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Awe as a Scientific Emotion

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Abstract

Awe has traditionally been considered a religious or spiritual emotion, yet scientists often report that awe motivates them to answer questions about the natural world, and to do so in naturalistic terms. Indeed, awe may be closely related to scientific discovery and theoretical advance. Awe is typically triggered by something vast (either literally or metaphorically) and initiates processes of accommodation, in which existing mental schemas are revised to make sense of the awe-inspiring stimuli. This process of accommodation is essential for the kind of belief revision that characterizes scientific reasoning and theory change. Across six studies, we find that the tendency to experience awe is positively associated with scientific thinking, and that this association is not shared by other positive emotions. Specifically, we show that the disposition to experience awe predicts a more accurate understanding of how science works, rejection of creationism, and rejection of unwarranted teleological explanations more broadly.

Keywords: Awe; Science; Teleology; Explanation

1. Introduction

Awe is often assumed to go hand in hand with belief in a divine creator. Indeed, experimentally induced experiences of awe (for instance, as a result of viewing vast nature scenes) can, at least in the short term, increase reported religiosity and spirituality (Valdesolo & Graham, 2014; Van Cappellen & Saroglou, 2012) and decrease the perceived explanatory power of science (Valdesolo, Park, & Gottlieb, 2016). Yet countless anecdotes reveal the experience of awe to be a catalyst of *science* and scientific advance (Sagan, 2006). Richard Dawkins (1997), for example, describes the “spine-shivering, breath-catching awe . . . that modern science can provide.” Charles Darwin famously underscored the grandeur in the view of life suggested by his theory of natural selection (Darwin,1968).

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How might awe relate to religious conviction, on the one hand, and to scientific inquiry, on the other? One answer comes from a theoretical perspective on the effects of awe on cognitive processing. According to Keltner and Haidt (2003), awe is a destabilizing emotion: It is elicited by something *vast*, either physically or metaphorically, that is difficult to understand. Looking at the night sky is a classic example; considering the vastness of the universe can feel impossible to grasp. Keltner and Haidt suggest that, as a result, awe stimulates processes of *accommodation*, in which existing mental schemata are revised to make sense of the awe-inspiring stimulus. Because accommodation can be difficult or unsuccessful, awe straddles the border between positive and negative—provoking a sense of wonder, but also one of powerlessness and uncertainty. In fact, recent experimental work suggests that inducing a sense of awe can decrease tolerance for uncertainty and ambiguity in the environment, driving individuals to reconcile that uncertainty by means of compensatory control (Kay, Moscovitch, & Laurin, 2010; Valdesolo & Graham, 2014), with religious notions of supernatural control offering one avenue for doing so (Valdesolo & Graham, 2014).

Science could offer an alternative response to awe by providing a sense of predictability, explanation, and control, perhaps similar, in the general sense, to that provided by religion (Farias, Newheiser, Kahane, & de Toledo, 2013; Rutjens, van Harreveld, & van der Pligt, 2013). Another possibility is that experimentally induced awe, which is often accompanied by an aversive sense of powerlessness, is fundamentally different from the ongoing sense of wonder that accompanies a scientific approach to the natural world. Consistent with this idea, recent work has shown that experimentally induced awe and *dispositional* awe yield different relationships with tolerance for uncertainty and ambiguity. Whereas experimentally induced awe is associated with *decreased* tolerance for uncertainty (Valdesolo & Graham, 2014), individuals who are prone to experiencing awe on a regular basis are known to have an *increased* tolerance for ambiguity and uncertainty (Shiota, Keltner, & John, 2006). To date, little work has investigated how or why state and dispositional awe might differ from each other, but the existing literature makes an interesting prediction. Given that science often requires *high* tolerance for uncertainty and ambiguity (Schwartz, 2008), and that conceptual changes—"accommodation"—are essential to both science education and scientific advance, we might expect *dispositional* awe to relate to the open-minded, scientific orientation toward the natural world described by Dawkins and Darwin and reported by so many working scientists.

Across six studies, we test this prediction by investigating the association between dispositional awe, on the one hand, and scientific thinking and scientific beliefs about the natural world, on the other. Our approach is guided by a trait emotion approach, widely used in the study of emotion-cognition relations (e.g., Keltner & Horberg, 2015; Lerner & Keltner, 2001). In Studies 1–3, we show that dispositional awe predicts an increased understanding of the nature of science (NOS). In Studies 4–5, we demonstrate that dispositional awe also predicts the endorsement of scientific claims about the origins of human life: evolution versus creation. Finally we show in Study 6 that dispositional awe predicts a decreased reliance on scientifically unwarranted teleological explanations more broadly.

2. Study 1

In Study 1, we sought to investigate the relationship between dispositional awe and a basic understanding of the scientific process, referred to as the NOS.

We measured dispositional awe using the Dispositional Positive Emotion Scale (DPES; Shiota et al., 2006; see Table 1), a well-validated instrument for measuring individual differences in tendencies to experience seven emotions, with either five or six items for each of the following emotions: joy, contentment, pride, love, compassion, amusement, and awe (sample item: "I feel wonder almost every day"). The DPES awe subscale captures individuals' tendency to feel awe on a regular basis and experience wonder about the external world, and, in past studies, has been found to predict increased altruism, curiosity, humility, and reduced cytokine response (Anderson, Gordon, Stellar, McNeil, Monroy, & Keltner, unpublished data; Piff, Dietze, Feinberg, Stancato, & Keltner, 2015; Stellar et al., 2015, 2018).

We measured beliefs about the NOS with a questionnaire designed to assess beliefs about multiple facets of science, captured by themes such as "scientific hypotheses and theories may be modified over time" and "the process of science is influenced by social and cultural factors" (sample item: "Scientific theories are subject to ongoing testing and revision"; Lombrozo, Thanukos, & Weisberg, 2008).

2.1. Method

We recruited 316 individuals (163 females; M_{age} = 35 years, SD = 12 years) from Amazon Mechanical Turk in exchange for payment. All studies were conducted after collecting pilot data in which we established the original effect. Sample sizes reported in this paper always exceeded the sample sizes used in pilot studies, usually by more than 30%. Participants in all studies had IP addresses from the United States. We restricted participation to those with approval ratings >95% on previous tasks, which has been shown to ensure high data quality (Peer, Vosgerau, & Acquisti, 2014). As such, no participants in any of our studies were excluded from analyses, though data from participants who did not complete the study were not analyzed.

Prior to entering the study, we filtered out workers who had participated in other studies reported in this paper or other studies from members of our research group that were methodologically or conceptually similar. Participants filled out, in random order, the

Table 1
Awe subscale of the Dispositional Positive Emotion Scale

1. I often feel awe.
2. I see beauty all around me.
3. I feel wonder almost every day.
4. I often look for patterns in the objects around me.
5. I have many opportunities to see the beauty of nature.
6. I seek out experiences that challenge my understanding of the world.

DPES (Shiota et al., 2006) and a 65-item NOS questionnaire (Lombrozo et al., 2008; see Table S2).

At the end of the study was a demographic survey that included a 1–7 rating reflecting belief in God (Gervais & Norenzayan, 2012), a political orientation rating that ranged from 1 ("very liberal") to 7 ("very conservative"), and a question about the highest level of education completed, with a set of nine options, including "high school/general education diploma," "some college," "2-year college," "4-year college," and several options for graduate degrees. Participants were also asked whether they had taken courses in biology, chemistry, or physics at the undergraduate or graduate level. Table 2 reports the characteristics of our sample in this and each subsequent study.

2.2. Results

As in prior work (Shiota et al., 2006), we found high reliability among the six items of the DPES measuring dispositional awe (Cronbach's $\alpha = 0.82$). We also found that the DPES subscales capturing different positive emotions were highly correlated (average r across six studies = .52), reflecting a general tendency to experience or report positive emotion. In each study, we therefore performed a regression analysis with all seven DPES emotions, belief in god, and education level (a factor variable) as predictors for the dependent variable of interest, thereby allowing us to identify variance attributable to dispositional awe while controlling for other positive emotions, religious belief, and education. Table 3 reports the key results across all six studies.

For Study 1, the dependent variable for this regression analysis was NOS score. As predicted, we found that individuals reporting higher levels of dispositional awe had a

Table 2
Characteristics of participant samples for each study

	Belief in God	Political Orientation	% w/College Degree or Higher	% w/Biology Education ≥ Undergrad Level	% w/Chemistry Education ≥ Undergrad Level	% w/Physics Education ≥ Undergrad Level
Study 1	4.29 (2.11)	3.42 (1.66)	49	51	42	32
Study 2	3.87 (2.09)	3.42 (1.68)	69	73	59	57
Study 3	3.57 (2.10)	3.08 (1.66)	44	47	40	30
Study 4	4.04 (2.14)	3.43 (1.66)	48	49	40	32
Study 5	4.03 (2.02)	3.37 (1.67)	46	49	40	34
Study 6	3.98 (2.11)	3.40 (1.73)	47	45	36	29

Note. Belief in god ranged from 1 (low) to 7 (high). Political orientation ranged from 1 (very conservative) to 7 (very liberal). Standard deviations are reported in parentheses.

Table 3
Results of Studies 1–6

	Study 1, n = 316	Study 2, n = 291	Study 3, n = 309	Study 4, n = 470	Study 5 (Creationism), n = 608	Study 5 (Theistic Evolution), n = 608	Study 6, n = 2,035
Awe	**0.35*****	**0.18***	**0.20***	**−0.12***	**−0.95**†	**−0.97***	**0.10*****
Joy	**−0.49*****	**−0.37****	**−0.34***	0.03	1.07	−0.32	**−0.25*****
Contentment	0.17	−0.04	0.03	**0.14***	**1.45***	−0.55	−0.01
Pride	0.07	−0.13	0.06	−0.08	−0.1	**1.35***	0.00
Love	0.04	0.08	−0.02	0.01	**−1.14***	0.3	0.04
Compassion	**0.17***	**0.22****	**0.17***	−0.02	−0.87	−2.25	**−0.06***
Amusement	0.07	**0.18****	−0.02	−0.01	0.24	0.69	**0.07****
Belief in god	−0.11	−0.05	−0.02	**0.67*****	**4.37*****	**7.46*****	**−0.21*****

Note. In each study, we performed a regression analysis with the seven DPES emotions and belief in god as predictors for the dependent variable of interest. All studies controlled for level of education. In addition, Study 2 included openness to new experience as an additional predictor, and Study 6 controlled for participant sample. Beta coefficients for each factor are reported above (Studies 1–6), with two dependent variables reported for Study 5. Beta coefficients for Study 5 are from a logistic regression. Significant coefficients are indicated in bold.
†p = .06; *p < .05; **p < .01; ***p < .001.

more accurate understanding of the NOS ($\beta = 0.35$, $t(300) = 4.40$, $p < .001$). Additional results are reported in Table 3.

3. Study 2

In Study 2, we sought to replicate the relationship between dispositional awe and NOS found in Study 1, while additionally considering individual variation in openness to new experience (John, Naumann, & Soto, 2008), which has been linked to both dispositional awe (Shiota et al., 2006) and scientific creativity (Feist, 2006), suggesting that it could be a common cause generating the observed association between dispositional awe and NOS. We additionally considered need for cognitive closure (Roets & Van Hiel, 2011) as an individual difference variable that could mediate the association between dispositional awe and NOS.

3.1. Method

Two-hundred and ninety-one individuals (148 females; M_{age} = 34 years, SD = 10 years) participated in this study. In addition to the complete set of measures included in Study 1, Study 2 included a measure of openness to new experience (John et al., 2008) and a measure of need for cognitive closure (Roets & Van Hiel, 2011). These measures were always included after the DPES and NOS scales (with the order of the two randomized) and before the demographic questions.

3.2. Results

Replicating previous findings (Shiota, Keltner, & Mossman, 2007; Shiota et al., 2006), dispositional awe related positively to openness, $r = .38$, $t(289) = 6.95$, $p < .001$, and negatively to need for cognitive closure, $r = -.19$, $t(289) = -3.34$, $p < .001$. We conducted a regression model identical to that in Study 1, but this time included openness to new experience as an additional predictor in our model. We found that dispositional awe still positively predicted NOS scores ($\beta = 0.18$, $t(274) = 2.20$, $p = .029$), suggesting that the relationship between dispositional awe and NOS is not an artifact of their shared association with openness to new experience.

We also considered a model in which need for cognitive closure was included as an additional predictor. When we did so, dispositional awe was no longer significantly related to NOS understanding ($\beta = -0.13$, $t(273) = 1.62$, $p = .107$), though need for cognitive closure was ($\beta = -0.21$, $t(273) = -3.13$, $p = .002$). We also tested whether need for cognitive closure mediates the relationship between dispositional awe and NOS using the "mediate" package in R (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014). The model was not significant ($b = 0.24$, 95% CI [0.04, 1.48]). This suggests that dispositional awe and need for cognitive closure share variance that may be responsible for the relationship between awe and NOS score, though the relationship does not appear to be one of straightforward mediation.

4. Study 3

Study 3 investigated the relationship between dispositional awe and a different measure of NOS understanding, generated from the Next Generation Science Standards (NGSS Lead States, 2013). We additionally aimed to probe the specificity of the association between dispositional awe and scientific beliefs by testing an association between dispositional awe and "scientism"—the belief that science provides the best or only route to knowledge. Unlike our measures of NOS, this measure does not capture the scientific attitude toward uncertainty and ignorance that motivates our predicted association between dispositional awe and a scientific worldview.

4.1. Method

In all, 309 individuals (148 females; $M_{age} = 32$ years, $SD = 11$ years) completed the study.

The procedure was identical to that of Study 1, with two modifications. First, the NOS measure was replaced with an alternative measure of the understanding of science based on the US National Research Council's NGSS, a framework for creating K-12 science curricula (NGSS Lead States, 2013). We adapted language from the NGSS's eight specific learning goals to create a novel NOS questionnaire (sample item: "Science knowledge is based on empirical evidence and includes the process of coordinating patterns of evidence with current theory"; see Table S3). Individuals indicated how much they agreed with each NOS item on a scale from 1 ("completely disagree") to 7 ("completely agree").

Second, we added a Belief in Science scale (Farias et al., 2013) as a measure of "scientism"—the view that science is the most universally applicable and valuable approach to the world (sample item: "The scientific method is the only reliable path to knowledge"). The beliefs captured by this measure are thought to deliver some of the same existential benefits as belief in supernatural control, such as decreased stress and anxiety (Farias et al., 2013).

4.2. Results

Using a similar regression model as in the first two studies, we again found that dispositional awe positively predicted NOS score ($\beta = 0.20$, $t(292) = 2.08$, $p = .039$). We also tested a similar model in which we used scientism as the dependent variable; this analysis failed to find a significant effect of dispositional awe ($\beta = 0.06$, $t(292) = .82$, $p > .250$).

5. Study 4

Studies 1–3 provide evidence that everyday experiences of awe—or dispositional awe—predict a sophisticated understanding of the scientific enterprise (NOS), but we found no evidence that awe is related to a dogmatic "faith" in the scientific method (scientism). These findings are among the first to empirically support a connection between awe and understanding the scientific process.

Is dispositional awe similarly related to the endorsement of specific scientific claims? In Study 4, we asked how dispositional awe relates to belief in evolution. Some view evolution as existentially threatening (Brem, Ranney, & Schindel, 2003), in part because it depicts the development of life on earth as the result of largely nondirected processes, which are seen as aversive and a threat to control (Kay et al., 2010). Indeed, prior work has found that diminishing feelings of control can increase people's preference for creationist theories over evolutionary ones (Rutjens, Van Der Pligt, & Van Harreveld, 2010), and experimentally induced awe similarly decreases endorsements of evolution (Valdesolo, Park, et al., 2016). If highly awe-prone individuals are more comfortable with ambiguity and uncertainty, however, they might find evolution less threatening and be *less* inclined toward creationist alternatives.

5.1. Method

In all, 470 individuals (241 females; $M_{age} = 34$ years, $SD = 11$ years) completed the study.

The procedure was identical to that of Study 1, except that we replaced the NOS questionnaire with items measuring belief in evolution and creationism. We presented participants with three questions that are routinely administered as part of Gallup public opinion polls. Participants indicated agreement on a scale from 1 (“strongly disagree”) to 7 (“strongly agree”) with the following three questions (italicized labels were not presented to participants):

5.1.1. Young earth creationism

God created human beings pretty much in their present form at one time within the last 10,000 years or so.

5.1.2. Theistic evolution

Human beings have developed over millions of years from less advanced forms of life, but God guided this process.

5.1.3. Nontheistic evolution

Human beings have developed over millions of years from less advanced forms of life, but God had no part in this process.

5.2. Results

Again using the seven DPES emotions, as well as belief in god and education level, as predictor variables, we found that high levels of dispositional awe were related to the *rejection* of young earth creationism ($\beta = -0.12$, $t(454) = -2.21$, $p = .028$), though not to endorsement of theistic evolution ($\beta = 0.10$, $t(454) = 1.62$, $p = .106$) or nontheistic evolution ($\beta = -0.12$, $t(454) = -2.21$, $p = .028$).

6. Study 5

In Study 5, we sought to replicate the association between dispositional awe and beliefs about human origins found in Study 4, but to do so using a different measure of evolutionary beliefs.

6.1. Method

In all, 608 individuals (309 females; $M_{age} = 34$ years, $SD = 12$ years) completed the study.

The procedure was identical to that of Study 4, except that we used an alternative measure of belief in evolution and creationism. Participants responded to either one or two questions taken from the Pew Research Center. They were initially asked to choose which option best represented their views: (a) “humans and other living things have evolved over time,” or (b) “humans and other living things have existed in their present form since the beginning of time.” Those who chose the former were then directed to choose one of two options: (a) “humans and other living things have evolved due to natural processes such as natural selection,” or (b) “a supreme being guided the evolution of living things for the purpose of creating humans and other life in the form it exists today.” The first question represents a forced-choice option between evolution and creationist theories, and the second represents a choice between nontheistic and theistic evolution.

6.2. Results

In a logistic regression with the same predictors as in previous studies, high levels of dispositional awe marginally predicted the likelihood of favoring an evolutionary view over a creationist alternative ($\beta = 0.95$, OR = 0.73, $z = -1.87$, $p = .061$) and significantly decreased the likelihood of endorsing a theistic (as opposed to a nontheistic) view of evolution ($\beta = -0.97$, OR = 0.69, $z = -2.02$, $p = .044$).

7. Study 6

Creationism could reflect teleological reasoning: a tendency to perceive the world as having been designed for a purpose (Kelemen, 1999). In appealing to intentional design, creationism offers a purpose for human existence (Gervais, 2015), whether or not that purpose is apparent from a human perspective. In Study 6, we investigated whether dispositional awe is associated with the rejection of other scientifically questionable teleological beliefs in nonbiological domains, such as the belief that physical phenomena (such as earthquakes) occur to achieve particular ends (Kelemen & DiYanni, 2005; Lombrozo, Kelemen, & Zaitchik, 2007).

7.1. Method

Study 6 combines data from three samples, which each completed the DPES, a task used to measure intuitive teleological commitments, and the relevant demographic information. The samples differed in several ways. In Sample A, participants completed 15 additional test items on an intuitive teleology task (detailed below). In Sample B, participants also completed a NOS questionnaire and measures of need for cognitive closure and openness to experience. In Sample C, participants completed a need for cognition scale. In all three samples, the task measuring intuitive teleological commitments was always completed first, and subsequent measures were presented in random order. The combined sample was comprised of 2,035 individuals (1,076 females; $M_{age} = 34$ years, $SD = 11$ years).

The intuitive teleology task was adapted from Kelemen, Rottman, and Seston (2013). Participants were asked to identify explanations—some teleological and some mechanistic—as true or false. They were prompted to read each item and respond within 5.5 s, at which point the screen automatically advanced to the next trial. Participants saw either 100 or 85 statements presented in a random order, 30 (or 15) of which were "test" items that described intuitively appealing but false teleological explanations for biological and nonbiological phenomena (e.g., "Bees exist in order to facilitate pollination in plants," "Lightening releases electricity in order to travel"). The remaining 70 nontest items had what should have been an obviously true or false explanation. We analyzed performance on the 15 test items that presented participants with intuitively appealing but false teleological explanations for nonbiological phenomena, as only one of the three independent samples (Sample A) included the 15 test items describing biological phenomena. These additional items were dropped in Samples B and C in light of independent evidence from our research group that responses were partially driven by misconceptions about natural selection rather than more general beliefs about science or purpose (Guha & Lombrozo, 2017).

We modified the 100 statements from the original task by Kelemen et al. (2013) in three ways (see Table S4). First, we included an equal number of items from biological and nonbiological domains (in Sample A). Second, the ratio of true versus false test items was varied across participants to ensure that response patterns were not determined by assumptions about the composition of items (e.g., that they would include an equal number of true and false items). Specifically, participants were randomly assigned to one of two conditions that varied the number of true statements within the set of 70 control items (20 or 50). Finally, our false teleological control items were all false in the same way: They all specified an incorrect function for some item or phenomenon that does have a function (e.g., "Window blinds have slats so that they can capture dust"; clearly the slats serve an alternative purpose).

7.2. Results

We measured test accuracy as the percentage of test items for which the participant correctly rejected the false teleological explanation. We used this proportion as the outcome variable in a regression model with the same predictors as previous studies, but because this study involved three different samples, we also included sample (A, B, or C) in our model as a covariate. We found that dispositional awe predicted the rejection of scientifically-unwarranted teleological explanations for the nonbiological natural world ($\beta = 0.10$, $t(2{,}016) = 3.31$, $p < .001$).[1]

We also used the same predictors to test a model that used accuracy on the baseline (e.g., nontest) items as the outcome variable. Awe did not predict performance accuracy on these items ($\beta = 0.05$, $t(2{,}016) = 1.67$, $p = .096$; see Table S1), though it did trend toward significance.

8. Discussion

The six studies reported here provide support for a previously undocumented relationship between awe and scientific thinking. The disposition to experience awe in daily life —as captured in the DPES—predicts a nuanced appreciation of the scientific process and the rejection of scientifically unwarranted beliefs. Specifically, our studies reveal that above and beyond other positive emotions (e.g., joy, contentment, amusement), belief in God, level of education, and openness to new experience, dispositional awe predicts

(a) understanding the NOS (Studies 1–3), (b) a rejection of creationism (Studies 4–5), a canonically teleological belief, and (c) rejecting scientifically questionable teleological explanations about the natural world more broadly (Study 6). Equally revealing is an association we did *not* observe. Dispositional awe predicted a nuanced understanding of the scientific process, but we failed to find evidence that awe is related to a dogmatic belief in the value of science above and beyond all other human endeavors ("scientism"). Our findings suggest that dispositional awe is associated with scientifically informed beliefs about the world, not with "faith" in science, though more work is necessary to establish and explore this latter point.

Our findings also suggest that the relationship between awe and scientific thinking is specific to awe, and not shared by other positive emotions, such as pride, joy, or amusement (see Table 3). In only seven of 42 possible cases did we observe a significant association between another positive emotion and our dependent measure in the same direction as that predicted and found for awe. If anything, our results suggest that general positivity (e.g., joy) tends to run counter to awe, and negatively predicts scientific thinking, whereas emotions that promote focus away from one's self and onto others, such as compassion, sometimes related positively to scientific thinking. These results suggest the value of a more thorough exploration of the relationships between positive emotions and scientific thinking; for now, we can note that awe was the only emotion to evince the predicted relationships with scientific thinking and scientific beliefs across all six studies.

Taken together, the findings from our six studies suggest that awe is not only consistent with a scientific approach to the world but positively associated with one. Moreover, this association makes sense in light of the connection between science and uncertainty. Engaging in science requires a willingness to revise beliefs in light of new evidence (to "accommodate"), and many scientific claims—such as evolution and other nonteleological processes—invoke probabilistic processes for which particular ends are not guaranteed (Valdesolo, Shtulman, & Baron, 2016).

It is worth noting, however, that the associations revealed by the present research are just that: associations, not causal connections. It could be that awe-prone individuals are better suited to scientific thinking because they frequently experience awe, or that facility with scientific thinking itself disposes people to experience awe more regularly. Yet a third possibility is that dispositional awe and scientific thinking share one or more common causes. These questions, and others, are rich areas for future work. For instance, it would be valuable for both theoretical and pedagogical reasons to know whether dispositional awe is associated not only with scientific thinking and beliefs, but also with greater facility in learning new scientific concepts (see Valdesolo, Shtulman, et al., 2016, for a related discussion).

We are, at present, agnostic as to the causal relationship between awe and scientific thinking. Whatever establishes the initial relationship, however, we speculate that it is mutually reinforcing, with a tendency toward awe encouraging scientific thinking that in turn reveals greater occasion for awe. It is easy to imagine how awe-inspiring experiences in the natural and social world reveal core elements of scientific thought—precision in classification, pattern detection, attention to complex causal processes—that in turn set the stage for further experiences of awe. The present work thus takes a first step toward understanding the relationship between awe and scientific thought, but a great deal remains to be done.

Note

1. We also found that performance on the test items, but not control items, varied as a function of the number of true statements within the set of 70 control items. Those who saw 20 true statements had significantly higher accuracy scores than those who saw 50 true statements (mean accuracy scores = 0.51 and 0.42, respectively; $t(2{,}033) = 8.43$, $p < .001$). To account for this discrepancy, we included condition as a covariate in a model that we tested in addition to the one reported in the main text. Condition was a significant predictor of test accuracy when included in the model ($b = 0.20$, $t(2{,}014) = 4.45$, $p < .001$), as was the interaction term for condition and dispositional awe ($\beta = -0.13$, $t(2{,}014) = -2.58$, $p = .010$). This interaction was driven by a stronger effect of awe for those who saw 50 true statements ($\beta = 0.14$, $t(1{,}006) = 3.13$, $p = .002$) than those who saw 20 true statements ($\beta = 0.07$, $t(992) = 1.62$, $p = .106$).

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Analyses not reported in the main text.
Table S2. Nature of science questionnaire (Studies 1–2).
Table S3. Nature of science questionnaire (Study 3).
Table S4. Statements used in Study 6.