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Awesome play: Awe increases preschooler's exploration and discovery

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Abstract

Affective states, exploration, and learning are tightly intertwined. For example, research has connected surprise to play and learning in early development (Stahl & Feigenson, 2015), but less is known about the potential impact of other affective states and how they might influence exploration and subsequent discovery. Given that past research has suggested that awe may increase feelings of uncertainty and lead to pursuit of cognitive accommodation in adults (Valdesolo & Graham, 2014), we posit that awe-induced uncertainty may similarly lead children to think-outside-the-box and explore more during play. In Experiment 1, we modify emotion-inducing videos (Awe, Happy and Calm) and validate them on adult participants using the perceived self-size Circle Task (Bai et al., 2017). In Experiment 2, children were presented with one of the three videos and their exploratory play with a novel toy was recorded. Results revealed both a significant effect of the manipulation (children associated with smaller selves in the Awe condition) and also an influence of the videos on play. Children in the Awe condition played more and explored more variably than children in the control conditions. These results suggest that awe influences motivation that increases variability and discovery in exploration.

Keywords: Cognition; Discovery; Emotion; Awe; Development

Introduction

A core component of active learning is the ability to identify and explore in situations of high uncertainty, which generates evidence to support learning. Even young children seem equipped to recognize and reconcile uncertainty, as play is a natural expression of this active learning ability. For example, research has shown that children become more motivated to playfully explore following uncertainty caused by conflicts with beliefs (Bonawitz, van Schijndel, Friel, & Schulz, 2012). Even infants increase information-seeking play behaviors in response to belief-violating events (Stahl & Feigenson, 2015). These results suggest an important role of surprise in driving exploratory play. However, children also explore more following uncertain events that are not necessarily surprising. For example, Schulz and Bonawitz (2007) found that preschoolers recognized causally confounded events and were more motivated to explore given the uncertainty caused by this confounding. These results raise the question of whether other affective and motivational factors may lead to increases in play given uncertainty.

A large body of literature that has looked at the effects of emotion on cognition (such as attention and memory), but this work has focused on how valence (either positive or negative) affects success in learning environments where the information is controlled for the participant. For example, literature looking at learning outcomes in the form of academic achievement finds that positive affect (such as group membership) facilitates success (Roeser, Midgley, & Urdan, 1996), while negative affect (such as performance anxiety) hinders it (Linnenbrink, 2006; Pekrun, Goetz, Titz, & Perry, 2002). However, in these studies, information is provided to the participant and there is no measure of the *drive* to explore and resolve information to support learning.

In contrast to general positive or negative affective states, some researchers have suggested that the state of awe links to feelings of uncertainty and furthermore motivates a desire to resolve uncertainty through exploration (Valdesolo & Graham, 2014). Here we investigate whether awe causes children to explore more, and more variably, during play.

Awe as an affective state

Awe arises similarly to surprise, from an unexpected event. It also resembles wonder or curiosity as it induces the salience of a knowledge gap with a strong desire to acquire more information. Individuals induced with awe develop a stronger interest in the world around them that does not rely on their past self-concept or personal goals (Keltner & Haidt, 1999; Zhang & Keltner, 2016). Awe has been associated with both positive and negative states (Keltner & Haidt, 2003). We are interested in how awe may affect approach behavior, and therefore will be focusing on background and methods looking at positive awe. Experiences of awe are defined by two main components: perceived vastness of the world and an inability to assimilate new information (Keltner & Haidt, 2003).

The experience of perceived vastness of the world comes about during 'larger-than-life' events. It can be elicited across many domains: from finding majesty in the natural environment or becoming confused by non-intuitive scientific theory. This yields an expansion in size of the individual's perceived universe, relative to the persons self and self-concept (Zhang & Keltner, 2016). Prototypical experiences of awe lead participants to define their presence as "small or insignificant," and leads to diminished self-size when compared to other positive emotions (Shiota, Keltner, & Mossman, 2007; Bai et al., 2017). Additionally, experienced awe also leads to feelings of "connectedness to the world" that are highly intense and meaningful, implying disengagement from the self and focus on the rest of the world.

The component of awe regarding an inability to assimilate new information is what differentiates it from similar epistemic states such as surprise. Those who are awestruck develop an awareness of a knowledge gap within the individual's concept space (Valdesolo, Shtulman, & Baron, 2017). Importantly, there is a failure to assimilate the new information presented by the awe elicitor into existing mental structures. This failure results in a need to restructure prior beliefs (i.e. cognitive accommodation) to meet the demands of understanding the 'awesome' elicitor.

Since awe involves an experience of perceived vastness of the world (and subsequent "smallness" of the self), this could lead to a"more-than-it-seems" perspective that could affect interpretation of new events. That is, inducing a state of awe may lead to "carry-over" effects such that new experiences are also interpreted as vast. Relatedly, if awe increases a need for cognitive accommodation, this could lead to approach-behavior that could affect interest in new events. That is, inducing a state of awe may lead to increased exploration in new learning environments as the learner is primed to reduce uncertainty.

Awe and Cognition

Given the behavioral tendencies of awestruck individuals, it is perhaps not surprising that it has been shown to influence various aspects of cognition. Inducing awe on participants leads to reported altered perception of time and changes in decision making (Rudd, D.Vohs, & Aaker, 2012). Specifically, Rudd et al. (2012) found that awestruck individuals are more willing to volunteer their free time to help others and prefer novel experiences over novel possessions when compared to those in other emotion-induced groups. Furthermore, awestruck participants are less impatient and claim to have more free time available during the day to complete tasks. These studies displayed carry-over effects from the awe-eliciting video stimuli to unrelated events, such that participants consciously reported willingness to volunteer and take extra steps in the unrelated situation despite no personal gain. In addition to awe's ability to promote altruistic behavior, inducing awe may lead to parallel findings of open-mindedness in active learning situations, such as increased exploratory behavior.

There are also strong claims of awe's capability in endorsing use of new schema in the face of uncertainty from unexpected, new information and from information-rich environments (Keltner & Haidt, 1999; Shiota, Campos, & Keltner, 2003). In recent findings, experimentally induced awe led participants to feel increased uncertainty in their judgments and decision making (Griskevicius, Shiota, & Neufeld, 2010). Participants were induced to either feel awe or a neutral state, then were read either a strong or weak persuasive argument. Awestruck participants reported finding weaker arguments less persuasive when compared to other participants. Furthermore, in a follow-up experiment, judgments made by participants in the awe condition were found to be partially mediated by decreased certainty as reported by certainty appraisals (Scherer, 1997) and demonstrated systematic cognitive processing represented by a higher number of total thoughts preceding their final decisions. These experiments provide evidence of awe's influence on cognitive accommodation. Notably, the awe-elicitor involved recollection of a prior experience brought about by a prompt. This experience of awe was not directly related in content to the arguments evaluated by the participants. Therefore, Griskevicius et al. (2010) have provided more evidence for awe's ability to redirect awareness away from the day-to-day concerns and to facilitate attention towards new incoming information (Shiota et al., 2007). Awe's influence on information-seeking behavior in the form of accommodative (as opposed to assimilating) schema could lend itself to increasing exploratory behavior in new learning environments.

In what follows, we present two experiments focused on awe and exploration. The first experiment with adult participants presents a verification of novel stimuli that induce awe (as well as two control states, Happy and Calm)[1]. In Experiment 2, we investigate whether awe (as compared to Happy and Calm states) leads preschoolers to engage in greater exploration and discovery using a novel toy paradigm[2]. Our hypothesis posits that children in the Awe condition will perceive the world as larger than before and therefore explore novel objects more in order to accommodate new information and reduce their uncertainty. Specifically, we predict that children induced with awe will explore more than children induced with other control emotions.

Experiment 1: Validation of Stimuli

In Experiment 1, we modified previously used videos reported to induce awe, happy, and calm states that corresponded with adult ratings of experiencing each state (Valdesolo & Graham, 2014). Stimuli elicitors for the emotional categories (Awe, Happy and Calm) of these past videos were created per the guidelines presented in Keltner and Haidt (2003). The Happy and Calm elicitors serve as controls, to support the hypothesis that Awe specifically (rather than general positive valence or general low arousal) induces changes. Because we required that the videos be adapted for use with children, we made the following changes: First, the background music used in the Happy condition video was changed. Second, videos were made to be notably shorter (previously five minutes, now two-and-a-half minutes), with some "scenes" being completely cut or spliced as needed. Third, all direct use of language (song lyrics or narration) were removed to avoid potential influence of language in the videos on later tasks.

Our goal was to create new stimuli for later use in eliciting Awe and Control states in preschoolers. To ensure our modified stimuli successfully induced the target emotions, we measured 'smallness of self' using the Circle Task developed and verified by Bai et al. (2017). Here, experimenters found

[1] In past literature (for example, Valdesolo, Park, & Gottlieb, 2016), the Happy and Calm conditions were referred to as Amusement and Neutral, respectively.

[2] This well established experimental paradigm is often used in developmental studies of exploration, e.g. Bonawitz et al., 2011.

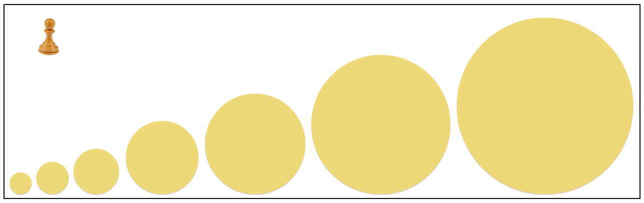

Figure 1: Stimuli used for the Circle Task in Experiments 1 and 2, as well as the pointer (top-left) used with children in Experiment 2.

that this pictorial measure was highly correlated with aspects of induced awe (such as feeling small and feeling insignificant). This task serves as a potential method that will be applicable for preschoolers, in contrast to long-form questionnaires that may not be suitable for use with children. For example, Shiota et al., 2007 use multiple surveys with many questions which are difficult for preschoolers. Thus, in this way our modified videos can be verified with a group of adult participants for later use with child studies.

Participants

74 participants were recruited from Amazon Mechanical Turk to participate in a short 4-minute study, and were each paid $0.75 for participation. Each participant was randomly assigned to one of three different conditions (Awe, Happy or Calm). We excluded 2 participants for failure to complete the task. The final sample consisted of 72 participants, with 24 in each condition.

Procedure

Each participant was randomly assigned to one of the three emotion-video conditions after providing consent. Each participant was instructed to ensure that their device's sound was turned "On" and to make sure that they pay close attention to the video. Participants watched the video, followed by a sound-check asking if they had their sound turned on.

For the Awe condition, clips from the BBC's *Planet Earth* were used. The video depicted scenes of nature (sweeping shots of grand natural structures such as mountains, forests and canyons), accompanied with a lyric-free version of Sigur Ros's *Hoppipolla*. For the Happy condition, clips from BBC's *A Walk on the Wild Side* were used, depicting animals in natural settings performing comedic actions (such as falling down or "dancing"), accompanied by a lyric-free Benny Hill's *Yakety Sax*. For the Calm condition, a video containing mundane interactions between small animals in nature from (*The Odd Couple*) was shown, removing the original narration, accompanied by Kevin MacLeod's *Hidden Agenda*.

To replicate past findings, we used the 'Symbolic self circle' task from Bai et al. (2017) (referenced as Circle Task, henceforth) to measure individuals' perceived sense of self-size. Following the finding by Valdesolo and Graham (2014) where individuals experiencing awe reported smaller self-

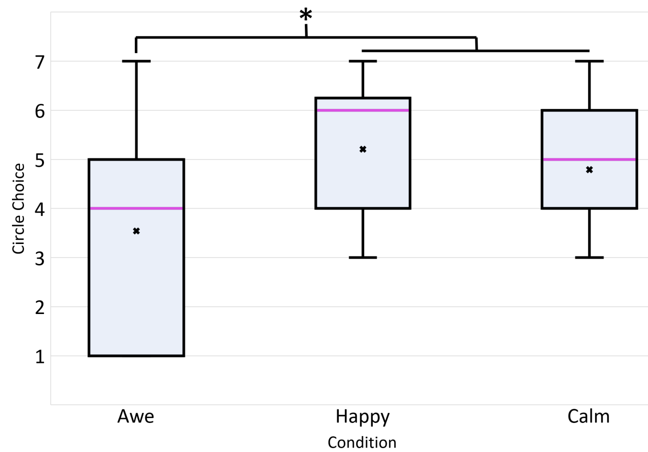

Figure 2: In Experiment 1, adults participants rated their Perceived Sense of Self-Size using the Circle Task as smallest following the Awe video as compared to the Happy and Calm control videos.

concepts than those in other positive states, participants were required to rate their size relative the rest of the world. Participants completed a forced-choice task where they were presented with seven circles (Figure 1), increasing in size from left-to-right. Above the circles was the prompt: "Pick the circle that best represents how big you feel right now."

Results and Discussion of Validation Study

We compared size ratings from the participants across the three conditions using a one-way ANOVA, revealing significant differences between the groups ($F(2, 69) = 6.85$, $p < 0.01$, $\omega^2 = 0.14$; Figure 2). Follow-up Tukey tests revealed that the mean choice of the Awe conditions ($M = 3.54$) differed significantly from the Happy ($M = 5.2$) and Calm ($M = 4.79$) conditions, such that participants reported feeling significantly smaller following the Awe video, (Awe vs. Happy, $t(46) = -3.14$, $p < .01$, $d = 1.02$; Awe vs. Calm, $t(46) = -2.56$, $p < .05$, $d = 0.76$). The Happy and Calm conditions did not significantly differ from each other, $t(46) = 1.12$, $p = .13$, $d = 0.25$.

Our goal in Experiment 1 was to validate new stimuli such that we could successfully induce target emotions in a manner similar to that in past research. Our validated stimuli further allowed us to reduce the length of the videos, mitigate potential cognitive interference from use of language and maintain within-domain content (nature). We also ensure the reliability of a simpler reporting method for use with children, as past research has used longer questionnaires that may not be suitable for use with younger populations. These validated stimuli can now be used to investigate the role of inducing awe in younger participants.

Figure 3: Novel Toy used with children in Experiment 2. The Key Function (Happy-Face Slide Whistle) is highlighted. Other possible actions included actions that could be seen as an attempted "intervention such as turning the green knobs to see if they activate lights, looking through a magnifying glass, or taking the entire box and shaking it. The largest number of unique actions that could be performed was approximately 30.

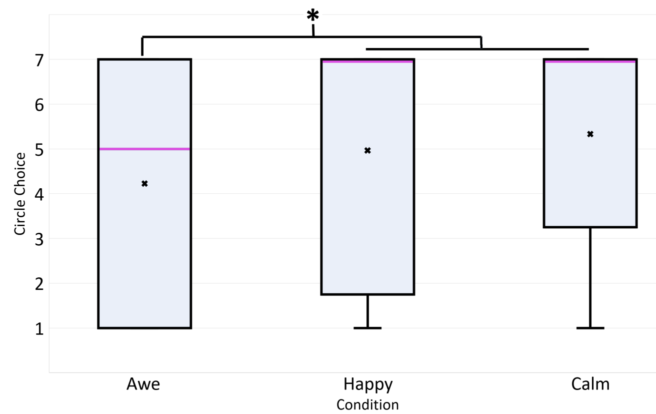

Figure 4: In Experiment 2, preschoolers' rated their Perceived Sense of Self-Size via the Circle Task as smaller in the Awe condition as compared to the Happy and Calm control conditions.

Experiment 2: Effects of Awe on preschooler's exploration of a novel toy

In Experiment 2 we investigate whether awe leads preschoolers to engage in greater exploration, as shown through play with a novel toy. If inducing awe causes perceptions of vast possibilities and increases drives to reduce uncertainty, then children may perceive the toy as potentially containing more discoverable functions and be more motivated to explore. Thus, we proceed with the *a priori* hypothesis that children in the Awe condition would show more variable exploration than children in the Happy or Calm conditions.

Participants

Preschool-aged children participated at local area preschools. Of the 100 participants, 9 were excluded from final analysis as a result of sibling, cohort, or caretaker interruption (n = 5) or refusal to play with the toy (n = 4). Therefore, our final sample consisted of 91 preschool-aged children (M_{age} = 56 months, range = 48 - 70 months, 50 females).

Procedure

Each participant was tested individually and randomly assigned to one of three different conditions: 31 in the Awe condition, 30 in the Happy condition and 30 in the Calm condition. In all conditions, the experimenter introduced the children to the Circle Task stimuli (Figure 1) and taught them how to use the stimuli. They then received a memory check before continuing the experiment (locating the smallest, biggest and 'not-too-big, not-too-small' circles). To complete the task, children were presented with a pointer (Figure 1) and asked to place and leave the pointer on the circle best representing their answer to the experimenter's questions. Children were asked the memory check questions until successfully providing correct answers for each location on the stimuli.

Then, one of the three emotion-eliciting videos from Experiment 1 was used to induce one of three target emotions in the participants. All children viewed the videos on a 15-inch Windows Laptop Computer. Prior to beginning the video, all children were told *"Alright! Now, we're going to watch a cool video about nature! Make sure to pay close attention!"* Children were also asked if they could see the screen and hear the music within the first five seconds of the video. Children then rated their own size relative the rest of the world, while considering the content of the watched video, being asked *"Now, let's think about the video we just watched. Could you take this pointer and show me which circle best shows how big or small you feel right now?"*

The experiment then moved onto the Exploratory Play task involving a novel toy (Figure 3) and a pedagogical demonstration (*"Look, my toy can make a noise!"*) while the experimenter pulled on a slide whistle with a happy-face knob attached. After the demonstration the experimenter said, *"Okay, now it's your turn to play with the toy. Go ahead and see if you can figure it out. I'm going to write something down over here, but you can let me know when you are all done!"* If children stopped playing with the toy for more than 15 seconds, the experimenter prompted *"Are you all done or would you like to play longer?"* If children asked to play longer but again stopped interacting with the toy for 15 seconds, the experimenter returned to the table and the study ended. If children continued to play with the toy without stopping, the study was ended after seven minutes of play.

Results

Two coders watched videos to record the amount of time spent playing with the toy as well as the number of unique actions on the toy. Inter-rater reliability was high for coded actions ($r(89) = 0.86$, $p < 0.0001$) and high for playtime ($r(89) = 0.97$, $p < 0.0001$). Planned contrasts are the main analysis and used for all reported results due to the *a priori* hypotheses. We formalize our predictions such that the Awe condition will differ from both the Happy and Calm condi-

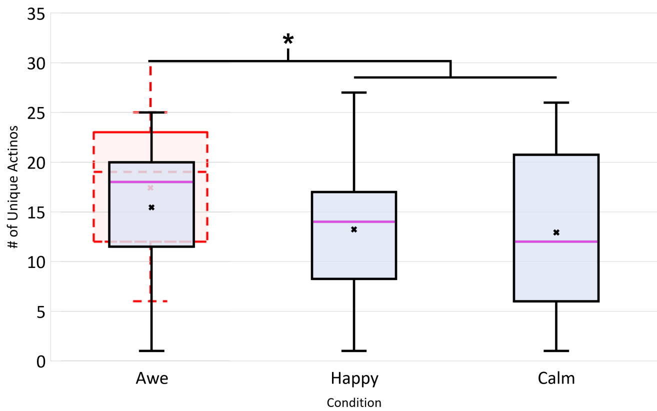

Figure 5: Children in the Awe condition (n = 31) showed marginally more variable play with the novel toy compared to children in the Happy and Calm conditions (n = 30, each). Additionally, the subset of children identified as "successfully induced with Awe" (n = 17, dashed red box) showed significantly more variable play compared to control conditions.

tions, but that these two control conditions would not differ from one another; thus the analysis was conducted with the weights 1, -0.5 and -0.5, respectively. Significance indicates a difference between the Awe and control conditions, but no difference between the controls (Happy and Calm).

Perceived Self-Size Assessment Our first measure required validating that the videos induced awe as found in adult participants in Experiment 1. Comparing the size responses on the Circle Task revealed non-significant differences among the three conditions, via one-way ANOVA ($F(2, 88) = 1.46$, $p = 0.23$, $\omega^2 = 0.01$; see Figure 4). However, our analysis via planned contrasts yielded significant results between the Awe and Control conditions ($t(88) = -1.62$, $p = 0.05$, $d = 0.35$). Specifically, children in the Awe condition reported significantly smaller self-perceptions than children in either the Happy or Calm conditions.

Playtime Our first question was whether children in the Awe condition played longer (M = 291 seconds) on average than children in either the Happy (M = 254 s) or Calm (M = 261 s) conditions. Although there were no significant differences in the total seconds of playtime between the Awe and Control conditions (t(88)=0.98, $p = 0.16$, $d = 0.21$), we suspected that this was due to the unusually high number of children "maxing" out the allotted 420 seconds of playtime. Indeed, comparing the number of children that reached the maximum amount of playtime in the awe condition (n = 17 (55%)) to the other two conditions (n = 10 (33%) and n = 8 (26%), respectively) revealed marginally significantly more children were playing in the Awe condition for the max amount of time ($\chi^2 = 5.61$, $p = .06$).

Actions Children in the Awe condition were marginally more likely to explore the toy more variably than children in the control conditions, (t(88) = 1.45, $p = 0.07$, $d = 0.32$; see Figure 5). In fact, in the Awe condition, the degree to which Awe was induced via the circle task score significantly correlated with the variability of play (r_s = -0.41, $t(29)$ = -2.43, $p = 0.01$). Children who were induced to feel more awe (as measured by smaller circle ratings) explored the toy more variably. (See Figure 6). Notably, there were several children for which the awe induction may not have worked as evidenced by their choice of the maximally large circle 7 (all but one other child in the Awe condition only chose circles 1 through 5). Follow-up comparisons between these induced children (n = 17) and children in the control conditions revealed significant differences between this Awe subset and control conditions, (t(74)=2.17, $p = 0.01$, $d = 0.59$).

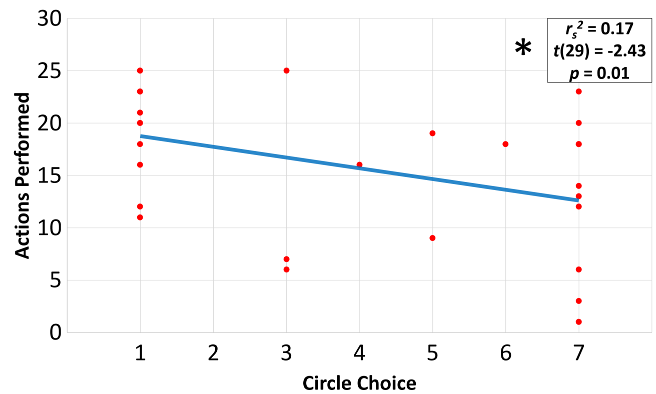

Figure 6: Spearman Rank Correlation. The degree of Awe induction (as measured by the circle size score) negatively correlated with the variability of actions during free play with the novel toy for children in the Awe condition.

Discussion

While past research has connected the role of states such as surprise to learning (Stahl & Feigenson, 2015), there is less research looking at how other affective states may contribute to learning. Relatively few studies investigate awe and cognition, and particularly few focus on children. We set out to investigate whether inducing awe in children led to greater exploration and discovery. In Experiment 1, we modified emotion-inducing videos (Awe, Happy and Calm) and validated them on adult participants using the perceived self-size Circle Task (Bai et al., 2017). In Experiment 2, children were presented with one of these videos and their exploratory play with a novel toy was recorded. Our results support our hypothesis, displaying differences when comparing the Awe conditions to the other two groups: children associated with smaller selves in the Awe condition and children who experienced awe explored more variably than their cohorts. These results suggest that awe may be linked to drives that increase uncertainty and also the motivation to resolve it.

One limitation of our study results from the lack of significance when comparing the averages across conditions for total time playing with the toy. We posit that this was a limitation of our experimental design, as evidenced by the over-all number of children (35 out of 91 participants (38.4%)) who reached the maximum amount of playtime but were interrupted and had the toy recollected by the experimenter. Given that more of the children in the Awe condition reached the maximum playtime compared to the two controls, and the fact that there was a (non-significant) trend towards a higher average playtime within the Awe condition, we suspect that awe does increase motivation as measured by total play time. Nonetheless, future work should allow for longer exploratory periods to mitigate ceiling effects.

Our results lend themselves to future work looking at affective states and their roles in different aspects of learning and motivation. This includes investigation of other cognitive behaviors in children, such as in decision making paradigms (i.e. probability inferences and risk taking behavior) or as teaching tools (i.e. in assessing what kinds of events may elicit awe in children, such as pedagogical questions (Yu, Bonawitz, & Shafto, 2017)). Additionally, further work could look into how affective states induced naturally may affect children's performance on cognitive tasks. With adults, common methods used in both measuring and inducing awe involve collecting reports of actual exposure to nature environments (Griskevicius et al., 2010; Valdesolo & Graham, 2014), in-lab priming with videos of vast natural scenes or prompt-initiated recollections of awe-inducing experiences (Zhang & Keltner, 2016). Children may be more or less predisposed to experience awe (especially in particular domains), and developmental differences may reveal important insights about this affective state.

Taken together, our results provide a first glimpse at the relationship between active learning and affect. Specifically, our results suggest that awe may influence perceptions of uncertainty and motivate reconciliation, leading to greater exploration and discovery in children's play. While play may be awesome, we believe awe can also be playful.

Acknowledgements

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