

ATTITUDES AND SOCIAL COGNITION

Awe, Daily Stress, and Elevated Life Satisfaction

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It is widely assumed that experiences of awe transform the meaning of daily stresses. Across six studies we tested whether and how the experience of awe is associated with reduced daily stress levels in the moment and, in so doing, leads to elevated life satisfaction. We first documented that individuals who tend to experience greater awe on a daily basis (Study 1) or who report higher levels of trait-like awe (Study 2) report lower levels of daily stress, even after controlling for other positive emotions. In follow-up experiments, after primed with awe (compared with amusement, joy, and pride), individuals reported lower levels of daily stress (Studies 3 and 5) and exhibited lower levels of sympathetic autonomic arousal when talking about their daily stresses (Study 4). Finally, in a naturalistic study, participants who took in an awe-inspiring view at the top of a 200-foot tower reported reduced levels of daily stress and central everyday concerns (Study 6). Mediation analyses revealed that (a) the association between awe and reduced daily stress can be explained by an appraisal of vastness vis-à-vis the self and (b) that the relationship between awe and decreased daily stress levels helps explain awe's positive influence upon life satisfaction. Overall, these findings suggest that experiencing awe can put daily stressors into perspective in the moment and, in so doing, increase well-being.

• : awe, daily stress, life satisfaction, small self

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In the woods, we return to reason and faith. There I feel that nothing can befall me in life,—no disgrace, no calamity (leaving me my eyes), which nature cannot repair. Standing on the bare ground,—my head bathed by the blithe air and uplifted into infinite space—all mean egotism vanishes. (Emerson, 1836, p. 13)

A widespread intuition about awe is that its experience transforms the stresses and struggles of daily living—in Emerson's

quote, awe from nature repairs “life's calamities.” In the midst and aftermath of the experience of awe, daily personal concerns—small, ordinary events causing anxiety, distress, and pain—seem, at least phenomenologically, to diminish in their significance.

In the current investigation we sought to offer the first evidence for this hypothesis. We did so by capturing awe at the trait and state levels, in the lab and in naturalistic settings, and with self-report and peripheral physiological measures of stress. Given that

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stresses often arise out of an immersive focus on the self (e.g., Buss, 1980; Hull, 1981; Pyszczynski & Greenberg, 1987; Scheier & Carver, 1977; see review by Ingram, 1990), in the search for mediation we

Dohrenwend, 1974; Holmes & Rahe, 1967; Kanner et al., 1981; Lazarus, 1984).

As a result, daily stresses have emerged as a central focus in the empirical literature, alongside the study of more chronic structural stresses and traumatizing major life events. For example, in an early study by Kanner et al. (1981), self-reported stress levels in response to daily hassles, compared with those from major life events, more significantly predicted both concurrent and subsequent somatic health status. In a similar vein, Monroe (1983) found that whereas levels of major life-changing stress only moderately correlated with individuals' psychological symptoms (e.g., sleep difficulties; measured by General Health Questionnaire [GHQ], Goldberg & Hillier, 1979), levels of daily stress significantly predicted psychological symptoms, even after controlling for initial symptom levels.

Moreover, reports of daily stress appear to mediate the influences of more severe life events upon mental and physical well-being (Caspi et al., 1987; DeLongis et al., 1982; Kanner et al., 1981; Pearlin et al., 1981). For example, involuntary disruption of a job might turn the more ordinary challenges of daily routines—such as purchasing life necessities, keeping the home orderly, getting the kids from school, and assisting with their homework—into more significant sources of stress, and thereby significantly alter personal well-being. Consistent with this reasoning, levels of stress in response to daily hassles have been found to mediate, or at least partially mediate, the impact of major life events on health status and well-being (e.g., Eckenrode, 1984; Johnson & Sherman, 1997; Pearlin et al., 1981).

Grounded in the aforementioned studies of awe and stress, we predicted that the experience of awe will reduce daily stress levels by altering individuals' appraisals of the self. Select studies set the stage for our central hypothesis. In a recent investigation of veterans and youth from underserved communities, an awe-inspiring experience of white water rafting significantly reduced participants' stress-related symptoms and boosted both short and long term well-being one-week after the rafting trip (Anderson et al., 2018). Trait level awe was found to be associated with reduced levels of interleukin 6 (IL6), a biomarker of the body's inflammation response, which covaries with levels of stress (Stellar et al., 2015). People led to feel awe in laboratory experiments reported a reduced awareness of day-to-day concerns (Shiota et al., 2007), greater well-being (Rudd et al., 2012), and elevated parasympathetic autonomic activation (Gordon et al., 2017), all indirectly related to reduced daily stress.

The present work extends these studies in three ways. First, whereas past studies have focused on awe felt in natural settings (e.g., Anderson et al., 2018), in the present investigation we tested the relationship between awe and stress using a diverse range of nature and nonnature related elicitors, including narrative recall, evocative videos, and in vivo situations. Second, in light of recent concerns about biases in memory reconstruction (DiGiovanni & Balcetis, 2018; Ross, 1989), we captured individuals' levels of daily stress across daily measurements, ratings of standard hassle lists, and stress-related physiological responses while talking about daily stress.

Finally, we provide evidence for experiences of awe are associated with reduced stress. Guided by an appraisal tendency account of emotion-cognicity

Participants and Procedure

One hundred twenty-three undergraduates (35 males) from a public university in Spain participated in exchange for course credit. The final sample size was determined in part from previous diary studies on emotion (e.g., Gordon & Chen, 2016) and in part by aiming to recruit as many participants as possible within two weeks. We only analyzed results after all participants completed the study. Participants ranged in age from 19–22 years old ($M = 19.67$, $SD = .47$). Participants filled out an online survey each night for 14 consecutive nights. Reminders were sent out every night at 8:00 p.m. Diaries completed after 8:00 a.m. on the following day were excluded from analyses. In total, participants finished 1705 diaries. Using the sensitivity curve produced by simulations from R package *simr* 1.5 (Green & MacLeod, 2016), we estimate that we achieved 80% power to detect effects of approximately a d -scored $B = -.07$, unstandardized $B = -.05$ or smaller (for more details, see the online supplemental materials).

Measures

Mindful of cultural biases introduced by translation of single words (e.g., Bai et al., 2017; Russell, 1989, 1994), we followed previous awe research (e.g., Bai et al., 2017) and oriented each participant to an understanding of awe through a theoretical definition and a facial expression of this emotion. Specifically, before the start of the daily diaries portion of the study, participants were instructed to complete an online survey in which we provided them with a general definition of awe (derived from Keltner & Haidt, 2003): “People sometimes experience the emotion of ‘awe’ when we are in the presence of something amazing or breathtaking, something that we perceive as being vast or that they do not fully understand in the moment, something that can fascinate or impress us, but that can also make us feel overwhelmed or a little bit frightened.” In addition to the definition, participants also viewed a photograph of facial expression that has been found to communicate awe reliably across different cultures (Bai et al., 2017; Shiota et al., 2004).

The daily measures were kept brief to maintain motivation (Reis & Gable, 2000). Participants reported how much they experienced awe in addition to joy, anxiety, sadness, contentment, pride, loneliness, gratefulness, anger, being tired, and amusement. Participants also responded to one statement assessing their stress (“Today I felt stressed, overburdened or pressured”). All items were measured on 11-point Likert scales (1 = *Not at all*, 11 = *Very much*).

As part of the daily diary, participants were also asked whether they experienced anything awe-eliciting during the day. If the answer was yes, they were asked to describe the awe-inducing daily event, including who they were with, where they were, what they saw, and how they felt (for analyses of the contents of the awe narratives, see the online supplemental materials). If participants did not experience awe that day, they were asked to write about a positive experience they had during the day (in total, participants wrote 248 awe experiences; each participant reported 2.02 awe experiences on average).

The daily diaries consisted of multiple data points nested within individuals as well as within each day (everyone completed the diaries during the same two-week period), violating assumptions of independence between subjects and days. Thus, we used a two-level cross-classified model to conduct our analyses. Level 1 intercepts were allowed to vary for the individual and day, and slopes were allowed to vary for the individual. These analyses were conducted using the *nlme* package in the statistical program R; degrees of freedom and F values were calculated using the Satterthwaite method (Bates et al., 2015; Kuznetsova et al., 2017), which yields F that are somewhere between the number of observations, individuals, and days depending on the relative variance explained by each factor; this also explains why the degrees of freedom varies from model to model. Finally, we report the significance of random effects using the *anova* function from *lmerTest* which reports likelihood ratio tests comparing the model to a model dropping the random effect being tested.

First, we examined whether the fluctuation of awe within the same participant was associated with daily stress levels. To do so, we predicted individuals’

their own norm across the two-week period, they reported feeling less stressed, $B = -.20$, 95% CI $[-.26, -.14]$, $(78.52) = -6.84$, $< .01$ (Table 1; for further analyses of within-subject variability, see the [online supplemental materials](#)). To rule out the possibility that the effect of daily awe experience on daily stress is actually tapping into differences in daily positive experiences, we controlled for the level of general daily positivity using an aggregated value of the other positive experiences—joy, contentment, pride, gratefulness, and amusement. As expected, the effect still held after controlling for general daily positivity, $B = -.08$, 95% CI $[-.13, -.02]$, $(345.87) = -2.75$, $= .01$. Finally, to rule out the possibility that daily awe led to reduced stress because of lower levels of stress the day before, we also ran an analysis of daily awe controlling for the daily stress level reported on the previous day as a covariate and found that the significant effect still held, $B = -.18$, 95% CI $[-.24, -.13]$, $(189.89) = -6.55$, $< .01$.

In addition, we also compared participants' reported daily stress on days when they reported an awe-inducing experience (for detailed content analyses of awe diaries, see the [online supplemental materials](#)) to their reported daily stress on days when they did not. The contrast was significant, $B = -.99$, 95% CI $[-1.44, -.54]$, $(86.82) = -4.35$, $< .01$, suggesting that participants were less stressed on days when they encountered one or more awe-inducing experiences. Furthermore, after controlling for the level of general daily positivity, the effect still held, $B = -.48$, 95% CI $[-.90, -.07]$, $(85.31) = -2.30$, $= .02$.

Taken together, the results from Study 1 support our first hypothesis that awe is associated with decreased daily stress. In keeping with Hypothesis 2, self-reports of the intensity of daily feelings of awe were significantly associated with individuals' daily stress levels even after controlling for other positive states (e.g., Fredrickson, 2001; Ruch, 2009). However, Study 1 was limited in certain ways. Our measure of daily stress was a single item that did not explicitly measure reactions toward daily stressors. Moreover, diary studies rely on retrospective self-reports, which may reflect participants' lay understanding of awe and daily stresses rather than actual relations between the two (Nisbett & Wilson, 1977; Parkinson & Manstead, 1992). In light of these concerns, we turned to survey and experimental techniques testing the relationship between awe and daily stress across both trait (Study 2) and state (Studies 3–6) levels.



Study 2 was designed to test the hypothesis that individuals who are more prone to experience awe will experience lower levels of daily stress. Emotional traits reflect the frequency and intensity with which individuals experience specific emotions (Keltner, 1996; Rosenberg, 1998) and often demonstrate similar effects on social cognition as emotional states (for a review, see Keltner & Lerner, 2010). In part justifying our second study, trait-based awe, as measured by the Dispositional Positive Emotion Scale (DPES; Shiota et al., 2006); was found to predict lower levels of proinflammatory cytokines—molecules that have a strong link with stress (Kiecolt-Glaser et al., 2002; Stellar et al., 2015). Furthermore, to test our hypothesis, we controlled for gender and ethnicity, both associated with levels of stress and well-being (e.g., Contrada et al., 2000; Nelson & Burke, 2002). To ascertain

awe on a regular basis reported lower intensities of stress associated with the 117 daily hassles, $\beta = -.13$, $b = -2.39$, $se = .02$. Lending further support to our first hypothesis, even after controlling for dispositional amusement, age, gender (1 = male, 2 = female), and ethnicity (0 = nonwhite, 1 = white), trait awe was still significantly associated with levels of stress associated with daily hassles, $\beta = -.14$, $b = -2.43$, $se = .02$ (for coefficients for each predictor, see the [online supplemental materials](#)).

Building on previous studies linking trait-level awe to lower levels of inflammatory cytokines (Kiecolt-Glaser et al., 2002; Stellar et al., 2015); Study 2 found that trait-level awe was negatively correlated with self-reported daily stress levels. Importantly, the relationship between awe and daily stress was not merely a function of positive affect (e.g., Shiota et al., 2006). We now turn to experimental inductions to test awe's causal effects on reduced daily stress levels, possible mediators of this effect, and how this effect in turn explains awe's relationship to elevated life satisfaction.

3.1.1. Awe and Amusement

In Study 3, we experimentally induced awe and amusement in the laboratory with videos of the natural world and compared their respective impacts on daily stress, which we captured with a new measure. More specifically, the hassles scale used in Study 2 was potentially biased by subjective, idiosyncratic meanings (e.g., problems with aging parents have enormously different meanings depending on the circumstances of a person's life). Moreover, some hassles are more central to personal goals and more closely related to psychological functioning (Gruen et al., 1988; McIntyre et al., 2008; Vázquez et al., 2001). Guided by previous research (Gruen et al., 1988), each participant in Study 3 reported his or her own central daily hassle—a stressor that reflects a major ongoing problem on a daily basis—and rated their level of stress in relation to this concern. We hypothesized that individuals who watched an awe-eliciting video would report lower levels of daily stress compared with the ones who watched amusing or neutral videos.

Finally, guided by an appraisal tendency-based approach (Lerner & Keltner, 2000; 2001), we examined how awe reduces daily stress. Within this framework, each emotion is defined by central appraisals that in turn shape cognitive processes (Lerner & Keltner, 2000, 2001). For example, experiences of anger that arise from appraisals of other people being in control of negative events increase the tendency to perceive other individuals as responsible for subsequent events (Keltner et al., 1993; Lerner & Keltner, 2000). Guided by this framework, we posited that awe arises from an appraisal of vastness (Bai et al., 2017; Keltner & Haidt, 2003) and then leads individuals to construe daily stressors through the lens of small self-appraisals. Specifically, we tested whether participants primed with awe were more likely to reference the two small self-appraisals established in past studies—vastness vis-à-vis the self and an insignificant sense of the self—in their narratives of stress compared with participants in the joy or neutral conditions.

3.1.2. Awe and Amusement

Participants

One hundred thirty-five college students at a major public west coast university in the United States participated in exchange for

one course credit. The sample was determined primarily by aiming to collect as much data as possible within one semester. We only analyzed results after all participants completed the study. Seven participants failed to follow the instructions (e.g., did not report central hassles in the preonline survey) and were thus excluded from all analyses. The final sample consisted of 128 college students (25 male; $M = 21.13$ yrs, $SD = 3.59$ yrs). According to post hoc power sensitivity analysis using G*Power 3.1.9.2, our final sample of 128 participants and $\alpha = .05$ allows us to achieve 80% power to detect effects of $\eta_p^2 = .072$ or larger for within-and-between factor interactions in a repeated measures ANOVA with two within (time) and three between (condition) factors (for more details, see the [online supplemental materials](#)). The ethnic distribution in this sample was: 47% European American, 1% African American, 11% US Latino, 26% Asian American, 2% Native American, and 12% other.

Measures and Procedure

Participants were invited to participate in a study of emotional experience. Before visiting the lab, they completed an online survey in which they reported what the central hassle is in their personal lives and its intensity. Within five days of completing this presurvey, participants completed the lab session. Upon arrival at the lab, participants were seated in individual testing cubicles

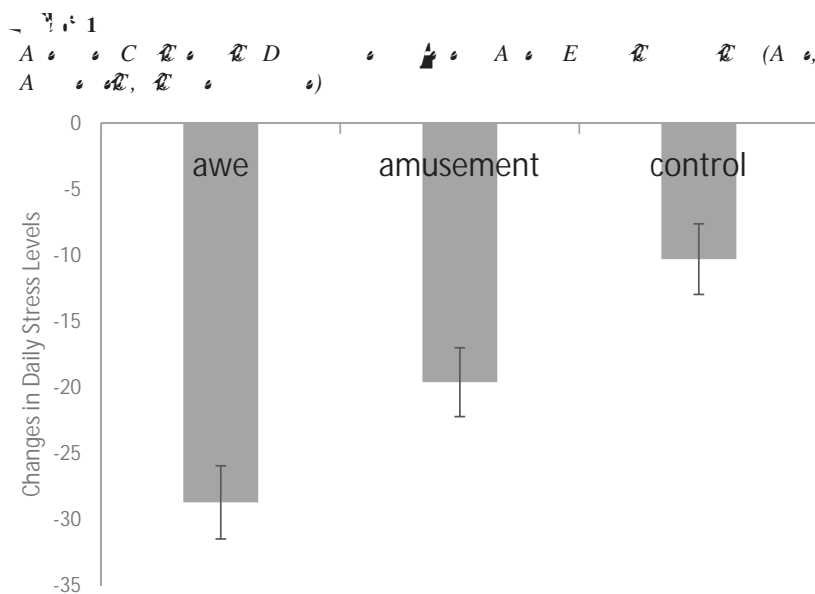


Figure 1. Error bars represent ± 1 SE (Study 3).

(amusement and pride) were not significant (coefficients for control emotions are presented in the [online supplemental materials](#)).

Awe and Appraisals of Daily Stressors

Of the participants in the awe condition, 50% referred to vastness vis-à-vis the self-appraisals when talking about their daily stressors, which is more than five times the frequency with which appraised vastness was mentioned in the amusement (9.75%) and neutral control (9.09%) conditions, $\chi^2 = 26.29$, $p < .001$. Furthermore, whereas 19.04% of participants in the awe condition endorsed an insignificant sense of the self when talking about their daily stressors, no participant in the amusement or neutral condition referred to this appraisal theme, $\chi^2 = 17.28$, $p < .001$. Consistent with our prediction, participants in the awe condition more frequently referred to both small self-appraisals—vastness vis-à-vis the self and an insignificant sense of the self—in their narratives of stress compared with participants in the amusement or neutral conditions.⁴

In Study 3, then, after watching an awe-eliciting video, participants reported that they were significantly less stressed and bothered by a central daily hassle in their lives—issues at school, or with their family, or the challenges of everyday life. Compared with their counterparts in the amusement and neutral states, participants in the awe condition reported the greatest reduction of daily stress levels after the emotion manipulation (Hypothesis 1). Moreover, self-reports of feelings of awe, but not the other emotions, were significantly correlated with reductions in daily stress levels (Hypothesis 2). Finally, we found that the experience of awe was accompanied by increased appraisals of vastness vis-à-vis the self and an insignificant sense of the self. These descriptive data provide evidence consistent with Hypothesis 3, and in Studies 5 and 6 examine whether awe-related shifts in appraisals of the small self help explain how awe reduces daily stress.

A critical limitation of Study 3 is our approach to ongoing stress. Namely, participants recalled an ongoing hassle in the past

5 days. This means that participants could have been thinking about a hassle from a few days ago, and our results more informative of how awe biases appraisals of recent but past stress rather than ongoing stress (for additional analyses with ongoing stressors only, see the [online supplemental materials](#)). Given this, in Study 4 we turn to in the moment, physiological reactions to talking about daily stress.



In Study 4 we experimentally manipulated the experience of awe in the lab and asked participants to think and talk about their daily stress afterward while stress-related physiology was recorded. We predicted that participants in the awe condition, compared with those in the neutral condition, would exhibit lower levels of skin conductance (SCL), a measurement of changes in eccrine (sweat) glands and a reliable marker of sympathetic arousal during a stress response (Ax, 1953; Dawson et al., 2000; Gross, 1998; Levenson, 2003; Mendes et al., 2007; Stemmler et al., 2001). We also hypothesized that heart rate (HR) would show a similar pattern of lower reactivity in the awe condition compared with the neutral condition. Despite HR receiving inputs from both the sympathetic and parasympathetic nervous system (Berntson et al., 1997; Shaffer et al., 2014), it is another index of sympathetic arousal during stress (Brosschot & Thayer, 2003; Kudielka et al., 2004; Schubert et al., 2009; Sommerfeldt et al., 2019; Wager et

⁴ We also conducted mediation models to test the indirect effect of the two small self-appraisals on the main effect of awe condition on post-manipulation daily stress levels after accounting for pre-manipulation daily stress levels via residualizing the scores (for details, see the [supplementary materials](#)). Consistent with Hypothesis 3, the indirect effect of the sense of vastness vis-à-vis the self-appraisal was significant; while the indirect effect of a sense of insignificant sense of the self was not significant (for detailed statistics, see the [supplementary materials](#)).

al., 2009). Finally, we also measured participants' self-reported stress levels at the end of the study. We predicted that these levels would be lower in the awe condition compared with the neutral condition.

Participants

One hundred seventy-five college students at a major public west coast university in the United States participated in exchange for 1.5 course credit. This sample was driven by aiming to collect as much data as possible within the time period covering summer session and the following fall semester. We only analyzed results after all participants completed the study. Among all participants, four encountered procedural or tech-related problems (e.g., building construction interfering with study), three reported health conditions (e.g., heart condition or coughing symptoms), five participants' data were missing, and eight participants failed to follow instructions. The data were not merged or analyzed until after data collection ended. The final sample size consisted of 155 participants (49 male; $M_{age} = 20.61$, $SD = 2.48$). Using the sensitivity curve produced by simulations from R package *simr* 1.5 (Green & MacLeod, 2016), we estimate that we achieved 80% power to detect effects of approximately a $d = 1.70$ or more extreme for SCL and $d = 2.65$ for HR (for more details, see the [online supplemental materials](#)). The ethnic distribution of this sample was: 18.1% European American, 58.1% Asian or Asian American, 1.9% African American, 14.8% Latino/Latina, .6% Native American, and 6.5% mixed race.

Procedure

Participants were invited to participate in a study of emotional experience. Before visiting the lab, they completed an online presurvey in which they reported one personal central hassle and rated the intensity of this hassle. Within 24 to 48 hr of completing this online survey, participants completed the lab session. Upon arrival at the lab, participants were seated in front of a computer and a large 44-in. screen TV. The experimenter applied sensors to participants' skin in Lead II configuration to gather Electrocardiogram (ECG) signals, a belt was placed on the torso to assess respiration, and two additional sensors were placed on the palmar surface of the participant's nondominant hand to measure skin conductance. We used the MP150 hardware and Acqknowledge 4.4 software (Biopac Systems, Inc.) for data acquisition and subsequently analyzed the data in one-Minute epochs using Mindware Technologies, LTD's ECG and EDA analysis programs. Participants were comfortably seated in a chair with arm rests and were instructed to maintain a similar posture throughout and minimize movement.

During the lab session, participants completed brief self-report measures of their general mood using a secure online survey program. Then each participant was given five minutes to rest, which allowed for habituation to wearing the physiological sensors. Participants then watched a five-Minute awe-inducing video or a neutral video (from Study 3). After watching the video, participants talked about the central daily hassle that they had written about in the presurvey. Each participant was given three minutes to prepare for the talk and then three minutes to talk about their stress in front

of a camera. The experimenter left the room after starting the video and remained outside during the task. Participants were informed that the experimenter could still be contacted over intercom. After completing the stress talk, participants completed a brief online survey in which they reported the level of stress they felt from their central hassle and the degree to which they felt different emotions. After completion of the survey, participants were instructed to rest for five minutes before the end of this study.

Measures

Stress. As in Study 3, in the presurvey participants were first asked to recall a central hassle that was most bothering them in the past two weeks and rated their level of stress on a scale from 1 (Not at all) to 100 (Very much). After talking about this daily stress in the lab, they again reported the intensity of their stress toward the hassle.

Heart Rate Variability (HRV). Data were acquired using the GSR100C amplifier connected to the BIOPAC MP150 system at a rate of 2000 Hz in a noise-free environment. GSR was recorded by placing a pair of silver-silver chloride electrodes with .05 M sodium chloride gel on the thenar and hypothenar eminence of the nondominant palm. SCL was assessed after the experiment using the EDA analysis software from Mindware Technologies.

ECG. ECG recordings were sampled at 2000 Hz. ECG signals were converted to beats per Minute to obtain HR. Mindware Technologies, LTD's HRV software was used for data cleaning. The software automatically identifies R-spikes using a proprietary algorithm. The resulting data are presented for visual inspection and manual R-spike deletion or insertion using the software's tools. As a rule for data cleaning, we chose only to insert R-spikes using the auto-midbeat function when one R-spike was missing; otherwise we only kept the largest, continuous segment of any one-Minute epoch. We set a threshold such that any 1-min segment must have at least 30 sec of continuous beat-to-beat data to qualify for inclusion.

Emotions. Participants reported the degree to which they felt each of nine emotions during the experience they wrote about (happiness, awe, joy, amusement, sadness, fear, anger, gratitude, pride) on a 7-point scale (1 = Not at all; 7 = Very much).

Data Coding and Analysis

Following the procedures of Study 3, video recordings of participants' discussion of their daily stress were coded by rotating teams of two coders (two research assistants were native Chinese speakers and two research assistants were native English speakers⁵) for small self-appraisals—the vastness vis-à-vis the self (intercoder reliability: Cohen's $\kappa = .60$) and the insignificant sense of the self (intercoder reliability: Cohen's $\kappa = .56$). Any disagreements between coders were settled by a third coder. All coders were naïve to the hypotheses.

⁵ Of the 155 participants, there were 22 participants who gave their stress speech in Chinese. All these videos were coded by research assistants who are native Chinese speakers. In addition, seven participants' video were not recorded or were delivered in other languages, yielding a total sample of 148 coded videos.

Results and Discussion

Awe and Decreased SCL

We first examined participants' average SCL reactivity for each phase—video, preparation, stress talk, and recovery (for full model on minute-by-minute data, see the [online supplemental materials](#)). To account for the repeated observations nested within subjects with a random intercept model (Aguinis et al., 2013; Brauer & Curtin, 2018; Pinheiro & Bates, 2000), we used a linear mixed effects regression with condition (awe vs. control), phase (video, preparation, stress talk, and the recovery), and their interactions entered as fixed effects. In our model, we also included each participant's baseline skin conductance levels (defined as the last Minute of the baseline period) as a covariate (Cacioppo et al., 2007; $\beta = 8.91$; $D = 7.19$). These analyses were conducted using the lmer test package in the statistical program R; degrees of freedom and p values were calculated using the Satterthwaite method (Bates et al., 2015; Kuznetsova et al., 2017). For reported β , we scored continuous variables across all observations.

Results revealed that the main effect of phase was significant, $F(3, 432.24) = 147.42$, $p < .01$. The main effect of condition was not significant, $F(1, 147.83) = 3.64$, $p = .06$, but, as expected, the interaction between phase and condition was significant, $F(3, 432.24) = 8.84$, $p < .01$. Following these results, we examined the estimates of the within-phase differences by condition from the multilevel model (see the [online supplemental materials](#) for more details). These follow-up results revealed that when participants were watching the video, the conditions did not differ ($\beta = .76$, 95% CI [-.42, 1.93], $(287.76) = -1.25$, $p = .21$, false discovery rate (FDR; Benjamini & Hochberg, 1995^b) adjusted $p = .21$, $\beta_{\text{dif}} = .10$). However, clear differences emerged after the manipulation. Compared with their counterparts in the control condition, participants in the awe condition exhibited significantly lower SCL reactivity when thinking about their daily stressors (preparation phase), $\beta = -1.46$, 95% CI [-2.63, -.28], $(287.91) = -2.41$, $p = .02$, FDR adjusted $p = .03$, $\beta_{\text{dif}} = -.19$; when talking about their daily stressors (stress talk phase), $\beta = -1.72$, 95% CI [-2.89, -.54], $(287.80) = -2.85$, $p = .005$, FDR adjusted $p = .02$, $\beta_{\text{dif}} = -.22$; and even during the recovery phase after the stress talk, $\beta = -1.42$, 95% CI [-2.60, -.23], $(290.91) = -2.34$, $p = .02$, FDR adjusted $p = .03$, $\beta_{\text{dif}} = -.18$ (see [Figure 2](#)).

Furthermore, supporting Hypothesis 2 and replicating the results from Studies 2 and 3, across conditions, participants' self-reports of awe were significantly negatively correlated with their SCL reactivity in response to daily stress (an aggregated mean of SCL reactivities across preparation and stress talk phrase), $\beta = -.20$, $p = .01$. More importantly, a regression analysis (as in Study 3) revealed that even after controlling for all the other emotions, there was still a trend indicating that the intensity of awe negatively predicts SCL among participants from both conditions, $B = -.23$, $E = .11$, $p = .04$ (coefficients for control emotions are presented in the [online supplemental materials](#)).

Awe and Decreased HR

A similar linear mixed effects regression analysis was conducted with heart rate as the dependent variable.⁷ Results revealed that the main effect of phase was significant, $F(3, 445.94) = 203.30$, $p < .01$. The main effect of condition was also significant, $F(1, 149.61) = 7.03$, $p = .01$, and the interaction between phase and condition was significant, $F(3, 445.95) = 3.94$, $p = .01$. Following these results, we examined the within-phase differences by condition based on the multilevel model. Results revealed that

after watching the video, compared with those in the control condition, awe condition participants' HR was significantly lower when thinking about their daily stress (preparation phase), $\beta = -2.57$, 95% CI [-4.40, -.73], $(406.56) = -2.72$, $p = .01$, FDR adjusted $p = .01$, $\beta_{\text{dif}} = -.21$; when talking about their daily stress (stress talk phase), $\beta = -3.56$, 95% CI [-5.40, -1.72], $(408.59) = -3.77$, $p < .01$, FDR adjusted $p < .01$, $\beta_{\text{dif}} = -.29$. Importantly, participants from the two conditions were observed with similar HR activities when they were watching the video, $\beta = -.72$, 95% CI [-2.55, 1.12], $(408.44) = -.76$, $p = .56$, FDR adjusted $p = .03$, $\beta_{\text{dif}} = -.06$; as well as during the recovery phase after the stress talk, $\beta = -.55$, 95% CI [-2.39, 1.30], $(410.51) = -.58$, $p = .56$, FDR adjusted $p = .56$, $\beta_{\text{dif}} = -.04$ (see [Figure 3](#)).⁸

Awe and Small Self-Appraisals

Converging with findings from Study 3, 20.27% participants in the awe condition endorsed a vastness vis-à-vis the self-appraisal when talking about their daily stressors after watching the video. This proportion is more than two times than those in the neutral (8.22%) conditions, $\chi^2 = 4.49$, $p = .03$. Furthermore, whereas 17.57% participants in the awe condition and 12.33% participants in the control condition referred to a diminished sense of the self when talking about their daily stressors, the contrast did not reach a conventional threshold for statistical significance, $\chi^2 = .80$, $p = .37$. These findings suggest that participants in the awe condition more frequently refer to small self-appraisals, vastness vis-à-vis the self especially, in their narratives of stress compared with participants in the neutral conditions.

Awe and Self-Reported Daily Stress

Finally, we examined participants' self-reported levels of daily stress. A 2 (emotion condition: awe vs. neutral) \times 2 (time: pre or post) assessment of daily stress levels) repeated measures ANOVA revealed that the interaction between condition and time was not significant, $F(1, 153) = .04$, $p = .95$.

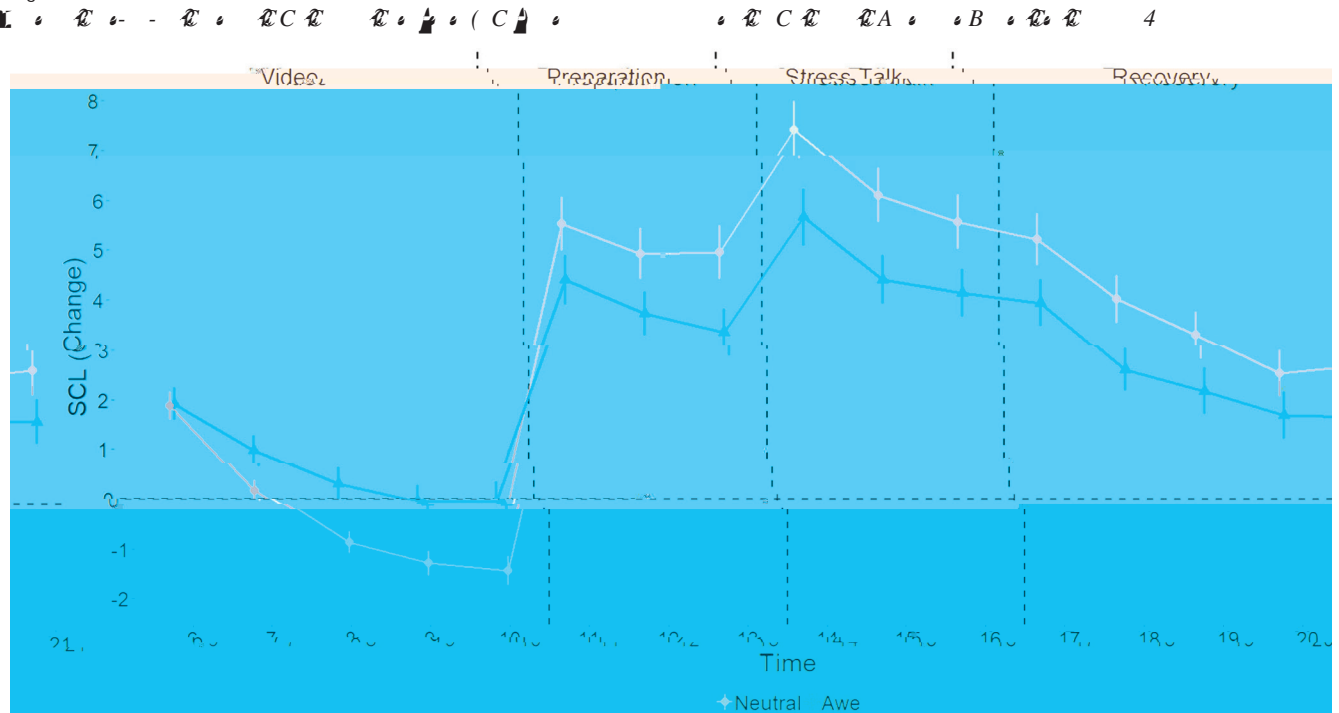
In sum, after watching an awe-eliciting video, participants exhibited lower SCL and HR compared with those in the control condition when thinking and talking about their daily stressors. Moreover, consistent with our second hypothesis, as participants reported more intense experiences of awe, they showed lower sympathetic arousal (SCL in this case). In addition, consistent with results from Study 3, awe altered individuals' appraisals of daily hassles: compared with participants in the neutral condition, participants in the awe condition

⁶ Mindful of the multiple comparisons and its potential likelihood of enhancing TYPE I error, we used the false discovery rate method to adjust our p values for our four comparisons (e.g., Benjamini & Hochberg, 1995).

⁷ Our data showed right-skew (skew = 1.86) in the first-level (i.e., measurement occasion) residuals of the model. The raw data approached excessive right-skew as well (skew = 0.94). In light of this concern, we also log-transformed heart rate and ran all the analyses again. The model with log-transformed heart rate showed acceptable right-skew (skew = 0.74), as did the log transformed raw data (skew = 0.10). The results are similar to the untransformed model. All the statistics can be found in the [supplementary materials](#).

⁸ We conducted a similar correlation analysis on subjective awe experience and HR. The correlation was not significant. For detailed analyses and explanations, see the [online supplemental materials](#).

Figure 2



4. SCL change scores were calculated by subtracting the last minute of the participants' baseline SCL from their current SCL. Error bars represent $\pm 1 E$ (Study 4). See the online article for the color version of this figure.

referred more frequently to vastness vis-à-vis the self, especially when talking about their daily stressor.

Finally, whereas participants in the awe condition exhibited significantly lower sympathetic arousal (SCL in this case) during the recovery phase compared with their counterparts in the neutral condition, their self-reported daily stress levels were not significantly different than controls. This result clearly departs from our hypothesis and the findings thus far, and may have been due to the fact that participants reported on their stress after an emotional disclosure, an intervention that has been shown to decrease subjective stressful reactions but not sympathetic arousal through enhanced emotion understanding (Clark, 1993; Cordova et al., 2001; Greenberg et al., 1996; Kennedy-Moore & Watson, 2001; Lepore et al., 2000, 2004; Zech & Rimé, 2005).

Study 5: Awe, the Small Self, and Decreased Daily Stress Levels

Thus far, we have seen that trait and state awe are associated with decreased levels of daily stress. In Study 5, we induced awe by asking participants to write about a prototypical experience of the emotion (e.g., Griskevicius et al., 2010). These data allowed us to test our hypothesis about awe and decreased daily stress in the moment through a greater variety of elicitors of awe than just nature, which has been a focus in the field thus far (e.g., Anderson et al., 2018). To further ascertain awe's unique impact upon daily stress, we contrasted the effect of awe with joy and pride. Joy, like awe, is a positive emotion, often accompanied by reduced self-related concerns, but it is not triggered by vastness and is often

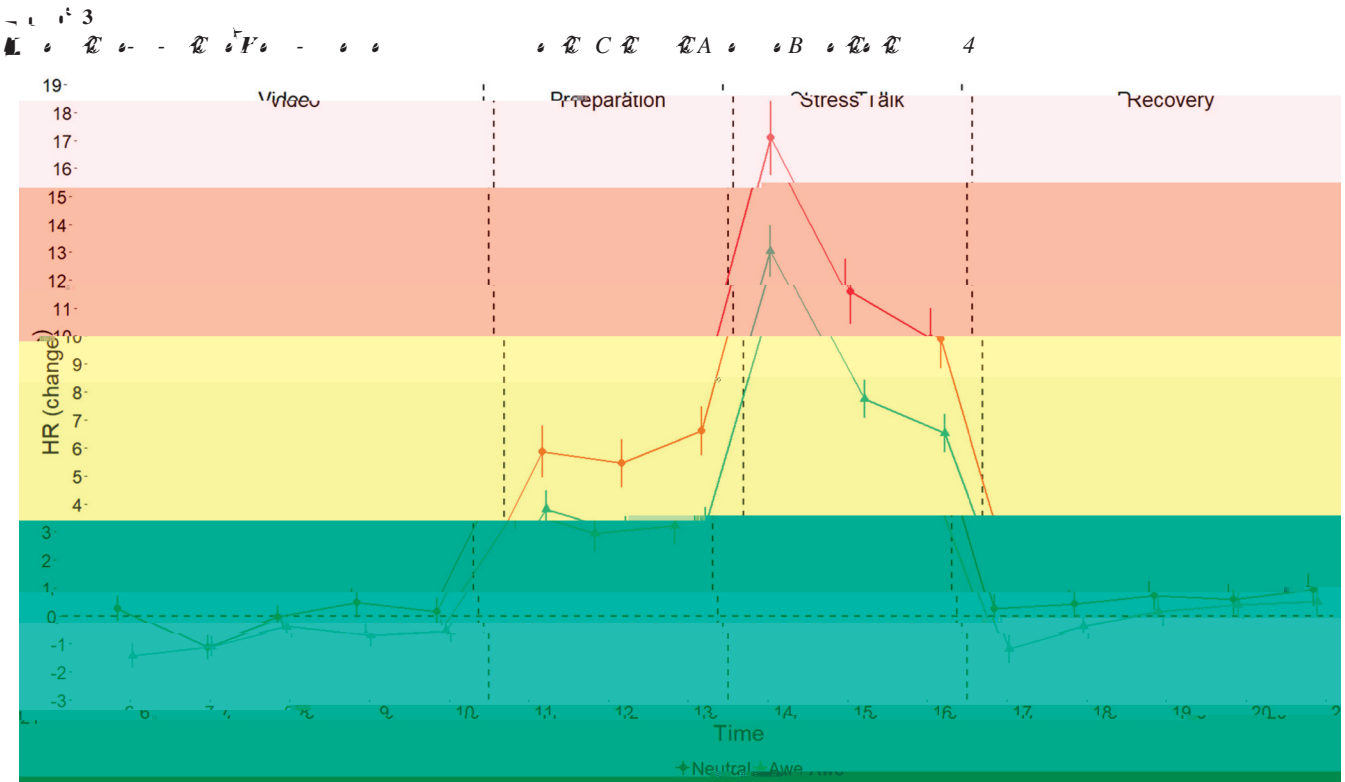
contrasted with awe (Bai et al., 2017; Piff et al., 2015; Shiota et al., 2007; Van Cappellen & Saroglou, 2012). Pride is also a positive emotion, but in contrast to awe, promotes self-focused attention (Bai et al., 2017; Tracy & Robins, 2004).

Finally, guided by the appraisal-tendency approach, we incorporated a measure that assessed both facets of the small self construct—vastness vis-à-vis the self and an insignificant sense of the self (Bai et al., 2017; Piff et al., 2015; Stellar et al., 2018)—and examined the role of each in driving the link between awe and reduced stress. Based on studies of stress interventions (e.g., Chiesa & Serretti, 2009; Grossman et al., 2004), we tested two competing predictions about mediation. Whereas the literature on self-distancing would suggest that appraisals of vastness vis-à-vis the self reduce stress (Ayduk & Kross, 2010; Kross & Ayduk, 2011), studies of narcissism find that an insignificant sense of the self might drive the stress-reducing effects of awe (e.g., Cheng et al., 2013). Our analyses, therefore, ascertain whether the reduction of daily stresses following from experiences of awe is produced by appraisals of vastness vis-à-vis the self or an insignificant sense of the self.

Method

Participants

Two hundred twenty-one college students at a major public west coast university in the United States participated in exchange for one course credit. This sample was determined by aiming to collect as much data as possible before the end of school year. We only analyzed results after all participants completed the study. Sixteen participants who failed more than one attention check (out



• Beats-per-minute (BPM) change scores were calculated by subtracting the last minute of the participants' baseline BPM from their current BPM. Error bars represent ± 1 SE (Study 4). See the online article for the color version of this figure.

of five) were excluded. The final sample consisted of 205 students (64 male, $M = 21.17$, $SD = 3.16$). According to a post hoc power sensitivity analysis in G*Power 3.1.9.2, our final sample of 205 participants and $\alpha = .05$ achieves 80% power to detect effects of $\eta_p^2 = .046$ or larger for the within-between interaction in a repeated measures ANOVA with two within (time) and three between (condition) factors (for more details, see the [online supplemental materials](#)). The ethnic distribution of this sample was as follows: 34% European American, 41% Asian or Asian American, 2% African American, 10% Latino/Latina, 3% Native American, and 10% were mixed race.

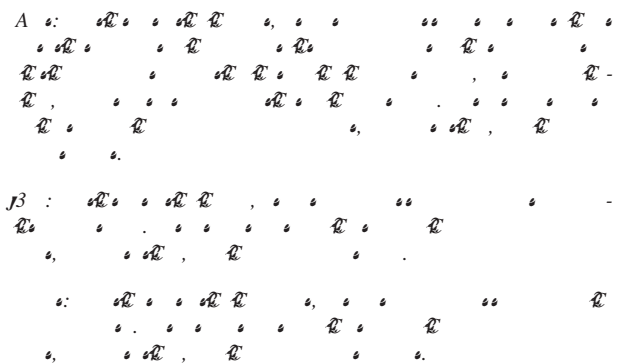
Measures and Procedure

After giving consent, participants completed measures of baseline daily stress levels, and then recalled and wrote about a personal experience of awe, joy, or pride. They then reported their daily stress levels and their appraisals of the self.

Stress. As in Study 3, participants recalled a central hassle that occurred in the past month and rated their level of stress on a scale from 1 (Not at all) to 10 (Very much).

Small self. Participants were randomly assigned to describe an experience that elicited awe, joy, or pride. Participants were provided with the definition of the target emotion (see below) and an emoticon (see the [Appendix](#)) showing the prototypical facial expression of the target emotion (Bai et al., 2017).

Following Strack et al. (1985), the instructions emphasized focusing on concrete, vivid, experiential aspects of the target emotion.



Small self. Participants' small self, the anticipated mediator between awe and reduced daily stress levels, was measured with a six-item scale derived from past studies (Bai et al., 2017; Piff et al., 2015; Stellar et al., 2018). To measure the sense of the sense of vastness vis-à-vis the self, participants indicated their agreement with three items from 1 (Not at all) to 7 (Very much). Items included: "I feel the presence of something greater than myself," "I feel the greatness of something," "I feel like I am in the presence of something grand." To measure the facet of an insignificant sense of the self, participants indicated their agreement with three items from 1 (Not at all) to 7 (Very much).

Items included: “I feel relatively small,” “I feel insignificant,” “I feel my personal needs are not important.”

Participants reported the degree to which they felt each of nine emotions during the experience they wrote about (happiness, awe, amusement, sadness, fear, anger, gratitude, pride) on a 7-point scale (1 = *not at all*; 7 = *very much*).

Data Coding

Two native English-speaking research assistants from the United States were trained to code each entry as elicited by something in nature or not (interrater reliability: Cohen’s $\kappa = .97$). A third native coder read all the codes and settled discrepancies between the two coders. All three coders were naïve to the hypotheses. In total, 36 of 66 awe narratives were coded as elicited by something in nature.

Awe Experience and Decreased Daily Stress Levels

To examine our prediction regarding awe’s impact on daily stress levels, we first examined participants’ reported levels of daily stress in response to the general hassle items within a 3 (emotion condition: awe vs. joy vs. pride) \times 2 (time: pre or post assessment of daily stress levels) repeated measures ANOVA. Results yielded a significant interaction between emotion condition and time, $F(2, 202) = 3.39$, $p = .036$, $\eta_p^2 = .03$ (see Figure 4). Simple effects analyses revealed that people in all three conditions were less bothered by their central daily hassle after the recall task, but this effect was much larger among participants in the awe condition, $F(1, 202) = 97.47$, $p < .001$, $\eta_p^2 = .33$, compared with those in the joy condition, $F(1, 202) = 56.09$, $p < .001$, $\eta_p^2 = .22$, or in the pride condition, $F(1, 202) = 39.80$, $p < .001$, $\eta_p^2 = .16$.

To explore the impact of emotion condition on changes in daily stress levels (a difference score calculated by subtracting their daily stress rating provided before emotion priming from their daily stress rating after writing their emotional experience), we conducted pairwise comparisons between the three conditions and present the false discovery rate (FDR) corrected p-values. The pairwise comparisons reveal that individuals in the awe condition ($M = -2.56$, $SE = .28$) demonstrated less stress than those in the joy ($M = -1.62$, $SE = .15$) condition ($F(1, 202) = 3.37$, $p = .01$, FDR adjusted $p = .03$). In addition, whereas individuals in the awe condition reported lower stress than those in the joy ($M = -1.94$, $SE = .20$) condition, the comparison were not significantly different ($F(1, 202) = .37$, $p = .09$, FDR adjusted $p = .14$). Finally, the comparison between the joy and pride conditions were also not significantly different ($F(1, 202) = .37$, $p = .39$, FDR adjusted $p = .39$). The overall results indicate there are differences, and the corrected p-values suggest the trend is awe being different than pride and joy, but given the trade-offs between Type I and Type II error when correcting p-values in multiple comparisons, a larger sample size would be needed to compare all three conditions simultaneously.

To rule out the possibility that awe’s effect on daily stress levels was only observed in response to nature elicitors, we compared levels of stress of participants who recalled a nature-related awe experience with those who recalled other elicitors of awe. Neither the interaction between elicitor and time significant, $F(1, 64) =$

$.05$, $p = .83$, nor the main effect of elicitor, $F(1, 64) = 3.08$, $p = .09$, were significant.

Supporting Hypothesis 2 and replicating the results from Studies 3 and 4, participants’ self-reports of awe were significantly correlated across conditions with decreases in daily stress levels, $r = -.18$, $p = .01$. Importantly, as in Studies 3 and 4, regression analyses across participants from all three conditions revealed that after controlling for other positive and negative emotions (happiness, amusement, sadness, fear, anger, gratitude, pride), awe was the only emotion that was significantly associated with changes in daily stress levels, $\beta = -.33$, $SE = .11$, $p = .002$ (coefficients for control emotions are presented in the [online supplemental materials](#)).

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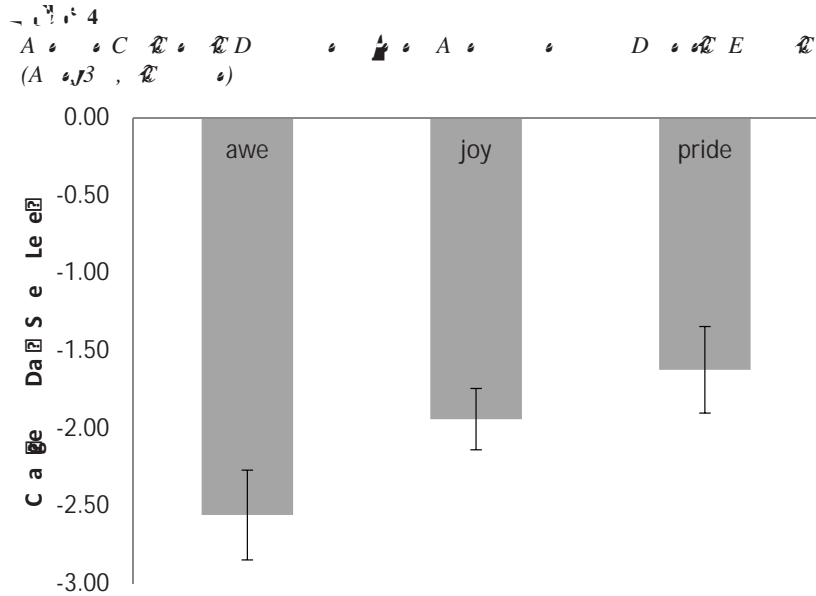


Figure 4. Error bars represent ± 1 SE (Study 5).

proposed mediating model using a bootstrapping procedure recommended by Preacher and Hayes (2004; 2008). Analyses were conducted with the PROCESS macro for SPSS (Hayes, 2013) using 5,000 bootstrap samples. This technique yielded a significant indirect path with a 95% bias-corrected confidence interval that did not include zero [-.13 to -.002], providing support for Hypothesis 3 that the sense of vastness vis-à-vis the self helps to explain awe's impact on decreased daily stress levels. We then treated the same model with the insignificant sense of the self facet set as the mediator in the model. This time, bootstrapping results revealed that the indirect effect was not significant (95% CI [-.02, .11]).

The results of Study 5 extend our understanding of the relation between experiencing awe and altered perspective of daily stresses in the moment. First, awe's calming effect on daily stress is not limited to immersion in nature, the source of awe in Studies 3 and 4. Moreover, consistent with Hypothesis 3, perceived vastness vis-à-vis the self emerged as the significant statistical driver of the

effects of awe on reduced hassle-related stress. Finally, Study 5 found that compared with two other positive emotions, joy and pride, the experience of awe more significantly mitigated negative appraisals of daily stressors in the moment. One limitation for Study 5 is that the manipulation includes verbal description of physical or social vastness, which might enhance participants' endorsement of vastness vis-à-vis the self-appraisal in their written response. In light of this concern, in our final study, we manipulated awe by immersing participants to an in-vivo situation and measured their stress and life satisfaction levels.



In our final study, we studied the relationship between awe and stress in a naturalistic setting. We predicted that: (a) when immersed in the experience of awe in a natural setting, individuals will report less stress associated with their daily hassles

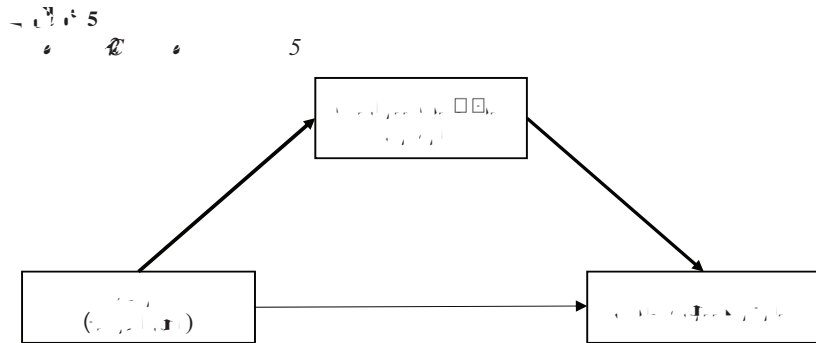


Figure 5. Conceptual model for Study 5.

(Hypothesis 1); (b) the intensity of the subjective experience of awe would significantly correlate with their daily stress levels (Hypothesis 2); and (c) that awe's attenuation of daily stress would be explained by a sense of vastness vis-à-vis the self (Hypothesis 3). Finally, guided by existing findings on both awe and daily stresses' association with well-being (e.g., Lazarus, 1984; Rudd et al., 2012; Stellar et al., 2015), we predicted that the positive effect of awe on enhanced life satisfaction can be explained, at least partially, by its impact on reduced daily stress levels (Hypothesis 4).

Participants

Eighty-six college students at a major public west coast university in the United States participated in exchange for one course credit. This sample was determined primarily by aiming to collect as much data as possible within a summer session. We only analyzed results after all participants completed the study. According to a post hoc power sensitivity analysis in G*Power 3.1.9.2, our final sample of 86 participants and $\alpha = .05$ achieves 80% power to detect effects of $\eta_p^2 = .085$ or larger for a repeated measures ANOVA interaction of two within (time) and two between (condition) factors (for more details, see the [online supplemental materials](#)). All our participants were college students (25 male; $M = 20.64$ yrs, $SD = 2.42$ yrs) at a major public west coast university who participated in the experiment in exchange for course credit. The ethnic distribution of the sample was as follows: 14% were European American, 1% were African American, 54% were Asian American, 20% were Latin American, and 12% were other ethnicities.

Measures and Procedure

Participants were invited to participate in a study of emotional experience. Upon arriving at the lab, participants filled out measures of daily stress levels and life satisfaction. Afterward, participants walked with the experimenter to the Campanile, a clock tower at the center of the UC Berkeley campus with a height of 200 feet, where they were told to finish another set of questionnaires. Mindful of the potential confounding biases introduced by the elevated height, we brought all participants to the top level of the tower and then randomly assigned them to one of two conditions. In the awe condition, participants looked out and enjoyed the expansive view of the Bay, San Francisco, and the Golden Gate Bridge. In the control condition, participants faced the inside wall of the tower and were not allowed to look out of the tower until they finished answering all the questions (see [Figure 6](#)). Participants in both conditions were asked to report their emotional experiences, sense of perceived vastness vis-à-vis the self, daily stress level, as well as life satisfaction while standing at the top level of the tower. Upon finishing, all participants were allowed to tour around the tower and were then brought across campus back to the lab room, debriefed, thanked, and released.

On a 7-point scale from 1 (not at all) to 7 (very much), participants indicated the extent to which they experienced amusement, happiness, awe, fear, and anger while

viewing either the interior of the tower or the bay from the top of the tower.

Participants reported upon vastness vis-à-vis of the self subscale with the same three items from Study 5 ($\alpha = .82$, $M = 4.44$, $SD = 1.70$).⁹

Participants reported upon central hassle-related stress levels as used in Study 3 and the general hassle scale as used in Study 2.

Participants reported on their life satisfaction as measured with the Satisfaction with Life Scale (Diener et al., 1985). This scale contains five items that measure global life satisfaction judgments. Participants responded using a seven-point Likert scale ranging from 1 (not at all) to 7 (very much), indicating how much they agreed or disagreed with each item in the current moment ($\alpha = .89$, $M_{\text{before}} = 4.79$, $SD_{\text{before}} = 1.21$; $\alpha = .89$, $M_{\text{after}} = 4.93$, $SD_{\text{after}} = 1.33$).

Awe Experienced at the Top Level of the Tower

An independent samples *t* test showed that compared with the participants who faced the wall in the interior of the Campanile (control condition; $M = 2.73$, $SD = 1.62$), participants who looked out of the tower (awe condition; $M = 5.26$, $SD = 1.48$) reported stronger feelings of awe ($t(84) = -7.56$, $p < .001$, $d = 1.84$).

Awe Decreases Daily Stress Levels

To examine our prediction regarding awe's impact on daily stress levels, we first examined participants' reported levels of daily stress in response to the general hassle items within a 2 (emotion condition: awe vs. control) \times 2 (time: pre- or postassessment of general hassle-related stress) repeated measures ANOVA. Results yielded a significant interaction between emotion condition and time, $F(1, 84) = 13.21$, $p < .001$, $\eta_p^2 = .14$. Simple effect analyses revealed that people in both conditions reported lower levels of daily stress in response to the general hassle items after walking to the top level of the tower, which fits with what is known about the benefits of being outdoors (e.g., Hartig et al., 2003; Kohlleppel et al., 2002; Mayer et al., 2009; Mitchell & Popham, 2008; Nisbett & Zelenski, 2011). This effect, however, was much larger among participants who were assigned to the awe condition ($M_{\text{dif}} = -33.90$, $SD_{\text{dif}} = 4.59$), $F(1, 84) = 73.40$, $p < .001$, $\eta_p^2 = .47$, compared with those individuals who were facing the inner side of the tower ($M_{\text{dif}} = -13.80$, $SD_{\text{dif}} = 3.16$), $F(1, 84) = 12.73$, $p = .001$, $\eta_p^2 = .13$.

Next, we examined participants' reported stress in response to their personal central daily hassles within a similar 2 (emotion condition: awe vs. control) \times 2 (time: pre- or postassessment of central hassle-related stress) repeated measures ANOVA. Again, we discovered a significant interaction between emotion condition

⁹ Following the same procedures used in Studies 3 and 4, participants' discussion of their daily stress when they were standing on the top of the tower were coded by teams of two coders for small self-appraisals—the vastness vis-à-vis the self and an insignificant sense of the self. Consistent with findings from Studies 3 and 4, we found that the ones in the awe condition applied more appraisals of vastness vis-à-vis the self when describing their daily stress. For detailed statistical analyses, see the [online supplemental materials](#).

and time, $F(1, 84) = 18.99$, $p < .001$, $\eta_p^2 = .18$. Simple effects analyses revealed that although people in both conditions were less bothered by their central daily hassle after walking to the top level of the tower, this effect was much larger among participants in the awe condition ($\beta_{\text{dif}} = -3.40$, $E = 2.18$), $F(1, 84) = 130.77$, $p < .001$, $\eta_p^2 = .61$, compared with the ones who were facing the inner side of the tower ($\beta_{\text{dif}} = -1.59$, $E_{\text{dif}} = 1.66$), $F(1, 84) = 29.91$, $p < .001$, $\eta_p^2 = .26$.

Awe Increases Life Satisfaction

To examine our predictions concerning awe and life satisfaction, we conducted a 2 (emotion condition: awe vs. control) \times 2 (time: pre- or postassessment) repeated measures ANOVA test with self-reported life satisfaction as the dependent variable. Consistent with our prediction, the interaction between emotion condition and time was significant, $F(1, 84) = 9.56$, $p = .003$, $\eta_p^2 = .10$. Simple effect analyses of this interaction revealed that, after viewing the awe-inducing scenery at the top level of the tower, participants' self-reported life satisfaction ($\beta = 5.07$, $E = .21$) was significantly higher than before ($\beta = 4.67$, $E = .19$), $F(1, 84) = 11.56$, $p = .001$, $\eta_p^2 = .12$. On the other hand, when viewing the inner side of the tower, participants' life satisfaction did not change from baseline, $F(1, 84) = .90$, $p = .35$.

Feelings of Awe and Changes in Daily Stress Levels

To test Hypothesis 2, we calculated each individual's daily stress level by standardizing the scores of general hassle-related stress level change (a difference score calculated by subtracting participants' baseline general hassle-related stress rating from their general hassle-related stress rating after getting to the top level of the tower) and central hassle-related stress level change (a difference score calculated by subtracting their baseline central hassle-related stress rating from their central hassle-related stress rating after getting to the top level of the tower from their central hassle-related stress rating before emotion priming) and averaged these two standard scores. Supporting Hypothesis 2, participants' self-reports of awe across conditions were significantly correlated with the changes of daily stress levels, $r = -.29$, $p = .006$.

Awe, the Small Self, Decreased Daily Stress Levels, and Increased Life Satisfaction

In our final analyses, we tested our mediation model on awe's effect on daily stress levels and its impact on increased life satisfaction in two ways. Figure 7 illustrates the mediational model and provides path coefficients. In the first model, we replicated our findings in Study 5, supporting the model that awe, through an elevated sense of vastness vis-à-vis the self, reduced daily stress levels. Following a similar bootstrapping procedure, using the SPSS PROCESS macro provided by Hayes (2013), we found a significant indirect effect of awe (in contrast to the control condition) on changes in daily stress levels through the sense of vastness vis-à-vis the self (95% CI [-.19, -.03]). The direct effect of awe on lowering daily stress levels reduces the effect (95% CI [-.47, -.15]) when the sense of vastness vis-à-vis the self was included in the model, in line with Hypothesis 3.

In a second set of analyses, we investigated the model in which awe, through decreased daily stress levels, leads to increased life satisfaction (Hypothesis 4). Following the same bootstrapping procedure, we discovered a significant indirect effect of awe (in contrast to the control condition) on life satisfaction change through decreased daily stress levels (95% CI [.03, .21]). The direct effect



Stress shapes both mental and physical health (e.g., Antonovsky, 1987; Folkman, 2013; Kanner et al., 1981). In the literature on stress, increasing attention has been paid to daily stresses—everyday hassles—that often predict mental and physical health in surprisingly powerful ways (e.g., DeLongis et al., 1982; Folkman & Lazarus, 1985; Kanner et al., 1981). In the present investigation, we focused on how awe reduces daily stresses.

The results of the current six studies lend direct support for this central hypothesis: experiencing awe is associated with immediately decreased levels of daily stress. This relationship was observed in the context of everyday life (Study 1), at the trait level (Study 2), after viewing awe-inducing video clips (Studies 3 and 4), when recalling a past experience of awe (Study 5), and in venturing outdoors and immersing oneself in an awe-inspiring setting (Study 6). Lending support to our second hypothesis, participants' reports of their experience of awe significantly correlated with reduced daily stress levels, even after controlling for other positive and negative emotional experiences (Studies 1–6). This finding is in line with studies showing that the experience of an emotion tracks emotion-specific influences upon cognition (Keltner & Horberg, 2015;

daily stress usually correlates with stress in response to major life events (Caspi et al., 1987; Kanner et al., 1981), many scholars of early stress intervention work conceptualized them as isomorphic and confounded them in measurement. Given evidence uncovering the unique causes and consequences of daily stress, we focused on daily stress and found that altered self-appraisals produced by experiences of awe can reduce the levels of stress felt toward daily events. It will be important for future research to test whether awe similarly attenuates the stress associated with major life events and conditions (e.g., death of a loved one, poverty, incarceration)—and why it may or may not work.

Our investigation also lends further credence to recent conceptual approaches that advocate the examination of distinct states within the broader family of positive emotions (Shiota et al., 2017). Although researchers have long been interested in differentiating negative emotions (e.g., anger, fear, and disgust), research on discrete positive emotions is more recent (e.g., Ekman, 1994; Fredrickson, 2001; Shiota et al., 2004). Our findings support earlier research on positive states generally predicting decreased levels of stress (e.g., Folkman & Moskowitz, 2000; Fredrickson, 2001). At the same time, by comparing awe to other positive emotions such as amusement (Study 2), joy (Studies 3 and 5), and pride (Study 5)—all of which are known to buffer stress and improve well-being (e.g., Fredrickson, 2001; Thorson et al., 1997)—our findings suggest that awe exerts unique influences upon daily stresses through introducing a sense of perceived vastness vis-à-vis the self. It will be important for future research to test other discrete positive emotions (e.g., contentment; Cordaro et al., 2016) and the mechanisms by which they mitigate stressful responses.

Finally, our findings advance the emerging science of awe, which has received increasing attention (e.g., Stellar et al., 2017). Past studies have focused on the influences of awe upon social—cognitive processes and behaviors, including a diminished sense of self (Bai et al., 2017), increased religious intentions (Van Cappellen & Saroglou, 2012), expanded time perception (Rudd et al., 2012), agency detection (Valdesolo & Graham, 2014), and increased prosocial behaviors (Piff et al., 2015). Our investigation is the first to explore systematically awe’s impact on mental health and well-being, providing evidence suggesting that beyond altering social cognitions, awe serves an important role in buffering individuals’ daily stress and improving overall well-being (see also Anderson et al., 2018).



Although we used a variety of methodological approaches to explore the link between awe and daily stresses, several limitations should be noted. We did not compare awe to other more prosocial positive emotions, such as gratitude and compassion, which may yield similar results as those obtained here given how they shift the individual’s attention away from the self.

Additional work should further elucidate

2004). For example, some studies have documented that veterans with posttraumatic stress disorder (PTSD) experience difficulties in daily striving and more easily experience stress on daily basis (e.g., Kashdan et al., 2010). Findings in the current study point to a potential remedy for vulnerable groups, such as veterans, who experience high stress from daily hassles, through developing treatments incorporating awe experiences.

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In the presence of something vast that transcends one's understanding of the current context, we are often in the state of awe. As this profound feeling may shift our attention away from focus only on the self toward the vastness vis-à-vis the self, the bothersome daily concerns seem to be less salient and daily stress becomes less intense, as Emerson long ago observed.

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Aguinis, H., Gottfredson, R. K., & Culpepper, S. A. (2013). Best-practice recommendations for estimating cross-level interaction effects using multilevel modeling. *Journal of Business Psychology*, 39(6), 1490–1528. <https://doi.org/10.1177/0149206313478188>

Anderson, C. L., Monroy, M., & Keltner, D. (2018). Awe in nature heals: Evidence from military veterans, at-risk youth, and college students. *Emotion*, 18(8), 1195–1202. <https://doi.org/10.1037/emo0000442>

Antonovsky, A. (1987). *Uncommon Sense: A Practical Approach to Resilience*. Jossey-Bass.

Ax, A. F. (1953). The physiological differentiation between fear and anger in humans. *Psychological Monographs*, 15(5), 433–442. <https://doi.org/10.1097/00006842-195309000-00007>

Ayduk, O., & Kross, E. (2008). Enhancing the pace of recovery: Self-distanced analysis of negative experiences reduces blood pressure reactivity. *Psychological Science*, 19(3), 229–231. <https://doi.org/10.1111/j.1467-9280.2008.02073.x>

Ayduk, O., & Kross, E. (2010). From a distance: Implications of spontaneous self-distancing for adaptive self-reflection. *Journal of Personality and Social Psychology*, 98(5), 809–829. <https://doi.org/10.1037/a0019205>

Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J. E., McNeil, G. D., Peng, K., & Keltner, D. (2017). Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. *Journal of Personality and Social Psychology*, 113(2), 185–209. <https://doi.org/10.1037/pspa0000087>

Bates, D., Machler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>

Baum, A., Garofalo, J. P., & Yali, A. N. N. (1999). Socioeconomic status and chronic stress: Does stress account for SES effects on health? *Health Psychology*, 18(6), 896–901. <https://doi.org/10.1111/j.1749-6632.1999.tb08111.x>

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Biometrika*, 82(1), 289–300.

Berntson, G. G., Bigger, J. T., Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik, M., Nagaraja, H. N., Porges, S. W., Saul, J. P., Stone, P. H., & van der Molen, M. W. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology*, 34(6), 623–648. <https://doi.org/10.1111/j.1469-8986.1997.tb02140.x>

Billings, A. G., & Moos, R. H. (1984). Coping, stress, and social resources among adults with unipolar depression. *Journal of Personality and Social Psychology*, 46(4), 877–891. <https://doi.org/10.1037/0022-3514.46.4.877>

Bodenmann, G., Meuwly, N., Bradbury, T. N., Gmelch, S., & Ledermann, T. (2010). Stress, anger, and verbal aggression in intimate relationships: Moderating effects of individual and dyadic coping. *Journal of Family Psychology*, 27(3), 408–424. <https://doi.org/10.1177/0265407510361616>

Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. *Annual Review of Psychology*, 54(1), 579–616. <https://doi.org/10.1146/annurev.psych.54.101601.145030>

Bower, J. E., Ganz, P. A., & Aziz, N. (2005). Altered cortisol response to psychologic stress in breast cancer survivors with persistent fatigue. *Psychosomatic Medicine*, 67(2), 277–280. <https://doi.org/10.1097/01.psy.0000155666.55034.c6>

Brauer, M., & Curtin, J. J. (2018). Linear mixed-effects models and the analysis of non-independent data: A unified framework to analyze categorical and continuous independent variables that vary within-subjects and/or within-items. *Journal of Experimental Psychology: Applied*, 23(3), 389–411. <https://doi.org/10.1037/met0000159>

Brosschot, J. F., & Thayer, J. F. (2003). Heart rate response is longer after negative emotions than after positive emotions. *Psychophysiology*, 50(3), 181–187. [https://doi.org/10.1016/S0167-8760\(03\)00146-6](https://doi.org/10.1016/S0167-8760(03)00146-6)

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, 84(4), 822–848. <https://doi.org/10.1037/0022-3514.84.4.822>

Brydon, L., Magid, K., & Steptoe, A. (2006). Platelets, coronary heart disease, and stress. *British Medical Journal*, 333(7522), 113–119. <https://doi.org/10.1016/j.bbi.2005.08.002>

Buss, A. H. (1980). *The Evolution of Human Intrasexual Competition*. Miller Freeman, Inc.

Byrne, D. G., & Whyte, H. M. (1980). Life events and myocardial infarction revisited: The role of measures of individual impact. *Psychosomatic Medicine*, 42(1), 1–10. <https://doi.org/10.1097/00006842-198001000-00001>

Cacioppo, J. T., & Tassinary, L. G., & Berntson, G. (Eds.). (2007). *The Heart of the Mind*. Cambridge University Press.

Campos, B., Shiota, M. N., Keltner, D., Gonzaga, G. C., & Goetz, J. L. (2013). What is shared, what is different? Core relational themes and expressive displays of eight positive emotions. *Journal of Personality and Social Psychology*, 104(1), 37–52. <https://doi.org/10.1080/02699931.2012.683852>

Caplan, R. D., & Jones, K. W. (1975). Effects of work load, role ambiguity, and type A personality on anxiety, depression, and heart rate. *Journal of Personality and Social Psychology*, 33(6), 713–719. <https://doi.org/10.1037/0021-9010.60.6.713>

Caspi, A., Bolger, N., & Eckenrode, J. (1987). Linking person and context in the daily stress process. *Journal of Personality and Social Psychology*, 52(1), 184–195. <https://doi.org/10.1037/0022-3514.52.1.184>

Cheng, J. T., Tracy, J. L., Foulsham, T., Kingstone, A., & Henrich, J. (2013). Two ways to the top: Evidence that dominance and prestige are distinct yet viable avenues to social rank and influence. *Journal of Personality and Social Psychology*, 104(1), 103–125. <https://doi.org/10.1037/a0030398>

Chiesa, A., & Serretti, A. (2009). Mindfulness-based stress reduction for stress management in healthy people: A review and meta-analysis. *Journal of Personality and Social Psychology*, 96(5), 593–600. <https://doi.org/10.1089/acm.2008.0495>

Clark, L. F. (1993). Stress and the cognitive-conversational benefits of social interaction. *Journal of Personality and Social Psychology*, 64(1), 25–55. <https://doi.org/10.1521/jscp.1993.12.1.25>

Cohen, S., & McKay, G. (1984). Social support, stress and the buffering hypothesis: A theoretical analysis. In A. Baum, J. E. Singer, & S. E. Taylor (Eds.), *Handbook of Psychology* (Vol. 4). Erlbaum.

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin*, 98(2), 310–357. <https://doi.org/10.1037/0033-2909.98.2.310>




- Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *JAMA*, 298(14), 1685–1687. <https://doi.org/10.1001/jama.298.14.1685>
- Cohen, S., Mermelstein, R., Kamarck, T., & Hoberman, H. M. (1985). Measuring the functional components of social support. *Journal of Personality and Social Psychology*, 48(1), 85–98. https://doi.org/10.1007/978-94-009-5115-0_5
- Contrada, R. J., Ashmore, R. D., Gary, M. L., Coups, E., Egeth, J. D., Sewell, A., Ewell, K., Goyal, T. M., & Chasse, V. (2000). Ethnicity-related sources of stress and their effects on well-being. *Cross-Cultural Research*, 34(4), 136–139. <https://doi.org/10.1111/1467-8721.00078>
- Cordaro, D. T., Brackett, M., Glass, L., & Anderson, C. L. (2016). Contentment: Perceived completeness across cultures and traditions. *Journal of Personality and Social Psychology*, 111(3), 221–235. <https://doi.org/10.1037/gpr0000082>
- Cordova, M. J., Cunningham, L. L., Carlson, C. R., & Andrykowski, M. A. (2001). Social constraints, cognitive processing, and adjustment to breast cancer. *Journal of Personality and Social Psychology*, 81(4), 706–711.

- Gruen, R. J., Folkman, S., & Lazarus, R. S. (1988). Centrality and individual differences in the meaning of daily hassles. *Journal of Personality and Social Psychology*, 56(4), 743–762. <https://doi.org/10.1111/j.1467-6494.1988.tb00475.x>
- Hancock, G. R., & Klockars, A. J. (1996). The quest for α : Developments in multiple comparison procedures in the quarter century since. *Psychological Bulletin*, 66(3), 269–306. <https://doi.org/10.1037/00346543066003269>
- Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Environment & Behavior*, 23(2), 109–123. [https://doi.org/10.1016/S0272-4944\(02\)00109-3](https://doi.org/10.1016/S0272-4944(02)00109-3)
- Hawkey, L. C., & Cacioppo, J. T. (2004). Stress and the aging immune system. *Biological Psychology*, 67(2), 114–119. <https://doi.org/10.1016/j.biopsycho.2003.09.005>
- Hayes, A. F. (2013). *Handbook of writing assessment* (2nd ed.). Guilford Press.
- Heijnen, C. J., & Kavelaars, A. (2005). Psychoneuroimmunology and chronic autoimmune diseases: Rheumatoid arthritis. In K. Vedhara & M. R. Irwin (Eds.), *Psychoneuroimmunology* (pp. 195–218). Oxford University Press. <https://doi.org/10.1093/med/psych/9780198568841.003.0008>
- Hobfoll, S. E. (1989). Conservation of resources: A new attempt at conceptualizing stress. *American Journal of Orthopsychiatry*, 44(3), 513–524. <https://doi.org/10.1037/0003-066X.44.3.513>
- Holahan, C. K., Holahan, C. J., & Belk, S. S. (1984). Adjustment in aging: The roles of life stress, hassles, and self-efficacy. *Journal of Aging and Health*, 3(4), 315–328. <https://doi.org/10.1037/0278-6133.3.4.315>
- Holmes, T. H., & Rahe, R. H. (1967). The Social Readjustment Rating Scale. *Journal of Psychosomatic Medicine*, 11(2), 213–218. [https://doi.org/10.1016/0022-3999\(67\)90010-4](https://doi.org/10.1016/0022-3999(67)90010-4)
- Hull, J. G. (1981). A self-awareness model of the causes and effects of alcohol consumption. *Journal of Abnormal Psychology*, 90(6), 586–600. <https://doi.org/10.1037/0021-843X.90.6.586>
- Ingram, R. E. (1990). Self-focused attention in clinical disorders: Review and a conceptual model. *Behavioral Assessment Review*, 107(2), 156–176. <https://doi.org/10.1037/0033-2909.107.2.156>
- Johnson, J. G., & Sherman, M. F. (1997). Daily hassles mediate the relationship between major life events and psychiatric symptomatology: Longitudinal findings from an adolescent sample. *Journal of the American Academy of Child and Adolescent Psychiatry*, 16(4), 389–404. <https://doi.org/10.1521/jscp.1997.16.4.389>
- Kanner, A., Coyne, J., Schaefer, C., & Lazarus, R. (1981). Comparison of two modes of stress measurement: Daily hassles and uplifts versus major life events. *Journal of Personality and Social Psychology*, 4(1), 1–39. <https://doi.org/10.1007/BF00844845>
- Kashdan, T. B., Breen, W. E., & Julian, T. (2010). Everyday strivings in war veterans with posttraumatic stress disorder: Suffering from a hyperfocus on avoidance and emotion regulation. *Behavioral Assessment Review*, 41(3), 350–363. <https://doi.org/10.1016/j.beth.2009.09.003>
- Keltner, D. (1996). Facial expressions of emotion and personality. In C. Malatesta-Magai & S. H. McFadden (Eds.), *Facial expressions of emotion* (pp. 385–402). Academic Press. <https://doi.org/10.1016/B978-012464995-8/50022-4>
- Keltner, D., & Bonanno, G. A. (1997). A study of laughter and dissociation: Distinct correlates of laughter and smiling during bereavement. *Journal of Personality and Social Psychology*, 73(4), 687–702. <https://doi.org/10.1037/0022-3514.73.4.687>
- Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition & Emotion*, 17(2), 297–314. <https://doi.org/10.1080/026999303022297>
- Keltner, D., & Horberg, E. J. (2015). Emotion cognition interactions. *American Psychologist* (Vol. 1, 623–664). American Psychological Association.
- Keltner, D., & Lerner, J. S. (2010). Emotion. In D. T. Gilbert, S. T. Fiske, & G. Lindsay (Eds.), *The handbook of emotion* (5th ed., pp. 312–347). McGraw-Hill. <https://doi.org/10.1002/9780470561119.socpsy001009>
- Keltner, D., Ellsworth, P. C., & Edwards, K. (1993). Beyond simple pessimism: Effects of sadness and anger on social perception. *Journal of Personality and Social Psychology*, 64(5), 740–752. <https://doi.org/10.1037/0022-3514.64.5.740>
- Kennedy-Moore, E., & Watson, J. C. (2001). How and when does emotional expression help? *Journal of Personality and Social Psychology*, 5(3), 187–212. <https://doi.org/10.1037/1089-2680.5.3.187>
- Kiecolt-Glaser, J. K., McGuire, L., Robles, T. F., & Glaser, R. (2002). Emotions, morbidity, and mortality: New perspectives from psychoneuroimmunology. *Annual Review of Psychology*, 53(1), 83–107. <https://doi.org/10.1146/annurev.psych.53.100901.135217>
- Kohleppel, T., Bradley, J. C., & Jacob, S. (2002). A walk through the garden: Can a visit to a botanic garden reduce stress? *Journal of Environmental Psychology*, 12(3), 489–492. <https://doi.org/10.21273/HORTTECH.12.3.489>
- Kross, E., & Ayduk, O. (2011). Making meaning out of negative experiences by self-distancing. *Cognition & Emotion*, 20(3), 187–191. <https://doi.org/10.1177/0963721411408883>
- Kudielka, B. M., Buske-Kirschbaum, A., Hellhammer, D. H., & Kirschbaum, C. (2004). Differential heart rate reactivity and recovery after psychosocial stress (TSST) in health children, younger adults, and elderly adults: The impact of age and gender. *International Journal of Psychophysiology*, 11(2), 116–121. https://doi.org/10.1207/s15327558ijbm1102_8
- Kuznetsova, A., Brockhoff, B., & Christensen, R. H. B. (2017). lmerTest

- Journal of Personality and Social Psychology*, 88(1), 50–62. <https://doi.org/10.1037/0022-3514.88.1.50>
- Lyubomirsky, S., Caldwell, N. D., & Nolen-Hoeksema, S. (1998). Effects of ruminative and distracting responses to depressed mood on retrieval of autobiographical memories. *Journal of Personality and Social Psychology*, 75(1), 166–177. <https://doi.org/10.1037/0022-3514.75.1.166>
- Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Behavioral Science & Research*, 131(6), 803–855. <https://doi.org/10.1037/0033-2909.131.6.803>
- Mauss, I. B., Troy, A. S., & LeBourgeois, M. K. (2013). Poorer sleep quality is associated with lower emotion-regulation ability in a laboratory paradigm. *Cognition & Emotion*, 27(3), 567–576. <https://doi.org/10.1080/02699931.2012.727783>
- Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial?: The role of connectedness to nature. *Environmental Behavior*, 41(5), 607–643. <https://doi.org/10.1177/0013916508319745>
- McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation: Central role of the brain. *Physiological Reviews*, 87(3), 873–904. <https://doi.org/10.1152/physrev.00041.2006>
- McGrath, J. E. (1970). A conceptual framework for research on stress. In J. E. McGrath (Ed.), *Stress: A conceptual framework* (pp. 10–21). Holt, Reinhart, and Winston.
- McIntyre, K. P., Korn, J. H., & Matsuo, H. (2008). Sweating the small stuff: How different types of hassles result in the experience of stress. *Stress*, 24(5), 383–392. <https://doi.org/10.1002/smi.1190>
- Mendes, W. B., Blascovich, J., Hunter, S. B., Lickel, B., & Jost, J. T. (2007). Threatened by the unexpected: Physiological responses during social interactions with expectancy-violating partners. *Journal of Personality and Social Psychology*, 92(4), 698–716. <https://doi.org/10.1037/0022-3514.92.4.698>
- Miller, J. G., Kahle, S., Lopez, M., & Hastings, P. D. (2015). Compassionate love buffers stress-reactive mothers from fight-or-flight parenting. *Development & Psychopathology*, 51(1), 36–43. <https://doi.org/10.1037/a0038236>
- Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environ-

- J3 E e E E* , 35(9), 625–636. <https://doi.org/10.1037/0022-3514.35.9.625>
- Schubert, C., Lambertz, M., Nelesen, R. A., Bardwell, W., Choi, J. B., & Dimsdale, J. E. (2009). Effects of stress on heart rate complexity—A comparison between short-term and chronic stress. *B -* , 80(3), 325–332. <https://doi.org/10.1016/j.biopsycho.2008.11.005>
- Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E. T. Higgins & R. M. Sorrentino (Eds.), *F E E E E F E E* (Vol. 2, pp. 527–561). Guilford Press.
- Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *J3 E e E E* , 45(3), 513–523. <https://doi.org/10.1037/0022-3514.45.3.513>
- Shaffer, F., McCraty, R., & Zerr, C. L. (2014). A healthy heart is not a metronome: An integrative review of the heart's anatomy and heart rate variability. *F E e E* , 5, 1040. <https://doi.org/10.3389/fpsyg.2014.01040>
- Shiota, M. N., Campos, B., Keltner, D., & Hertenstein, M. J. (2004). Positive emotion and the regulation of interpersonal relationships. In R. S. Feldman & P. Philippot (Eds.), *E e E e E* (pp. 129–157). Erlbaum.
- Shiota, M. N., Campos, B., Oveis, C., Hertenstein, M. J., Simon-Thomas, E., & Keltner, D. (2017). Beyond happiness: Building a science of discrete positive emotions. *A e E* , 72(7), 617–643. <https://doi.org/10.1037/a0040456>
- Shiota, M. N., Keltner, D., & John, O. P. (2006). Positive emotion dispositions differentially associated with Big Five personality and attachment style. *E3 E e* , 1(2), 61–71. <https://doi.org/10.1080/17439760500510833>
- Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *C E E E E - E* , 21(5), 944–963. <https://doi.org/10.1080/02699930600923668>
- Sommerfeldt, S. L., Schaefer, S. M., Brauer, M., Ryff, C. D., & Davidson, R. J. (2019). Individual differences in the association between subjective stress and heart rate are related to psychological and physical well-being. *E e e* , 30(7), 1016–1029. <https://doi.org/10.1177/0956797619849555>
- Stellar, J. E., Gordon, A. M., Piff, P. K., Cordaro, D., Anderson, C. L., Bai, Y., Maruskin, L. A., & Keltner, D. (2017). Self-transcendent emotions and their social functions: Compassion, gratitude, and awe bind us to others through prosociality. *E E e e* , 9(3), 200–207. <https://doi.org/10.1177/1754073916684557>
- Stellar, J. E., Gordon, A., Anderson, C. L., Piff, P. K., McNeil, G. D., & Keltner, D. (2018). Awe and humility. *J3 E e E E* , 114(2), 258–269. <https://doi.org/10.1037/pspi0000109>
- Stellar, J. E., John-Henderson, N., Anderson, C. L., Gordon, A. M., McNeil, G. D., & Keltner, D. (2015). Positive affect and markers of inflammation: Discrete positive emotions predict lower levels of inflammatory cytokines. *E E* , 15(2), 129–133. <https://doi.org/10.1037/emo0000033>
- Stemmler, G., Heldmann, M., Pauls, C. A., & Scherer, T. (2001). Constraints for emotion specificity in fear and anger: The context counts. *E e e* , 38(2), 275–291. <https://doi.org/10.1111/1469-8986.3820275>
- Strack, R., Schwarz, N., & Gschneidinger, E. (1985). Happiness and reminiscing: The role of time perspective, affect, and mode of thinking. *J3 - E e E E* , 49(6), 1460–1469. <https://doi.org/10.1037/0022-3514.49.6.1460>
- Thorson, J. A., Powell, F. C., Sarmany-Schuller, I., & Hampes, W. P. (1997). Psychological health and sense of humor. *J3 E C E -* , 53(6), 605–619. [https://doi.org/10.1002/\(SICI\)1097-4679\(199710\)53:6:3.CO:2-I](https://doi.org/10.1002/(SICI)1097-4679(199710)53:6:3.CO:2-I)
- Tracy, J. L., & Robins, R. W. (2004). Putting the self into self-conscious emotions: A theoretical model. *E* , 15(2), 103–125. https://doi.org/10.1207/s15327965pli1502_01
- Valdesolo, P., & Graham, J. (2014). Awe, uncertainty, and agency detection. *E e* , 25(1), 170–178. <https://doi.org/10.1177/0956797613501884>
- Van Cappellen, P., & Saroglou, V. (2012). Awe activates religious and spiritual feelings and behavioral intentions. *e E E* , 4(3), 223–236. <https://doi.org/10.1037/a0025986>
- Van Der Helm, E., Yao, J., Dutt, S., Rao, V., Saletin, J. M., & Walker, M. P. (2011). REM sleep potentiates amygdala activity to previous emotional experiences. *C E B* , 21(23), 2029–2032. <https://doi.org/10.1016/j.cub.2011.10.052>
- Vázquez, C., Jiménez, F., Saura, F., & Avia, M. D. (2001). The importance of “importance”: A longitudinal confirmation of the attributional-stress model of depression measuring the importance of the attributions and the impact of the stressor. *e E E E D e e e* , 31(2), 205–214. [https://doi.org/10.1016/S0191-8869\(00\)00129-X](https://doi.org/10.1016/S0191-8869(00)00129-X)
- Wager, T. D., van Ast, V. A., Hughes, B. L., Davidson, M. L., Lindquist, M. A., & Ochsner, K. N. (2009). Brain mediators of cardiovascular responses to social threat, part II: Prefrontal-subcortical pathways and relationship with anxiety. *e e* , 47(3), 836–851. <https://doi.org/10.1016/j.neuroimage.2009.05.044>
- Zarski, J. J. (1984). Hassles and health: A replication. *F e* , 3(3), 243–251. <https://doi.org/10.1037/0278-6133.3.3.243>
- Zech, E., & Rimé, B. (2005). Is talking about an emotional experience helpful? Effects on emotional recovery and perceived benefits. *C E & e : A E E E E J3 E E e & e* , 12(4), 270–287. <https://doi.org/10.1002/cpp.460>

Awe, Joy, and Pride

Emotion	Emoticon
Awe	
Joy	
Pride	

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