

ATTITUDES AND SOCIAL COGNITION

Awe, Daily Stress, and Elevated Life Satisfaction

Yang Bai¹, Joseph Ocampo², Gening Jin³, Serena Chen², Veronica Benet-Martinez⁴, Maria Monroy²,
Craig Anderson², and Dacher Keltner²¹ Guanghua School of Management, Peking University² Department of Psychology, University of California, Berkeley³ The Permanente Medical Group, Inc., Oakland, California⁴ Department of Political and Social Sciences, Universitat Pompeu Fabra

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.

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

Supplemental materials: <https://doi.org/10.1037/pspa0000267.supp>

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

Yang Bai  <https://orcid.org/0000-0002-6085-9533>

Joseph Ocampo  <https://orcid.org/0000-0003-0187-4052>

Gening Jin  <https://orcid.org/0000-0003-2219-8807>

Veronica Benet-Martinez  <https://orcid.org/0000-0002-3352-9731>

Maria Monroy  <https://orcid.org/0000-0003-2216-8835>

Craig Anderson  <https://orcid.org/0000-0003-0931-1617>

This research was supported by Grant 38671 from the John Templeton Foundation. Author contributions: Yang Bai, Joseph Ocampo, Gening Jin, and Dacher Keltner designed research; Yang Bai, Gening Jin, Joseph Ocampo, Dacher Keltner, and Veronica Benet-Martinez performed research; Yang Bai, Gening Jin, Joseph Ocampo, Dacher Keltner, and Serena Chen wrote the paper;

Maria Monroy and Craig Anderson designed and conducted Study 1 together; all authors participated in research design discussions. We thank Erin Morrisey, Zhilin Li, Kayla Marissa Ruiz, Brandon Jackson Leggins, Chenoa Levy, Tiffany Tran, Jingxin Chen, Tsoi Jingyi, Karen Kwan, Lisa Ann Yu, Enna Chen, and Yunfei Qiang for their assistance with data collection and coding.

Data and code for all studies in this article can be found on OSF (https://osf.io/duqwm/?view_only=0d8f6a447f88496fae91e34d304b4e0a).

Correspondence concerning this article should be addressed to Yang Bai, Guanghua School of Management, Peking University, 5 Yiheyuan Rd, Haidian District, Beijing, China, 100871. Email: ybai@gsm.pku.edu.cn or baiyang@berkeley.edu

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 find that awe-related shifts toward the self reduce the stress associated with daily living, and in turn elevate personal life satisfaction.

Awe, the Small Self, and Stress

Stress is ubiquitous and consequential. It arises when individuals encounter events that they *appraise* as threatening or harmful and is experienced in terms of subjective feelings of lack of control and hopelessness (Folkman et al., 1986; Folkman & Lazarus, 1988; Hobfoll, 1989; Lazarus, 1966; Lazarus & Folkman, 1984; McEwen, 2007; McGrath, 1970). Stressful experiences are closely associated with depression and anxiety, physical risks (e.g., accidents), and lifestyle problems including drug abuse and other forms of impulsivity (e.g., Bodenmann et al., 2010; Bower et al., 2005; Brydon et al., 2006; Cohen et al., 2007; Duijts et al., 2003; Epel et al., 2001; Heijnen & Kavelaars, 2005). Understanding when and why stress responses emerge, and how to reduce their magnitude, are a central focus in the literature on mental and physical well-being.

Stress is shaped by the extent to which the individual *appraises* the present context as taxing or exceeding current social, financial, and cognitive resources (e.g., Folkman, 2013; Lazarus, 1966; Ortony et al., 1990; Pearlin et al., 1981). This appraisal analysis has inspired a number of literatures interested in how shifts in cognitive appraisals, brought about by mindfulness practices, reappraisal, and even exercise and sleep, lead to reductions in stress (e.g., Brown & Ryan, 2003; Gross, 1998, 2002; Gross & John, 2003; Mauss et al., 2013; Puterman et al., 2010; Van Der Helm et al., 2011). More relevant to the present focus on positive emotion, studies have found that the cultivation of gratitude (Emmons & McCullough, 2003), laughter (Keltner & Bonanno, 1997), and love (Miller et al., 2015) can reduce levels of stress, often through shifts in appraisals of the self and the social environment.

Awe is an emotional state that arises when people feel that they are in the presence of something grand that transcends their current frame of reference (Keltner & Haidt, 2003; Shiota et al., 2007, 2017). A wide range of stimuli—ranging from natural wonders to human art and artifacts to the virtues and magnanimity of other people—can elicit awe (Bai et al., 2017; Stellar et al., 2018). However awe is elicited, two core themes are shared among the family of awe experiences: The first is a sense of vastness in response to the physical, social, or conceptual size of the entity producing awe; the second is a need to update one's current mental schema to make sense of what produced the experience of awe (e.g., Keltner & Haidt, 2003).

Empirical studies have begun to document how awe shifts appraisals of the social environment and the self. State and trait awe, when compared with other positive emotions, have been found to predict greater comfort with revising mental schema to assimilate novel information (Shiota et al., 2007), the sense of having more time to help others (Rudd et al., 2012), and lower intolerance of uncertainty and greater belief in supernatural agents (Valdesolo & Graham, 2014).

Most germane to our investigation, awe at both trait and state levels is associated with shifts in self-appraisals, producing a

“small self”—a diminished sense of the self vis-à-vis that which is vast (Bai et al., 2017; Piff et al., 2015; Stellar et al., 2018). The “small self” has two components (Bai et al., 2017; Piff et al., 2015). The first is a sense of vastness vis-à-vis the self, often described as an awareness of a large force or entity to which the self is connected. For example, individuals who are more prone to experience awe, but not joy or pride, are more likely to describe themselves as members of all-encompassing social categories, such as “an inhabitant of the earth” (Shiota et al., 2007). In studies of state awe, people led to experience awe reported an elevated sense of connectedness to people in general (Van Cappellen & Saroglou, 2012) and greater awareness of common humanity (Piff et al., 2015) compared with those who experienced pride or amusement.

Alongside an awareness of large entities or forces, the “small self” has a second component—an insignificant sense of the self. In relevant empirical work, in august natural settings and in the context of daily living people feeling awe selected smaller circles to represent the self, drew a smaller self-image, and even wrote smaller letters in signing “Me,” compared with their counterparts in control conditions (Bai et al., 2017). In other research, participants immersed in a recollection of awe, compared with those who recalled joy experiences, perceived themselves as smaller and less significant (Campos et al., 2013; Shiota et al., 2007). In turn, this awe-related diminished sense of the self has been shown to lead to greater humility and prosociality (Piff et al., 2015; Rudd et al., 2012; Stellar et al., 2018; Van Cappellen & Saroglou, 2012).

These two components of “small self” suggest how awe might diminish the levels of daily stress. Specifically, a reduced focus on the self and shifted self-appraisals are robust predictors of reduced stress (e.g., Ayduk & Kross, 2008, 2010; Kross & Ayduk, 2011; Libby et al., 2005; Lyubomirsky et al., 1998; Nolen-Hoeksema, 1991; Pyszczynski & Greenberg, 1987). Namely, processes that foster disengagement with the self, such as self-distancing (e.g., Ayduk & Kross, 2010; Kross & Ayduk, 2011), self-distracting (e.g., Lyubomirsky et al., 1998; Nolen-Hoeksema, 1991), and mindfulness (e.g., Brown & Ryan, 2003), are associated with reduced stress and enhanced well-being. Given the centrality of “small self” to awe experiences, we predicted that experiences of awe would be associated with reduced daily stress.

Awe and Daily Stress

Stress can arise from anything that happens in one's daily routine. Such daily stresses, or “daily hassles,” stem from ordinary troubles of family life (e.g., the demands of children and parents; bickering and complaints between spouses), issues and conflicts in the workplace (e.g., work overload and underload; role ambiguity; subtle forms of harassment), and more quotidian properties of the social and physical environment (e.g., rush hour traffic, pollution, inequality; Caplan & Jones, 1975; Caspi et al., 1987; Frankenhaeuser & Gardell, 1976; Lazarus, 1981; Lazarus & Cohen, 1977; Novaco et al., 1979; Pearlin, 1975). If *appraised* as bothersome or annoying, daily stresses predict mental and physical difficulties and dysfunction (DeLongis et al., 1982; Eckenrode, 1984; Holahan et al., 1984; Kanner et al., 1981; Monroe, 1983; Norman & Malla, 1993; Zarski, 1984). Everyday stressors yield surprisingly large effects upon health and psychological well-being (e.g., Byrne & Whyte, 1980; DeLongis et al., 1982; Dohrenwend &

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 & Balcetiis, 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 *how* experiences of awe are associated with reduced stress. Guided by an appraisal tendency account of emotion-cognition interactions (Lerner et al., 2015; Lerner & Keltner, 2001), we examined the contributions of two awe-related small self-appraisal tendencies: vastness vis-à-vis the

self and an insignificant sense of the self (Bai et al., 2017). We pitted these two appraisals against one another in mediation models to begin to understand how awe might be associated with reduced daily stress.

The Present Investigation

We examined the relationship between awe and stress during daily experiences, at the trait level, in the lab, and in ecologically rich natural settings. Our first hypothesis was that awe, relative to other positive emotions—for example, joy, amusement, or pride—would relate to reduced daily stress at both trait and state levels (Hypothesis 1). In keeping with theoretical analyses of how emotional experiences guide cognitive processes (e.g., Keltner & Horberg, 2015; Lerner et al., 2015; Schwarz, 1990), we predicted that the intensity of the subjective experience of awe would be associated with reduced daily stress levels (Hypothesis 2; see also Bai et al., 2017). Guided by the aforementioned appraisal tendency account and the positive association between altered self-appraisals and stress (e.g., Ayduk & Kross, 2010), we further predicted that experiences of awe would be associated with reduced stress via the small self-appraisal (Hypothesis 3). Finally, given awe's close association with well-being (Rudd et al., 2012; Stellar et al., 2015) and the well-documented impact of daily stress upon psychological health (e.g., Caspi et al., 1987; DeLongis et al., 1982; Kanner et al., 1981; Pearlin et al., 1981), we hypothesized that awe will increase life satisfaction through diminishing daily stress (Hypothesis 4).

We also tested alternative explanations of the hypothesized association between awe and stress. Most importantly, a robust literature finds that more global positivity, and positive emotions such as amusement, joy, and pride, are associated with reduced stress (e.g., Lyubomirsky et al., 2005). These empirical literatures raise the question of whether the hypothesized influences of awe upon stress are unique to awe or simply part of the more general tendency for positive states to reduce stress. In light of this concern, in Study 1, we controlled for other general daily positive states (joy, contentment, pride, gratefulness, and amusement). Moreover, guided by recent analyses of more specific positive emotions (Cowen & Keltner, 2017; Shiota et al., 2017) and their overlap and distinctions from awe (Bai et al., 2017; Piff et al., 2015; Shiota et al., 2007), we contrasted awe against emotions with similar valence and arousal but different cognitive appraisal tendencies (Lerner & Keltner, 2001; Oveis et al., 2010). Specifically, in Studies 2 and 3 we pitted awe against amusement, and in Studies 5 we pitted awe against joy and pride.

Study 1: Daily Awe and Daily Stress

In Study 1, we used a daily diary method, which is ideal for studying emotions and theoretically relevant outcomes in the ecologically rich contexts of everyday life (Bolger et al., 2003; Reis, 1994). For two weeks, participants reported their daily emotional experiences and levels of daily stress every night before they went to bed. We predicted that daily experiences of awe would be associated with lower levels of daily stress and this effect would hold after controlling for other positive states (e.g., joy, amusement, pride, and contentment).

Method

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 z -scored $B = -.07$, unstandardized $B = -.05$ or smaller (for more details, see the online supplemental materials).

Measures

Defining Awe for Participants. 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).

Daily Measures. 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 *daily stress levels* (“Today I felt stressed, overburdened or pressured”). All items were measured on 11-point Likert scales (1 = *not at all*, 11 = *as much as I’ve ever felt/done*).

Awe Narratives. 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).

Results

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 *lmer* 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), which yields df 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 *ranova* function from *lmer* 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’ daily stress from a person-centered awe variable. Consistent with Hypothesis 1, the effect was significant. On days when the average participant experienced more awe than

Table 1
Model Coefficients Predicting Daily Stress (Study 1)

Predictor	B	Fixed linear slope effects			Random slope effects		
		95% CI	df	t	SD_{slope}	df	χ^2
Model 1							
Daily awe intensity (person-centered)	−0.20***	[−0.26, −0.14]	78.52	−6.84	0.15*	2	8.83
Model 2							
Daily awe intensity (person-centered)	−0.08**	[−0.13, −0.02]	345.87	−2.75	0.07	3	4.29
Daily positive affect intensity (person-centered)	−0.38***	[−0.48, −0.29]	115.02	−7.72	0.33***	3	30.53
Model 3							
Daily awe intensity (person-centered)	−0.18***	[−0.24, −0.13]	189.89	−6.55	0.11*	3	10.55
Lagged daily awe intensity (person-centered)	0.28***	[0.22, 0.34]	137.14	9.53	0.17***	3	18.17
Model 4							
Dichotomous awe (0 = no awe, 1 = awe)	−0.99***	[−1.44, −0.54]	86.82	−4.35	1.38***	2	22.02
Model 5							
Dichotomous awe (0 = no awe, 1 = awe)	−0.48*	[−0.90, −0.07]	85.31	−2.30	1.13**	3	13.10
Positive affect intensity (person-centered)	−0.41***	[−0.50, −0.31]	105.48	−8.35	0.35***	3	30.15

* $p < .05$. ** $p < .01$. *** $p < .001$.

their own norm across the two-week period, they reported feeling less stressed, $B = -.20$, 95% CI $[-.26, -.14]$, $t(78.52) = -6.84$, $p < .01$ (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 $[-.13, -.02]$, $t(345.87) = -2.75$, $p = .01$. 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 $[-.24, -.13]$, $t(189.89) = -6.55$, $p < .01$.

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 $[-1.44, -.54]$, $t(86.82) = -4.35$, $p < .01$, 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 $[-.90, -.07]$, $t(85.31) = -2.30$, $p = .02$.

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: Dispositional Awe and Daily Stress

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's unique contribution to reduced daily stress, we also controlled for dispositional amusement, another positive emotion which involves similar appraisals of violated expectations like awe (Bai et al., 2017; Piff et al., 2015; Stellar et al., 2018).

Method

Participants

A total of 329 students at a major public west coast university in the United States participated in exchange for course credit. The sample size was primarily determined by our motivation to collect as much data as possible until the end of the school semester. We only analyzed results after all participants completed the study. Nine participants who failed more than two attention checks were excluded from our analyses. The final sample consisted of 320 participants (81 male, $M = 20.49$ yrs, $SD = 2.54$ yrs), leaving us with the ability to detect effects of $r = .156$ or larger at 80% power according to a post hoc power sensitivity analysis. This sample was 2% African American, 37% European American, 37% Asian American, 12% Latin American, 3% other ethnicities, and 9% mixed race.

Measures and Procedure

After giving consent, participants were directed to a web page to complete a series of questionnaires.

Dispositional Positive Emotion. Dispositional awe and dispositional amusement were measured by two subscales of the well-validated Dispositional Positive Emotion Scales (DPES; Shiota et al., 2006). The awe subscale contains six items: *I often feel awe, I see beauty all around me, I feel wonder almost every day, I have many opportunities to see the beauty of nature, I often look for patterns in objects around me, I seek out experiences that challenge my understanding* ($M = 4.66$, $SD = .98$, $\alpha = .81$). The amusement subscale is made up of five items, such as: *I find humor in everything, and the people around me make a lot of jokes* ($M = 5.00$, $SD = .98$, $\alpha = .79$). Participants reported their level of agreement with each statement on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Daily Stresses. Participants' daily stress levels were assessed using the Hassles Scale (Kanner et al., 1981); which contains a list of 117 hassles distributed across: work, health, family, friends, practical considerations, and chance occurrences (e.g., concerns about weight, physical appearance, misplacing or losing things, etc.). Participants were instructed to report the occurrence of any hassle from the list which has "hassled" them in the past month and the severity of the experience on a 4-point Likert scale: *none or did not occur, somewhat severe, moderately severe, or extremely severe*. Participants' severity ratings for the hassles they reported experiencing were summed to form a single index of hassle-related daily stress.¹

Results and Discussion

To test our first hypothesis, we regressed each participant's daily stress level on DPES awe. As expected, trait awe was significantly correlated with daily stress, such that people who tend to feel more

¹We also calculated the total number of hassles each participant experienced by counting the number of hassles rated as bothersome for each participant. The same correlation test revealed that DPES awe was not significantly correlated with the total number of hassles, suggesting that participants with higher awe proneness experience a similar amount of hassles while appraising them as less bothersome compared with those who are less awe prone (for detailed statistics, see the online supplemental materials).

awe on a regular basis reported lower intensities of stress associated with the 117 daily hassles, $\beta = -.13$, $t = -2.39$, $p = .02$. 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, $\beta = -.14$, $t = -2.43$, $p = .02$ (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.

Study 3: Nature-Related Awe and Daily Stress

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.

Method

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 where they watched a video designed to elicit awe, amusement, or a neutral state. After watching the video, participants described their central daily hassle again and rate how stressful and bothersome it is. All stimuli were viewed on a 22-in. monitor with a resolution of 1680×1050 and 75 Hz refresh rate.

Daily Stresses. As an indication of their daily stress, participants reported upon their most recent central hassle and then rated its intensity, guided by the following instructions (adapted from Gruen et al., 1988):

Hassles can differ in how much they say about you as a distinctive individual. Some hassles may be very central and revealing, and others may not be. A central hassle is one that you have a lot of concern about. This kind of hassle could reflect a troubling problem for you, perhaps a problem that is an ongoing theme in your life, such as an unresolved conflict, an unfulfilled need, or a personal inadequacy. Please think about the most stressful central hassle you have experienced in the past 1 month up to the present.

Participants then wrote about their central daily hassle in 5 to 10 sentences and used a scale from 1 (*not stressful and bothersome at all*) to 100 (*extremely stressful and bothersome*) to evaluate how stressful and bothersome the central daily hassle was.

Emotion Manipulation. The awe-inducing video was a five-minute montage from the BBC's *Planet Earth* nature documentary depicting aerial images of avalanches, waterfalls, mountains, oceans, and forests (Valdesolo & Graham, 2014). The amusement-eliciting video was a five-minute montage from the BBC's *Walk on the Wild Side* depicting wild animals from various ecosystems whose voices were overdubbed by actors engaging in funny conversations in their respective natural environments. The neutral clip was a five-minute news interview conducted by Mike Wallace.

Manipulation Check. Participants reported the degree to which they felt amusement, awe, anger, sadness, pride, and fear on a seven-point scale from 1 (*not at all*) to 7 (*extremely*).

Data Coding and Analysis

Coding of Appraisal Themes. After watching the video in the lab, participants were instructed to describe their hassle again. To test whether the manipulation triggered participants' endorsement of the two types of small self-appraisals when thinking about their daily stress, we had two native English-speaking research assistants coded the appraisals of each stressor. A third coder read all the codes and settled discrepancies between the two coders. All three coders were naïve to the hypotheses.

Appraisals of Vastness Vis-à-Vis the Self. Two coders coded each entry as including the presence or absence of something vast vis-à-vis the self (interrater reliability: Cohen's $\kappa = .94$). For example, the following narrative reported by one participant was coded as referring to something vast in relation to the self:

Transitioning to living in a dorm is getting easier. I am getting better at managing the daily hassles and how I react to them. The video made my problems seem petty and small, compared with the power and majesty of Earth and nature. Accommodating other's shower schedules now seems like a very little thing to do—it is hardly a huge burden to tolerate other's quirks, as I know I have my own. Watching the video helped to put my little daily annoyances into perspective. It reminded me to be respectful of others even when they bug you, as we are all just humans living on planet Earth.

Appraisals of an Insignificant Sense of the Self. Two coders coded each entry for whether it referred to an insignificant sense of the self (interrater reliability: Cohen's $\kappa = .60$). For example, the following narrative reported by a separate participant includes references to the insignificant perception of the self:

It seems small in relation to the view of the whole world. However, it is still important in the realm of my small existence. It affects me personally but I do realize that it doesn't have a negative effect on anyone else really and that the world is much larger and comprises of many more people and organisms than myself.

Results and Discussion

Manipulation Check

Participants' self-reported emotions confirmed that those who watched the awe-inducing video ($M = 6.33$, $SD = .95$) experienced stronger feelings of awe compared with participants who watched the amusement-inducing video ($M = 3.02$, $SD = 1.47$) as well as those who watched the neutral video ($M = 2.98$, $SD = 1.71$), $F(2, 125) = 77.99$, $p < .01$, $\eta_p^2 = .55$. Participants in the amusement condition ($M = 6.12$, $SD = .83$) experienced more amusement compared with those in the awe ($M = 4.21$, $SD = 2.03$) and neutral ($M = 3.32$, $SD = 1.63$) conditions, $F(2, 125) = 35.14$, $p < .01$, $\eta_p^2 = .36$.

Awe and 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 their own central daily stressor within a 3 (emotion condition: awe vs. amusement vs. neutral) \times 2 (time:

pre or post) assessment of daily stress levels) repeated-measures ANOVA.² Results yielded a significant interaction between emotion condition and time, $F(2, 125) = 10.43$, $p < .001$, $\eta_p^2 = .14$ (see Figure 1). Simple effects analyses revealed that people in all three conditions were less bothered by their central daily hassle after watching a video, but this effect was much larger among participants in the awe condition ($M_{dif} = -28.10$, $SE = 2.77$), $F(1, 125) = 107.69$, $p < .001$, $\eta_p^2 = .46$, compared with those in the amusement condition ($M_{dif} = -19.76$, $SE_{dif} = 2.61$), $F(1, 125) = 53.28$, $p < .001$, $\eta_p^2 = .30$, or control condition ($M_{dif} = -10.82$, $SE_{dif} = 2.67$), $F(1, 125) = 16.73$, $p < .001$, $\eta_p^2 = .12$.

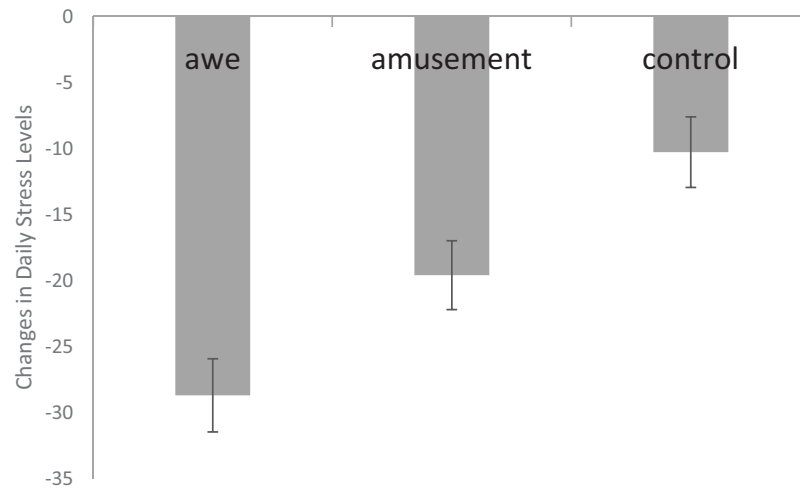
To further test the impact of emotion conditions on daily stress reduction, we calculated each participants' changes in daily stress levels (a difference score calculated by subtracting their baseline daily stress levels from their daily stress levels after watching the video) and conducted two hypothesis driven contrasts.³ In the first "control contrast," we tested whether participants primed with positive feelings—awe and amusement—reported higher reductions in levels of daily stress than those in the neutral condition by comparing the awe and amusement conditions to the neutral condition (coded as awe = 1, amusement = 1, neutral = -2). In the second contrast ("awe and amusement contrast") we compared the two positive emotion manipulation conditions—awe and amusement condition (coded as awe = 1, amusement = -1, neutral = 0). As expected, the control contrast was significant, $F(1, 125) = 16.12$, $p < .001$, $\eta_p^2 = .11$. Furthermore, whereas participants in the awe condition reported lower scores of daily stress compared with those in the amusement condition, the awe and amusement contrast did not surpass a conventional threshold for statistical significance, $F(1, 125) = 4.74$, $p = .03$, $\eta_p^2 = .04$. These results suggest that compared with both the control condition and amusement condition, experiences of awe more significantly decreased participants' current reports of the stressfulness of their hassle.

Supporting Hypothesis 2, across all three conditions, participants' self-reports of awe were significantly correlated with changes in daily stress levels, $r = -.35$, $p < .001$. In light of concerns that emotion manipulations may elicit nontarget emotions that drive the effect (e.g., Piff et al., 2015); we ran a regression model in which we entered awe together with all the other emotions—amusement, pride, sadness, fear, and anger—simultaneously as the predictor of changes in daily stress levels among participants from all three conditions. Even after controlling for all the other emotions collected, the intensity of the awe experience still significantly correlated with the reduction of intensity of perceived daily stress, $\beta = -.30$, $SE = .11$, $p = .008$. The correlations between changes in daily stress levels and other positive emotions

² We also employed ANCOVA models to test the differences between conditions. Detailed statistics can be found in the [online supplemental materials](#).

³ Orthogonal contrasts used in a-priori planned comparisons are viewed by many statisticians as the gold standard for testing a researcher's theory (Saville, 1990). These orthogonal contrasts explain unique variance in the data, whereas non-orthogonal contrasts explain partially overlapping variance in the data, i.e., a null for one test correlates highly with a null for another test (Hancock & Klockars, 1996). Compared with other ways of comparing the mean difference across conditions, orthogonal contrasts require fewer tests and thus reduce the chance of both Type 1 and Type 2 errors.

Figure 1
Average Changes in Daily Stress Levels After Emotion Priming (Awe, Amusement, and Neutral State)



Note. 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.

Study 4: Awe and Physiological Reactions Discussing 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.

Method

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; $M_{age} = 20.61$, $SD_{age} = 2.48$). 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 $|M_{diff}| = 1.70$ or more extreme for SCL and $|M_{diff}| = 2.65$ 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

Self-Reported Daily Stresses. 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 stressful and bothersome at all*) to 100 (*extremely stressful and bothersome*). After talking about this daily stress in the lab, they again reported the intensity of their stress toward the hassle.

Skin Conductance. 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.

Heart Rate. 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 = *extremely*).

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; $M = 8.91$; $SD = 7.19$). These analyses were conducted using the lmerest 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 z -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 ($M_{dif} = .76, 95\% \text{ CI } [-.42, 1.93], t(287.76) = -1.25, p = .21$, false discovery rate (FDR; Benjamini & Hochberg, 1995⁶) adjusted $p = .21, \beta_{dif} = .10$). 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), $M_{dif} = -1.46, 95\% \text{ CI } [-2.63, -.28], t(287.91) = -2.41, p = .02, \text{ FDR adjusted } p = .03, \beta_{dif} = -.19$; when talking about their daily stressors (stress talk phase), $M_{dif} = -1.72, 95\% \text{ CI } [-2.89, -.54], t(287.80) = -2.85, p = .005, \text{ FDR adjusted } p = .02, \beta_{dif} = -.22$; and even during the recovery phase after the stress talk, $M_{dif} = -1.42, 95\% \text{ CI } [-2.60, -.23], t(290.91) = -2.34, p = .02, \text{ FDR adjusted } p = .03, \beta_{dif} = -.18$ (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), $r = -.20, p = .01$. 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, $B = -.23, SE = .11, p = .04$ (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), $M_{dif} = -2.57, 95\% \text{ CI } [-4.40, -.73], t(406.56) = -2.72, p = .01, \text{ FDR adjusted } p = .01, \beta_{dif} = -.21$; when talking about their daily stress (stress talk phase), $M_{dif} = -3.56, 95\% \text{ CI } [-5.40, -1.72], t(408.59) = -3.77, p < .01, \text{ FDR adjusted } p < .01, \beta_{dif} = -.29$. Importantly, participants from the two conditions were observed with similar HR activities when they were watching the video, $M_{dif} = -.72, 95\% \text{ CI } [-2.55, 1.12], t(408.44) = -.76, p = .56, \text{ FDR adjusted } p = .03, \beta_{dif} = -.06$; as well as during the recovery phase after the stress talk, $M_{dif} = -.55, 95\% \text{ CI } [-2.39, 1.30], t(410.51) = -.58, p = .56, \text{ FDR adjusted } p = .56, \beta_{dif} = -.04$ (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, $F(1, 153) = .04, p = .95$.

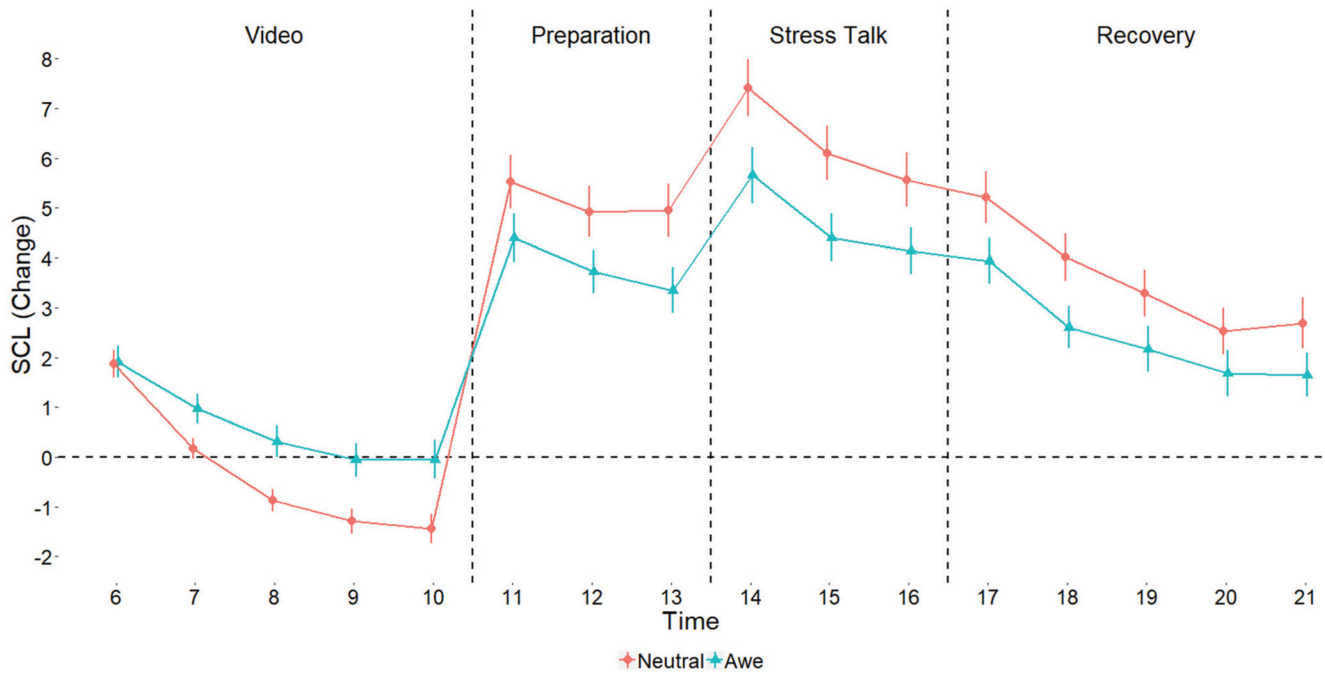
In sum, after watching an awe-eliciting video, participants exhibited lower SCL and HR compared with those in the control condition when thinking and talking about their daily stressors. Moreover, consistent with our second hypothesis, as participants reported more intense experiences of awe, they showed 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
The Minute-by-Minute Skin Conductance Level (SCL) Reactivity by Phase and Condition After the Baseline in Study 4



Note. SCL change scores were calculated by subtracting the last minute of the participants' baseline SCL from their current SCL. Error bars represent ± 1 SE (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.

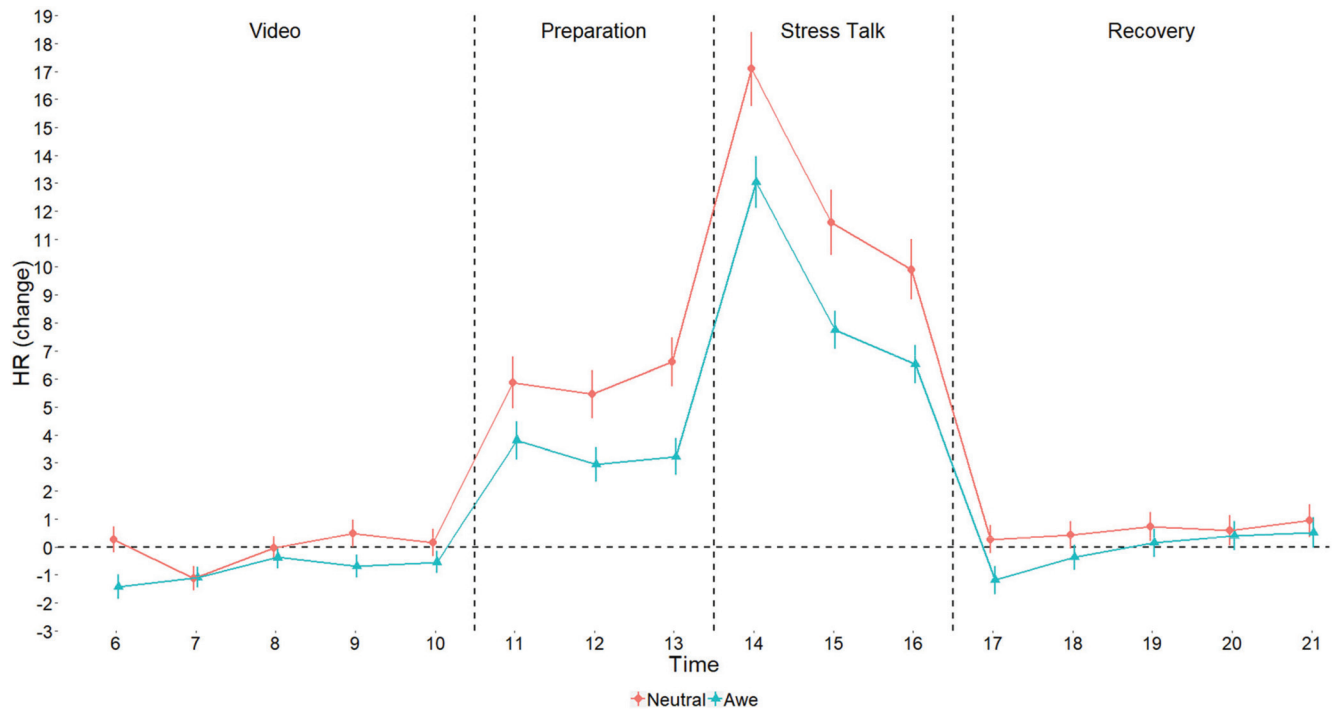
Method

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

Figure 3

The Minute-by-Minute Heart-Rate Reactivity by Phase and Condition After the Baseline in Study 4



Note. 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.

Daily Stresses. 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 stressful and bothersome at all*) to 10 (*extremely stressful and bothersome*).

Emotion Elicitation. 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.

Awe: When experiencing awe, people usually feel like they are in the presence of something or someone that is so great in terms of size or intensity that their current understanding of the world, their surroundings, or themselves is challenged in some way. Please take a few minutes to think about a particular time, fairly recently, during which you felt awe.

Joy: When experiencing joy, people usually feel a burst of great happiness or delight. Please take a few minutes to think about a particular time, fairly recently, during which you felt joy.

Pride: When experiencing pride, people usually feel proud and accomplished. Please take a few minutes to think about a particular time, fairly recently, during which you felt pride.

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 (*strongly disagree*) to 7 (*strongly agree*). 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 (*strongly disagree*) to 7 (*strongly agree*).

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

Emotions. 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 = *extremely*).

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.

Results and Discussion

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 ($M_{dif} = -2.56, SE = .28$) demonstrated less stress than those in the pride ($M_{dif} = -1.62, SE = .15$) condition ($SE = .37, p = .01, FDR$ adjusted $p = .03$). In addition, whereas individuals in the awe condition reported lower stress than those in the joy ($M_{dif} = -1.94, SE = .20$) condition, the comparison were not significantly different ($SE = .37, p = .09, FDR$ adjusted $p = .14$). Finally, the comparison between the joy and pride conditions were also not significantly different ($SE = .37, p = .39, FDR$ 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](#)).

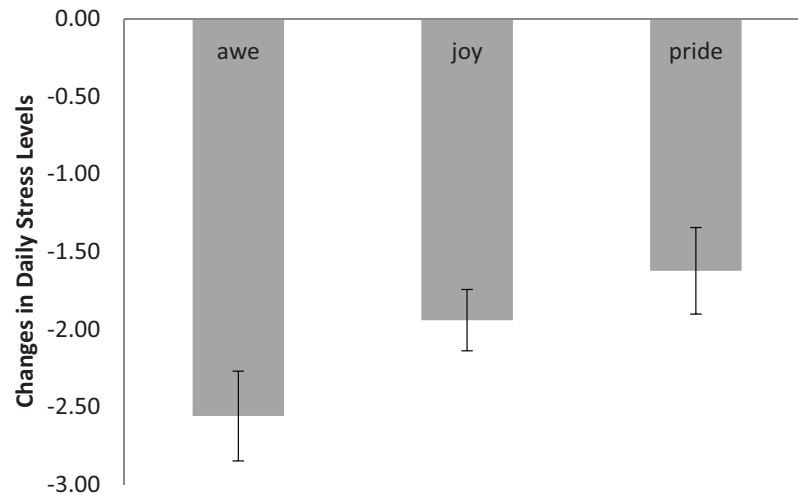
Awe, Two Facets of the Small Self, and Reduced Daily Stress

A principal factor analysis using Varimax rotation of the six items yielded two factors with an eigenvalue above 1.0 (one at 2.67 and the other at 1.96). As expected, the first rotated factor included the three items measuring a sense of vastness vis-à-vis the self and accounted for 40.56% of the total variance. The second rotated factor consisted of the three items measuring an insignificant sense of the self and accounted for 36.38% of the variance. Appraisals of vastness vis-à-vis the self and an insignificant sense of the self appear to be distinct facets of the small self (Bai et al., 2017; Piff et al., 2015).

We next examined whether awe impacts these two dimensions of the small self. To test this, we first conducted a three-way (emotional condition: awe vs. joy vs. pride) ANOVA with each participants’ average score on the perceived vastness vis-à-vis the self subscale ($\alpha = .88; M = 4.92, SD = 1.43$). Results revealed the predicted emotion condition effect, $F(2, 202) = 6.17, p = .002, \eta_p^2 = .06$. Furthermore, we conducted the two orthogonal contrasts. In the first contrast (“awe contrast”), we tested whether awe ($M = 5.41, SD = 1.30$), compared with joy ($M = 4.71, SD = 1.55$) and pride ($M = 4.66, SD = 1.31$), introduced a stronger sense of perceived vastness vis-à-vis the self (coded as awe = 2, joy = -1, pride = -1). In the second contrast (“positive contrast”) we compared the joy condition to the pride condition (coded as awe = 0, joy = 1, pride = -1). As expected, the awe contrast was significant, $F(1, 202) = 12.31, p = .001, \eta_p^2 = .06$, whereas the positive contrast was not, $F(1, 202) = .04, p = .84$, revealing that awe, but not joy or pride, produced a stronger sense of perceived vastness vis-à-vis the self. We further conducted a similar ANOVA with each participant’s average score on the insignificant sense of the self subscale ($\alpha = .80; M = 2.99, SD = 1.43$), which yielded a significant condition effect, $F(2, 202) = 7.13, p = .001, \eta_p^2 = .07$. Again, the same awe contrast was significant, $F(1, 202) = 13.92, p < .001, \eta_p^2 = .06$, but the positive contrast was not, $F(1, 202) = .37, p = .54$.

We then tested the two hypotheses concerning how awe leads to reduced daily stress. We first tested the model in which the perceived vastness vis-à-vis the self facet was set as the mediator. As one can see in Figure 5, the negative association between the awe-eliciting condition (in contrast to joy- and pride-eliciting conditions; coded as awe = 2, joy = -1, pride = -1) and decreases in daily stress levels became nonsignificant when a sense of vastness vis-à-vis of the self was included in the model. We tested the

Figure 4
Average Changes in Daily Stress Levels After Primed With Different Emotions (Awe, Joy, and Pride)



Note. Error bars represent $\pm 1 SE$ (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 $[-.02$, $.11]$).

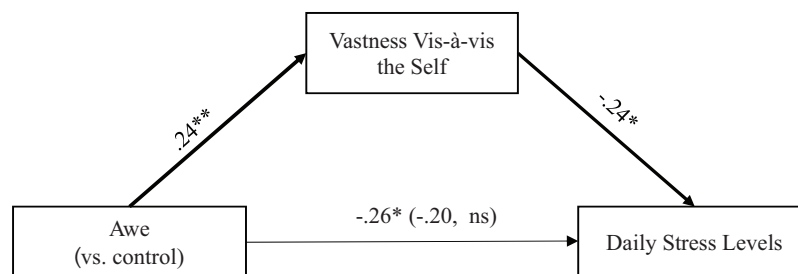
The results of Study 5 extend our understanding of the relation between experiencing awe and altered perspective of daily stresses in the moment. First, awe's calming effect on daily stress is not limited to immersion in nature, the source of awe in Studies 3 and 4. Moreover, consistent with Hypothesis 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.

Study 6: Awe, Reduced Daily Stress Levels, and Enhanced Life Satisfaction

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
Mediation Model for Study 5



Note. The predictor variable compares the awe condition with the joy and pride conditions (coded as awe = 2, joy = -1, pride = -1). Analyses control for the orthogonal control contrast (coded as awe = 0, joy = 1, pride = -1). Unstandardized coefficients are displayed.

* $p < .05$, ** $p < .01$.

(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).

Method

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.

Emotional Experience. On a 7-point scale from 1 (*not at all*) to 7 (*extremely*), 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.

Small Self. 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

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

Life Satisfaction. 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 (*strongly disagree*) to 7 (*strongly agree*), indicating how much they agreed or disagreed with each item in the current moment ($\alpha = .89$, $M_{\text{before}} = 4.79$, $SD_{\text{before}} = 1.21$; $\alpha = .89$, $M_{\text{after}} = 4.93$, $SD_{\text{after}} = 1.33$).

Results and Discussion

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 ($M_{\text{dif}} = -33.90$, $SE_{\text{dif}} = 4.59$), $F(1, 84) = 73.40$, $p < .001$, $\eta_p^2 = .47$, compared with those individuals who were facing the inner side of the tower ($M_{\text{dif}} = -13.80$, $SE_{\text{dif}} = 3.16$), $F(1, 84) = 12.73$, $p = .001$, $\eta_p^2 = .13$.

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](#).

Figure 6

View of the UC Berkeley Campus From Campanile Tower Used to Induce Awe (Left) and the Inside of Campanile Tower Used for the Control Condition (Right) in Study 6



Note. See the online article for the color version of this figure.

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 ($M_{\text{dif}} = -3.40, SE = 2.18, F(1, 84) = 130.77, p < .001, \eta_p^2 = .61$, compared with the ones who were facing the inner side of the tower ($M_{\text{dif}} = -1.59, SE_{\text{dif}} = 1.66, F(1, 84) = 29.91, p < .001, \eta_p^2 = .26$).

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 ($M = 5.07, SE = .21$) was significantly higher than before ($M = 4.67, SE = .19, F(1, 84) = 11.56, p = .001, \eta_p^2 = .12$). 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, $r = -.29, p = .006$.

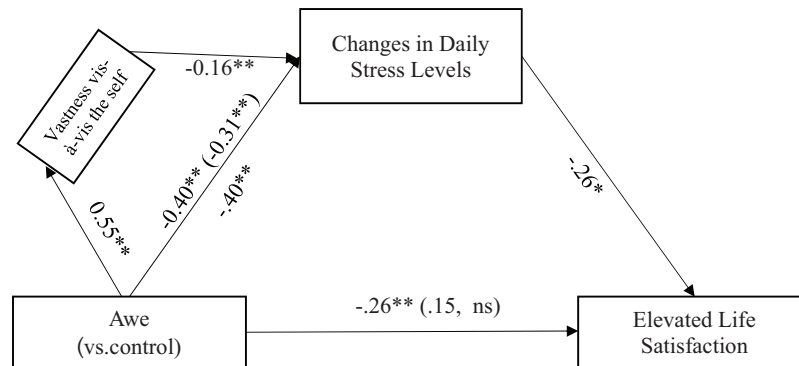
Awe, the Small Self, Decreased Daily Stress Levels, and Increased Life Satisfaction

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 of awe on life satisfaction change became no longer significant (95% CI $[-.03, .33]$) when the change of daily stress levels was included in the model.

In sum, the results of Study 6 provide evidence consistent with all of the hypotheses guiding this investigation. By immersing participants into an awe-inspiring context, we documented that state-level awe experiences significantly decrease individuals' daily stress levels (Hypothesis 1). Furthermore, individuals' awe experience intensity was significantly correlated with decreases in their daily stress intensity (Hypothesis 2). Moreover, findings from the mediation model suggest that appraisals of vastness vis-à-vis the self in part explain awe's impact on decreased daily stress levels (Hypothesis 3). Finally, this study is the first to provide evidence that awe, through decreased daily stress levels, can elevate life satisfaction (Hypotheses 4).

Figure 7
Mediation Model for Study 6



Note. The predictor variable compares the awe condition with control condition (coded as awe = 1, control = -1). Unstandardized coefficients are displayed.
* $p < .05$. ** $p < .01$.

General Discussion

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; Lerner et al., 2015; Schwarz & Clore, 1983). Finally, in Study 4 we documented awe's impact on physiological reactions toward daily stress: when thinking and talking about a daily stressor, individuals in the awe condition exhibited significantly lower levels of sympathetic arousal compared with those in the neutral condition.

Across studies, we tried to balance the external validity afforded by an experience-sampling approach (diary) with the internal validity afforded by more controlled approaches. Experience sampling data show that the negative association between awe and daily stress levels holds in people's actual lived experiences. Cross-sectional and experimental studies replicated this finding in both self-report and physiological responses and yielded one answer to the question of *why* awe reduces daily stress levels in the moment. Across our studies, we found that the link between awe and decreased daily stress levels may be due, in part, to an appraisal of vastness vis-à-vis the self—an important facet of awe's impact on self-appraisals (Bai et al., 2017). Further analyses revealed that the mitigation of daily

concerns helps explain why awe promotes life satisfaction. In Study 6, compared with participants in the control condition, participants primed with awe reported greater improvement in life satisfaction, a change mediated by their reduced daily stress levels.

The present set of studies' wide variety of methods provides converging evidence for the idea that awe reduces stress through shifts in the sense of self vis-à-vis vast things that are larger than the self. Specifically, the studies relied on different designs (diary, correlational, quasi-experimental, experimental), different manipulations of awe (daily report, narrative recall, compelling videos, and in vivo, experience in naturalistic setting), different measures of stress (daily measure, hassle check list, personalized central hassle report, physiological reactivity), and different language and cultural contexts (Spain & United States, including diverse ethnic samples in the United States). The fact that our predictions were supported across this diversity of methodologies and contexts highlights the robustness of the influence of awe upon reduced hassle-related stress.

Our results also speak to and reduce the plausibility of an alternative explanation: that awe's impact on daily stress is simply attributable to the general benefits of immersion in nature (e.g., Hartig et al., 2003; Kohlleppel et al., 2002; Mayer et al., 2009). In Study 4, compared with those who were immersed in recalling a nature-based, awe-eliciting situations, those who recalled nonnature, awe-eliciting experiences reported similar reductions in daily stress levels. Our findings suggest that awe exerts a specific and likely unique effect on daily stresses that is distinct from the influences of other positive emotions, not confounded by more general positive affect, and not limited to experiences in nature.

Theoretical Implications

This research makes a number of contributions to the growing literature on positive emotion and stress reduction. First, by focusing on one pervasive kind of stress—daily stress—the current research complements previous work emphasizing the importance of differentiating various types of stressors and identifying their specific interventions (e.g., Caplan & Jones, 1975; Caspi et al., 1987; Frankenhaeuser & Gardell, 1976; Kanner et al., 1981; Lazarus & Cohen, 1977; Novaco et al., 1979; Pearlman, 1975). Because

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).

Limitations and Future Directions

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 *why* awe is associated with decreased levels of daily stress. Whereas we focused on the mediating role of the small self-appraisal—the appraisal of vastness vis-à-vis the self specifically—other plausible mechanisms include: enhanced sense of social support (e.g., Bai et al., 2017; Cohen et al., 1985; Cohen & McKay, 1984; Cohen & Wills, 1985) and personal resources (e.g., time availability, Baum et al., 1999; Billings & Moos, 1984; Rudd et al., 2012). Furthermore, whereas

the current work focused on testing awe's impact on altered appraisals of daily stress, future work should explore whether awe also introduces biases in memory of past stressors (for controlled analyses with ongoing stressors only, see the [online supplemental materials](#)) as well as whether awe buffers the individual from new stressors.

Furthermore, our focus was on awe as a positive emotion. Negatively valenced awe experiences, however, are relatively common (12% to 24% in some studies) and are elicited by more fearful and threatening elicitors such as thunderstorms, earthquakes, and floods, and this negative awe does not predict elevated well-being (Gordon et al., 2017). It seems plausible that more threat-based forms of awe, accompanied by enhanced fear and anxiety, will amplify stress responses and produce results opposite from those observed here. Alternatively, it is also plausible that negatively valenced awe, again through altering one's self-appraisals, will mitigate the negative evaluations of daily stressors. Future studies need to pit these predictions against one another.

The major limitation of the current work is that, although we measured awe's impact on daily stress at the trait and state levels, the question of how these influences unfold over time and across contexts remains unaddressed. In the current investigation, we measured one's daily awe experience across a two-week time period. It will be important for future research to extend current findings by employing diary methodology over a longer period of time to capture a wider range of awe and stressful experiences. Furthermore, in our experiments (Studies 3–6), we measured individuals' appraisal of their daily stress immediately after the awe manipulation, leaving the question of whether awe could introduce long-term impact on daily stressors. To answer this question, a very critical future research agenda would be to test and measure the lasting effect of awe on stress. Finally, past research (e.g., Fredrickson et al., 2003; Fredrickson & Levenson, 1998) has demonstrated that positive emotions, in addition to interrupting ongoing stress, may facilitate recovery from stress. This raises questions about whether and how awe impacts levels of stress in chronic situations. In light of the findings presented here, one might speculate if awe will also yield unique benefits to recovery from chronic stressors, such as trauma following combat or exposure to violence (e.g., Anderson et al., 2018).

In the current investigation, we focused on daily stress, seemingly minor daily irritations. One notable direction for future empirical science would be to examine daily uplifts that capture the positive experiences derived from minor everyday events such as relating well with friends, eating outside, and spending time with family. It is important to note that uplifts are not merely mirrored experiences of daily stressors. Indeed, they only moderately correlate with daily stress and have clearly distinguishable functions in maintaining daily well-being (Kanner et al., 1981; Reis et al., 2000). Perhaps awe, through introducing a realization of the vastness vis-à-vis the self, may lead individuals to pay more attention to those relatively minor but good moments in their life and thus lead to positive impacts on daily well-being.

Finally, it would be both theoretically intriguing and practically useful to test awe's impact on daily stresses among other populations, such as the elderly, veterans, people with chronic disease or terminal diagnoses, at-risk youth, people who live in more threat-filled contexts, and people vulnerable to the pernicious consequences of chronic stress (for reviews, see Hawkey & Cacioppo,

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.

Conclusion

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.

References

- Aguinis, H., Gottfredson, R. K., & Culpepper, S. A. (2013). Best-practice recommendations for estimating cross-level interaction effects using multilevel modeling. *Journal of Management*, 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). *Unraveling the mystery of health: How people manage stress and stay well*. Jossey-Bass.
- Ax, A. F. (1953). The physiological differentiation between fear and anger in humans. *Psychosomatic Medicine*, 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? *Annals of the New York Academy of Sciences*, 896(1), 131–144. <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. *Journal of the Royal Statistical Society: Series B (Methodological)*, 57(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 Social and Personal Relationships*, 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. *Psychological Methods*, 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. *International Journal of 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. *Brain, Behavior, and Immunity*, 20(2), 113–119. <https://doi.org/10.1016/j.bbi.2005.08.002>
- Buss, A. H. (1980). *Self-consciousness and social anxiety*. 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). *Handbook of psychophysiology*. 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. *Cognition and Emotion*, 27(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 Applied Psychology*, 60(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 Alternative and Complementary Medicine*, 15(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 Social and Clinical Psychology*, 12(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 and health* (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. *Journal of the American Medical Association*, 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. *Social support: Theory, research and applications* (pp. 73–94). Springer Netherlands. 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. *Current Directions in Psychological Science*, 9(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. *Review of General Psychology*, 20(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 Consulting and Clinical Psychology*, 69(4), 706–711. <https://doi.org/10.1037/0022-006X.69.4.706>
- Cowen, A. S., & Keltner, D. (2017). Self-report captures 27 distinct categories of emotion bridged by continuous gradients. *Proceedings of the National Academy of Sciences of the United States of America*, 114(38), E7900–E7909. <https://doi.org/10.1073/pnas.1702247114>
- Dawson, M. E., Schell, A. M., & Filion, D. L. (2000). *Handbook of psychophysiology*. Cambridge University Press.
- DeLongis, A., Coyne, J. C., Dakof, G., Folkman, S., & Lazarus, R. S. (1982). Relationship of daily hassles, uplifts, and major life events to health status. *Health Psychology*, 1(2), 119–136. <https://doi.org/10.1037/0278-6133.1.2.119>
- Diener, E. D., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The Satisfaction With Life Scale. *Journal of Personality Assessment*, 49(1), 71–75. https://doi.org/10.1207/s15327752jpa4901_13
- DiGiovanni, A., & Balcutis, E. (2018). Measuring the impact of social support on dietary behavior: Assessing techniques and calling for the use of daily diaries. *Psychology and Behavioral Science International Journal*, 9(4), 555767.
- Dohrenwend, B. S., & Dohrenwend, B. P. (Eds.). (1974). *Stressful life events: Their nature and effects*. Wiley.
- Duijts, S. F., Zeegers, M. P., & Borne, B. V. (2003). The association between stressful life events and breast cancer risk: A meta-analysis. *International Journal of Cancer*, 107(6), 1023–1029. <https://doi.org/10.1002/ijc.11504>
- Eckenrode, J. (1984). Impact of chronic and acute stressors on daily reports of mood. *Journal of Personality and Social Psychology*, 46(4), 907–918. <https://doi.org/10.1037/0022-3514.46.4.907>
- Ekman, P. (1994). All emotions are basic. In P. Ekman & R. J. Davidson, (Eds.). *The nature of emotion: Fundamental questions* (pp. 15–19). Oxford University Press.
- Emerson, R. W. (1836). *Nature*. Reprinted in *Ralph Waldo Emerson, selected essays* (1982). Penguin.
- Emmons, R. A., & McCullough, M. E. (2003). Counting blessings versus burdens: An experimental investigation of gratitude and subjective well-being in daily life. *Journal of Personality and Social Psychology*, 84(2), 377–389. <https://doi.org/10.1037/0022-3514.84.2.377>
- Epel, E., Lapidus, R., McEwen, B., & Brownell, K. (2001). Stress may add bite to appetite in women: A laboratory study of stress-induced cortisol and eating behavior. *Psychoneuroendocrinology*, 26(1), 37–49. [https://doi.org/10.1016/S0306-4530\(00\)00035-4](https://doi.org/10.1016/S0306-4530(00)00035-4)
- Folkman, S. (2013). *Stress: Appraisal and coping*. Springer. https://doi.org/10.1007/978-1-4419-1005-9_215
- Folkman, S., & Lazarus, R. S. (1985). If it changes it must be a process: Study of emotion and coping during three stages of a college examination. *Journal of Personality and Social Psychology*, 48(1), 150–170. <https://doi.org/10.1037/0022-3514.48.1.150>
- Folkman, S., & Lazarus, R. S. (1988). The relationship between coping and emotion: Implications for theory and research. *Social Science & Medicine*, 26(3), 309–317. [https://doi.org/10.1016/0277-9536\(88\)90395-4](https://doi.org/10.1016/0277-9536(88)90395-4)
- Folkman, S., & Moskowitz, J. T. (2000). Positive affect and the other side of coping. *American Psychologist*, 55(6), 647–654. <https://doi.org/10.1037/0003-066X.55.6.647>
- Folkman, S., Lazarus, R. S., Dunkel-Schetter, C., DeLongis, A., & Gruen, R. J. (1986). Dynamics of a stressful encounter: Cognitive appraisal, coping, and encounter outcomes. *Journal of Personality and Social Psychology*, 50(5), 992–1003. <https://doi.org/10.1037/0022-3514.50.5.992>
- Frankenhaeuser, M., & Gardell, B. (1976). Underload and overload in working life: Outline of a multidisciplinary approach. *Journal of Human Stress*, 2(3), 35–46. <https://doi.org/10.1080/0097840X.1976.9936068>
- Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, 56(3), 218–226. <https://doi.org/10.1037/0003-066X.56.3.218>
- Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion*, 12(2), 191–220. <https://doi.org/10.1080/02699398379718>
- Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Larkin, G. R. (2003). What good are positive emotions in crisis? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology*, 84(2), 365–376. <https://doi.org/10.1037/0022-3514.84.2.365>
- Goldberg, D. P., & Hillier, V. F. (1979). A scaled version of the General Health Questionnaire. *Psychological Medicine*, 9(1), 139–145. <https://doi.org/10.1017/S0033291700021644>
- Gordon, A. M., & Chen, S. (2016). Do you get where I'm coming from? Perceived understanding buffers against the negative impact of conflict on relationship satisfaction. *Journal of Personality and Social Psychology*, 110(2), 239–260. <https://doi.org/10.1037/pspi0000039>
- Gordon, A. M., Stellar, J. E., Anderson, C. L., McNeil, G. D., Loew, D., & Keltner, D. (2017). The dark side of the sublime: Distinguishing a threat-based variant of awe. *Journal of Personality and Social Psychology*, 113(2), 310–328. <https://doi.org/10.1037/pspp0000120>
- Green, P., & MacLeod, C. J. (2016). SIMR: An R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution*, 7(4), 493–498. <https://doi.org/10.1111/2041-210X.12504>
- Greenberg, M. A., Wortman, C. B., & Stone, A. A. (1996). Emotional expression and physical health: Revising traumatic memories or fostering self-regulation? *Journal of Personality and Social Psychology*, 71(3), 588–602. <https://doi.org/10.1037/0022-3514.71.3.588>
- Griskevicius, V., Shiota, M. N., & Neufeld, S. L. (2010). Influence of different positive emotions on persuasion processing: A functional evolutionary approach. *Emotion*, 10(2), 190–206. <https://doi.org/10.1037/a0018421>
- Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, 74(1), 224–237. <https://doi.org/10.1037/0022-3514.74.1.224>
- Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology*, 39(3), 281–291. <https://doi.org/10.1017/S0048577201393198>
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348–362. <https://doi.org/10.1037/0022-3514.85.2.348>
- Grossman, P., Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of Psychosomatic Research*, 57(1), 35–43. [https://doi.org/10.1016/S0022-3999\(03\)00573-7](https://doi.org/10.1016/S0022-3999(03)00573-7)




- Gruen, R. J., Folkman, S., & Lazarus, R. S. (1988). Centrality and individual differences in the meaning of daily hassles. *Journal of Personality*, 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. *Review of Educational Research*, 66(3), 269–306. <https://doi.org/10.3102/00346543066003269>
- Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Gärling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology*, 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. *Brain, Behavior, and Immunity*, 18(2), 114–119. <https://doi.org/10.1016/j.bbi.2003.09.005>
- Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Press.
- Heijnen, C. J., & Kavelaars, A. (2005). Psychoneuroimmunology and chronic autoimmune diseases: Rheumatoid arthritis. In K. Vedhara & M. R. Irwin (Eds.), *Human 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 Psychologist*, 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. *Health Psychology*, 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 Research*, 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. *Psychological Bulletin*, 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 Social and Clinical Psychology*, 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 Behavioral Medicine*, 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. *Behavior Therapy*, 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.), *Handbook of emotion, aging, and the life course* (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 and Emotion*, 17(2), 297–314. <https://doi.org/10.1080/02699930302297>
- Keltner, D., & Horberg, E. J. (2015). Emotion cognition interactions. *APA handbook of personality and social psychology* (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 social psychology* (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? *Review of General 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>
- Kohlleppel, T., Bradley, J. C., & Jacob, S. (2002). A walk through the garden: Can a visit to a botanic garden reduce stress? *HortTechnology*, 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. *Current Directions in Psychological Science*, 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 Behavioral Medicine*, 11(2), 116–121. https://doi.org/10.1207/s15327558ijbm1102_8
- Kuznetsova, A., Brockhoff, B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, 82(13), 1–26. <https://doi.org/10.18637/jss.v082.i13>
- Lazarus, R. S. (1966). *Psychological stress and the coping process*. McGraw-Hill.
- Lazarus, R. S. (1981). The stress and coping paradigm. In C. Eisdorfer, D. Cohen, A. Kleinman, & P. Maxim (Eds.), *Models for clinical psychopathology* (pp. 177–214). Spectrum. https://doi.org/10.1007/978-94-015-7129-6_24
- Lazarus, R. S. (1984). Puzzles in the study of daily hassles. *Journal of Behavioral Medicine*, 7(4), 375–389. <https://doi.org/10.1007/BF00845271>
- Lazarus, R. S., & Cohen, J. B. (1977). Environmental stress. In I. Altman & J. F. Wohlwill (Eds.), *Human behavior and environment* (pp. 89–127). Springer. https://doi.org/10.1007/978-1-4684-0808-9_3
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer.
- Lepore, S. J., Fernandez-Berrocá, P., Ragan, J., & Ramos, N. (2004). It's not that bad: Social challenges to emotional disclosure enhance adjustment to stress. *Anxiety, Stress, and Coping*, 17(4), 341–361. <https://doi.org/10.1080/10615800412331318625>
- Lepore, S. J., Ragan, J. D., & Jones, S. (2000). Talking facilitates cognitive-emotional processes of adaptation to an acute stressor. *Journal of Personality and Social Psychology*, 78(3), 499–508. <https://doi.org/10.1037/0022-3514.78.3.499>
- Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgment and choice. *Cognition and Emotion*, 14(4), 473–493. <https://doi.org/10.1080/026999300402763>
- Lerner, J. S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology*, 81(1), 146–159. <https://doi.org/10.1037/0022-3514.81.1.146>
- Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and decision making. *Annual Review of Psychology*, 66, 799–823. <https://doi.org/10.1146/annurev-psych-010213-115043>
- Levenson, R. W. (2003). Autonomic specificity and emotion. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 212–224). Oxford University Press.
- Libby, L. K., Eibach, R. P., & Gilovich, T. (2005). Here's looking at me: The effect of memory perspective on assessments of personal change.

- 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? *Psychological Bulletin*, 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 and 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. *Environment and 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.), *Social and psychological factors in stress* (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 and Health*, 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. *Developmental Psychology*, 51(1), 36–43. <https://doi.org/10.1037/a0038236>
- Mitchell, R., & Popham, F. (2008). Effect of exposure to natural environment on health inequalities: An observational population study. *Lancet*, 372(9650), 1655–1660. [https://doi.org/10.1016/S0140-6736\(08\)61689-X](https://doi.org/10.1016/S0140-6736(08)61689-X)
- Monroe, S. M. (1983). Major and minor life events as predictors of psychological distress: Further issues and findings. *Journal of Behavioral Medicine*, 6(2), 189–205. <https://doi.org/10.1007/BF00845380>
- Nelson, D. L., & Burke, R. J. (2002). A framework for examining gender, work stress, and health. In D. L. Nelson & R. J. Burke (Eds.), *Gender, work stress, and health* (pp. 3–14). American Psychological Association. <https://doi.org/10.1037/10467-001>
- Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, 84(3), 231–259. <https://doi.org/10.1037/0033-295X.84.3.231>
- Nisbett, E. K., & Zelenski, J. M. (2011). Underestimating nearby nature: Affective forecasting errors obscure the happy path to sustainability. *Psychological Science*, 22(9), 1101–1106. <https://doi.org/10.1177/0956797611418527>
- Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology*, 100(4), 569–582. <https://doi.org/10.1037/0021-843X.100.4.569>
- Norman, R. M., & Malla, A. K. (1993). Stressful life events and schizophrenia: I: A review of the research. *The British Journal of Psychiatry*, 162(2), 161–166. <https://doi.org/10.1192/bjp.162.2.161>
- Novaco, R. W., Stokols, D., Campbell, J., & Stokols, J. (1979). Transportation, stress, and community psychology. *American Journal of Community Psychology*, 7(4), 361–380. <https://doi.org/10.1007/BF00894380>
- Ortony, A., Clore, G. L., & Collins, A. (1990). *The cognitive structure of emotions*. Cambridge University Press.
- Oveis, C., Horberg, E. J., & Keltner, D. (2010). Compassion, pride, and social intuitions of self-other similarity. *Journal of Personality and Social Psychology*, 98(4), 618–630. <https://doi.org/10.1037/a0017628>
- Parkinson, B., & Manstead, A. S. R. (1992). Appraisal as a cause of emotion. In M. S. Clark (Ed.), *Review of personality and social psychology*: Vol. 13. *Emotion* (pp. 122–149). Sage.
- Pearlin, L. I. (1975). Status inequality and stress in marriage. *American Sociological Review*, 40(3), 344–357. <https://doi.org/10.2307/2094462>
- Pearlin, L. I., Menaghan, E. G., Lieberman, M. A., & Mullan, J. T. (1981). The stress process. *Journal of Health and Social Behavior*, 22(4), 337–356. <https://doi.org/10.2307/2136676>
- Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., & Keltner, D. (2015). Awe, the small self, and prosocial behavior. *Journal of Personality and Social Psychology*, 108(6), 883–899. <https://doi.org/10.1037/pspi0000018>
- Pinheiro, J. C., & Bates, D. M. (2000). *Linear mixed-effects models: Basic concepts and examples. Mixed-effects models in S and S-Plus* (pp. 3–56). Springer Science & Business Media.
- Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40(3), 879–891. <https://doi.org/10.3758/BRM.40.3.879>
- Preacher, K., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, 36(4), 717–731. <https://doi.org/10.3758/BF03206553>
- Puterman, E., Lin, J., Blackburn, E., O'Donovan, A., Adler, N., & Epel, E. (2010). The power of exercise: Buffering the effect of chronic stress on telomere length. *PLoS ONE*, 5(5), e10837. <https://doi.org/10.1371/journal.pone.0010837>
- Pyszczynski, T., & Greenberg, J. (1987). Self-regulatory perseverance and the depressive self-focusing style: A self-awareness theory of reactive depression. *Psychological Bulletin*, 102(1), 122–138. <https://doi.org/10.1037/0033-2909.102.1.122>
- Reis, H. T. (1994). Domains of experience: Investigating relationship processes from three perspectives. In R. Erber & R. Gilmour (Eds.), *Theoretical frameworks for personal relationships* (pp. 87–110). Erlbaum.
- Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 190–222). Cambridge University Press.
- Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, J., & Ryan, R. M. (2000). Daily well-being: The role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin*, 26(4), 419–435. <https://doi.org/10.1177/0146167200266002>
- Rosenberg, E. L. (1998). Levels of analysis and the organization of affect. *Review of General Psychology*, 2(3), 247–270. <https://doi.org/10.1037/1089-2680.2.3.247>
- Ross, M. (1989). Relation of implicit theories to the construction of personal histories. *Psychological Review*, 96(2), 341–357. <https://doi.org/10.1037/0033-295X.96.2.341>
- Ruch, W. (2009). Amusement. In D. Sander & K. Scherer (Eds.), *The oxford companion to emotion and the affective sciences* (pp. 27–28). Oxford University Press.
- Rudd, M., Vohs, K. D., & Aaker, J. (2012). Awe expands people's perception of time, alters decision making, and enhances well-being. *Psychological Science*, 23(10), 1130–1136. <https://doi.org/10.1177/0956797612438731>
- Russell, J. A. (1989). Measures of emotion. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research, and experience* (Vol. 4, pp. 83–111). Academic Press.
- Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin*, 115, 102–141.
- Saville, D. J. (1990). Multiple comparison procedures: The practical solution. *The American Statistician*, 44(2), 174–180.
- Scheier, M. F., & Carver, C. S. (1977). Self-focused attention and the experience of emotion: Attraction, repulsion, elation, and depression.

- Journal of Personality and Social Psychology*, 35(9), 625–636. <https://doi.org/10.1037/0022-3514.35.9.625>
- Schubert, C., Lambert, 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. *Biological Psychology*, 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.), *Handbook of motivation and cognition: Foundations of social behavior* (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. *Journal of Personality and Social Psychology*, 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. *Frontiers in Psychology*, 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.), *The regulation of emotion* (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. *American Psychologist*, 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. *The Journal of Positive Psychology*, 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. *Cognition and Emotion*, 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. *Psychological Science*, 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. *Emotion Review*, 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. *Journal of Personality and Social Psychology*, 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. *Emotion*, 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. *Psychophysiology*, 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. *Journal of Personality and Social Psychology*, 49(6), 1460–1469. <https://doi.org/10.1037/0022-3514.49.6.1460>
- Thorson, J. A., Powell, F. C., Sarmany-Schuller, I., & Hamps, W. P. (1997). Psychological health and sense of humor. *Journal of Clinical Psychology*, 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. *Psychological Inquiry*, 15(2), 103–125. https://doi.org/10.1207/s15327965pli1502_01
- Valdesolo, P., & Graham, J. (2014). Awe, uncertainty, and agency detection. *Psychological Science*, 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. *Psychology of Religion and Spirituality*, 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. *Current Biology*, 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. *Personality and Individual Differences*, 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. *NeuroImage*, 47(3), 836–851. <https://doi.org/10.1016/j.neuroimage.2009.05.044>
- Zarski, J. J. (1984). Hassles and health: A replication. *Health Psychology*, 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. *Clinical Psychology & Psychotherapy: An International Journal of Theory & Practice*, 12(4), 270–287. <https://doi.org/10.1002/cpp.460>

(Appendix follows)

Appendix
Emoticons Used in Study 5

Emotion	Emoticon
Awe	
Joy	
Pride	

Received May 14, 2019
Revision received December 23, 2020
Accepted January 2, 2021 ■