

UC Berkeley

UC Berkeley Electronic Theses and Dissertations

Title

Trait and State Based Experience of Awe Promotes Creativity

Permalink

<https://escholarship.org/uc/item/9k10094r>

Author

Zhang, Jia Wei

Publication Date

2017

Peer reviewed|Thesis/dissertation

Trait and State Based Experience of Awe Promotes Creativity By

Jia Wei Zhang

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Psychology

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Dacher Keltner, Chair

Professor Serena Chen

Professor Oliver John

Professor Dana Carney

Spring 2017

Abstract

Trait and State Based Experience of Awe Promotes Creativity

by

Jia Wei Zhang

Doctor of Philosophy in Psychology

University of California, Berkeley

Professor Dacher Keltner, Chair

Creativity has many benefits and scientists seek to understand what fosters it. Extant research suggests that positive emotions foster creativity. Guided by the appraisal-tendency framework, which details how closely related emotions differentially influence cognitive processes, four studies (N = 1,508) documented that trait and induced awe, compared to amusement, promotes creativity. Two trait based studies found that awe-prone people in the USA, Iran, and Malaysia reported more creative tendencies (Study 1) and were more likely to solve a creativity problem (Study 2). Turning to state-based awe, people experimentally induced to experience awe were more likely than people induced with amusement to consider unconventional associations (Study 3) and generate original ideas (Study 4). However, Study 5 (N = 152) did not reveal significant difference across experimental conditions on the Duncker Candle Task using the actual materials in the laboratory. This is the first set of studies that documented the unique contribution that awe has on promoting creativity.

Trait and State Based Experience of Awe Promotes Creativity

“He...who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed.”

~ Albert Einstein

Creativity has many benefits. For instance, creative individuals are more satisfied with life (Tan, Ho, Ho, & Ow, 2008) and perform better academically (Chamorro-Premuzic, 2006). Creative employees make more sales and receive better supervisor-rated employee job performance (Gong, Huang, & Farh, 2009), and report greater career satisfaction and feel more included by their organization (Kim, Hon & Grant, 2009). Given these and other documented benefits of creativity, researchers have sought to understand the factors that boost creativity, such as promotion focus, embodied metaphors, and multicultural experiences (Friedman & Forster, 2001; Leung et al., 2012; Maddux & Galinsky, 2009).

One consistent predictor of increased creativity is trait and state positive emotions (Lyubomirsky, King, & Diener, 2005). This literature, though, has focused on positive emotions more generally and have not ascertained whether some positive emotions promote creativity more so than others. Guided by the appraisal-tendency framework for understanding the influences of specific emotion upon social cognitions (Lerner & Keltner, 2000; 2001), we test the hypothesis that trait and state based experience of awe uniquely promote creativity when compared to other positive emotions.

An Appraisal-Tendency Framework Approach to Awe and Creativity

The appraisal-tendency framework (ATF; see Horberg et al., 2011; Lerner & Keltner, 2000; Lerner et al., 2015) is grounded in two basic assumptions: (a) emotions organize specific response systems—expression, physiology, experiential—that enable individuals to respond adaptively to emotion-eliciting stimuli (Campos et al., 2013; Frijda et al., 1989; Keltner & Haidt, 2003; Levenson, 2011) and (b) each discrete emotion is defined by a distinct pattern of appraisals that constitute the individual’s interpretations of emotion-eliciting stimuli and that guide subsequent cognitive processes in ways that are consistent with the emotion specific appraisals (Keltner, Ellsworth, & Edwards, 1993; Lerner et al., 2003; Lerner et al., 2004; Oveis et al., 2010; Smith & Ellsworth, 1985). A critical implication of this theory is that discrete emotions with the same valence and arousal but different appraisals will influence cognitive processes in different ways. For instance, appraising a negative event as uncertain and under situational control will lead people to experience fear, which promotes risk-averse thoughts and behaviors. On the other hand, appraising a negative event as certain and under human control will lead people to experience anger, which promotes risk-seeking thoughts and behaviors (Lerner & Keltner, 2001). This theoretical perspective has also led to investigations of sadness and disgust on loss aversion (Lerner, Small, & Lowenstein, 2004), anger and sadness on causal attribution (Keltner et al., 1993), disgust and anger on moral judgments of purity (Horberg et al., 2009), and compassion and pride in shifts on self-representation (Oveis et al., 2010).

Guided in part by ATF, Keltner and Haidt (2003) outlined two appraisals that are central to awe: vastness and accommodation. Vastness refers to appraising the stimulus as transcending one’s typical frame of reference, be it physical, temporal, or semantic. Accommodation refers to the processes by which the individual restructures prior beliefs to understand the stimulus. These two appraisals, in turn, lead to the experience of awe and are believed to cause people to explore the environment, gain new information, and as a result, create new ways of thinking (Shiota et al., 2004; Zhang & Keltner, 2015). Consistent with these assertions, people often report themes related to exploring, altering extant worldviews, and generating novel perspectives in

retrospective accounts of awe-related experiences (Campos et al., 2013; Shiota et al., 2007). Therefore, the experience of awe can lead to an open mindset, orient people to explore, and approach experiences with unconventional perspectives—all of which are processes critical to creativity.

The ATF provides a conceptual framework and methodological approach to testing this hypothesis, and ruling out a broader valenced based hypothesis that all positive emotions increase creativity. More specifically, guided by the ATF, we contrasted the effects of awe with amusement upon creative thought, because amusement is an emotion defined by positive valence and arousal (e.g., Shiota et al., 2006). Amusement, however, is defined by different eliciting appraisals than awe (see Campos et al., 2013; Tong, 2014). Amusement is defined by appraisals of incongruity, violations of expectations, and the resolution of such contradictions (Campos et al., 2013; McGraw & Warren, 2010; Wyer & Collins, 1992). The central appraisal themes of amusement – perceived incongruity and the resolution of contradiction – diverge from those of awe – perceived vastness and the need to change past beliefs – and make these two epistemologically oriented positive emotions appropriate and stringent comparison states.

Relevant research lends indirect support to the central hypothesis of this investigation, that awe promotes creativity. For example, people who recounted an awe experience, relative to one of happiness, reported being more willing to engage in a creative activity in the next hour (Shiota et al., 2007). Studies of trait-based awe have shown that it is positively associated with greater self- and peer-reported openness to experience, whereas amusement is only weakly associated with openness to experience (Shiota et al., 2006). Similarly, people prone to experience awe, compared to amusement, are more likely to possess intellectual (e.g., love of learning, creativity) character strengths related to creativity (Gusewell & Ruch, 2012). People prone to experience awe (Shiota et al., 2007), as well as those induced to feel awe, compared to dispositional or induced amusement (Valdesolo & Graham, 2013), were more likely to show greater tolerance for uncertainty. Interestingly, despite the similarity in their appraisal processes, induced amusement leads to conforming attitudes towards weak arguments, whereas induced awe facilitates divergent attitudes by generating more unique thoughts through felt skepticism and uncertainty (Griskevicius et al., 2010). These studies all highlight how awe, but not amusement, leads people to be more oriented to processes that should lead to greater creativity.

Operationalizing Creativity: A Multi-Component Approach

Given the complexity of creativity, researchers tend to use a multi-component approach to measure the process, including measures of creative personality, convergent creativity, and divergent creativity (Feist, 1998; Gino & Ariely, 2011; Maddux & Galinsky, 2009; see Table 1 for a summary). These complementary methods are grounded in the definition of creativity as a willingness to consider a wide variety of possibilities and engage in the process of generating knowledge that leads to an idea which refines the existing understanding of a phenomenon (Amabile, 1983, Simonton, 2000; Sternberg, 1999).

One approach focuses on assessments of creative traits, or the *creative personality*. For example, Hocevar (1980) developed a series of activities and achievements that are considered as creative (e.g., worked as an editor for a school or university literary publication; Won an award for musical accomplishments; etc.). People who have participated or attained these achievements more frequently were deemed as creative people. Moreover, Gough (1979) developed a series of personality adjectives that people could use to appraise their self as creative or not by checking off (or not) words related to creativity, such as insightful, original, and unconventional. More recently, Lee and Ashton developed the HEXACO personality inventory that contains the four-

item unconventionality (e.g., “*I think of myself as a somewhat eccentric person.*”) and four-item creativity (e.g., *I would enjoy creating a work of art, such as a novel, a song, or a painting*”) subscales subsumed within the openness to experience factor. Since then, the psychometric properties of these scales have been replicated in different cultures (e.g., Dutch, French, Germany, Japan, Korea; Ashton et al., 2007; Boies et al., 2004; De Vries, Lee & Ashton, 2008; Wakabayashi, 2014). Importantly, these self-report measures of creativity, used in this investigation, predict peer-reports of creativity and nonconformity over the life-span (Helson, 1999) and actual creative achievements (Silvia et al., 2011).

Convergent creativity is defined as altering existing conventional knowledge and reapplying that knowledge to discover the best answer to a problem (Cropley, 2006). For example, the Duncker Candle Problem (Duncker & Lee, 1945), is a widely used behavioral measure of creativity that we adapted for the current research. In this task, participants are presented with a picture showing a table that contains a candle, a box of tacks, and a pack of matches on a table next to a cardboard wall, and asked to figure out a solution to attach the candle to the wall so that it can burn without dropping wax to the table or the floor. The correct solution is to empty the box of tacks, use a tack to attach the box onto the wall, light the candle, and place the burning candle in the box. Thus, the task tests participants’ ability to recognize existing conceptual relations that are seemingly dissociated and generate a solution that unites the concepts. Another widely used convergent creativity task is the category inclusion task (Rosch, 1975). In this task, participants are given a strong (e.g., “bus”), intermediate (e.g., “airplane”), and weak (e.g., “camel”) exemplar of a category (e.g., “vehicle”). They are then instructed to rate how much each exemplar fits within a category. Higher ratings of weak exemplars (i.e., agreeing a weak exemplar fits within a specific category) are taken as an indicator of convergent creativity because this indicates a willingness to reorganize one’s existing mental structure to consider unconventional associations.

Whereas convergent creativity indexes creativity within a set of pre-defined choices, *divergent creativity* involves people freely generating novel associations about a stimulus (Runco & Charles, 1993; Silvia et al., 2008). A widely used method to measure divergent creativity is asking people to generate numerous responses to a problem (Baas et al., 2008; Leung & Chiu, 2008; Nijstad, De Dreu, Rietzschel & Baas, 2010). Researchers then evaluate these responses for their fluency (i.e., the number of unique ideas), flexibility (i.e., the breadth of unique categories), and originality (i.e., the extent to which the ideas are infrequent, novel, and original), attributes that tend to correlate, but only moderately, thus capturing separate features of this kind of creativity (Silvia et al., 2008).

Prior research has often measured these three kinds of creativity, for purposes of generalizability (Baas et al., 2008; De Dreu & Nijstad, 2008; De Dreu et al., 2008; Gino & Ariely, 2011; Leung et al., 2008, 2012; Maddux & Galinsky, 2009; Sligte et al., 2011). Guided by this precedent, we also take a multi method approach to test our hypothesis that awe promotes creativity.

Overview of Current Research

Guided by an appraisal tendency framework and the multicomponent analysis of creativity, across four studies we tested the hypothesis that awe, compared to amusement, will uniquely promote creativity. Study 1 examined whether awe-prone people in the USA, Iran, and Malaysia, have more creative personality than amusement-prone people (Study 1). Study 2 examined whether awe-prone people are more likely to solve a creativity problem than amusement-prone people. Then, two experimental studies tested whether induced awe, compared

to amusement, uniquely cause individuals to consider unconventional associations (Study 3) and generate original ideas (Study 4). Study 5 tested whether induced awe, compared to amusement, and a control condition promoted greater likelihood of solving the Duncker Candle Problem using *actual* materials in the task (i.e., board, candle, tacks, matches, and box). The second goal of Study 5 was to test accommodation in a mediation model to determine its mediating effect on the relation between experimentally induced awe and likelihood of solving the creativity task. Across these studies, we ensured that our samples were demographically diverse, incorporating people in different age groups and from different cultures. Moreover, we captured the experience of awe at the trait and state level, and through varied manipulations of awe, including narrative recall and videos.

Study 1: Dispositional Awe Predicts Greater Creative Personality in the US, Iran, and Malaysia

Study 1 tests whether dispositional awe, compared to dispositional amusement, is associated with unconventionality and creativity (Ashton & Lee, 2007). We expected dispositional awe to be uniquely associated with unconventionality and creativity above and beyond dispositional amusement. To increase the generalizability of our results, we tested our hypothesis on adolescents and across three different cultures (USA, Iran, and Malaysia). The inclusion of three diverse cultures with differences in the frequency of experiencing awe (Razavi et al., 2016) as well as important personality correlates of creativity, such as openness to experience informs us about the robustness and generalizability of the relationship between awe and creativity in diverse cultural environment.

Pilot study. First, we sought to document that the measures of creativity we used in Study 1 (i.e., unconventionality & creativity subscales from the HEXACO; Ashton & Lee, 2007) are valid measures of creative personality. To do this, we recruited 177 participants from Mturk ($M = 35.5$, $SD = 11$; 48% Female; 84% Caucasian Americans) who completed the unconventionality and creativity subscales, as well as the Creative Behavior Inventory (CBI; Hocesvar, 1980), Gough's Creative Personality Scale (GCPS; Gough, 1979), and Creative Cognitive Style (CCS; Kirton, 1976) in this order, all of which were used in Gino and Ariely (2011) and validated in prior research to robustly predict creative performance (Barron & Harrington, 1981; Tierney & Farmer, 2002; Zhou & Oldham, 2001).

First, participants indicated their agreement with 4-item that measured unconventionality (e.g., “*I like people who have unconventional views*”; $\alpha = .58$) and 4-item that measured creativity (e.g., “*People have often told me that I have a good imagination*”; $\alpha = .77$) on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Next, they completed the CBI, which is a list of 77 activities that are deemed as creative (e.g., “*Worked as an editor for a newspaper or similar organization.*”) Participants indicated the frequency in which they engaged in their behaviors on a 4-point scale from 1 (*never*) to 4 (*more than 5 times*). We averaged the participants rating for each activity ($M = 1.60$, $SD = 0.40$). Afterward, participants choose adjectives that described them from a list of 30. Participants received a point every time they checked a creative personality adjective (e.g., insightful, original; $M = 3.30$, $SD = 1.30$). Finally, participants answered the 5-item CCS on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*; $M = 5.00$, $SD = 1.30$; $\alpha = .90$).

We standardized all the measures and reported the zero order correlations in Table 2. We found that the unconventionality and creativity subscales were positively correlated with all three creative personality scales. These results provide support for the unconventionality and creativity subscales as valid measures of creative personality.

Method

Participants and Procedures

The four samples consisted of: (a) 175 students (Study 1a; $M_{age} = 21.30$, $SD = 3.0$, range 18-37; 69% female, 29% Caucasian) from a large American university on the West Coast who participated for extra credit, (b) 385 adolescents from a public high school in northern California (Study 1b; $M_{age} = 15.90$, $SD = 1.34$, range 12-20; 56% female, 26% Caucasian) who participated for a nominal compensation, (c) 255 Iranian adults² (Study 1c; $M_{age} = 31.60$, $SD = 8.90$, range 19-67; 65% female) who participated in exchange for a chance to win a raffle, and (d) 286 students (Study 1d; $M_{age} = 21$, $SD = 1.70$, range 18-29; 85% female) from a private university in Malaysia who participated for partial course credit. Participants in sample 1a and 1c completed the study online, where they first provided informed consent, then completed the dispositional awe and amusement scales (Shiota et al., 2006; Razavi et al., 2016), as well as the unconventionality and creativity scales (Ashton & Lee, 2007). Adolescents in sample 1b were given a packet that included an invitation letter, parental consent form, adolescent assent form, and the study survey. Students who returned the completed materials constituted the sample. Malaysia students in sample 1d completed a packet that included a consent form and the study survey in the beginning of class. For the Iranian sample, all measures were translated into Persian by one of the co-authors and independently back-translated into English by a separate co-author—both authors are bilingual Persian-English speakers. Disagreements between the translators were resolved by discussion. The Malaysian students are all fluent in English, and thus, completed the study in English.

Measures

Dispositional discrete emotions. All participants completed the dispositional awe and dispositional amusement subscale from the Dispositional Positive Emotions Scale (Shiota et al., 2006; Razavi et al., 2016) on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*; Study 1a: $M_{awe} = 4.69$, $SD = 1.12$, $\alpha = .88$; $M_{amusement} = 4.73$, $SD = 1.09$, $\alpha = .82$; Study 1b: $M_{awe} = 4.75$, $SD = 1.10$, $\alpha = .85$; $M_{amusement} = 4.81$, $SD = 1.15$, $\alpha = .80$; Study 1c: $M_{awe} = 4.16$, $SD = 1.15$, $\alpha = .77$; $M_{amusement} = 4.07$, $SD = 1.37$, $\alpha = .79$; Study 1d: $M_{awe} = 4.52$, $SD = 0.95$, $\alpha = .75$; $M_{amusement} = 4.67$, $SD = 1.16$, $\alpha = .78$). Awe and amusement are positively correlated across each of the four samples ($r_s \geq .38$, $p_s < .001$).

Creative Personality. Participants completed the unconventionality and creativity subscales from The HEXACO Personality Inventory (Ashton & Lee, 2007) to measure two facets of a creative person. Participants in sample 1a, 1b, and 1c rated their level of agreement with each statement from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*) and participants in sample 1d rated from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). Four-item assessed unconventionality (e.g., “*I think that paying attention to radical ideas is a waste of time*”; Study 1a: $M = 4.75$, $SD = 1.00$, $\alpha = .63$; Study 1b: $M = 3.43$, $SD = 0.64$, $\alpha = .50$; Study 1c: $M = 4.53$, $SD = 1.14$, $\alpha = .44$; Study 1d: $M = 4.77$, $SD = 0.85$, $\alpha = .50$), and four-item assessed creativity (e.g., “*People have often told me that I have a good imagination*”; Study 1a: $M = 4.62$, $SD = 1.22$, $\alpha = .78$; Study 1b: $M = 3.47$, $SD = 0.81$, $\alpha = .65$; Study 1c: $M = 5.33$, $SD = 1.29$, $\alpha = .68$; Study 1d: $M = 4.43$, $SD = 1.27$, $\alpha = .73$). Unconventionality and creativity were moderately correlated across samples ($r_s \geq .25$, $p_s < .001$).

Results and Discussion

Is dispositional awe associated with creative personality? As shown in Table 3, awe was associated with greater unconventionality ($r_s \geq .26, p_s < .001$) and creativity ($r_s \geq .30, p_s < .001$) in all samples. Conversely, while amusement also showed positive relations with unconventionality and creativity, the correlations are smaller and less consistent than dispositional awe. We compute the meta-analytic correlations between dispositional awe and dispositional amusement with creative personality. As expected, the meta-analytic correlations demonstrated that dispositional awe had a higher correlations ($r = .32$) than dispositional amusement ($r = .15$), $Z = 5.97, p < .001$

Is dispositional awe uniquely associated with creative personality? We used partial correlations to test if dispositional awe is uniquely associated with creative personality more than amusement across the four samples. In all samples, we found that the relations between dispositional awe and the creative personality measures remained after controlling for dispositional amusement. However, the relations between dispositional amusement and the creative personality measures were mostly reduced to non-significant after controlling for dispositional awe (see Table 3).

To summarize, Study 1 showed that trait awe is uniquely associated with creative personality independent of dispositional amusement in adults and adolescents, and in quite different cultures. However, these results are limited to the extent that people self-reported their creative personality. In Study 2, we test the hypothesis that trait awe but not amusement will predict increased convergent creativity as assessed with the Duncker Candle Problem.

Study 2: Dispositional Awe Predicts More Convergent Creativity

Study 2 tested whether dispositional awe was related to actual convergent creativity. Specifically, participants were instructed to complete the Duncker Candle Problem (Duncker & Lee, 1945), a task used to measure people's convergent creativity (Gino & Ariely, 2011; Isen et al., 1987; Maddux & Galinsky, 2009; Maddux et al., 2010). Moreover, we continue to control for dispositional amusement to ascertain the unique effect of dispositional awe on creative ability.

Method

Participants and Procedures

Study 2 consisted of 301 students ($M_{age} = 21.20, SD = 2.70$, age range 18-47; 61% female, 18% Caucasian Americans) from a large American university on the West Coast who participated for partial course credit. Participants completed the dispositional awe and dispositional amusement subscales from the DPES (Shiota et al., 2006) and then completed the Duncker Candle Problem (Duncker & Lee, 1945), as well as a demographic questionnaire.

Measures

Dispositional discrete emotions. Similar to previous studies, participants completed the dispositional awe ($M = 4.80, SD = 1.00, \alpha = .82$) and dispositional amusement subscales ($M = 4.70, SD = 1.09, \alpha = .81$) from the DPES (Shiota et al., 2006) Awe and amusement was positively correlated ($r = .62, p < .001$).

Convergent Creativity. In this task, participants were presented with a picture of the Duncker Candle Problem, which shows a table that contains a candle, a box of tacks, and a pack of matches on a table next to a cardboard wall (see Figure 1). Specifically, participants were instructed to think of a solution to attach the candle to the wall so that it can burn without dropping wax to the table or the floor. The correct solution is to empty the box of tacks, use the tacks to attach the box onto the wall, light the candle, and place the burning candle in the box. Thus, this task requires participants to view the objects beyond their typical functions to find the correct solution. Similar to previous research (Gino & Ariely, 2011; Isen et al., 1987; Maddux &

Galinsky, 2009; Maddux et al., 2010), we instructed a research assistant to code participant's solution as correct only if the response included the use of the box as a candleholder. Overall, 145 of the 301 participants solved the problem correctly (48%).

Results and Brief Discussion

We standardized dispositional awe and dispositional amusement and conducted a logistic regression. Whereas dispositional awe was a significant predictor of achieving a correct solution, in keeping with our hypothesis ($B = .32$, $SE = .16$, $Wald = 4.16$, $p = .041$, $\text{Exp}(B) = 1.37$, $d = 0.17$, 95% CI [1.01, 1.86]; see Table 4), dispositional amusement was not ($B = .06$, $SE = .15$, $Wald = 0.15$, $p = .69$, $\text{Exp}(B) = 1.06$, 95% CI [-.79, 1.43]). In other words, people who are prone to experience awe are 37% more likely than people less prone to awe to solve the Duncker Candle Problem. The results from our first two studies, then, show that trait awe, but not trait amusement, uniquely predicts creative personality and actual convergent creativity, as measured by likelihood to solve the Duncker Candle problem. We now turn to experimental tests of our awe and creativity hypothesis.

Study 3: Induced Awe Enhances Convergent Creativity

In Study 3, participants relived either an actual awe or amusement experience or they were assigned to a control condition, allowing us to assess the directionality of the influence of these two emotions upon creativity (Griskevicius et al. 2010; Piff et al., 2015; Rudd et al., 2012). We measured creativity using the cognitive inclusiveness task, a measure of convergent creativity (see Table 1) that captures people's willingness to consider unconventional associations (De Dreu et al., 2008; Rosch, 1975).

Method

Participants and Procedure

The participants were 185 adults ($M_{age} = 34.40$, $SD = 13.30$, range 18-71; 48% female; 72% Caucasian) recruited from Amazon's Mechanical Turk (Mturk) for a nominal compensation. Participants accessed the study through an online server and provided implied consent. Then, they were randomly assigned into one of three conditions in which they recalled an experience of awe or amusement or neutral content. The instructions were taken verbatim from Griskevicius et al. (2010) and Piff et al. (2015). Participants in the awe condition received the following instruction: "*Please try to recall an event in your life when you saw a particular panoramic view for the first time. Some examples might be seeing the Grand Canyon, seeing the view from high up on a mountain, or seeing the skyline of a big city for the first time. Please recall a specific event when you saw this view for the first time, rather than a general period of time.*" Participants in the amusement condition received the following instruction: "*Please try to recall an event in your life when you heard a funny joke or when something funny happened. Please recall a specific event that was funny, rather than a general period of time.*" Participants in the control condition received the following instruction: "*Please try to recall the last time you did the laundry.*" All participants were told to remember the event as vividly as they could and to write about the event in as much detail as they could. Afterward, participants indicated their momentary feelings of awe, amusement, and happiness from 1 (*not at all*) to 7 (*a lot*)—this served as our manipulation check². Then, participants completed the cognitive inclusiveness task, a demographic questionnaire, and were debriefed and thanked for their participation.

Measures

Creativity. Guided by prior research (De Dreu & Nijstad, 2008; De Dreu et al., 2008; Isen et al., 1987), participants indicated how prototypical three exemplars were of a particular category from 1 (*not at all*) to 10 (*very prototypical*). Within each category, participants were presented with one exemplar that is considered strongly prototypical, moderately prototypical, and weakly prototypical of that category. Specifically, the four categories presented to the participants (with strong, intermediate, and weak exemplars) were: (a) “vehicle” (i.e., bus, airplane, camel), (b) “vegetable” (i.e., carrot, potato, garlic), (c) “clothes” (i.e., skirt, shoes, handbag), and (d) “furniture” (i.e., couch, lamp, telephone). We averaged each participant’s rating of prototypicality for each exemplar type across all four categories—these ratings were moderately reliable: strong ($\alpha = .76$), moderate ($\alpha = .58$), and weak ($\alpha = .61$). Ratings of prototypicality for the strong exemplars and moderate exemplars were positively correlated ($r = .40, p < .001$); however, the ratings for strong exemplars and weak exemplars were not correlated ($r = -.06, p > .05$). Also, ratings of prototypicality for moderate and weak exemplars were positively correlated ($r = .42, p < .001$). In this task, ratings of weak exemplars, instead of strong and intermediate exemplars, are taken as indicators of enhanced convergent creativity because they indicate a willingness to reorganize the existing mental structure to consider unconventional associations between the weak exemplars and a category (Baas et al., 2008; De Dreu et al., 2008; Isen et al., 1987). Thus, we expected awe to increase ratings of prototypicality for weak exemplars.

Results and Brief Discussion

Manipulation Check. An analysis of variance (ANOVA) indicated that participants’ feelings of awe ($F[2, 182] = 87.5, p < .001$), amusement ($F[2, 179] = 48.4, p < .001$), and happiness ($F[2, 182] = 48.5, p < .001$) differed across conditions. As shown in Table 5, these findings suggest that the targeted emotions (i.e., awe and amusement) were always experienced most strongly in their respective conditions and did not differ on general positivity. Therefore, the manipulation was considered successful.

Does awe cause greater creativity? An analysis of variance (ANOVA) indicated that induced awe, compared to amusement, or the control condition, led to differences in cognitive inclusiveness (see Table 6). As expected, and in line with previous research (De Dreu et al., 2008), ratings of prototypicality for strong ($F[2, 182] = .37, p > .05$) and moderate ($F[2, 182] = .29, p > .05$) exemplars did not differ across conditions. However, ratings of prototypicality for weak exemplars were significantly different across the three conditions ($F[2, 182] = 4.02, p < .05$). As shown in Table 6, participants in the awe condition ($M = 4.00, SD = 1.87$) reported higher prototypical ratings for weak exemplars than participants in the amusement ($M = 3.32, SD = 1.61$), $t = 2.30, r = .19, p = .022$, and control conditions ($M = 3.21, SD = 1.37$), $t = 2.70, r = .23, p = .008$. Importantly, the latter two conditions did not differ from each other ($p = .72$). Thus, awe increased ratings of prototypicality for weak exemplars.

Study 3 improved upon the limitations of Studies 1 and 2 with an experimental approach that showed people who are induced with awe displayed greater convergent creativity. Specifically, participants who relived a time when they experienced awe, compared to reliving amusement, or a control condition, were more willing to consider unconventional associations. Thus, Studies 1-3 have found that awe, at a trait or state level, promote creative personality and convergent creativity. In Study 4, we aim to examine the effect of induced awe on divergent creativity.

Study 4: Induced Awe Enhances Divergent Creativity

Study 4 tested whether people induced to experience awe or amusement through watching a video would display greater divergent creativity. Specifically, participants completed a brainstorming task that was similar to other brainstorming tasks used to measure divergent creativity (e.g., thinking of different uses for a brick; Akinola & Mendes, 2008; De Dreu et al., 2008; Guilford, 1970; Vohs et al., 2013). Similar to past studies (Akinola & Mendes, 2008; De Dreu et al., 2008; Leung et al., 2012; Vohs et al., 2013), we used judges to code for the three distinct, but interrelated, components of divergent creativity: fluency, cognitive flexibility, and originality.

Method

Participants and Procedure

Participants were 107 students ($M_{age} = 21.0$, $SD = 3.2$, range 18-43; 75% female; 71% Caucasian) from a large public university on the West Coast who received partial course credit. They accessed the study through an online server and provided implied consent. Afterward, they were randomly assigned to watch one of two videos: (a) a three-minute clip that elicited amusement, consisting of various scenes from the movie *Toy Story* or (b) a three-minute clip that elicited awe, composed of sweeping shots of the planets.

We conducted a separate pilot study to ensure that the two conditions induced the desired emotions (Piff et al., 2015). Forty-seven participants from Mturk viewed the awe and amusement videos and indicated the extent to which they experienced awe (i.e., awe, wonder, and amazement), amusement (i.e., amusement and humorous), and happiness from 1 (*not at all*) to 7 (*extremely*). As shown in Table 5, the awe condition produced greater levels of awe compared with the amusement condition while the amusement condition produced higher levels of amusement than the awe condition. Importantly, happiness (general positivity) did not vary by conditions. These results suggest that the awe and amusement conditions successfully elicited our target emotions and did not differ from one another in terms of positivity.

After the video induction, participants completed a brainstorming task focused on improving the teaching quality in the psychology department (De Dreu et al., 2008). Specifically, participants were told that the psychology department was interested in their solutions, suggestions, and ideas for improving the teaching quality. Participants had five minutes to type as many ideas as they could. At the end of the five minutes, participants were debriefed and thanked for their participation.

Measure

Creativity. The participants' ideas were coded for the three components of divergent thinking (Baas et al., 2008; Leung & Chiu, 2008; Nijstad et al., 2010) by three research assistants who were blind to the condition and hypotheses. To assess fluency, the research assistants counted the number of unique ideas generated by each participant (Cohen's $K = .62$; Landis & Koch, 1977) with higher values indicated more fluency ($M = 1.33$, $SD = 0.69$; De Dreu et al., 2008). To assess cognitive flexibility, the research assistants were instructed to assign each unique idea into one of the following categories: (a) university environment (e.g., architecture of lecture halls, seminar rooms, and opening hours), (b) student facilities (e.g., extracurricular activities, library access, and classroom interiors), (c) student quality (e.g., selecting better students and increasing cooperation; contact among students), (d) teaching materials (e.g., readers, textbooks, handouts of PowerPoint presentations, examination issues, and grading systems), (e) teachers (e.g., teacher training and selection, use of teaching evaluations, and use of mentors and coaches), (f) policy (e.g., scholarships and other financial issues, information

distribution, and reduced bureaucracy), and (g) other issues (Cohen's $K = .55$). Higher number of categories indicated more flexibility ($M = 1.21, SD = 0.43$; Nijstad et al., 2002). To assess originality, the research assistants rated if “*each unique idea or suggestion is infrequent, novel, and original*” from 1 (*not original at all*) to 5 (*very original*; $\alpha = .64$). High rating indicated greater originality ($M = 2.41, SD = 0.75$). Based on these codes, fluency and flexibility were moderately correlated ($r = .49, p < .05$); however, originality was only moderately correlated with fluency ($r = .27, p < .05$) and not associated with flexibility ($r = .04, p > .05$). These lower correlations reduce any concern that originality was confounded by the other two components (Silvia et al., 2008).

Results and Brief Discussion

Does awe influence divergent creativity? We used a multivariate ANOVA to examine whether induced awe, compared to amusement, led to differences in fluency, flexibility, or originality (see Table 6). Interestingly, participants in the awe condition ($M = 1.29, SD = 0.61$) and amusement condition ($M = 1.38, SD = 0.78$) generated the same numbers of ideas, $t(105) = 0.65, p > .05$; also, the total number of categories these ideas fell into was similar in the awe ($M = 1.23, SD = 0.47$) and amusement conditions ($M = 1.16, SD = 0.38$), $t(105) = 0.70, p > .05$. However, participants in the awe condition ($M = 2.54, SD = 0.76$), compared to amusement condition ($M = 2.25, SD = 0.71$), generated ideas that were rated as more original, $t(105) = 2.01, r = .19, p = .047$. Study 4 showed that people who experienced awe compared to amusement generated an equal number of unique ideas that fell into an equal number of categories. However, participants induced to experience awe, compared to amusement, generated ideas that were more original. Therefore, feeling awe, compared to amusement, did not increase fluency or flexibility; whereas, feeling awe did increase originality.

Study 5: Induced Awe and Solving the Duncker Candle Task in the Lab

The first goal of Study 5 was to bolster the correlational and experimental evidence in previous studies by testing whether induced awe, compared to amusement, *and* a control condition promoted greater likelihood of solving the Duncker Candle Problem (Duncker & Lee, 1945) using *actual* materials in the task (i.e., board, candle, tacks, matches, and box). The second goal of Study 5 was to test accommodation in a mediation model to determine its mediating effect on the relation between experimentally induced awe and likelihood of solving the creativity task. We aimed for the minimum per-condition sample size of 20 as outlined by Simmons, Nelson, and Simonsohn (2011). More specifically, we aimed to recruit at least 60 people across this study's three conditions (i.e., awe, amusement, and control).

Method

Participants and Procedure

The study was posted on the online recruitment website for the duration of two semesters. At the end of the second semester, we were able to recruit a total of 156 participants from a large public university on the West Coast who received partial course credit. We excluded four participants because they had seen the task before, resulting in final sample of 152 participants. ($M_{age} = 21.00, SD = 3.00, range 18-37; 77\% female; 58\% Asian Americans$). Participants arrived at the laboratory and were seated in front of a computer connected to a 48 inches flat screen television. They provided informed consent, video releases, and were randomly assigned to watch one of three videos: a 2-minute neutral clip, in which man describes the construction of a kitchen countertop; a 2-minute clip that elicited amusement, consisting of a montage of nature clips from the BBC's comedic series, *Walk on the Wild Side*, composed of animals in their natural habitats acting in ways that are funny; or a 5-min clip inducing awe, consisting of nature

clips from the BBC's *Planet Earth* series composed of grand, sweeping shots of scenic vistas, mountains, plains, forests, and canyons. The awe and amusement clips have been validated by prior research (Piff et al., 2015). Afterward, participants indicated their momentary feelings of awe, amusement, happiness, and negative affect from 1 (*not at all*) to 7 (*a lot*)—this served as our manipulation check. Then, participants completed the accommodation items, Duncker Candle Task, a demographic questionnaire, and were debriefed and thanked for their participation.

Measure

State emotions. After the manipulation, we assessed participants' feelings of awe (i.e., awe, wonder, and amazement; $M = 3.80$, $SD = 1.70$, $\alpha = .91$), amusement (i.e., amusement & humorous; $M = 4.20$, $SD = 1.77$, $\alpha = .80$), happiness (i.e., happy & cheerful; $M = 4.26$, $SD = 1.69$, $\alpha = .92$), and four negative emotions (i.e., disgusted [$M = 1.30$, $SD = 0.88$], angry [$M = 1.22$, $SD = 0.74$], fear [$M = 1.32$, $SD = 0.84$], and sadness [$M = 1.49$, $SD = 1.04$]). Participants completed these state emotions on a 1 (*not at all*) to 7 (*a lot*).

Accommodation. To measure accommodation, we created a five-item scale based on the theoretical definition of accommodation from Keltner and Haidt (2003). Specifically, we showed participants a list of potential discoveries in the future (e.g., “Discover a group of indigenous people that we didn't know existed”; “Find a cure to the top three most deadly cancer types: Breast, colorectal, lung cancer”; “Humans will be able to inhabit Mars within the next 50 years”; “Reduce poverty level in the USA from 1:6 to 1:20”; “Extraterrestrial life will be discovered within the next 20 years.”) Participants responded on a 7-point Likert scale from 1 (*completely unlikely*) to 7 (*completely likely*; $M = 3.16$, $SD = 0.64$, $\alpha = .52$).

Duncker candle task. After they complete the accommodation measure, participants sat in front of a desk and were presented with the Duncker Candle Task materials (i.e., board, candle, tacks, matches, and box; see Figure 2). Participants were notified that they will be videotaped during the task and were given the following instructions:

“In front of you is a candle, a stack of matches, a box of tacks, and a wooden board. You have 3 minutes to figure out using only the objects on the table, how to attach the candle to the board so that the candle could burn properly and does not drip wax on the table or the floor. Please note, DO NOT actually light the matches. I will leave the room now. Once you believe you have solved the task, please alert me. If you have not alert me by the end of the 3 minutes, I will re-enter the room and stop the task.”

Consistent with Study 2 and past research (Gino & Ariely, 2011; Isen et al., 1987; Maddux & Galinsky, 2009; Maddux et al., 2010), we instructed a research assistant to code participant's solution as correct only if the response included the use of the box as a candleholder. Overall, 33 of the 152 participants solved the problem correctly (22%).

Results and Brief Discussion

Manipulation check. An analysis of variance (ANOVA) indicated that participants' feelings of awe ($F[2, 149] = 29.80$, $p < .001$), amusement ($F[2, 149] = 25.15$, $p < .001$), and happiness ($F[2, 149] = 11.00$, $p < .001$) differed across conditions. However, participants' feelings of disgusted ($F[2, 149] = 0.95$, $p = .39$), angry ($F[2, 149] = 0.23$, $p = .79$), fear ($F[2, 149] = 2.31$, $p = .10$), and sadness ($F[2, 149] = 1.51$, $p = .22$) did not differ across conditions. As shown in Table 5, these findings suggest that the targeted emotions (i.e., awe and amusement) were always experienced most strongly in their respective conditions and did not differ on other negative emotion items. Therefore, the manipulation was considered successful.

Accommodation. An analysis of variance (ANOVA) indicated that conditions differences in accommodation ($F[2, 149] = 3.50, p = .033$). Specifically, participants in the awe condition ($M = 3.30, SD = 0.60$) did not report greater accommodation than participants in the amusement condition ($M = 3.19, SD = 0.67, t = 0.84, p = .40$). However, participants in the awe condition reported greater accommodation than people in the control condition ($M = 2.97, SD = 0.62, t = 2.59, r = .21, p = .01$). The amusement and control conditions did not differ from each other ($p = .084$). Thus, awe significantly increased ratings of accommodation compared to control but not amusement.

Did accommodation significantly predict likelihood of solving the creativity task? A binary logistic regression revealed that accommodation did not significantly predict whether or not people were able to solve the creativity task ($B = .02, SE = .20, Wald = .01, p = .90, \text{Exp}(B) = 1.02, 95\% \text{ CI } [.70, 1.50]$).

Creativity. We analyzed the data using binary logistic regression with an indicator contrast comparing the control and amusement conditions with the awe condition (i.e., Awe is the reference). The results showed that people in the control condition were not significantly different from people in the awe conditions at solving the candle task ($B = .13, SE = .50, Wald = .07, p = .79, \text{Exp}(B) = 1.13, 95\% \text{ CI } [.42, 3.09]$). Moreover, the results also showed that people in the amusement condition were not significantly different from people in the awe conditions at solving the candle task ($B = .59, SE = .48, Wald = 1.52, p = .21, \text{Exp}(B) = 1.81, 95\% \text{ CI } [.70, 4.68]$).

Together, the results from Study 5 were mixed. First, we observed people in the awe conditions reported more accommodation tendencies than people in the control, but not the amusement condition. One issue is that the items we created didn't fit together well, which suppress the power needed to detect condition differences. The average inter-correlation between the five-item was $r = .37$. The corrected item-total correlations suggest that items one (Discover a group of indigenous people that we didn't know existed; $r = .17$) and four (Reduce poverty level in the USA from 1:6 to 1:20; $r = .16$) had particularly low item-total correlations. When we removed these two items from the scale, the reliability of the three remaining items is $.60$. However, even if we re-analyze the data with just these three items, we discover that the results remain similar to the original analysis with the five items. Another issue could be that we didn't create items that validly measure accommodation as defined by Keltner & Haidt (2003). Accommodation arises from seeing a stimuli that challenge our normal day-to-day frame of reference and are not already integrated into our understanding of the world. Perhaps, the items isn't measuring peoples' need or attempt to revise their mental structure, but more of a measure of people's intuition of the future. We also did not find any significant difference across conditions on the probability of solving the candle task. A major reason may be that we obtained a particularly low overall percentage of people who actually solved the task (23%; awe [9/51], amusement [14/50], control [10/51]). The participants from past research, on average, were able to solve the task at close to or higher than 50% of the time (Study 2 [48%]; Gino & Ariely, 2011 [47%]; Isen et al., 1987 [50%]; Maddux & Galinsky, 2009 [54%]; Maddux et al., 2010 [65%]). This suggests that we did not detect a significant difference across conditions on solving the task because our participants were highly skewed towards *not* being able to solve the task. Why is the overall probability of solving the task so much lower compared to previous research? First, previous research have mostly used the pictorial version of the candle task. Isen et al., (1987) was the exception, in which they also used actual materials. The key difference between the pictorial version and the current research (and with Isen et al.,) was that participants can move

the objects around. More importantly, both Isen et al., and the current research used a wooden board that wasn't affixed to the wall. While the participants were completing the task in the lab, they were being videotaped. So, we were able to examine the video for clues. One behavior that stood out was 26 out of 152 participants moved the board from its original position (i.e., against the wall). This prevents participants from properly thinking about the key to solving the task: "using the objects on the table... how to attach the candle to the board so that the candle could burn properly and does not drip wax on the table or the floor." That is, they are supposed to think of the board as a part of the wall that can't be moved (just like the pictorial version). For instance, out of the 33 people who were able to solve the task, 29 did *not* move the board and 4 *did* move the board. A chi-square test of whether moving the board or not and being able to solve the task or not wasn't significant ($\chi^2 = 0.74, p = .39$). However, there is an obvious trend that suggests people, in general, were more likely to solve the task if they did not move the board (29 vs. 4). Perhaps, the act of moving the board may have influenced participants' cognitive processes to form the proper steps to solving the task. As a result, we discovered that this study was conducted with systematic error in the instructions that led the participant's to misunderstand the instructions and the goal of the task. We should conduct the study again, especially reminding the participants that they can't move the board.

General Discussion

It is widely accepted that positive emotions promote creativity (Lyubomirsky et al., 2005). However, the ATF approach asserts that similarly valenced emotions will yield distinct effects upon cognitive processes depending on core appraisal themes of the emotions (Lerner et al., 2015). This framework suggests that specific positive emotions should be more conducive to creativity than others. Guided by this framework, we tested the hypothesis that the experience of awe, a positive emotion defined by the appraisals of vastness and the need for accommodation, would lead to more creativity than another positive emotion with different appraisals, amusement. The results of four studies support our central hypothesis: trait and state awe, but not amusement, predicted increased creative personality traits and convergent and divergent creativity as assessed with behavioral and self-report measures.

Implications and Future Directions

Building upon past studies of positive emotions and creativity (Isen et al., 1987; Lyubomirsky et al., 2005), the current results provide a more nuanced understanding of the positive emotional antecedents of creativity. Awe appears to be a central engine of creativity in the positive emotions realm. Despite the consistency of the present results, several lines of research are needed to be more fully confident in our central claim about awe and creativity. First, research is needed that compares awe's effects upon creativity to other closely related positive emotions, most notably gratitude, joy, and interest.

Second, it is important to note that we studied a more positive form of awe. A recent investigation documented that threat-related awe, for example when viewing a natural disaster, produces much different thought processes and physiological response than the more positive kind of awe studied here (Gordon et al., 2016). It is quite plausible that threat-based awe actually dampens creativity, given the narrowing effects of fear upon cognitive processing (Mineka & Sutton, 1992). On the other hand, however, others have shown that negative emotions led people to produce greater artistic creativity (Akinola & Mendes, 2008). This suggests two potentially interesting future research programs. First, it may be pertinent to compare the effects of positive awe with threat-based awe on different creativity outcomes. The results of this type of research will illuminate the extent to which the variations of awe experiences lead to creativity

differentially or equally well. Another future direction is examining the effect of the positive and negative variants of awe experiences on domain specific measures of creativity. Unlike broad measures of creativity (e.g., different uses of a brick), we may see certain emotions enhance some specific types of creative tasks more so than awe. For example, one could examine whether induced compassion will lead people to come up with creative ways to help a person who is suffering to a greater extent compared to induced awe. These will be important research programs that can further contribute to the emerging science of awe and the literature documenting the function of awe.

While Studies 1-4 showed that awe predicts and promotes creativity, they did not test the process underlying this link. One of the goal of Study 5 was to test accommodation as a potential mechanism. However, we discovered that participants in both the awe and amusement conditions reported more accommodation than people in the control condition, but the awe and amusement did not differ from each other. We speculate that the items we created may not be a valid measure of accommodation as defined by Keltner and Haidt (2005). Instead, these items may be measuring an intuition about the future that aligns more along the lines of tolerance for ambiguity (Shiota et al., 2007). We note that there is an existing 15-item scale developed by Stanovich and West (1999) that may be measuring accommodation. The authors developed this scale with the goal of measuring peoples' reasoning tendencies independent of prior belief and the willingness to change one's beliefs in the face of contradictory evidence (e.g., "People should take into consideration evidence that goes against their beliefs"; "People should revise their beliefs in response to new information or evidence.") Future research could adapt this scale and use it as the basis to develop and perhaps, conduct a pilot study to validate a set of items that measures accommodation.

Besides accommodation, we speculate curiosity would be a potential mediator as well. Observations of creative thinkers such as writers, inventors, or scientists provide clues suggesting that awe leads to a state of curiosity, which then facilitates creative performances. Curiosity is an intrinsically motivated cognitive state that propels the individual to approach and explore a target experience as well as the external environment (Kashdan & Fincham, 2004), and is widely assumed to promote creativity (Amabile, 2001). Also, Kashdan and Fincham (2002) argued that curiosity is a necessary prerequisite for creativity because curiosity is a self-regulating mechanism that leads people to intrinsically allocate extensive personal efforts to integrate novel experiences. Indeed, past research supports this connection between curiosity and enhanced creativity. For example, trait curiosity is positively associated with the need for cognition (i.e., the tendency to enjoy effortful intellectual activities) as well as openness to experience in (a) younger American adults (Kashdan et al., 2004) and (b) German adults (Mussel, 2010). Furthermore, interest, an emotion that is conceptually and empirically related to curiosity (Kashdan & Silvia, 2009; Silvia, 2006), has been linked to creativity. For instance, people who are prone to find things interesting report greater openness to experience (Silvia, 2008). Participants who are induced to feel interest show greater perseverance (an important component of creativity; see Csikszentmihalyi, 1999; Sternberg & Lubart, 1991) by spending more time on an anagram task (Thoman et al., 2011). Future research should examine accommodation and curiosity as a mechanisms for the link between awe and creativity.

The emerging science on awe have demonstrated many positive functions of awe (e.g., humility, prosocial behaviors, well-being; see Zhang & Keltner, 2015 for a review). One challenge for future research is developing interventions that can translate these positive consequences into real world changes in daily life. The current research, together with prior

findings, set the stage for several possibilities. Keltner and Haidt (2003) posited that “the most common experience of awe...is the response to natural objects, such as mountains, vistas, and oceans” (p. 309). Following this thinking, a majority of research have use nature stimuli to induce feeling of awe (e.g., look up at a tree, video depicting natural landscape; Piff et al., 2015; Rudd et al., 2012; Shiota et al., 2007; Valdesolo & Graham, 2013; Van Cappellen & Saroglou, 2012). For this reason, we propose that nature immersion is a fruitful approach to evoke feelings of awe in everyday life because natural landscapes tends to be easily accessible and affordable (e.g., neighborhood, state, and national parks), and past research have demonstrated a short walk around rural nature setting or hiking in remote landscape can increase various cognitive abilities (Berman et al., 2012; Atchley, Strayer & Atchley, 2012). In study 4, we induced awe with a video showing sweeping shots of the planets. This manipulation allowed us to generalize our findings to a non-nature domain. But importantly, it also suggests planetarium shows at various scientific museums as another feasible approach to boost awe in everyday life. Testing these suggestions under real life circumstances will be ambitious, requires careful planning, and cooperation between scientists and institutions. Nonetheless, state and national parks, as well as scientific museums serves millions of people each year, if done right, the implications could be wide-ranging.

Limitations

Some of our findings warrant discussion about their limitations. For example, Study 4 discovered that induced awe only had an effect on originality, but not the fluency or flexibility of ideas generated. In part this is fitting with the claim that originality is the central component in divergent thinking because it is more important to have one original idea than many ideas that fall into various categories (Leung et al., 2012; Rietzschel et al., 2007). Additionally, the fact that awe and amusement did not differ on fluency and flexibility helps rule out the alternative explanation that participants who produced original ideas simply gave more effort in generating ideas (Vohs et al., 2013).

Nonetheless, Study 4 arguably provides weak evidence for an effect of awe on convergent creativity because the effects of originality was barely-significant that was embedded within multiple comparisons. However, we should point out that we used multivariate analysis of variance to test the comparisons on the three outcomes. The multivariate analysis of variance essentially controls the family error rate (reduces the chance of incorrectly rejecting the null hypothesis with successive analysis of variance) and keeps the family error rate equal to the standard alpha cut-off level of .05. Moreover, the significance of this study could have been reduced by the relatively low agreement on the coding conducted by the research assistant. That is, if the reliability was higher, we would expected the significance of the alpha level to decrease. Given some of the limitations we see in Study 4, perhaps, it is fairer to state that the results are exploratory in nature.

We conducted Study 5 with the goal of including a control condition that was missing in Study 4, examining accommodation as a possible mechanism, and testing participant’s actual ability to solve the Duncker Candle task with the actual materials. The results revealed no significant differences across conditions on the creativity task. We watched the recording of participants’ behaviors during the creativity task and discovered that moving the board may have influenced the thought process towards correctly solving the task. That is, the study revealed systematic error that we could have prevented by clearly instructing the participants that they cannot move the board. This is an interesting caveat that would benefit other researchers who

intends to employ the Duncker Candle Task in a laboratory setting. We intend to conduct the same study again, giving participants precise instruction not to move the board.

The present investigation was also limited in terms of the operationalization of creativity. Although we tested the effect of awe upon established measures of creativity, there are other components of creativity that future research could examine. These may include a teacher's rating of a student's creative performance or a supervisor's evaluation of a teams' brain storming session. If awe improves individual creative performance, we expect people who are awe-prone to display more creativity in daily life and to be observed by proximal others as creative people. Researchers could measure employees' trait-level awe and use experience sampling method to collect daily creative performance measures (e.g., ideas generated during meetings) through self-report and/or reports from co-workers, as well as supervisors. Such studies would provide intriguing external validity to our established awe and creativity link.

Conclusion

Creativity is a highly-sought after skill. We discovered that the experience of awe is a positive emotion that is conducive to creativity. Our results add to the burgeoning science of awe, demonstrating the widespread benefits of this understudied positive emotion. Awe triggering experiences, such as the simple act of looking up at the sky, are abundant in everyday life, and may prove to be a potent source of creativity. In sum, we urge people to "pause to wonder and stand rapt in awe" because it could open up their creative potentials.

References

- Akinola, M., & Mendes, W. B. (2008). The dark side of creativity: Biological vulnerability and negative emotions lead to greater artistic creativity. *Personality and Social Psychology Bulletin*, *34*, 1677-1686.
- Amabile, T. M. (2001). Beyond talent: John Irving and the passionate craft of creativity. *American Psychologist*, *56*, 333-336.
- Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology*, *45*, 357-376.
- Ashton, M. C., & Lee, K. (2007). Empirical, theoretical, and practical advantages of the HEXACO model of personality structure. *Personality and Social Psychology Review*, *11*, 150-166.
- Baas, M., De Dreu, C. K., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, *134*, 779-806.
- Barron, F., & Harrington, D. M. (1981). Creativity, intelligence, and personality. *Annual Review of Psychology*, *32*, 439-476.
- Boies, K., Yoo, T. Y., Ebacher, A., Lee, K., & Ashton, M. C. (2004). Validity studies psychometric properties of scores on the French and Korean versions of the Hexaco personality inventory. *Educational and Psychological Measurement*, *64*, 992-1006.
- 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 & Emotion*, *27*, 37-52.
- Chamorro-Premuzic, T. (2006). Creativity versus conscientiousness: Which is a better predictor of student performance? *Applied Cognitive Psychology*, *20*, 521-531.
- Cropley, A. (2006). In praise of convergent thinking. *Creativity Research Journal*, *18*, 391-404.
- De Dreu, C. K., & Nijstad, B. A. (2008). Mental set and creative thought in social conflict:

- threat rigidity versus motivated focus. *Journal of Personality and Social Psychology*, *95*, 648-661.
- De Dreu, C. K., Baas, M., & Nijstad, B. A. (2008). Hedonic tone and activation level in the mood-creativity link: Toward a dual pathway to creativity model. *Journal of Personality and Social Psychology*, *94*, 739-756.
- De Vries, R. E., Lee, K., & Ashton, M. C. (2008). The Dutch HEXACO Personality Inventory: Psychometric properties, self–other agreement, and relations with psychopathy among low and high acquaintanceship dyads. *Journal of Personality Assessment*, *90*, 142-151.
- Duncker, K., & Lees, L. S. (1945). On problem-solving. *Psychological Monographs*, *58*, i-113.
- Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review*, *2*, 290-309.
- Friedman, R. S., & Förster, J. (2001). The effects of promotion and prevention cues on creativity. *Journal of Personality and Social Psychology*, *81*, 1001-1013.
- Frijda, N. H., Kuipers, P., & Ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology*, *57*, 212-228.
- Gino, F., & Ariely, D. (2011). The dark side of creativity: Original thinkers can be more dishonest. *Journal of Personality and Social Psychology*, *102*, 445-459.
- Gong, Y., Huang, J. C., & Farh, J. L. (2009). Employee learning orientation, transformational leadership, and employee creativity: The mediating role of employee creative self-efficacy. *Academy of Management Journal*, *52*, 765-778.
- Gough, H. G. (1979). A creative personality scale for the Adjective Check List. *Journal of Personality and Social Psychology*, *37*, 1398-1405.
- Griskevicius, V., Shiota, M. N., & Neufeld, S. L. (2010). Influence of different positive emotions on persuasion processing: A functional evolutionary approach. *Emotion*, *10*, 190-206.
- Guilford, J. P. (1970). Creativity: Retrospect and prospect. *The Journal of Creative Behavior*, *4*, 149-168.
- Güsewell, A., & Ruch, W. (2012). Are there multiple channels through which we connect with beauty and excellence? *The Journal of Positive Psychology*, *7*, 516-529.
- Gordon, A. M., Stellar, J. E., Anderson, C. L., McNeil, G. D., Loew, D., & Keltner, D. (2016). The dark side of the sublime: Distinguishing a threat-based variant of awe. *Journal of Personality and Social Psychology*.
- Helson, R. (1999). A longitudinal study of creative personality in women. *Creativity Research Journal*, *12*, 89-101.
- Hocevar, D. (1980). Intelligence, divergent thinking, and creativity. *Intelligence*, *4*, 25-40.
- Horberg, E. J., Oveis, C., & Keltner, D. (2011). Emotions as moral amplifiers: An appraisal tendency approach to the influences of distinct emotions upon moral judgment. *Emotion Review*, *3*, 237-244.
- Horberg, E. J., Oveis, C., Keltner, D., & Cohen, A. B. (2009). Disgust and the moralization of purity. *Journal of Personality and Social Psychology*, *97*, 963-976.
- Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, *52*, 1122-1131.
- Kashdan, T. B., & Silvia, P. J. (2009). Curiosity and interest: The benefits of thriving on novelty and challenge. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (2nd ed., pp. 367-374). New York, NY: Oxford University Press.
- Kashdan, T. B., Rose, P., & Fincham, F. D. (2004). Curiosity and exploration: Facilitating

- positive subjective experiences and personal growth opportunities. *Journal of Personality Assessment*, 82, 291-305.
- Kashdan, T. B., & Fincham, F. D. (2004). Facilitating curiosity: A social and self-regulatory perspective for scientifically based interventions. In P. A. Linley & S. Joseph (Eds.), *International handbook of positive psychology in practice: From research to application*. Hoboken, NJ: Wiley.
- Kashdan, T. B., & Fincham, F. D. (2002). Facilitating creativity by regulating curiosity. *American Psychologist*, 57, 373-376.
- Keltner, D., & Lerner, J. S. (2010). Emotion. *Handbook of Social Psychology*.
- Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition & Emotion*, 17, 297-314.
- 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, 740-752.
- Kim, T. Y., Hon, A. H., & Crant, J. M. (2009). Proactive personality, employee creativity, and newcomer outcomes: A longitudinal study. *Journal of Business and Psychology*, 24, 93-103.
- Kirton, M. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology*, 61, 622-629.
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33, 159-174.
- Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and decision making. *Annual Review of Psychology*, 66, 799-823.
- Lerner, J. S., Small, D. A., & Loewenstein, G. (2004). Heart strings and purse strings carryover effects of emotions on economic decisions. *Psychological Science*, 15, 337-341.
- Lerner, J. S., Gonzalez, R. M., Small, D. A., & Fischhoff, B. (2003). Effects of fear and anger on perceived risks of terrorism a national field experiment. *Psychological Science*, 14, 144-150.
- Lerner, J. S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology*, 81, 146-159.
- Lerner, J. S., & Keltner, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgement and choice. *Cognition & Emotion*, 14, 473-493.
- Leung, A. K. Y., Kim, S., Polman, E., Ong, L. S., Qiu, L., Goncalo, J. A., & Sanchez-Burks, J. (2012). Embodied metaphors and creative “acts”. *Psychological Science*, 23, 502-509.
- Leung, A. K. Y., & Chiu, C. Y. (2008). Interactive effects of multicultural experiences and openness to experience on creative potential. *Creativity Research Journal*, 20, 376-382.
- Levenson, R. W. (2011). Basic emotion questions. *Emotion Review*, 3, 379-386.
- Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin*, 131, 803-855.
- Maddux, W. W., Adam, H., & Galinsky, A. D. (2010). When in Rome... Learn why the Romans do what they do: How multicultural learning experiences facilitate creativity. *Personality and Social Psychology Bulletin*, 36, 731-741.
- Maddux, W. W., & Galinsky, A. D. (2009). Cultural borders and mental barriers: The relationship between living abroad and creativity. *Journal of Personality and Social Psychology*, 96, 1047-1061.
- McGraw, A. P., & Warren, C. (2010). Benign violations: Making immoral behavior funny.

- Psychological Science*, 21, 1141–1149
- Mineka, S., & Sutton, S. K. (1992). Cognitive biases and the emotional disorders. *Psychological Science*, 3, 65-69.
- Mussel, P. (2010). Epistemic curiosity and related constructs: Lacking evidence of discriminant validity. *Personality and Individual Differences*, 49, 506-510.
- Nijstad, B. A., De Dreu, C. K., Rietzschel, E. F., & Baas, M. (2010). The dual pathway to creativity model: Creative ideation as a function of flexibility and persistence. *European Review of Social Psychology*, 21, 34-77.
- Oveis, C., Horberg, E. J., & Keltner, D. (2010). Compassion, pride, and social intuitions of self-other similarity. *Journal of Personality and Social Psychology*, 98, 618-630.
- 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, 883-899.
- Razavi, P., Zhang, J. W., Hekiert, D., Yoo, S. H., & Howell, R. T. (2016). Cross-Cultural Similarities and Differences in the Experience of Awe. *Emotion*, 16, 1097-1101.
- Rietzschel, E. F., De Dreu, C. K., & Nijstad, B. A. (2007). Personal need for structure and creative performance: The moderating influence of fear of invalidity. *Personality and Social Psychology Bulletin*, 33, 855-866.
- Rosch, E. (1975). Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, 104, 192-233.
- 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, 1130-1136.
- Runco, M. A., & Charles, R. E. (1993). Judgments of originality and appropriateness as predictors of creativity. *Personality and Individual Differences*, 15, 537-546.
- Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition and Emotion*, 21, 944-963.
- 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, 61-71.
- Shiota, M. N., Campos, B., Keltner, D., & Hertenstein, M. J. (2004). Positive emotion and the regulation of interpersonal relationships (pp. 127–155). In P. Philippot & R. S. Feldman (Eds.), *The regulation of emotion*. Mahwah, NJ: Erlbaum.
- Silvia, P. J., Kaufman, J. C., Reiter-Palmon, R., & Wigert, B. (2011). Cantankerous creativity: Honesty–Humility, Agreeableness, and the HEXACO structure of creative achievement. *Personality and Individual Differences*, 51, 687-689.
- Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., ... & Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts*, 2, 68-85.
- Silvia, P. J. (2008). Interest—The curious emotion. *Current Directions in Psychological Science*, 17, 57-60.
- Silvia, P. J. (2006). *Exploring the psychology of interest*. Oxford University Press.
- Simonton, D. K. (2000). Creativity: Cognitive, personal, developmental, and social aspects. *American psychologist*, 55, 151-158.
- Sligte, D. J., De Dreu, C. K., & Nijstad, B. A. (2011). Power, stability of power, and creativity. *Journal of Experimental Social Psychology*, 47, 891-897.

- Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology*, 48, 813-838.
- Stanovich, K. E., & West, R. F. (1997). Reasoning independently of prior belief and individual differences in actively open-minded thinking. *Journal of Educational Psychology*, 89, 342-357.
- Sternberg, R. J. (Ed.). (1999). *Handbook of creativity*. Cambridge University Press.
- Sternberg, R. J., & Lubart, T. I. (1991). An investment theory of creativity and its development. *Human Development*, 34, 1-31.
- Tan, A. G., Ho, V., Ho, E., & Ow, S. (2008). High school students' perceived creativity self-efficacy and emotions in a service learning context. *The International Journal of Creativity & Problem Solving*, 18, 115-126.
- Tierney, P., & Farmer, S. M. (2002). Creative self-efficacy: Its potential antecedents and relationship to creative performance. *Academy of Management Journal*, 45, 1137-1148.
- Thoman, D. B., Smith, J. L., & Silvia, P. J. (2011). The resource replenishment function of interest. *Social Psychological and Personality Science*, 2, 592-599.
- Tong, E. M. (2014). Differentiation of 13 positive emotions by appraisals. *Cognition and Emotion*, 29, 484-503.
- Valdesolo, P., & Graham, J. (2013). Awe, uncertainty, and agency detection. *Psychological Science*, 25, 170-178.
- Vohs, K. D., Redden, J. P., & Rahinel, R. (2013). Physical order produces healthy choices, generosity, and conventionality, whereas disorder produces creativity. *Psychological Science*, 24, 1860-1867.
- Wakabayashi, A. (2014). A sixth personality domain that is independent of the Big Five domains: The psychometric properties of the HEXACO Personality Inventory in a Japanese sample. *Japanese Psychological Research*, 56, 211-223.
- Wyer, R. S., & Collins, J. E. (1992). A theory of humor elicitation. *Psychological Review*, 99, 663-688.
- Zhang, J. W., & Keltner, D. Awe and the natural environment. In Friedman, H. (Eds.), (2015). *Encyclopedia of mental health: Second edition*. Elsevier: Oxford, UK.
- Zhou, J., & Oldham, G. R. (2001). Enhancing creative performance: Effects of expected developmental assessment strategies and creative personality. *The Journal of Creative Behavior*, 35, 151-167.

Table 1

A Synopsis of the Components, Definitions, Selected Studies and Measures of Creativity

Components	Definition	Selected studies	Sample measures	Employed in the Following Studies
Creative personality	Individuals who naturally have a creative predisposition	Gino & Ariely (2011) Silvia et al. (2011)	Gough's creativity personality scale; Hocevar's creative behavior inventory; Creative cognitive style HEXACO – unconventionality & creativity	Pilot study & Study 1
Convergent creativity	Individual's ability to formulate a single best solution to a problem	De Dre et al. (2008) Gino & Ariely (2011) & Maddux et al. (2010)	Prototypical exemplars Duncker candle problem	Studies 2, 3
Divergent creativity	Individual's ability to generate multiple alternative original ideas to a problem	Akinola & Mendes (2008) De Dreu et al. (2008) Vohs et al. (2013)	Unusual themes Improve teaching quality Unusual use task	Study 4

Table 2

A Pilot Study Verifying the Relationship between HEXACO Unconventional and Creativity Scales with the Creative Personality

Scales used in Gino and Ariely (2011)

	HEXACO unconventionality	HEXACO creativity
Creativity personality measures		
Hocevar creative behavior inventory	.27*	.49*
Gough creative personality check list	.40*	.49*
Creative cognitive style	.48*	.68*

Note. The correlation between unconventionality and creativity is $r = .50$; * $p < .05$

Table 3

Zero Order and Partial Correlations between Dispositional Awe, Dispositional Amusement, and Creative Personality Measures

Creative personality measure	Dispositional awe	Dispositional amusement
HEXACO (Study 1a; USA college students)		
Unconventionality	.30* (.32*)	.02 (-.13)
Creativity	.31* (.27*)	.15* (.03)
HEXACO (Study 1b; USA high school students)		
Unconventionality	.33* (.26*)	.24* (.13*)
Creativity	.30* (.29*)	.07 (-.07)
HEXACO (Study 1c; Iran adults)		
Unconventionality	.26* (.25*)	.09 (.03)
Creativity	.35* (.31*)	.23* (.16*)
HEXACO (Study 1d; Malaysia college students)		
Unconventionality	.30* (.25*)	.19* (.09)
Creativity	.38* (.32*)	.23* (.11)
Meta-analytic average of awe and creativity measures (Fisher r to z transformation)	.32	.15

Note. Correlations in the parentheses are partial correlations controlling for dispositional amusement or dispositional awe; The meta-analytic effect of awe is significantly different from amusement, $Z = 5.97, p < .001$; * $p < .05$

Table 4

Summary of Logistic Regression Analysis for Dispositional Awe and Dispositional Amusement Predicting Odds of Solving Duncker Candle Problem

Predictors	Duncker candle problem						
	B	SE	Wald	<i>p</i>	Exp(B)	95% CI Lower	95% CI Upper
Dispositional awe	.32*	.16	4.16	.041	1.37	1.01	1.86
Dispositional amusement	.06	.15	.15	.69	1.06	-.79	1.43

Note. Exp(B) is the odds ratio. Exp(B) value indicates that awe prone people are 37% more likely to solve the Duncker Candle Problem.

Table 5

A Summary of the Links between Induced Awe, Amusement, and Control on Manipulation Checks for Experimental Studies 3 & 4

	Awe	Amusement	Control
Manipulation check (Study 3)			
Awe	5.32 (1.79) _a	2.90 (1.78) _b	1.60 (1.03) _b
Amusement	3.71 (2.02) _a	5.59 (1.51) _b	2.54 (1.71) _c
Happiness	5.39 (1.64) _a	5.43 (1.33) _a	2.88 (1.93) _b
Manipulation check (Study 4)			
Awe	4.75 (2.06) _a	2.86 (1.51) _b	-
Amusement	3.13 (1.75) _b	5.12 (1.57) _a	-
Happiness	4.78 (2.04) _a	4.83 (1.81) _a	-
Manipulation check (Study 5)			
Awe	5.03 (1.54) _a	3.68 (1.17) _b	2.84 (1.60) _c
Amusement	3.98 (1.63) _a	5.29 (1.14) _b	3.16 (1.72) _c
Happiness	4.10 (1.70) _a	5.05 (1.09) _b	3.61 (1.81) _a
Disgusted	1.35 (0.93) _a	1.18 (0.52) _a	1.20 (0.57) _a
Angry	1.22 (0.64) _a	1.18 (0.56) _a	1.14 (0.53) _a
Fear	1.45 (0.95) _a	1.16 (0.51) _a	1.24 (0.59) _a
Sadness	1.65 (1.07) _a	1.34 (0.80) _a	1.39 (0.96) _a

Note. Means with different subscripts are significantly different from each other. The Levene statistics showed that the homogeneity of variance assumption was violated for incidental awe, amusement, and happy in Study 3 and awe, amusement, happiness, disgusted, and fear in Study 5. Therefore, we used the Games-Howell post-hoc test to compare the mean differences for these outcomes.

Table 6

A Summary of the Links between Induced Awe, Amusement, and Control on Creativity Measures for Experimental Studies 3 & 4

	Awe	Amusement	Control
Cognitive inclusiveness (Study 3)			
Strong	9.19 (1.47) _a	9.35 (0.92) _a	9.35 (1.04) _a
Intermediate	6.85 (1.95) _a	6.95 (1.77) _a	6.70 (1.67) _a
Weak	4.00 (1.87) _a	3.32 (1.61) _b	3.21 (1.37) _b
Improve teaching quality (Study 4)			
Fluency	1.29 (0.61) _a	1.38 (0.78) _a	-
Categories	1.23 (0.47) _a	1.16 (0.38) _a	-
Originality	2.54 (0.76) _a	2.25 (0.71) _b	-

Note. Means with different subscripts are significantly different from each other. The Levene statistics showed that the homogeneity of variance assumption was violated for weak exemplar in Study 3. Therefore, we used the Games-Howell post-hoc test to compare the mean differences for this outcome.

Figure 1

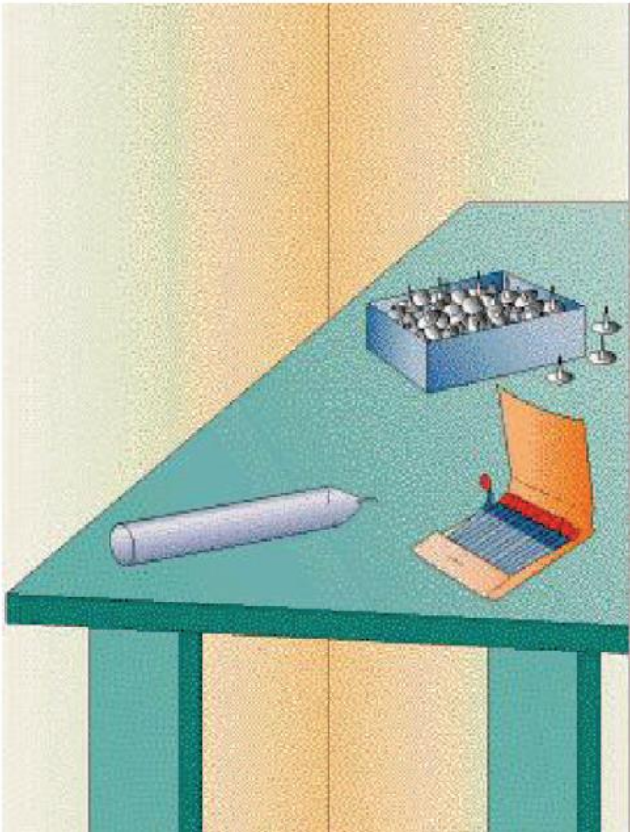


Figure 2

