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Awe or horror: Differentiating two emotional responses to schema-incongruence

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1 **Abstract**

2 Experiences that contradict one's core concepts (e.g. of the world, people, the self)
3 elicit intense emotions. Such schema incongruence can elicit awe, wherein experiences that
4 are too vast to understand with existing cognitive schemata cause one to feel that schemata
5 should be updated [i.e., a "need for cognitive accommodation" (NFA); Keltner & Haidt,
6 2003]. However, other emotional responses to schema incongruence, such as horror, have not
7 been investigated.

8 The current studies compared awe and horror to investigate if they are distinct
9 schema-incongruent emotional responses. Study 1 observed significant differences between
10 awe and horror in cognitive appraisals (e.g., certainty, legitimacy), indicating several areas of
11 dissimilarity. Study 2 found evidence that awe and horror are both responses to schema-
12 incongruence, as schema incongruence and NFA were salient in awe and horror, but not a
13 contrast emotion. However, awe and horror were elicited by different types of schema
14 incongruence: awe by spiritual vastness, horror by extremity. Awe-eliciting experiences also
15 appeared to be easier to assimilate than horrifying experiences, as NFA and uncertainty were
16 significantly lower in awe than in horror. Differences in the functions of horror and awe are
17 also discussed.

18 Word count: 185

19 Keywords: awe, horror, emotional appraisals, cognitive schema

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3 “[L]ike it or not, Auschwitz expands the universe of consciousness no less than
4 landing on the moon.” – Miller, 2004

5 **Introduction**

6 Emotions are shaped by cognitive schemata. Schemata, patterns of cognition that
7 organize knowledge and conceptual relationships (Fiske & Linville, 1980), are developed via
8 experience and help us quickly appraise events. In turn, these appraisals elicit emotions
9 (Smith & Ellsworth, 1985). If a situation is consistent with one’s cognitive schemata, it elicits
10 an emotion that motivates adaptive behavioural responses (Keltner & Gross, 1999) and
11 reinforces the schemata that guided it (Clore & Gasper, 2000). But what is the emotional
12 response to experiences that are incommensurable with one’s existing schemata?

13 This paper proposes that events and phenomena that violate mental representations of
14 the world elicit “schema-incongruent emotions” that motivate not just behavioural responses,
15 but also cognitive restructuring of the categories through which one interprets the world, i.e.,
16 cognitive accommodation (Piaget, 1950). Awe is one such schema-incongruent emotion
17 (Keltner & Haidt, 2003) and horror is another. Although some view horror as a subtype of
18 awe (Gordon et al., 2017; Shiota, Keltner, & Mossman, 2007), the current studies provide
19 evidence that they are different emotional responses.

20 Although the emotional components of awe have been investigated (e.g., Bonner &
21 Friedman, 2011; Shiota et al., 2007), horror has yet to be investigated as a natural
22 emotion[insert footnote 1 here]. However, horror appears to exhibit the five components of
23 emotion (Scherer, 2005): Darwin (1872) described horror’s facial expression and
24 biophysiological symptoms, PTSD researchers[insert footnote 2 here] (e.g., Janoff-Bulman,

1 1992) and philosophers (Carroll, 1990) have detailed the subjective experience of horror,
2 survival psychology has described horror's action tendencies (Leach, 1994) and linguistic
3 analysis has identified appraisals that distinguish horror from other fear states (Wierzbicka,
4 1988).

5 *Emotional responses to schema incongruence*

6 Cognitive schemata are generalised beliefs about the self and the world that help
7 humans efficiently understand and categorise information and experiences. They operate
8 automatically and can be activated by external stimuli without conscious awareness (Nisbett
9 & Wilson, 1977; Taylor & Fiske, 1978). Schemata are resilient against disconfirmation:
10 information that does not fit is usually discounted, ignored, reappraised or revised to be
11 consistent with current schemata (Lodge & Taber, 2000). Such "cognitive assimilation" is
12 efficient and maintains a consistent worldview, so it is the default human information-
13 processing style (Piaget, 1950).

14 However, experiences that cannot be explained with existing schemata are often
15 relevant to survival (e.g., signal changes to vital environmental or social resources). Thus, the
16 adaptive cognitive response to schema incongruence is to update one's schemata accurately,
17 without schema-driven alteration (Diamond & Zoladz, 2016). This is "cognitive
18 accommodation", which entails bottom-up, stimulus-driven information processing (as
19 opposed to the top-down, schema-driven information processing of assimilation; Bless &
20 Fiedler, 2006; Fiedler & Bless, 2000). The difference between assimilation and
21 accommodation can be illustrated with the example of the 9/11 terrorist attacks, in which
22 terrorists flew two planes into the World Trade Centre in New York. Immediately after the
23 first plane hit, people assimilated the news by interpreting the event as an accident, which
24 was consistent with the schemata it activated (e.g., airline crashes). However, the second

1 plane strike invalidated the accident interpretation and forced people to accommodate their
2 understanding of the world to incorporate a new reality (Yum & Schenck-Hamlin, 2005).

3 Emotional responses to schema-incongruence may facilitate cognitive accommodation
4 by increasing neurocognitive plasticity (Diamond, Campbell, Park, Halonen, & Zoladz, 2007)
5 and weakening the attitudes, beliefs and assumptions that would otherwise facilitate
6 assimilation (Dalglish & Power, 2004; Lodge & Taber, 2000). This is experienced as a
7 “need for cognitive accommodation” (NFA): the perception that one cannot assimilate an
8 experience into existing schemata and should therefore modify one’s understanding of the
9 world to make sense of it (Keltner & Haidt, 2003). NFA shifts attention away from internal
10 knowledge structures and toward the external elicitor, privileging data-driven perceptual
11 processing over meaning-making conceptual processing (Bless & Fiedler, 2006). In
12 summary, schema-incongruent information both activates and violates a schema, which
13 elicits intense emotions that increase cognitive plasticity and bottom-up processing to
14 facilitate schematic revision.

15 ***Two types of schema-incongruence: Vastness and extremity***

16 “Schema incongruence” is how much an experience or entity deviates from “the self’s
17 ordinary level of experience or frame of reference” (Shiota et al., 2007, p. 945). Because
18 schemata are “cognitive manifestations of psychological needs” (e.g., security, interpersonal
19 belonging; McCann & Pearlman, 1990), they are sensitive to changes in one’s physical and
20 social environments that affect one’s ability to satisfy these needs. Different types of schema
21 incongruence elicit different responses, depending on what signals they give about the
22 environment.

23 Some types of schema-incongruity – such as vastness – signal new opportunities to
24 meet one’s needs (e.g., abundant nature, extraordinary people, spiritual forces). Vast
25 phenomena exist on a scale beyond full human comprehension and typically elicit awe

1 (Keltner & Haidt, 2003), which is associated with increased schematic flexibility that helps
2 one capitalise on the opportunities signalled by vastness (Armstrong & Detweiler-Bedell,
3 2008; Shiota et al., 2007). Awe-eliciting vastness causes categories to become more inclusive
4 (Shiota et al., 2007), less egocentric (Piff, Dietze, Feinberg, Stancato, & Keltner, 2015) and
5 more metaphysically-oriented (Van Cappellen & Saroglou, 2012) and can increase
6 perceptions of purpose, meaning and order in the world (Valdesolo & Graham, 2014).

7 Conversely, another type of schema-incongruity – extremity – signals that vital
8 resources, relationships or assumptions have become unviable or dangerous and one must
9 adapt to meet one’s needs. Similar to biological extremity (i.e., conditions too abnormal to
10 acclimate to and therefore necessitate adaptation; Gutschick & BassiriRad, 2003), extremity
11 is constituted by events or behaviors that deviate too much from basic world assumptions to
12 be assimilated, and instead require schematic accommodation. Extremity exceeds the limits
13 of comprehensibility or presumed possibility and is thus evaluated as “unthinkable” and
14 elicits appraisals associated with horror, such as, “I didn’t think that something like this could
15 happen” (Wierzbicka, 1988). For example, although deception and aggression are considered
16 morally wrong, they are understandable: “Most people can conceive of themselves lying,
17 stealing, breaking a promise, robbing a store, hitting someone, even killing”. However,
18 *extreme* deception or aggression “baffles understanding” and “stretch[es] our imaginations,
19 our understanding of what human beings are capable of” because it is “conduct that one
20 cannot conceive of oneself engaging in” (Singer, 2004, p. 195-196).

21 Vastness and extremity violate different schematic aspects. Vastness is a spatial or
22 conceptual expansiveness that violates schematic scale expectations and reveals the limits of
23 one’s knowledge. For example, someone whose experience with trees has been limited to
24 12m tall trees will have their concept of nature’s scale violated by seeing a 110m tall tree,
25 which will motivate adjustment of that schema’s spatial criteria. Because this schema

1 incongruity does not contradict other defining schematic traits, this accommodation is not
2 problematic. In contrast, extremity typically contradicts or negates core schematic traits. In
3 extremity (i.e., excessive conceptual distance from schematic norms), an entity (often a
4 person) exhibits a trait or behavior to a disproportionate degree that violates basic schematic
5 criteria for category inclusion. For example, the schema of “parent” includes both protecting
6 and disciplining one’s child. But a parent whose extreme “discipline” contravenes
7 “protection” (e.g., starving a child as punishment) violates the “parent” schema. To
8 accommodate this attribute-level schema incongruity, either the perpetrator must be
9 dissociated from the category (e.g., create new schema of “unfit parents”) or the “parent”
10 schemata must change to acknowledge that all parents can act similarly.

11 ***Awe and horror are distinct emotional responses to schema incongruence***

12 We propose that awe and horror are two different emotional responses to schema
13 incongruence. Schema-incongruent emotions are a subcategory of “knowledge emotions”
14 (e.g., surprise, interest, confusion), which are elicited by challenges to one’s thoughts and
15 knowledge (Silvia, 2010). We propose that schema-incongruent emotions are distinct among
16 knowledge emotions in being elicited by *global* challenges to one’s schematic structures (i.e.,
17 how one’s worldview is organized), rather than local challenges to the content of one’s
18 knowledge. Whereas trivial aberrations or novelties elicit surprise, confusion or interest, awe
19 and horror are elicited by contradictions of core schemata (e.g., moral values).

20 Because awe and horror both involve schema incongruence and NFA, some have
21 speculated that horror is a combination of fear and awe (Shiota et al., 2007) or a subtype of
22 awe (Gordon et al., 2017, Study 2b). However, empirical and theoretical research indicates
23 that awe and horror are different emotional responses to different types of schema
24 incongruence. Awe is elicited by entities and actions that enhance and strengthen systems of
25 meaning (Yaden, Haidt, Hood, Vago, & Newberg, 2017), such as art and moral excellence

1 (Shiota et al., 2007). In contrast, horror elicitors, such as catastrophe and cruelty, undermine
2 systems of meaning (Kristeva, 1982). Thus, they have opposite effects on basic world
3 assumptions: horror “shatters” them (Janoff-Bulman, 1992), but awe affirms or expands them
4 (Van Cappellen, Saroglou, Iweins, Piovesana, & Fredrickson, 2013).

5 Horror may sometimes be conflated with awe because both can involve fear (Gordon
6 et al., 2017; Piff et al., 2015). However, the fear in awe and horror differ in several aspects.
7 First, fear is central to horror, but peripheral and non-essential to awe (Bonner & Friedman,
8 2011; Keltner & Haidt, 2003). Second, whereas horror is a response to physical or existential
9 damage (Cavell, 1979), the fearful aspects of awe are appraised as benign (Bonner &
10 Friedman, 2011). Third, the fear in awe reflects respect or deference towards power (Keltner
11 & Haidt, 2003), but in horror is antagonistic to the elicitor and rejects it as abhorrent and
12 unnatural (Carroll, 1990; Kristeva, 1982). Fourth, horrified fear is a response to the
13 realization that *actual harm is currently occurring or has occurred* (Cavell, 1979), but fear in
14 awe is felt towards the *hypothetical* harm a powerful elicitor could cause in the future (Kant,
15 1790/1951).

16 Awe and horror also have different cognitive effects. Awe can expand ontological
17 schemata beyond the material world, leading to metaphysical inferences (Valdesolo &
18 Graham, 2014), feelings of personal connection with higher powers (Piff et al., 2015) and in-
19 group members (Krause & Hayward, 2015) and a reduced sense of a personal self (Yaden et
20 al., 2017). In contrast, horrifying experiences disrupt schemata related to safety, trust, power,
21 self-esteem and/or intimacy (Lisa McCann, Sakheim, & Abrahamson, 1988).

22 ***The Present Research***

23 The goal of this research is to investigate if awe and horror are different emotional
24 responses to schema-incongruent experiences. To test this, we investigated if they differ in
25 cognitive appraisals (Study 1) and elicitors (Study 2). Additionally, to test if awe and horror

1 are both responses to schema-incongruence, we investigated if schema-incongruence and
2 NFA were greater in awe and horror than in the schema-congruent emotion of contentment
3 (Study 2).

4 **Study 1: Cognitive appraisals in awe and horror**

5 Study 1 compared cognitive appraisals in awe and horror to investigate how they are
6 different and similar.

7 Hypothesis 1: because horror is aversive, Horror[insert footnote 3 here] will have
8 lower attention-related appraisals (e.g., focusing on the elicitor) than Awe.

9 Hypothesis 2: because horror is associated with survival situations, Horror will have
10 higher appraisals of goal-path obstacles and anticipated effort than Awe.

11 Hypothesis 3: because horror is associated with interpersonal conflict, Horror will
12 have higher appraisals of external human agency and lower appraisals of legitimacy and
13 pleasantness than Awe.

14 Hypothesis 4: because we assume that both are schema-incongruent emotions, we
15 predicted that Awe and Horror will have similarly low appraisals of certainty (i.e., high NFA)
16 and personal agency, and similarly high appraisals of situational agency[insert footnote 4
17 here].

18 ***Method***

19 *Participants*

20 Two-hundred-and-nineteen participants recruited on Mechanical Turk completed a
21 “survey on emotional experiences” for US\$1.25. Participants were required to be U.S.-born
22 native English speakers who were at least 18 years old and had not lived outside the U.S. for
23 more than two years. Participants exhibiting any of the following were excluded from
24 analysis: failed an attention check item, did not follow directions on open-response questions

1 (e.g., did not write about a specific event), exhibited answer straight-lining (low response
2 variance, $sd < .50$ for all Likert responses) or rated feeling the target emotion “not at all”.
3 Thirty-one participants’ data were excluded, leaving 188 participants for analysis[insert
4 footnote 5 here] ($M_{age} = 36.80$, $SD_{age} = 11.17$, $Range = 20-71$; 96 females, 89 males, 2 other;
5 76.4% European American, 9.9% African American, 1.1% Latino, 3.2% Asian American,
6 0.5% South Asian, 8.5% mixed race). A post-hoc power analysis[insert footnote 6 here] using
7 G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) indicated 92% power to detect medium-
8 sized effects ($d = .5$) in independent t-tests with a .05 two-tailed type 1 error probability.

9 *Procedure*

10 After providing consent, participants were randomly assigned to the Awe condition or
11 the Horror condition and asked to recall a personal experience of the target emotion, defined
12 as:

13 “[Awe/Horror] is an emotion felt towards something vast[insert footnote 7 here] that
14 you can’t fully understand at the time, in which...”

15 *Awe Condition:* “...you feel someone or something is amazing or sublime.”

16 *Horror Condition:* “...someone or something was harmed or damaged.”

17 Participants responded to the prompt via nine open-response questions adapted from
18 Smith & Ellsworth (1985; e.g., “What happened to make you feel awe/horror?”). Next,
19 participants rated cognitive and emotional appraisals of the target experience.[insert footnote
20 8 here] Lastly, they provided demographic information and were debriefed.

21 *Measures*

22 *Cognitive appraisals.* Participants rated 23 items measuring nine appraisal domains of
23 the target experience adapted from Smith and Ellsworth (1985) using a nine-point Likert
24 scale (1=“not at all”, 9=“extremely”; see Supplementary Materials for item-level

1 means)[insert footnote 9 here]. The items for each domain were averaged to form aggregate
2 variables (see Table 1).

3 *Manipulation check.* Participants rated how much they felt *awe* and *horror* during the
4 situation (presented among twenty emotion items) on a 7-point scale (1=“not at all”,
5 7=“extremely”).

6 **Results**

7 *Manipulation check*

8 Welch’s t-tests showed that *awe* was higher in the Awe condition and *horror* was
9 higher in the Horror condition (see Table 1). *Awe* and *horror* were uncorrelated in both
10 conditions, $r_s \leq .07$, $p_s \geq .51$.

11 *Appraisal dimensions*

12 Welch’s t-tests showed Awe and Horror differed in cognitive appraisals (see Table
13 1). Consistent with Hypotheses 1–3, appraisals of attentional activity and fairness were
14 greater in Awe, appraisals of external human agency, goal-path obstacles and anticipated
15 effort were greater in Horror, and appraisals of situational agency were equal between
16 conditions. However, contrary to Hypothesis 4, personal agency and certainty were
17 significantly higher in Awe than in Horror.[insert footnote 10 here]

18 [Table 1 near here]

19 **Discussion**

20 Emotion ratings for *awe* and *horror* were uncorrelated and between-condition mean-
21 differences had large effect sizes, supporting our general hypothesis that horror and awe are
22 different emotional experiences.

23 Awe and Horror differed in eight of nine appraisal dimensions. Horror had lower
24 appraisals of self-agency and certainty, which, combined with appraisals of greater goal-path

1 obstacles and anticipated effort, indicate coping anxiety, possibly because horrifying
2 situations have physical or cognitive demands that exceed one's abilities (Leach, 1994). In
3 contrast, the low appraisals of anticipated effort and goal-path obstacles in Awe may indicate
4 that the physical world and its constraints were less salient (e.g., self-transcendence; Yaden,
5 Haidt, et al., 2017).

6 Contrary to Hypothesis 4, certainty was higher in Awe than in Horror. Other research
7 similarly found that certainty was higher in positive awe than negative "threat-based awe"
8 (Gordon et al., 2017), but the effect size observed here is three times larger. This could
9 indicate that horror involves greater NFA than awe or that horrific NFA is more difficult to
10 resolve (Dalglish & Power, 2004). It is also possible that spontaneous meaning-making
11 helps accommodate schema-incongruence in awe (e.g. Valdesolo & Graham, 2014) but not in
12 horror.

13 Situational agency was the only appraisal dimension with no between-condition
14 difference. However, situational agency appraisals probably reflect different attribution
15 targets in the two emotions (Brewin & Shapiro, 1984). In Awe, situational agency may reflect
16 feelings of self-transcendence or a "small self" (Piff et al., 2015). In contrast, because horror
17 is elicited by harm and involves blame-related appraisals (external human agency, low
18 legitimacy), situational agency in horror may reflect hostility and blame (Feigenson, 2002) or
19 feelings of personal helplessness or dissociation (Brewin & Holmes, 2003).

20 One limitation of Study 1 was that it only compared awe and horror against each
21 other. Thus, we can discuss how they differ from each other, but not how they might be
22 similar relative to schema-congruent emotions. Therefore, Study 2 included a contrast
23 condition.

1 **Study 2: Vastness and NFA in awe and horror**

2 We propose that both awe and horror are elicited by schema incongruence and result
3 in NFA. To test if schema incongruence and NFA are greater in awe and horror than a
4 schema-*congruent* emotion, Study 2 contrasted awe and horror with contentment, which is
5 elicited by schema congruent experiences, such as the satisfaction of basic needs and goals
6 (Berenbaum, 2002).

7 Hypothesis 1: Awe and Horror will have significantly more schema incongruence
8 than Contentment.

9 Hypothesis 2: Awe and Horror will have significantly more NFA than Contentment.

10 An additional exploratory purpose of this study was to investigate what types of
11 experiences elicit awe and horror. To do so, a qualitative analysis was performed on
12 participants' written descriptions of awe and horror. Because coding categories were created
13 using inductive analysis, we had only one hypothesis about elicitors:

14 Hypothesis 3: Horror will be elicited by harm more frequently than Awe.

15 ***Method***

16 *Participants*

17 One-hundred-and-eighty-one participants recruited on Mechanical Turk participated
18 for US\$2.00. Participant requirements and exclusion criteria were identical to Study 1,
19 resulting in the exclusion of 47 participants' data[insert footnote 11 here], leaving 134 for
20 analysis (females = 81, males = 53; $M_{age} = 38.55$, $SD_{age} = 12.21$, Range = 20-64; 76.1%
21 European American, 7.5% African American, 5.2% East Asian American, 2.2% South Asian
22 or Indian, 1.5% Latino or Hispanic, 0.7% Middle Eastern, 0.7% Native American, 5% mixed
23 ethnicity, 0.7% chose not to answer). A post-hoc power analysis[insert footnote 12 here]
24 using G*Power indicated 93% power to detect medium-sized effects in chi-square tests (ϕ
25 = .3) with $\alpha = .05$ and 95% power to detect medium-sized effects in omnibus within-factors

1 ANOVAs ($\eta^2 = .06$) using three repeated measures with $\alpha = .05$ and post-hoc pairwise
2 comparisons with Bonferroni-adjusted $\alpha = .017$ ($d = .5$).

3 *Procedure*

4 A within-subjects design was used with three conditions (Awe, Horror, Contentment)
5 randomly counterbalanced. After providing consent, participants were asked to “vividly
6 recall a personal experience of [awe/horror/contentment] (not including experiences of
7 fictional products, e.g., movies, books)” and write 3-5 sentences about it. After writing about
8 the first target emotion, they rated its schema incongruence and NFA. This process was
9 repeated for the second and third emotions in turn. Lastly, participants provided demographic
10 data and were debriefed.

11 To explore what elicits awe and horror, written responses for the Awe and Horror
12 conditions were coded for elicitor categories. Categories were created via inductive coding by
13 the first author. Two hypothesis-blind coders applied dichotomous (applicable, not
14 applicable), non-mutually-exclusive elicitor codes to scenarios. The elicitor categories were:
15 “another person(s)”[insert footnote 13 here], “event”, “nature”, “human-made objects”,
16 “location or physical surroundings”, “information”[insert footnote 14 here] and “animals”.
17 Additionally, to differentiate horror from negative threat-based awe, scenarios were coded
18 with mutually-exclusive themes of “harm”, “death” and “threat without harm”, as well as a
19 non-mutually exclusive theme of “silver linings” (i.e., something positive occurring during
20 something negative). Thirty-four percent of scenarios[insert footnote 15 here] were coded by
21 both coders and initial Krippendorff alphas ranged .69–1.00, $M = .81$. [insert footnote 16 here]
22 Coding disagreements were resolved via three-way discussion with the first author.

23 *Measures*

24 *Schema Incongruence and NFA.* Items measuring schema incongruence and NFA
25 were based on previous theoretical and empirical descriptions of schema incongruence in awe

1 and horror (Keltner & Haidt, 2003; Janoff-Bulman, 1992; Schurtz et al., 2012; Shiota et al.,
2 2007; Piff et al., 2015). Because current theory asserts that schema incongruence causes NFA
3 (Janoff-Bulman, 1992; Keltner & Haidt, 2003), schema incongruence items measured how
4 much elicitors deviated from normality, and NFA items measured cognitive reactions to such
5 deviations. All items were rated on five-point Likert scales.

6 *Schema Incongruence*: Participants rated the schema incongruence of the eliciting
7 experience in relative and absolute terms (see Tables 3 and S2). *Relative incongruence*
8 measured deviance from “things you normally experience in everyday life” (-2=“much less
9 than normal”, 0=“the same as normal”, +2=“much greater than normal”; remapped to 1–5
10 scale for analysis). *Absolute incongruence* measured the applicability of general schema-
11 deviance qualities (1=“does not describe it at all”, 5=“describes it extremely well”).

12 *NFA items*: Participants rated three aspects of NFA (see Tables 4 and S3): *difficulty*
13 *assimilating the experience* (1=“does not describe it at all”, 5=“describes it extremely”),
14 *belief/value contradiction* (1=“very much contradicted”, 3=“neither contradicted nor
15 supported”, 5=“very much supported”; answers reverse-coded for analysis) and *cognitive*
16 *emotions* (1=“did not feel this at all”, 5=“felt this extremely”).

17 *Manipulation check*. Participants rated how much *awe*, *horror* and *contentment* they
18 felt during the experience (1=“did not feel at all”; 5=“felt extremely”), embedded within ten
19 emotion items.

20 **Results**

21 *Manipulation check*

22 One-way within-subjects ANOVAs with condition as the within-subjects factor
23 confirmed that each emotion was significantly greater within its target condition (all omnibus
24 and pairwise p s < .001, η^2 s \leq .63). Ratings for *awe* and *horror* were uncorrelated in all
25 conditions, r s \leq |.10|, p s \geq .23.

1 *Extremity* was higher in Horror than in Awe or Contentment, and higher in Awe than
2 Contentment (all $ps < .001$; see Figure 1).

3 There was a significant main effect for *Spiritual Vastness*, $F(1.78, 236) = 93.08$
4 with .89 Greenhouse-Geisser correction, $p < .001$, $\eta^2 = .41$. Pairwise comparisons indicated
5 *Spiritual Vastness* was higher in Awe than in Horror or Contentment, and higher in
6 Contentment than Horror (all $ps < .001$; see Figure 1).

7 Thus, two types of schema incongruence were observed (*Extremity* and *Spiritual*
8 *Vastness*) and, supporting Hypothesis 1, *Extremity* was salient in Horror, *Spiritual Vastness*
9 was salient in Awe and neither were salient in Contentment.

10 [Figure 1 near here]

11 *NFA*

12 *NFA* items were reduced using a Maximum Likelihood EFA with promax rotation.
13 Two factors emerged (see Table 4).[insert footnote 18 here] The first factor was interpreted
14 as *Shock* ($\alpha = .89$) and comprised items indicating the difficulty in cognitive assimilation. The
15 second factor was interpreted as *Chaos* ($\alpha = .76$) and comprised items indicating disorienting
16 mismatches with existing epistemic systems (Neimeyer, Herrero, & Botella, 2006).
17 Regression factor scores were used for subsequent analyses.

18 [Table 4 near here]

19 To test Hypothesis 2, one-way within-subjects ANOVAs were conducted on *Shock*
20 and *Chaos* with condition as the within-subjects factor. There was a main effect for *Shock*,
21 $F(1.82, 242) = 154.69$ with .90 Greenhouse-Geisser correction, $p < .001$, $\eta^2 = .54$. Post hoc
22 Bonferroni pairwise comparisons indicated *Shock* was higher in Horror than in Awe, $p < .001$
23 and Contentment, and higher in Awe than Contentment, $p < .008$ (Figure 2).

24 There was a main effect for *Chaos*, $F(2, 266) = 217.43$ with .91 Greenhouse-Geisser
25 correction, $p < .001$, $\eta^2 = .65$, and pairwise comparisons indicated *Chaos* was higher in

1 Horror than in Awe, $p < .001$, but did not differ between Awe and Contentment, $p = .90$
2 (Figure 2).

3 [Figure 2 near here]

4 ***Discussion***

5 Results from Study 2 indicated that both awe and horror are elicited by schema
6 incongruence and cause greater NFA than contentment. The data also provide further
7 evidence that awe and horror are empirically differentiable based on differences in elicitor
8 and type of schema incongruence.

9 Qualitative analysis indicated that awe and horror are elicited by different types of
10 experiences. Horror was usually elicited by harmful events, but awe rarely was. Further, awe
11 at harmful events was usually not felt toward the harm itself, but toward something positive
12 occurring despite the harmful situation. Such “silver linings” were completely absent from
13 horror scenarios. Additionally, horror (but not awe) was frequently elicited by information
14 (rather than first-hand witnessing), indicating that “the mere thought of” schema-incongruent
15 harm can elicit horror. In contrast, awe relies more on sensory perception (Shiota et al.,
16 2007). Thus, unlike negative threat-based awe, which has the same elicitors as positive awe
17 (e.g., nature; Gordon et al., 2017) horror had distinctly different elicitors, providing further
18 evidence that horror is not a fearful variant of awe.

19 Horror and Awe had significantly higher levels of schema incongruence and NFA
20 than Contentment, supporting the hypothesis that awe and horror are schema-incongruent
21 emotional responses. However, awe and horror appear to be differentiable based on what type
22 of schema incongruence is salient: transgressive *Extremity* in Horror, transcendent *Spiritual*
23 *Vastness* in Awe.

24 The high *Chaos* in Horror (i.e., confusion due to contradictions of one’s beliefs and
25 values) supports philosophical arguments that horrific things damage systems of meaning. It

1 also indicates that not all harm elicits horror, only senseless harm that violates our values;
2 morally justifiable harm may fail to horrify us (Rai, Valdesolo, & Graham, 2017).

3 While Horror involved high levels of NFA, Awe did not. Awe showed relatively mild
4 *Shock* coupled with and amazement at something that *supports* schemata (i.e., the inverse of
5 *Chaos*). However, because belief-consistent information has greater power to change one's
6 way of thinking (Fugelsang & Dunbar, 2005), one possibility is that mildly shocking
7 experiences that support one's beliefs and values lead to euphoric accommodation (e.g.,
8 epiphany, enlightenment).

9 **General discussion**

10 These studies offer evidence that awe and horror are distinctly different emotional
11 responses to schema incongruence. Awe and horror differed in cognitive appraisals (Study 1),
12 schema-incongruence and elicitors (Study 2). Awe was typically elicited by spiritually vast
13 experiences of nature, people, events and locations, whereas horror was elicited by harmful
14 events and extremity.

15 Both awe and horror involved NFA, but the NFA in awe was relatively mild, possibly
16 indicating some degree of belief-driven assimilation. Although awe involved NFA (*Shock*), it
17 also involved moderately high appraisals of certainty (for similar midscale appraisals of
18 certainty, see Gordon et al., 2017; Tong & Jia, 2017) and amazement at things that *support*
19 existing values and worldviews (low *Chaos*), indicating that the experiences were not
20 difficult to assimilate. Previous research similarly found that NFA is either not salient in awe
21 (e.g., not greater in awe relative to a contrast emotion, negatively correlated with awe ratings;
22 Schurtz et al., 2012) or less salient than vastness (e.g., lower ratings, smaller neutral-contrast
23 effect sizes; Chirico et al., 2017; Chirico, Ferrise, Cordella, & Gaggioli, 2018). The relatively
24 low salience of NFA may be due to the “noetic” sense of revelation and intuitive insight often

1 reported in awe (James, 1902), which would increase appraisals of certainty (Yaden et al.,
2 2017). Thus, accommodation in awe is not based on schema-conflict resolution, but rather
3 schematic expansion (Shiota et al., 2007), wherein schemata attain a broader scope of
4 meaning and greater explanatory weight (Fugelsang & Dunbar, 2005).

5 However, the low NFA in awe raises the question of whether awe involves top-down
6 assimilation. According to Fiedler & Bless (2000), assimilation involves “appetitive
7 learning” (e.g., exploratory behaviour, self-efficacy, approach motivations) that alters stimuli
8 to match schemata. With this in mind, many of awe’s effects indicate schema-driven
9 *assimilation* rather than stimulus-driven accommodation (Bless & Fiedler, 2006; Fiedler &
10 Bless, 2000): awe facilitates inferential abstractions (Valdesolo & Graham, 2014),
11 strengthens pre-existing beliefs (Valdesolo, Shtulman, & Baron, 2016), expands “oceanic”
12 categorization (Shiota et al., 2007), increases exploratory behaviour (e.g., using a greater
13 number of unique actions to interact with a novel object; Colantonio & Bonawitz, 2018) and
14 facilitates creative thinking (Chirico, Glaveanu, Cipresso, Riva, & Gaggioli, 2018). However,
15 creating unusual or novel connections between semantically distant concepts does not
16 transform or create new schemata. Creativity, imagination and play are *assimilative* processes
17 that use internal schemata to identify conceptual similarities in external stimuli and shape the
18 stimuli so they more clearly manifest schemata (Piaget, 1962). In contrast, in
19 accommodation, the external stimulus alters internal cognitive structures so they more
20 accurately reflect stimuli (e.g., imitation, not creativity).

21 The differences between awe and horror indicate different adaptive functions (Keltner
22 & Gross, 1999). It has been proposed that awe supports *group-level* fitness via the
23 downstream social effects of collective bonding, such as broadened social resources (Stellar
24 et al., 2017), prosociality and stabilised social hierarchies (Keltner & Haidt, 2003). In
25 contrast, horror may facilitate *individual* survival via its effects on cognition. Horror involves

1 recognition of painful truths that create a more complex worldview that “inoculates” against
2 psychological malfunction (Janoff-Bulman, 2006) and stress-related impairments of working
3 memory and executive function (Leach, 2012) during subsequent extreme situations. The
4 immediate effects of horror likely include arousal, attentive immobility and intense memory
5 of the elicitor, which enhance learning about dangerous, novel or unpredictable
6 environments, such as those encountered during migration or great ecological or societal
7 change (Diamond & Zoladz, 2016).

8 **Limitations, contributions and future directions**

9 Although the studies presented here have shown that the emotional appraisal
10 dimensions and elicitors of horror are different than those in awe, they do not furnish enough
11 evidence to declare that horror qualifies as a distinct emotion. These studies act as first step
12 towards future empirical investigations that can clarify this issue.

13 One methodological limitation arising from the lack of prior empirical data on horror
14 is that, because its elicitor qualities were unclear, we used retrospective recall to elicit the
15 target emotions, a technique common in emotion research, including research on awe (Shiota
16 et al., 2007; Griskevicius et al. 2010; Gordon et al., 2017), but one that is vulnerable to
17 memory biases (Bradburn et al., 1987). Future studies should use standardized elicitors, such
18 as photos and films, to confirm and expand on the findings presented here. One interesting
19 area of inquiry would be awe and horror differ physiologically. For example, awe involves
20 sympathetic nervous system withdrawal (Shiota et al., 2011), whereas anecdotal reports of
21 horror indicate both sympathetic nervous system activation (e.g., nausea, tachycardia) and
22 autonomic suppression (e.g., tonic immobility; Marx, Forsyth, Gallup, Fusé, & Lexington,
23 2008).

1 Another limitation of these studies is the use of the emotion labels “awe” and
2 “horror”, which may have introduced demand characteristics. In particular, the definition of
3 horror from Study 1 should be tested without emotion labels to ascertain its validity.
4 Although manipulation checks indicated this definition was adequate to differentiate horror
5 from awe, it may require clarification to discriminate horror from other negative emotions,
6 such as defining the elicitor as “shocking” or “against one’s core beliefs or values”.

7 Although Study 2 used a positive emotion contrast condition, there was no negative
8 contrast emotion. Previous studies have investigated how awe differs from multiple positive
9 emotions (Campos et al., 2013; Tong, 2015), but horror requires such clarification, such as
10 how horror differs from fear and disgust.

11 Finally, the current study only sampled the US population. Although awe has been
12 observed across cultures (Bai et al., 2017), because horror is elicited by irreconcilable
13 contradictions of one’s values or beliefs, it may be salient in cultures with analytic
14 ontological beliefs (e.g., the “law” of non-contradiction), such as the English-speaking West,
15 but not in cultures with dialectical ontologies that accept fundamental contradictions (e.g.,
16 East Asia; Peng & Nisbett, 1999).

17 Despite their limitations, these studies provide valuable data. First, they show that the
18 combination of schema-incongruence and NFA describes not just awe, but also horror, thus
19 introducing the concept of schema-incongruent emotions. Second, they indicate how awe and
20 horror are distinct emotional responses. Third, these studies are (to our knowledge) the first
21 empirical examination of horror as a natural emotion and address a gap in the literature,
22 providing a groundwork for future research. Last, our results problematize the centrality of
23 NFA in awe, which has been theoretically proposed (Keltner & Haidt, 2003) but not
24 empirically verified. Future research should investigate the nature of accommodation and
25 assimilation in awe. For example, awe may involve a type of NFA that the current measures

1 could not capture, such as violations of materialist beliefs and naïve physics. Similarly,
2 research should localize which aspects of belief and value systems are violated by horror
3 (e.g., moral imperatives, social trust and conceptualizations of embodiment).

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Footnotes

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[1] Previous psychological research on horror has been limited to “art horror” (e.g., psychological responses to cinematic fiction), which is different from “natural horror” towards real-life events (Carroll, 1990).

[2] However trauma and horror are not equivalent. Horror is one potential etiological factor in PTSD (Dalgleish & Power, 2004), but most horrifying events are not traumatic.

[3] Because we use the terms “awe” and “horror” to denote three different things (study conditions, Likert emotion ratings, emotions), we use the following conventions to distinguish between them: study conditions are capitalised (*Awe*, *Horror*), emotion ratings are italicised and lower-case (*awe*, *horror*) and emotions (in discussion, not the data) are unitalicised and lower-case (*awe*, *horror*).

[4] Data was collected before publication of Gordon et al. (2017), so their findings on “certainty” appraisals did not inform our hypotheses.

[5] Because these strict exclusion criteria caused many participants to be excluded, we separately analyzed data from all participants who missed ≤ 2 attention check questions ($N=212$). All results were consistent with those reported here, with no differences in *p*-values.

[6] Prior to data collection, sample sizes were determined using Cohen (1992)’s rule of thumb for medium effect sizes for .05 alpha and doubling it to obviate inattentiveness of online participants.

[7] Note that in Study 1, horror was defined as “vast” for participants, which is inconsistent with Study 2’s results. When Study 1 was conducted, we assumed schema incongruence in both awe and horror was “vastness”. Study 2 tested this assumption, but found no support for it.

[8] Study 1 was part of a larger study that included variables not reported here.

1 [9]Four items were split into two items each: *Anticipated Effort-effort* (“mental effort”,
2 “physical effort”), *Situation-Control* (“fate/destiny was in control”, “chance/coincidence was
3 in control”), *Situation-Responsibility* (“fate/destiny was responsible”, “chance/coincidence
4 was responsible”) and *Legitimacy-cheated* (“you were cheated”, “someone else was
5 cheated”).

6 [10]Similar to Gordon et al. (2017), the reliability for Personal Agency was low, so separate
7 t-tests were conducted on “personal control” and “personal responsibility”. For both
8 individual and composite variables, ratings in Awe were significantly higher than in Horror
9 ($ts \leq 3.15, ps = .002$).

10 [11]We separately analyzed data from all participants (N=181). All results were entirely
11 consistent with those reported, including EFA item loadings and ANOVA results (both
12 omnibus and pairwise).

13 [12]Sample size was based on Everitt (1975), stipulating a N:p ratio of 10.

14 [13]To discriminate elicitation by a person from elicitation by a person’s actions, “another
15 person” was defined as elicitation by a person’s traits or the fact that such a person exists;
16 elicitation by a person’s actions were coded as “events”.

17 [14]“Information” included hearing/reading something second-hand or discovering first-hand
18 evidence (rather than directly witnessing).

19 [15]Due to a database error, twelve horror scenarios were not coded.

20 [16]The two-coder alpha for the “event” category was 0.59, so a third coder independently
21 coded all scenarios for this theme; the three-coder alpha was .69.

22 [17]KMO=.835, Bartlett’s $\chi^2(91) = 2338, p < .001$. Eigenvalues and parallel analysis in SPSS
23 (O’Connor, 2000) indicated two factors. Four items were removed: *social significance* and
24 *personal significance* (failed to load), *power* (double-loaded) and *physical size/number*

1 (communality < .20). The two factors showed good discriminant validity, $r=.17$ (i.e., shared
2 2.9% of variation).
3 [18]KMO=.877 Bartlett's $\chi^2(45) = 2235, p < .001$. Eigenvalues and parallel analysis indicated
4 two factors. Three items were removed: *absorbed* (communality <.20), *shocked* (cross-
5 loaded), *easy to understand* (cross-loaded). *Amazement* cross-loaded, but was retained
6 because the loading difference was almost .40. The two factors were negatively correlated (-.
7 49), sharing 24% of variance.

References

- 1
2 Armstrong, T., & Detweiler-Bedell, B. (2008). Beauty as an emotion: The exhilarating
3 prospect of mastering a challenging world. *Review of General Psychology, 12*(4), 305–
4 329.
- 5 Bai, Y., Maruskin, L., Chen, S., Gordon, A., Stellar, J., McNeil, G., ... Keltner, D. (2017).
6 Awe, the diminished self, and collective engagement: Universals and cultural variations
7 in the small self. *Journal of Personality and Social Psychology, 113*(2), 185–209.
- 8 Berenbaum, H. (2002). Varieties of joy-related pleasurable activities and feelings. *Cognition*
9 *& Emotion, 16*(4), 473–494.
- 10 Bless, H., & Fiedler, H. (2006). Mood and the regulation of information processing and
11 behavior. In J. P. Forgas (Ed.), *Affect in social thinking and behavior* (pp. 65–84). New
12 York: Psychology Press.
- 13 Bonner, E., & Friedman, H. (2011). A conceptual clarification of the experience of awe: An
14 interpretative phenomenological analysis. *The Humanistic Psychologist, 39*, 222–235.
- 15 Brewin, C., & Holmes, E. (2003). Psychological theories of posttraumatic stress disorder.
16 *Clinical Psychology Review, 23*(3), 339–376.
- 17 Brewin, C., & Shapiro, D. (1984). Beyond locus of control: Attribution of responsibility for
18 positive and negative outcomes. *British Journal of Psychology, 75*(1), 43–49.
- 19 Campos, B., Shiota, M., Keltner, D., Gonzaga, G., & Goetz, J. (2013). What is shared, what
20 is different? Core relational themes and expressive displays of eight positive emotions.
21 *Cognition & Emotion, 27*(1), 37–52.
- 22 Carroll, N. (1990). *The philosophy of horror: Or, paradoxes of the heart*. Cambridge:
23 Routledge.
- 24 Cavell, S. (1979). *The claim of reason: Wittgenstein, skepticism, morality, and tragedy*. New
25 York: Oxford University Press.

- 1 Chirico, A., Cipresso, P., Yaden, D., Biassoni, F., Riva, G., & Gaggioli, A. (2017).
2 Effectiveness of immersive videos in inducing awe: An experimental study. *Scientific*
3 *Reports*, 7(1).
- 4 Chirico, A., Ferrise, F., Cordella, L., & Gaggioli, A. (2018). Designing awe in virtual reality:
5 An experimental study. *Frontiers in Psychology*, 8, 2351.
- 6 Chirico, A., Glaveanu, V., Cipresso, P., Riva, G., & Gaggioli, A. (2018). Awe enhances
7 creative thinking: An experimental study. *Creativity Research Journal*, 30(2), 123–131.
- 8 Clore, G., & Gasper, K. (2000). Feeling is believing: Some affective influences on belief. In
9 N. Frijda, A. Manstead, & S. Bem (Eds.), *Emotions and beliefs: How feelings influence*
10 *thoughts* (pp. 10–44). Cambridge University Press.
- 11 Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155–159.
- 12 Colantonio, J., & Bonawitz, E. (2018). Awesome play: Awe increases preschooler's
13 exploration and discovery. *Open Science Framework*.
- 14 Dalgleish, T., & Power, M. (2004). Emotion-specific and emotion-non-specific components
15 of posttraumatic stress disorder (PTSD): Implications for a taxonomy of related
16 psychopathology. *Behaviour Research and Therapy*, 42(9), 1069–1088.
- 17 Darwin, C. (1872). *The expression of the emotions in man and animals*. London: Harper-
18 Collins.
- 19 Diamond, D., Campbell, A., Park, C., Halonen, J., & Zoladz, P. (2007). The temporal
20 dynamics model of emotional memory processing: A synthesis on the neurobiological
21 basis of stress-induced amnesia, flashbulb and traumatic memories, and the Yerkes-
22 Dodson Law. *Neural Plasticity*, 60803, 1–33.
- 23 Diamond, D., & Zoladz, P. (2016). Dysfunctional or hyperfunctional? The amygdala in
24 posttraumatic stress disorder is the bull in the evolutionary china shop. *Journal of*
25 *Neuroscience Research*, 94(6), 437–444.

- 1 Everitt, B. (1975). Multivariate analysis: The need for data, and other problems. *The British*
2 *Journal of Psychiatry*, 126(3), 237–240.
- 3 Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical
4 power analysis program for the social, behavioral, and biomedical sciences. *Behavior*
5 *Research Methods*, 39(2), 175–191.
- 6 Feigenson, N. (2002). Emotions, risk perceptions and blaming in 9/11 cases. *Brooklyn Law*
7 *Review*, 68(4), 959–1001.
- 8 Fiedler, K., & Bless, H. (2000). The formation of beliefs at the interface of affective and
9 cognitive processes. In N. Frijda, A. Manstead, & S. Bem (Eds.), *Emotions and beliefs:*
10 *How feelings influence thoughts* (pp. 144–170). Paris: Cambridge University Press.
- 11 Fiske, S., & Linville, P. (1980). What does the schema concept buy us? *Personality and*
12 *Social Psychology Bulletin*, 6(4), 543–557.
- 13 Fugelsang, J., & Dunbar, K. (2005). Brain-based mechanisms underlying complex causal
14 thinking. *Neuropsychologia*, 43, 1204–1213.
- 15 Gordon, A., Stellar, J., Anderson, C., Mcneil, G., Loew, D., & Keltner, D. (2017). The dark
16 side of the sublime: Distinguishing a threat-based variant of awe. *Journal of Personality*
17 *and Social Psychology*, 113(2), 310–328.
- 18 Gutschick, V., & BassiriRad, H. (2003). Extreme events as shaping physiology, ecology, and
19 evolution of plants: Toward a unified definition and evaluation of their consequences.
20 *New Phytologist*, 160, 21–42.
- 21 James, W. (1902). *The varieties of religious experience*. London: Longmans, Green.
- 22 Janoff-Bulman, R. (1992). *Shattered assumptions: Toward a new psychology of trauma*. New
23 York: Free Press.
- 24 Janoff-Bulman, R. (2006). Schema-change perspectives on posttraumatic growth. In L.
25 Calhoun & R. Tedeschi (Eds.), *Handbook of posttraumatic growth: Research and*

- 1 *practice* (pp. 81–99). Mahwah, NJ: Lawrence Erlbaum Associates.
- 2 Kant, I. (1951). *Critique of Judgment*. (J.H. Bernard, Trans.). New York: Hafner Publishing
3 Company. (Original work published 1790).
- 4 Keltner, D., & Gross, J. (1999). Functional accounts of emotions. *Cognition and Emotion*,
5 13(5), 467–480.
- 6 Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion.
7 *Cognition and Emotion*, 17(3), 297–314.
- 8 Krause, N., & Hayward, R. (2015). Assessing whether practical wisdom and awe of God are
9 associated with life satisfaction. *Psychology of Religion and Spirituality*, 7(1), 51–59.
- 10 Kristeva, J. (1982). *Powers of Horror: An Essay on Abjection*. (Trans. L.S. Roudiez.). New
11 York: Columbia University Press.
- 12 Leach, J. (1994). *Survival psychology*. Basingstoke: MacMillan.
- 13 Leach, J. (2012). Maladaptive behavior in survivors: Dysexecutive survivor syndrome.
14 *Aviation Space and Environmental Medicine*, 83(12), 1152–1161.
- 15 Lodge, M., & Taber, C. (2000). Three steps toward a theory of motivated political reasoning.
16 In A. Lupia, M. D. (Mathew D. McCubbins, & S. L. Popkin (Eds.), *Elements of reason:*
17 *Cognition, choice, and the bounds of rationality* (pp. 183–213). London: Cambridge
18 University Press.
- 19 Marx, B., Forsyth, J., Gallup, G., Fusé, T., & Lexington, J. (2008). Tonic immobility as an
20 evolved predator defense: Implications for sexual assault survivors. *Clinical*
21 *Psychology: Science and Practice*, 15(1), 74–90.
- 22 McCann, L., & Pearlman, L. (1990). Vicarious traumatization: A framework for
23 understanding the psychological effects of working with victims. *Journal of Traumatic*
24 *Stress*, 3(1), 131–149.
- 25 McCann, L., Sakheim, D., & Abrahamson, D. (1988). Trauma and Victimization: A model of

- 1 psychological adaptation. *The Counseling Psychologist*, *16*(4), 531–594.
- 2 Miller, A. (2004). Introduction and Overview. In A. Miller (Ed.), *The Social Psychology of*
3 *Good and Evil* (pp. 1–17). New York: Guilford.
- 4 Neimeyer, R., Herrero, O., & Botella, L. (2006). Chaos to coherence: Psychotherapeutic
5 integration of traumatic loss. *Journal of Constructivist Psychology*, *19*(2), 127–145.
- 6 Nisbett, R., & Wilson, T. (1977). Telling more than we can know: Verbal reports on mental
7 processes. *Psychological Review*, *84*(3), 231–259.
- 8 O'Connor, B. (2000). SPSS and SAS programs for determining the number of components
9 using parallel analysis and Velicer's MAP test. *Behavior Research Methods,*
10 *Instruments, & Computers*, *32*(3), 396–402.
- 11 Peng, K., & Nisbett, R. (1999). Culture, dialectics, and reasoning about contradiction.
12 *American Psychologist*, *54*(9), 741–754.
- 13 Piaget, J. (1950). *The psychology of intelligence*. London: Routledge & Paul.
- 14 Piaget, J. (1962). *Play, dreams and imitation*. New York: Norton.
- 15 Piff, P., Dietze, P., Feinberg, M., Stancato, D., & Keltner, D. (2015). Awe, the small self, and
16 prosocial behavior. *Journal of Personality and Social Psychology*, *108*(6), 883–899.
- 17 Rai, T., Valdesolo, P., & Graham, J. (2017). Dehumanization increases instrumental violence,
18 but not moral violence. *PNAS*, *114*(32), 8511–8516.
- 19 Scherer, K. (2005). What are emotions? And how can they be measured? *Social Science*
20 *Information*, *44*(4), 695–729.
- 21 Schurtz, D., Blincoe, S., Smith, R., Powell, C., Combs, D., & Kim, S. (2012). Exploring the
22 social aspects of goose bumps and their role in awe and envy. *Motivation and Emotion*,
23 *36*(2), 205–217.
- 24 Shiota, M., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and
25 effects on self-concept. *Cognition & Emotion*, *21*(5), 944–963.

- 1 Silvia, P. (2010). Confusion and interest: The role of knowledge emotions in aesthetic
2 experience. *Psychology of Aesthetics, Creativity, and the Arts*, 4(2), 75–80.
- 3 Singer, M. (2004). The Concept of Evil. *Philosophy*, 78(308), 185–214.
- 4 Smith, C., & Ellsworth, P. (1985). Patterns of cognitive appraisal in emotion. *Journal of*
5 *Personality & Social Psychology*, 48(4), 813–838.
- 6 Stellar, J., Gordon, A., Piff, P., Cordaro, D., Anderson, C., Bai, Y., ... Keltner, D. (2017).
7 Self-transcendent emotions and their social functions: Compassion, gratitude, and awe
8 bind us to others through prosociality. *Emotion Review*, 9(3), 200–207.
- 9 Taylor, S., & Fiske, S. (1978). Saliency, attention, and attribution: Top of the head
10 phenomena. *Advances in Experimental Social Psychology*, 11, 249–288.
- 11 Tong, E., & Jia, L. (2017). Positive emotion, appraisal, and the role of appraisal overlap in
12 positive emotion co-occurrence. *Emotion*, 17(1), 40–54.
- 13 Valdesolo, P., & Graham, J. (2014). Awe, uncertainty, and agency detection. *Psychological*
14 *Science*, 25(1), 170–178.
- 15 Valdesolo, P., Shtulman, A., & Baron, A. (2016). Science is awe-some: The emotional
16 antecedents of science learning. *Emotion Review*, 1–23.
- 17 Van Cappellen, P., & Saroglou, V. (2012). Awe activates religious and spiritual feelings and
18 behavioral intentions. *Psychology of Religion and Spirituality*, 4(3), 223–236.
- 19 Van Cappellen, P., Saroglou, V., Iweins, C., Piovesana, M., & Fredrickson, B. (2013). Self-
20 transcendent positive emotions increase spirituality through basic world assumptions.
21 *Cognition and Emotion*, 27(8), 1378–1394.
- 22 Wierzbicka, A. (1988). The semantics of emotions: Fear and its relatives in English.
23 *Australian Journal of Linguistics*, 10, 359–375.
- 24 Yaden, D., Haidt, J., Hood, R., Vago, D., & Newberg, A. (2017). The varieties of self-
25 transcendent experience. *Review of General Psychology*, 21(2), 143–160.

1 Yaden, D., Le Nguyen, K., Kern, M., Wintering, N., Eichstaedt, J., Schwartz, H., ...
2 Newberg, A. (2017). The noetic quality: A multimethod exploratory study. *Psychology*
3 *of Consciousness: Theory, Research and Practice*, 4(1), 54–62.
4 Yum, Y.-O., & Schenck-Hamlin, W. (2005). Reactions to 9/11 as a function of terror
5 management and perspective taking. *The Journal of Social Psychology*, 145(3), 265–
6 286.
7
8