a second analysis we investigated whether the subjective awe ratings were correlated with perceived body size, by using the data from Study 2, 3 and 4, in which comparable measures of body size estimation were used (i.e. the Body Size Estimation task). For Study 2, we included body size estimation data from the experimental condition (i.e. the absorption condition), because a within-subjects design was used and we were interested in the relation between perceived awe and body perception. For Study 3, we included data from all participants, including the awe, the positive control and the neutral control condition. For Study 4 we included the data following the visit of the exhibition (i.e. as again a repeated measures design was used and we were interested in the relation between awe and body perception). For all studies (N = 264), we included Experiment (Study 2, 3 and 4), demographic information (i.e. gender and age) and self-reported feelings of awe as predictors in a hierarchical regression analysis to predict body size estimates.

For the hierarchical regression analysis of the body size estimates, the main model was significant, $F(4, 259) = 2.4$, $p = .047$, $R^2 = .04$ (see **Table 5**). A significant effect of awe on body size perception was found, $t(263) = -2.40$, $p = .017$, $B = -.025$ ($SE = .010$), $\beta = -.212$, reflecting that with increased feelings of awe, participants tended to perceive their body as smaller. The other predictor variables were not significant.

7. General Discussion

In the present series of studies we investigated the effects of awe on body size perception. In different studies we found tentative evidence for the notion that self-reported awe was associated with smaller body size estimates, as measured using a pictorial representation of the participant's body. In addition, across our studies we investigated the effect of absorption as potential moderator on the experience of awe. In contrast to our initial hypothesis, the personality trait of absorption did not moderate effects of our experimental manipulation on perceived awe and body size perception. However, across different studies we found that absorption was positively related to self-reported awe: participants scoring high on the Tellegen absorption scale overall reported higher feelings of awe. These findings provide novel insight in the antecedents and the psychological mechanisms underlying the experience of awe. As discussed in the Introduction, awe can be elicited by a wide range of different activities and circumstances and awe has been associated with many different consequences, including effects on prosocial behavior and environmental awareness [8, 13, 40, 41]. Our findings suggest that the tendency to get absorbed in one's experiences predispose people to experience awe and that a key feature of feelings of awe may be that people literally feel themselves as smaller compared to the environment. Below we will discuss the relation between awe, body size perception and absorption in more detail.

	B	SE	β	t	p
Constant	3.207	0.871		3.681	< .001
Study	0.345	0.217	0.154	1.594	0.112
Age	0.007	0.007	0.073	0.944	0.346
Gender	–0.314	0.214	–0.091	–1.470	0.143
Awe	–0.025	0.010	–0.212	–2.400	0.017

Table 5: Linear model of predictors of body size estimates across Study 2–4.

Following the notion that the experience of awe is characterized by a process of de-selfing [8], we hypothesized that feelings of awe would be accompanied by smaller estimates of body size. In Pre-test 1 a significant relation was observed between perceived awe and body size: participants who reported stronger feelings of awe tended to perceive their body as smaller. In Study 3 a significant effect of awe on body size perception was observed: participants perceived their body to be smaller in the awe condition compared to the control conditions. In Study 2 and Study 4 the pattern of results was in the same direction and the effects were marginally significant. In the meta-analysis across all studies a small but significant relation between awe and body perception was found: stronger feelings of awe were related to smaller body size estimates. Thus, these findings provide tentative support for our hypothesis that feelings of awe are characterized by literally feeling small, resulting in smaller estimates of the size of one's body. Previous studies regarding effects of awe on self-perception [6, 8, 13] may have suffered from the common method bias [21]. The present study avoids this potential confound, as the questions we used to assess feelings of awe did not contain items directly related to body perception and we used a simple graphical representation of one's body to directly measure body size estimates. We note that that our dependent measure was primarily related to the conscious and subjective perception of one's body, which has been referred to in the literature as 'body image' [42]. In contrast, 'body schema' refers to the implicit perception of one's body that underlies our actions in the world. An interesting question for future research would be to investigate whether feelings of awe also affect the implicit perception of one's body, for instance by using more implicit measures of body size (e.g. pointing; walking).

Related to this, we also included an object size estimation task in Study 2 and 3 and a distance estimation task in Study 4, as we hypothesized that the perception of oneself being smaller could result in an overestimation of

object size and distance. We did not find an effect of awe on these dependent measures, but this may be related to the fact that the measures that we used were sub-optimal. First, the object size estimation task [28] resulted in a large variability in participants' responses and the resulting size estimates were unreliable. Second, in Study 2 and 4 we used the size estimation tasks in a repeated measures design: accordingly the dependent measures were highly correlated and as a consequence it may have been difficult to capture an eventual additional effect of our awe manipulation. Third, the object size and distance estimation task depend to a strong extent on semantic memory (e.g. knowing the height of the Eiffel tower; knowing the distance from Amsterdam to Paris) and as such it remains questionable whether these measures are indirectly related to perceived body size at all. Alternative measures that do not depend on prior semantic memory (e.g. simple height or distance estimation task of visually presented objects; cf. [32]) may be better suited to capture the indirect effects of perceived body size on perception and could be used in future studies. Finally, the finding that awe is related to direct but not to indirect measures of body perception, echoes a more general concern in research on body perception, as recent studies have reported a similar dissociation between direct and indirect measures of body perception, for instance in research on body illusions [43]. Thus, results regarding the indirect effects of awe on body perception – as measured through object size and distance estimation tasks – remain inconclusive.

Although we hypothesized that absorption would be a moderator on the effects of awe- manipulations on feelings of awe, no such relation was observed. Still, across four studies we found a strong relation between the personality trait of absorption and feelings of awe: overall participants scoring high on absorption tended to report stronger feelings of awe – irrespective of the experimental manipulation. In addition, in Study 2 we showed that experimentally manipulating absorption could boost feelings of awe: when participants were instructed to get absorbed in a video, this resulted in stronger feelings of awe, compared to when participants were watching the video with an analytical mindset. Previous studies have suggested that individual differences in 'dispositional awe' could underlie experiences of awe [6, 8, 33]. We note that the absorption scale differs in important respects from the dispositional awe scale: instead of directly assessing the frequency and intensity of awe experiences [6], the Tellegen absorption scale measures one's general tendency to get absorbed in sensory events and activities [35]. As such, absorption has been proposed as a trait-like personality feature [44], which has been associated with hypnosis-proneness [45], but also with sensitivity for having religious [16] and spiritual experiences [17]. The present study convincingly shows a strong relation between the disposition to get absorbed and state-like experiences of awe, and moreover, we report that experimentally boosting absorption induces stronger feelings of awe. Interestingly, we also found that people scoring high on absorption tend to report stronger feelings of awe, also in response to the control videos (e.g. neutral and positive videos). This finding has important implications for future research that may benefit from including the absorption scale as a control variable. The central importance of absorption for feelings of awe is in line with the notion that awe can be characterized as a receptive state that fully engages one's attentional resources [46]. A similar ability to get absorbed may underlie the experience of flow in relation to activities such as music making or sports [47], but also videogaming [48] and the experience of 'presence' in virtual reality applications [49].

Next to showing the effects of absorption on awe, across the different studies we also found preliminary evidence for a relation between absorption and body size perception. In Study 1 and 2 we found that participants scoring high on absorption tended to underestimate the size of their body. Furthermore, in Study 3, the effects of awe on explicit body size perception tended to be more pronounced for participants scoring high on absorption (although the effect was only marginally significant). Although these findings were exploratory and need to be interpreted with caution, the notion that individual differences in absorption may be related to differences in the perception of one's body, opens interesting avenues for future research, e.g. on bodily illusions and on the perception of peripersonal space (i.e. the subjective perception of the space directly surrounding our body). It could well be, for instance, that a reduced or a diminished awareness of one's body may provide a predisposition for having self-transcendent experiences (see for instance: [25]).

Finally, we note that in our study we primarily focused on the positive aspects of the awe-experience (i.e. as becomes evident from the questions we used as our dependent measure; see: **Appendix 1**). However, awe is a complex emotion that is also associated with negative feelings, such as threat and anxiety, and these aspects were not included in the present study. This lack of attention to more negative aspects of 'awe' reflects a more general bias in the psychological literature on awe that has primarily focused on awe as a positive emotion [6, 8] and future studies will need to focus on the dark side of awe as well (e.g. awe could lead to passivity, loss of self) to get a more complete picture of this complex emotion.

8. Conclusions

We found that stronger feelings of awe were associated with smaller body size estimates. The personality trait of absorption was found to be strongly related to feelings of awe: people scoring high on absorption tended to report overall stronger feelings of awe – irrespective of the experimental manipulation. Experimentally manipulating absorption by instructing participants to get fully absorbed in an external stimulus resulted in stronger feelings of awe. These findings indicate that changes in the perception of one's body and the tendency to get absorbed in one's experiences may be key features underlying the experience of awe.

Competing Interests
The authors declare that they have no competing interests.

Supplementary Material Online
Pre-test 1 and Pre-test 2 of different awe-stimuli; see http://dx.doi.org/10.1525/collabra.36.smo

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Appendix I
Manipulation check questionnaire about the experience of awe.

Dutch:

1. In welke mate riep het zien van de video een gevoel van schoonheid bij u op?
2. In welke mate gaf de video u het gevoel dat het leven uiteindelijk allemaal één is?
3. In welke mate gaf de video u het gevoel dat u boven uzelf uitsteeg?
4. In welke mate had u tijdens het zien van de video het gevoel dat u het besef van tijd en ruimte kwijt raakte?
5. In welke mate gaf de video u het gevoel dat ons leven deel uitmaakt van een groter geheel?
6. In welke mate was u onder de indruk door het zien van de video?
7. In welke mate riep de video bij u een gevoel van ontzag op?
8. In welke mate had u een esthetische- of schoonheidservaring bij het zien van de video?

English:

1. To what extent did watching the video induce the experience of something beautiful?
2. To what extent did the video induce the feeling that ultimately all life is one?
3. To what extent did the video induce feelings of self-transcendence?
4. To what extent did you experience a loss of sense of space and time during watching the video?
5. To what extent did the video induce the feeling that our life is part of a bigger whole?
6. To what extent were you impressed by watching the video?
7. To what extent did the video induce feelings of awe?
8. To what extent did you have an aesthetic experience while watching the video?

Notes
[1] After participants received the instruction regarding the experiment they conducted the study at their own pace in a cubicle. Some participants failed to watch the video because they failed to click on the link and this became evident in the analysis (i.e. we recorded the time that participants spent on watching the video).

[2] Participants were randomly assigned to either the awe, the positive control or the neutral control condition through a computerized procedure. Due to drop-out of participants (see above), we ended up with slightly more participants in the neutral control compared to the other conditions.

[3] In addition to measures of body size, we also included a perspective taking task and the inclusion-of-other-in-the-self scale as dependent measures. There was no significant effect of awe on these dependent measures, but for the sake of brevity, we only report here effects of awe on body size estimation.

[4] We also investigated whether our experimental manipulation could have affected the scores on the Tellegen absorption scale. However, no effect of Condition on Absorption was observed, $F(2, 86) < 1.0$, n.s.).

[5] However, we note that the hypothesized direction about our expected effects differed between participants (i.e. emotion might lead to a smaller or a larger perception of the self). Exclusion of participants who figured out the purpose of the experiment, did not change the pattern of results observed.

[6] Specifically, participants conducted the vividness of visual imagery scale, a visual imagery training and test and a mental letter rotation task.

[7] However, when directly comparing the awe-ratings between Study 1 and 2 the difference was non-significant ($t(73) = 1.3$, $p = .21$ and $t(73) = -1.1$, $p = .30$), but this may have been related to the unequal distribution and the relatively small number of participants used for this comparison (N = 47 vs. N = 28).

[8] As the Tellegen Absorption scale is copyright protected, unfortunately it is not possible to report the specific items to which these numbers refer.

[9] Specifically participants conducted a study on the perception of 'status and power' and a study on art perception before this task. Following the experiment, participants conducted a study on 'compensatory control'. This was the same for all participants and accordingly, any effect of the experimental context cannot explain the differences that we find between the different experimental conditions.

[10] As can be seen in Figure 2 there was no linear decrease in the size of the bodies depicted and accordingly non-parametric tests may have been better suited to test the effects of awe on body perception. The results when using a non-parametric correlation test were comparable to the effects reported in the main analysis, with only a significant correlation observed between the awe-ratings and the body-size perception during the pre-test: Kendall's $tau = -.171$, $p = .016$.

[11] To this end data from Study 2 was treated as if it was a between-subjects design, by only including data from the first block.

References

1. Dworkin, R. 2013. *Religion without god*. Harvard, MA: Harvard University Press.
2. Van Cappellen, P., and Saroglou, V. 2012. Awe Activates Religious and Spiritual Feelings and Behavioral Intentions. Psychology of Religion and Spirituality 4(3): 223–236. DOI: http://dx.doi.org/10.1037/a0025986
3. Konecni, V. J. 2011. Aesthetic Trinity Theory and the Sublime. Philosophy Today 55(1): 64–73. DOI: http://dx.doi.org/10.5840/philtoday201155162
4. Vandenabeele, B. 2003. Schopenhauer, Nietzsche, and the aesthetically sublime. Journal of Aesthetic Education 37(1): 90–106. DOI: http://dx.doi.org/10.2307/3527424
5. Shiota, M. N., Campos, B., and Keltner, D. 2003. The faces of positive emotion – Prototype displays of awe, amusement, and pride. Emotions inside Out 1000: 296–299.
6. Shiota, M. N., Keltner, D., and Mossman, A. 2007. The nature of awe: Elicitors, appraisals, and effects on self-concept. Cognition & Emotion 21(5): 944–963. DOI: http://dx.doi.org/10.1080/02699930600923668
7. Campos, B., Shiota, M. N., Keltner, D., Gonzaga, G. C., and Goetz, J. L. 2013. What is shared, what is different? Core relational themes and expressive displays of eight positive emotions. Cognition & Emotion 27(1): 37–52. DOI: http://dx.doi.org/10.1080/02699931.2012.683852
8. Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., and Keltner, D. 2015. Awe, the small self, and prosocial behavior. Journal of personality and social psychology 108(6): 883–899. DOI: http://dx.doi.org/10.1037/pspi0000018
9. Rudd, M., Vohs, K. D., and Aaker, J. 2012. Awe Expands People's Perception of Time, Alters Decision Making, and Enhances Well-Being. Psychological Science 23(10): 1130–1136. DOI: http://dx.doi.org/10.1177/0956797612438731
10. Valdesolo, P., and Graham, J. 2014. Awe, Uncertainty, and Agency Detection. Psychological Science 25(1): 170–178. DOI: http://dx.doi.org/10.1177/0956797613501884
11. Van Cappellen, P., Saroglou, V., Iweins, C., Piovesana, M., and Fredrickson, B. L. 2013. Self-transcendent positive emotions increase spirituality through basic world assumptions. Cognition & Emotion 27(8): 1378–1394. DOI: http://dx.doi.org/10.1080/02699931.2013.787395
12. Weinstein, N., Przybylski, A. K., and Ryan, R. M. 2009. Can Nature Make Us More Caring? Effects of Immersion in Nature on Intrinsic Aspirations and Generosity. Personality and Social Psychology Bulletin 35(10): 1315–1329. DOI: http://dx.doi.org/10.1177/0146167209341649
13. Zhang, J. W., Piff, P. K., Iyer, R., Koleva, S., and Keltner, D. 2014. An occasion for unselfing: Beautiful nature leads to prosociality. Journal of Environmental Psychology 37: 61–72. DOI: http://dx.doi.org/10.1016/j.jenvp.2013.11.008
14. Zhang, J. W., Howell, R. T., and Iyer, R. 2014. Engagement with natural beauty moderates the positive relation between connectedness with nature and psychological well-being. Journal of Environmental Psychology 38: 55–63. DOI: http://dx.doi.org/10.1016/j.jenvp.2013.12.013
15. Gallagher, S., Reinerman-Jones, L., Sollins, B., and Janz, B. 2014. Using a simulated environment to investigate experiences reported during space travel. Theoretical Issues in Ergonomics Science 15(4). DOI: http://dx.doi.org/10.1080/1463922X.2013.869370
16. Luhrmann, T. M., Nusbaum, H., and Thisted, R. 2010. The Absorption Hypothesis: Learning to Hear God in Evangelical Christianity. American Anthropologist 112(1): 66–78. DOI: http://dx.doi.org/10.1111/j.1548-1433.2009.01197.x
17. van Elk, M. 2015. An EEG study on the effects of induced spiritual experiences on somatosensory processing and sensory suppression. Journal for the Cognitive Science of Religion.
18. Keltner, D., and Haidt, J. 2003. Approaching awe, a moral, spiritual, and aesthetic emotion. Cognition & Emotion 17(2): 297–314. DOI: http://dx.doi.org/10.1080/02699930302297
19. Bockelman, P., Reinerman-Jones, L., and Gallagher, S. 2013. Methodological lessons in neurophenomenology: review of a baseline study and recommendations for research approaches. Frontiers in Human Neuroscience 7. DOI: http://dx.doi.org/10.3389/fnhum.2013.00608
20. Reinerman-Jones, L., Sollins, B., Gallagher, S., and Janz, B. 2013. Neurophenomenology: an integrated approach to exploring awe and wonder. South African Journal of Philosophy 32(4): 295–309. DOI: http://dx.doi.org/10.1080/02580136.2013.867397
21. Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., and Podsakoff, N. P. 2003. Common method biases in behavioral research: A critical review of the literature and recommended remedies. Journal of Applied Psychology 88(5): 879–903. DOi: http://dx.doi.org/10.1037/0021-9010.88.5.879
22. Blanke, O., Slater, M., and Serino, A. 2015. Behavioral, Neural, and Computational Principles of Bodily Self-Consciousness. Neuron 88(1): 145–166. DOI: http://dx.doi.org/10.1016/j.neuron.2015.09.029
23. Newberg, A. B., Alavi, A., Baime, M., Pourdehnad, M., Santanna, J., and d'Aquid, E. 2001. The measurement of regional cerebral blood flow during the complex cognitive task of meditation: a preliminary SPECT study. Psychiatry Research-Neuroimaging 106(2): 113–122. DOI: http://dx.doi.org/10.1016/S0925-4927(01)00074-9
24. Newberg, A. B., and Iversen, J. 2003. The neural basis of the complex mental task of meditation: neurotransmitter and neurochemical considerations. Medical Hypotheses 61(2): 282–291. DOI: http://dx.doi.org/10.1016/S0306-9877(03)00175-0
25. Urgesi, C., Aglioti, S. M., Skrap, M., and Fabbro, F. 2010. The Spiritual Brain: Selective Cortical Lesions

Modulate Human Self-Transcendence. Neuron 65(3): 309–319. DOI: http://dx.doi.org/10.1016/j.neuron.2010.01.026
26. Witt, J., Proffitt, D. R., and Epstein, W. 2005. Tool use affects perceived distance, but only when you intend to use it. Journal of Experimental Psychology-Human Perception and Performance 31(5): 880–888. DOI: http://dx.doi.org/10.1037/0096-1523.31.5.880
27. Linkenauger, S. A., Witt, J. K., Stefanucci, J. K., Bakdash, J. Z., and Proffitt, D. R. 2009. The Effects of Handedness and Reachability on Perceived Distance. Journal of Experimental Psychology-Human Perception and Performance 35(6): 1649–1660. DOI: http://dx.doi.org/10.1037/a0016875
28. Eerland, A., Guadalupe, T. M., and Zwaan, R. A. 2011. Leaning to the Left Makes the Eiffel Tower Seem Smaller: Posture-Modulated Estimation. Psychological Science 22(12): 1511–1514. DOI: http://dx.doi.org/10.1177/0956797611420731
29. Proffitt, D. R., Stefanucci, J., Banton, T., and Epstein, W. 2003. The role of effort in perceiving distance. Psychological Science 14(2): 106–112. DOI: http://dx.doi.org/10.1111/1467-9280.t01-1-01427
30. Witt, J., Linkenauger, S., Bakdash, J., Augustyn, J., Cook, A., and Proffitt, D. 2009. The long road of pain: chronic pain increases perceived distance. Experimental Brain Research 192(1): 145–148. DOI: http://dx.doi.org/10.1007/s00221-008-1594-3
31. Aron, A., Aron, E. N., and Smollan, D. 1992. Inclusion of Other in the Self Scale and the Structure of Interpersonal Closeness. Journal of personality and social psychology 63(4): 596–612. DOI: http://dx.doi.org/10.1037/0022-3514.63.4.596
32. Dominici, N., Daprati, E., Nico, D., Cappellini, G., Ivanenko, Y. P., and Lacquaniti, F. 2009. Changes in the Limb Kinematics and Walking-Distance Estimation After Shank Elongation: Evidence for a Locomotor Body Schema? (vol 101, pg 1419, 2009). Journal of Neurophysiology 101(5): 2734–2734.
33. Shiota, M. N., Eltner, D., and John, O. P. 2006. Positive emotion dispositions differentially associated with Big Five personality and attachment style. The Journal of Positive Psychology 1(2): 61–71. DOI: http://dx.doi.org/10.1080/17439760500510833
34. Saroglou, V., Buxant, C., and Tilquin, J. 2008. Positive emotions as leading to religion and spirituality. The Journal of Positive Psychology 3(3): 165–173. DOI: http://dx.doi.org/10.1080/17439760801998737
35. Tellegen, A., and Atkinson, G. 1974. Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. Journal of abnormal psychology 83(3): 268. DOI: http://dx.doi.org/10.1037/h0036681
36. Brattico, E., Jacobsen, T., De Baene, W., Glerean, E., and Tervaniemi, M. 2010. Cognitive vs. affective listening modes and judgments of music – An ERP study. Biological Psychology 85(3): 393–409. DOI: http://dx.doi.org/10.1016/j.biopsycho.2010.08.014
37. Greenwald, A. G. 1976. Within-subjects designs: To use or not to use? Psychological Bulletin 83(2): 314–320. DOI: http://dx.doi.org/10.1037/0033-2909.83.2.314
38. Liberman, N., and Forster, J. 2009. Distancing From Experienced Self: How Global-Versus-Local Perception Affects Estimation of Psychological Distance. Journal of personality and social psychology 97(2): 203–216. DOI: http://dx.doi.org/10.1037/a0015671
39. Henrich, J., Heine, S. J., and Norenzayan, A. 2010. Beyond WEIRD: Towards a broad-based behavioral science. Behavioral and Brain Sciences 33(2–3): 111–135. DOI: http://dx.doi.org/10.1017/S0140525X10000725
40. Kamitsis, I., and Francis, A. J. P. 2013. Spirituality mediates the relationship between engagement with nature and psychological wellbeing. Journal of Environmental Psychology 36: 136–143. DOI: http://dx.doi.org/10.1016/j.jenvp.2013.07.013
41. Schnall, S., Roper, J., and Fessler, D. M. T. 2010. Elevation Leads to Altruistic Behavior. Psychological Science 21(3): 315–320. DOI: http://dx.doi.org/10.1177/0956797609359882
42. de Vignemont, F. 2010. Body schema and body image-Pros and cons. Neuropsychologia 48(3): 669–680. DOI: http://dx.doi.org/10.1016/j.neuropsychologia.2009.09.022
43. Rohde, M., Di Luca, M., and Ernst, M. O. 2011. The rubber hand illusion: feeling of ownership and proprioceptive drift do not go hand in hand. PloS one 6(6): e21659. DOI: http://dx.doi.org/10.1371/journal.pone.0021659
44. Pekala, R. J., Wenger, C. F., and Levine, R. L. 1985. Individual-Differences in Phenomenological Experience – States of Consciousness as a Function of Absorption. Journal of personality and social psychology 48(1): 125–132. DOI: http://dx.doi.org/10.1037/0022-3514.48.1.125
45. Council, J. R., Kirsch, I., and Hafner, L. P. 1986. Expectancy Versus Absorption in the Prediction of Hypnotic Responding. Journal of personality and social psychology 50(1): 182–189. DOI: http://dx.doi.org/10.1037/0022-3514.50.1.182
46. Fuller, R. 2006. Wonder and the religious sensibility: A study in religion and emotion. Journal of Religion 86(3): 364–384. DOI: http://dx.doi.org/10.1086/503693
47. Csikszentmihalyi, M. 1991. Flow: The psychology of optimal experience. New York: HarperPerennial.
48. Dauphin, B., and Heller, G. 2010. Going to Other Worlds: The Relationships between Videogaming, Psychological Absorption, and Daydreaming Styles. Cyberpsychology Behavior and Social Networking 13(2): 169–172. DOI: http://dx.doi.org/10.1089/cyber.2009.0065
49. Murray, C. D., Fox, J., and Pettifer, S. 2007. Absorption, dissociation, locus of control and presence in virtual reality. Computers in Human

Behavior 23(3): 1347–1354. DOI: http://dx.doi.org/10.1016/j.chb.2004.12.010
50. Bradley, M. M., and Lang, P. J. 1994. Measuring emotion: the Self-Assessment Manikin and the Semantic Differential. Journal of Behavior Therapy and Experimental Psychiatry 25(1): 49–59. DOI: http://dx.doi.org/10.1016/0005-7916(94)90063-9
51. Maruskin, L. A., Thrash, T. M., and Elliot, A. J. 2012. The Chills as a Psychological Construct: Content Universe, Factor Structure, Affective Composition, Elicitors, Trait Antecedents, and Consequences. Journal of personality and social psychology 103(1): 135–157. DOI: http://dx.doi.org/10.1037/a0028117
52. Salimpoor, V. N., Benovoy, M., Longo, G., Cooperstock, J. R., and Zatorre, R. J. 2009. The Rewarding Aspects of Music Listening Are Related to Degree of Emotional Arousal. Plos One 4(10). DOI: http://dx.doi.org/10.1371/journal.pone.0007487
53. Spreckelmeyer, K. N., Kutas, M., Urbach, T. P., Altenmuller, E., and Munte, T. F. 2006. Combined perception of emotion in pictures and musical sounds. Brain Research 1070(1): 160–170. DOI: http://dx.doi.org/10.1016/j.brainres.2005.11.075
54. Suedfeld, P., Legkaia, K., and Brcic, J. 2010. Changes in the Hierarchy of Value References Associated With Flying in Space. Journal of Personality 78(5): 1411–1436. DOI: http://dx.doi.org/10.1111/j.1467-6494.2010.00656.x
55. Vieillard, S., Peretz, I., Gosselin, N., Khalfa, S., Gagnon, L., and Bouchard, B. 2008. Happy, sad, scary and peaceful musical excerpts for research on emotions. Cognition & Emotion 22(4): 720–752. DOI: http://dx.doi.org/10.1080/02699930701503567
56. Zentner, M., Grandjean, D., and Scherer, K. R. 2008. Emotions evoked by the sound of music: Characterization, classification, and measurement. Emotion 8(4): 494–521. DOI: http://dx.doi.org/10.1037/1528-3542.8.4.494

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