Investigating Positive and Threat-Based Awe in Natural and Built Environments

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

Staggeringly immense or beautiful awe-inspiring structures, such as religious monumental architecture, have long been important to human culture and society. With the emerging psychological literature on awe, a nascent avenue of research is beginning to uncover specific psychosocial and physiological effects of feeling awe through architecture. Most psychological work relies on nature imagery to evoke awe; yet architecturally-induced awe, which is studied very little, has enormous implications for how awe-eliciting architecture—such as cultural and religious sites—facilitate their sociocultural functions through built form. Besides the awe-inducing stimulus, the specific type of awe elicited also has potential to produce different effects. Many positive effects associated with feeling awe have been demonstrated empirically, including increased prosocial behavior, increased feelings of connection to others, and enhanced physical health through lower levels of proinflammatory cytokines. Recent work has turned to the darker side of awe, investigating effects of feeling threat-based awe, or awe elicited through a threatening stimulus. Although both positive and threat-based awe result in a smaller sense of self, threat-based awe is associated with greater feelings of powerlessness and fear than positive awe. Thus, we hypothesize that awe-inspiring environments may have distinct effects based on whether they induce positive awe or threat-based awe, as well as whether the environment is natural or built. Specifically, we predict that while positive awe will facilitate feelings of universality and integration into larger groups (e.g., the world), threat-based awe will promote social connection to smaller social groups (e.g., one's community). We further predict that this effect will be more pronounced for architectural environments, which have inherent social meaning, compared to natural environments. Across three online studies, we explore effects of positive and threat-based awe elicited through nature and architecture. Study 1 ($N = 116$) uses videos of natural phenomena used in previous work to replicate previous findings on positive and threat-based awe: We show that threat-based awe leads to greater feelings of powerlessness and fear than positive awe, and that both positive and threat-based awe result in a smaller perceived self-size than no awe. Study 2 (N = 100) extends these findings to architectural environments chosen to elicit positive and threat-based awe. While both awe conditions in Study 2 led to a smaller perceived self-size than the control condition as predicted, the architectural video meant to elicit threat-based awe elicited positive awe for most participants. Because we failed to elicit threat-based awe with architectural stimuli in Study 2, Study 3 (N = 85) compared only effects of positive awe elicited through natural and architectural environments on feelings of universality and identification with others. We find that both natural and architecturally induced positive awe similarly promote feelings of universality and connection with people all over the world, compared to a control condition. This research expands our understanding of how we respond to beautiful and threatening awe-evoking environments, from ancient monumental structures and natural phenomena to the supertall skyscrapers and natural disasters that are becoming increasingly common. This research furthermore helps us understand what awe-related effects demonstrated in cognitive science will have implications for architectural design.

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Chapter 1: General Introduction

Human beings navigate and encounter architectural spaces every day. Occasionally—through intention (as during travel) or through chance—we encounter buildings that are so impressive, perhaps imposing, in their size or power that our world seems to pause, and our worldview is redefined. Such awe-inducing aesthetic experiences, specifically elicited through architecture, are the subject of this dissertation.

The built environment has the capacity to influence our behaviors and internal states (e.g., Ellard, 2015; Evans & McCoy, 1998; Gifford, 2014; Goldhagen, 2017; Hillier, 1996; Negami et al., 2019; Vartanian et al., 2015). Studying the socioemotional effects of architectural experience, including that which evokes awe, holds importance both for informing architectural design as well as for understanding how the buildings we occupy, navigate and encounter shape our psychology.

The first part of this chapter will review awe as defined in contemporary psychology in order to situate the current research project within the field. The next section will distinguish awe from related emotions and discuss the importance of the measurement of awe for scientific rigor. Awe and its neural manifestations are then discussed. Once the concept of awe has been thus elaborated, the functions of awe will be discussed, including its function within the domain of architecture. Architecturally induced awe will be discussed in more detail before introducing the research questions guiding the current research project.

Awe in contemporary psychology

Although awe has been studied philosophically for centuries (e.g., Burke, 1757/1990), it has only been recently (around 25 years) that awe has been studied empirically in the field of psychology. As defined in the contemporary psychology literature, awe is an emotion composed of two parts: perceptual or conceptual vastness, (e.g., in physical size, power, or ability) and cognitive accommodation (Keltner and Haidt, 2003; Yaden et al., 2017).

Accommodation refers to a Piagetian process whereby an existing mental schema must adjust to account for a new event or stimulus; and is distinguished from cognitive assimilation, in which a new stimulus is incorporated into an existing mental schema (Piaget & Inhelder, 1966/1969). According to Keltner and Haidt (2003), an experience requires both vastness and a need for cognitive accommodation for it to induce a feeling of awe. Keltner and Haidt (2003) do not specify whether this accommodation needs to be successful (they speculate that successful and unsuccessful accommodation may give rise to different variants of awe); most importantly, however, the stimulus must transcend one's current frame of reference and thus violate one's expectations for it to provoke awe.

A core component to experiencing awe is a resulting feeling of smallness or insignificance, or what has been termed "the small self" (e.g., Bai et al., 2017; Piff et al., 2015). This small-self effect can be a physical experience of feeling small in the face of something much larger than oneself, or it can refer to a conceptual experience of feeling insignificant in a vast universe (Bai et al., 2017). This sense of a small self has been linked empirically to greater prosocial behavior (e.g., Piff et al., 2015; Rudd et al., 2012), greater feelings of humility (Stellar et al., 2018) and to greater feelings of connection to others (Bai et al., 2017).

Although the study of awe has only recently gained momentum in empirical psychology, it is situated in a robust and long-standing field of emotion research. The relationships between different emotional states, cognition, behavior, and physiology have been well-studied in psychology, neuroscience, and cognitive science (e.g., Lench et al., 2011). Many effects associated with different emotions have been studied, such as on learning (e.g., Um et al., 2012), memory (e.g., Phelps, 2004), and problem solving (e.g., Isen et al., 1987). In other words, research on awe builds on work that has demonstrated strong relationships between emotion, cognition, and behavior. Of particular relevance to awe, work on other positive emotions has shown relationships between positive emotions and prosocial behavior (e.g., George & Brief, 1992; Lyubomirsky et al., 2005). Arousal, which is closely tied to emotion (e.g., Barrett, 1998; Kensinger & Corkin, 2004), has also been shown to have the capacity to change cognition and behavior (e.g., Easterbrook, 1959; Öhman et al., 2001; Yerkes & Dodson, 1908). Indeed, the little extant work that has studied physiological arousal in relation to awe has demonstrated relationships between awe and arousal (Gordon et al., 2017; see also Stellar et al., 2015 for work on awe and biological markers of stress). Building on this body of work in emotion science, awe has been demonstrated to be a complex emotion with a variety of effects on cognition and behavior.

Variants of awe

Recently in empirical psychology, researchers have begun to investigate variants of awe. Specifically, researchers have distinguished "positive awe," awe that has positive valence, from "threat-based awe," awe that arises from a threatening experience (Gordon et al., 2017). In much of the psychological literature, awe has been treated as a mostly or a purely positive emotion with positive psychological and behavioral effects. For example, recent work has found that feeling awe can promote prosocial behavior (Piff et al., 2015; Prade & Saroglou, 2016; Rudd et al., 2012; Stellar et al., 2017), facilitate feelings of spirituality (Van Capellen & Saroglou, 2012), result in more faithful memory for events (Danvers & Shiota, 2017), and is even associated with stronger immune response compared to other positive emotions (Stellar et al., 2015). Unlike positive awe, threat-based awe is associated with more negative outcomes, such as greater fear and feelings of powerlessness, lower self-control, and increased physiological arousal (Gordon et al., 2017). Threat-based awe may help to explain some of the divergent findings in the awe literature (e.g., Piff et al., 2015).

The treatment of awe as having variants, or at least the characterization of positive awe as purely positive in valence, contradicts the idea of awe as a fundamentally mixed emotion: Keltner and Haidt (2003) themselves described awe as both “profoundly positive and terrifyingly negative” (though Keltner & Haidt, 2003 also posited the existence of variants of awe). Since Keltner and Haidt’s 2003 paper, researchers have largely treated awe as a positive emotion. This shift in the study of awe from characterizing awe as a complex emotion to focusing on its positive variant may reflect the broader linguistic evolution of the understanding of the word “awe” from originally connoting fear or dread (Oxford English Dictionary, 2019) to the current implication of a more positive experience (e.g., “awesome” used positively in colloquial or trivial usage, Oxford English Dictionary, 2019).

Distinguishing and measuring awe

As a construct, awe is difficult to measure because of other closely related emotions that have been studied throughout history (e.g., the sublime, admiration, wonder), and because participants who report feeling awe may not have the same understanding of the word “awe” as defined in contemporary psychology. Here I will discuss how awe may be distinguished from other related emotions, from early philosophical works to contemporary psychology and empirical aesthetics; and I will discuss the related challenge of measuring awe.

Perhaps the most well-known philosophical discourse on an awe-adjacent emotion (i.e., one that is close to awe in theoretical space, for instance along dimensions of valence and arousal) is that of Edmund Burke and his work on the sublime. In fact, Keltner and Haidt (2003) based their seminal work on awe on Burke's writings on the sublime from the 18^{th} century. The sublime rests fundamentally on terror (Burke, 1757/1990), though it is to be noted that Burke did not distinguish between the sublime as an emotional experience and the sublime as a type of stimulus (Konečni, 2005); thus, the sublime here may be more akin to the threat-based variant of awe. Burke (1757/1990) wrote of two components to the sublime, power and obscurity: Power, he wrote, "derives all its sublimity from the terror with which it is generally accompanied" (p. 60) and obscurity prevents one from understanding the sublime stimulus.

Burke's idea of power in the sublime (1757/1990) became the basis for Keltner and Haidt's (2003) perceptual vastness; and Burke's idea of obscurity (1757/1990) was translated into a need for cognitive accommodation (Keltner & Haidt, 2003). Similarly, Rudolph Otto, on his writing on religious terror, or what he termed "the numinous" (1923/1958), wrote of "numinous dread," or awe, as involving a sense of "overpoweringness" and the "wholly other," elements that may be mapped onto Keltner and Haidt's (2003) vastness and accommodation, respectively. Thus, other thinkers have arrived at similar conclusions about the nature of awe well before it was defined in contemporary psychological terms.

In contemporary psychology, awe has also been categorized as a self-transcendent emotion (Stellar et al., 2017; Van Cappellen et al., 2013; Yaden et al., 2017): It is an emotion that momentarily takes one out of oneself, such that one's attention is turned away from the self (Yaden et al., 2017). Other self-transcendent emotions include admiration, elevation and gratitude; these emotions are all other-focused (Stellar et al., 2017). Self-transcendent emotions are characterized by two essential components: An annhilational component that results in a feeling of a loss or diminishment of self, and a relational component that brings an increased feeling of connection to others or the world (Yaden et al., 2017). Awe is theorized to induce a self-transcendent experience that is especially strong (Yaden et al., 2017).

Awe may also be studied in the context of other related emotional states receiving empirical attention in psychology. For example, awe-adjacent emotions are commonly studied in the field of empirical aesthetics, the scientific study of aesthetic experience. In this field, researchers have studied wonder (Fingerhut & Prinz, 2018), fascination (Schindler et al., 2017), chills (Nusbaum et al., 2014), feeling moved (Cova & Deonna, 2014), and feeling like crying (Cotter et al., 2018) in response to aesthetic stimuli such as visual art or music (see also Menninghaus et al., 2019 for an overview of aesthetic emotions). Awe is distinguished from these other aesthetic emotions in it having both the components of perceptual or conceptual vastness and creating a need for cognitive accommodation. For example, wonder may be a response to stimuli that provoke a need for cognitive accommodation, but may not be vast (though Fingerhut & Prinz, 2018 argue that wonder is a less intense form of awe). Because of these related concepts, "awe" as commonly or colloquially understood may be ambiguous in its meaning. For instance, when participants were asked in one study what "awe" means to them, they reported words such as "wonder," "surprising," and "amazing" (Dudek, 2017).

Because of the nebulous nature of the word "awe," the disparity between academic and colloquial definitions, and the many related concepts that may confuse the definition of awe, awe presents a challenge in self-report measurement. In contemporary psychological studies, awe is typically measured through self-report using a Likert-type scale (e.g., on a scale from one to seven). To ensure that participants have a consistent understanding of the word awe, some researchers present participants with definitions of awe (e.g., Gordon et al., 2017; Negami, 2016). However, this strategy presents its own problems: Keltner and Haidt's (2003) definition, especially its cognitive accommodation component, can be difficult to understand; but a dictionary definition (e.g., “An emotion variously combining dread, veneration, and wonder that is inspired by authority or by the sacred or sublime,” Merriam-Webster online) may not capture the psychological definition or may be too leading (e.g., participants may use examples in the definition to guide their response as a way to confirm the material presented to them). Furthermore, a Likert-type scale assumes that awe exists on a continuum, that one can feel “a little” awe or “a lot” of awe. However, this question of whether awe can be experienced in degrees or whether it is an “all-or-none” phenomenon has not been explored empirically (and, moreover, may be complicated by the fact that its two components, perceptual vastness and a need for cognitive accommodation, arguably exist on a continuum and binary scale, respectively). For the current project, I developed a measure of positive and threat-based awe that seeks to address this measurement challenge by establishing a shared understanding of these terms between the researchers and participants.

Awe and the brain

Within the field of psychology, there are contrasting views on how the brain and body respond to emotional events. The most common view of emotional response is that emotions have distinct physiological signatures, termed the “classical view” of emotions (Barrett, 2017). In contrast, the newer theory of constructed emotion uses a Bayesian, active inference framework of the brain (Barrett & Satpute, 2019; Hesp et al., 2019) and posits that emotion is a neurally, biologically, and contextually constructed event which arises from domain general, rather than highly specific, neural networks (Barrett, 2016; Barrett & Satpute, 2019). The constructed theory of emotion is driven by the view that variation in neural activity, physiological response, and behavior is in fact more universal to emotional experiences than common physiological or behavioral outcomes (Barrett & Satpute, 2019).

Some of the psychological work on awe assumes a classical view of emotion, predicting specific physiological responses or behaviors to positive or negative variants of awe. For example, in a study of the body's response to different positive emotions, researchers found a significant relationship between feeling awe and lower levels of proinflammatory cytokines, which are essential to fighting infection and injury, but can have negative consequences when levels are chronically high (Stellar et al., 2015). However, this study did not show causality: They did not show whether, for example, feeling awe led to lower levels of cytokines (which would fit with a classical view of emotion, in which an emotion, awe, leads to a specific response in the body) or whether lower levels of cytokines created a physiological condition that increased the probability that participants interpreted that bodily sensation, along with contextual cues, as a feeling of awe (an interpretation that would be supported by a constructed view of emotion).

In another example, Gordon et al. (2017) measured sympathetic physiological responses to positive and threat-based awe. Specifically, participants watched an awe-inducing video meant to evoke variable levels of fear while researchers recorded their sympathetic activity through heart rate (HR) and skin conductance level (SCL), and their parasympathetic activity through respiratory sinus arrhythmia (RSA), an indirect measure of vagal tone. They found that awe did not predict physiological changes (in SCL or HR), but threat did predict HR and SCL, whereas positive affect predicted RSA (Gordon et al., 2017). These results are in accordance with classical-view findings of fear responses; however, these effect sizes were small (Cohen's f^2 ranging from .05 - .13).

Another study examining physiological response to awe studied behavioral freezing as a threat response to awe monumental, awe-inducing architecture (Joye & Dewitte, 2016). In this study, participants shown images of imposing skyscrapers slowed their motor output (computer mouse movement) compared to participants shown images of low buildings (Joye & Dewitte, 2016). According to a classical view, then, feeling positive awe should lead to greater parasympathetic activation and lower levels of proinflammatory cytokines, whereas threat-based awe should lead to greater sympathetic activation and behavioral freezing. According to the theory of constructed emotion, awe would look more variable in the brain, in physiological responses, and in behavior.

Beyond neural and physiological response to emotion, Yaden et al.'s (2017) work may shed light on the neural underpinnings of awe as a self-transcendent experience (STE). Following from their separation of STEs into annhilational (loss of self) and relational (connection to others) components, they speculate that STEs should be associated with decreased activity in the superior and inferior parietal cortex, brain regions that are involved in bodily space and representing bodily boundaries; and that STEs should be associated with increased neuropeptides that have been linked to perceived social connection, such as oxytocin and arginine vasopressin (Yaden et al., 2017).

Other work in psychology and neuroscience indicate that the default mode network (DMN) may be implicated in awe-inducing experiences, as it shows decreased activity during non-self-referential tasks (Sheline et al., 2008). The categorization of awe as a self-transcendent emotion (Stellar et al., 2017; Yaden et al., 2017) that directs one's attention away from the self would then predict reduced blood flow in areas implicated in the DMN. Indeed, van Elk et al. (2018) found in a functional magnetic resonance imaging (fMRI) study that inducing (positive) awe using videos of natural scenery resulted in reduced activity in brain areas implicated in the DMN (specifically, the frontal pole, posterior cingulate cortex and angular gyrus), compared to another positive emotion. However, arousal was not matched between conditions in this study, which could also influence DMN activity, as suggested by Horovitz et al. (2009) (though this idea is controversial—see for example Koike et al., 2011). Other work investigating structural brain characteristics using magnetic resonance imaging (MRI) also found a negative association between dispositional (positive) awe and brain volume of the middle/posterior cingulate cortex, as well as the anterior cingulate cortex and middle temporal gyrus (MTG) (Guan et al., 2018). On the other hand, fMRI work has found increased DMN activity in response to intense aesthetic experience (Belfi et al., 2019; Vessel, Starr, & Rubin, 2012). This increased DMN activity may have been a function of the experimental tasks, which made participants' personal tastes and judgements salient (Vessel, Starr, & Rubin, 2013). Yet as awe can constitute both a self-transcendent emotion and an intense aesthetic experience, it will be interesting to study the DMN specifically in response to awe-inducing aesthetic experiences using a wide range of stimuli, such as artwork and architecture.

The relationship between the brain and variants of awe has just begun to be explored. A recent fMRI study by Takano and Nomura (in press) investigated brain activity during inductions of positive and threat-based awe using video clips. Compared to valence-matched controls (positive awe compared to amusement and threat-based awe compared to fear), they found decreased activity in the left MTG for both positive and threat-based awe conditions. The left MTG has been suggested to be implicated in recognizing or resolving incongruities (Bartolo et al., 2006; Guan et al., 2018) and in integrating different types of information processing (Davey et al., 2016); Takano and Nomura (in press) suggest that decreased left MTG activity during an awe experience may reflect the challenge an awe-inducing experience presents to one's existing mental schemas. This study thus supports from a neuroscientific view the characterization of awe as provoking a need for cognitive accommodation, as well as shows that this response is common between both positive and threat-based variants of awe. Although this study used nature imagery as awe elicitors, these results suggest that this pattern of activity would occur for other stimuli, such as architecture, if they also trigger cognitive accommodation.

In addition to brain activity during awe experiences, structural brain characteristics associated with positive and threat-based awe have also begun to be examined. In a recent MRI study, Guan et al. (2019) investigated neural correlates of positive and threat-based awe using a correlational voxel-based morphometry technique to explore the relationship between awe ratings and regional gray matter volume (rGMV). They found that higher ratings of positive awe were associated with greater GMV in the precuneus (implicated in self-awareness, Kjaer et al., 2002; Vago & Silbersweig, 2012) and less GMV in the left fusiform gyrus and right calcarine gyrus; and that higher ratings of threat-based awe were associated with less GMV in the left and right insula (implicated in self-awareness, various emotional states, and interoception; Critchley et al., 2004; Eckert et al., 2009; Jabbi et al., 2008; Paulus & Stein, 2006; Phan et al., 2002; Schienle et al., 2002; Stark et al., 2003) and left superior temporal gyrus (implicated in empathy, Morelli & Lieberman, 2013; Perry et al., 2011). However, because the researchers measured structural characteristics of the brain (rather than brain activity), the study design does not allow for specific conclusions about how feeling awe may affect brain activity, the direction of the association between brain volume and awe ratings, or how feeling awe relates to the functions associated with these brain areas. More work is needed to more fully understand brain activity and structure as it relates to awe and its core components.

The function of awe

Theory on why awe may have evolved may provide greater insight into this complex emotion. The literature that has focused on or theorized the evolutionary adaptation or function of awe offers two main functional accounts: that of awe as a primarily social emotion (e.g., Bai et al., 2017), and that of awe as an information-seeking emotion (e.g., Danvers & Shiota, 2017). These two accounts may be a function of the two core components of awe, vastness and cognitive accommodation. Specifically, because awe is provoked by perceptually vast stimuli, the accompanying feeling of smallness can facilitate both submission to a powerful elicitor (Joye & Verpooten, 2013) and a feeling of connection to others (Bai et al., 2017; Joye & Verpooten, 2013). Likewise, because awe upsets existing mental representations through provoking a need for cognitive accommodation (Keltner & Haidt, 2003), awe may facilitate seeking and incorporating new information by challenging and reducing reliance on existing schemas (Danvers & Shiota, 2017).

A third functional account of awe is more environmentally focused, and posits that awe serves as an indication of a safe environment (Chirico & Yaden, 2018). This theory draws from environmental psychology's prospect and refuge theory (Appleton, 1996) which states that humans feel safest in environments that afford both a sweeping prospect for observation of any potential approaching threats, as well as refuge from these threats. Because vast, sweeping landscapes that offer both prospect and refuge are a powerful elicitor of awe, Chirico & Yaden (2018) theorize that nature was primary in the development of awe as an emotion.

Although no extant work has focused on the function of threat-based awe specifically, extant work again hints at two possible functions, social and informational. Socially, if threat-based awe leads to feeling small and powerless, threat-based awe may reinforce social hierarchies through making people feel submissive to more powerful individuals. Bai et al. (2017) speculate that one outcome of negative awe may be protection of one's ingroup, at the expense of and through violence against outgroups: Indeed, hostile attitudes towards outgroups has been found to be a social response to threat (Riek, Mania, & Gaertner, 2006). In terms of an informational function of threat-based awe, Keltner and Haidt (2003) speculated that threat-based awe may be a function of an inability to accommodate the awe-inducing experience: Thus, threat-based awe may serve to protect one's beliefs and worldviews, which may in turn have social benefits, such as maintaining shared understanding for community cohesion.

Architecturally induced awe

Although most empirical work on awe has used nature imagery, such as landscapes, to evoke awe (e.g., Bai et al., 2017; Danvers & Shiota, 2017; Gordon et al., 2017; Piff et al., 2015; Rudd et al., 2012; Valdesolo & Graham, 2014; Van Cappellen & Saroglou, 2012), awe may be induced through a variety of stimuli, such as through architecture, music, powerful people, or even ideas (Keltner & Haidt, 2003; Shiota et al., 2007). Theoretical work suggests that architecturally induced awe may facilitate functions of particular importance to religious communities and individual religious experience. Joye and Verpooten (2013) theorize that religious monumental architecture (RMA), such as the Pyramids of Giza, capitalize on the more primordial function of awe as a submissive emotion in the face of a powerful person to make people feel small and submissive in the face of an astoundingly large and awe-inspiring structure. Treatments of awe outside of psychology also reveal close links between awe, religion, and architectural space (the links between awe and religion have been discussed, see, e.g., Otto on the numinous, 1923/1958). For instance, Mircea Eliade, in his work on the manifestation of "the sacred" writes that "some parts of space are qualitatively different from others" in the religious (or spiritual) experience of space (1957/1987, p. 20) and of encountering a manifestation of divinity through architecture. These theoretical treatments of architectural awe point to the need for empirical support of these claims.

There is some extant empirical work that establishes the capacity of architecture to evoke awe. In my previous work, I was able to determine what specific architectural features (of building interiors, e.g., ceiling height, presence of windows) lead to awe (Negami, 2016). In this work, features of architectural interiors and the emotional responses they evoked were modeled together to determine which specific features were associated with a feeling of awe. We found that features reflecting adornment (e.g., ornament, imagery and art) and immensity (e.g., size of space, repeating elements, ceiling height), both encompassing perceptual vastness, significantly predicted a feeling of awe (Negami, 2016). In another study, Joye and Dewitte (2016) used monumental buildings to evoke threat-based awe. In this study, participants' threat response (specifically, freezing behavior) was measured in response to virtual renderings of tall, imposing skyscrapers; this study lends further evidence that monumental architecture has the capacity to elicit (threat-based) awe. Finally, more recent work by Collado & Manrique (2019) used images of buildings that were vast in size, detail, or power needed for their construction to evoke awe (measured indirectly, through statements such as "This image makes me feel insignificant") as well as boost positive affect.

There is sparse work on architecturally induced awe (Collado & Manrique, 2019; Joye & Dewitte, 2016; Joye & Verpooten, 2013; Negami, 2016) and there is need for more. Architecture, being intrinsically socially meaningful (in its construction, its function and its use) has vastly different implications as an awe-evoking stimulus from natural settings, which do not necessarily carry social meaning. The socioemotional effects of feeling awe through architecture may thus be distinct from awe as induced through nature. These effects would have strong implications for architectural design and use. Furthermore, architecture is important to study as an awe-inducing stimuli for a simpler reason: People spend the majority of their time in and around buildings. The established capacity of architecture to shape how we feel and how we behave lends further importance to studying specific emotions evoked by architecture. Moreover, the buildings that have strong cultural significance, such as religious sites, cultural sites, and institutional buildings, are also the ones that tend to be awe-inspiring, with perceptually or conceptually vast characteristics such as size, age, or ornamentation. Studying awe evoked through architecture may provide insight into how these buildings achieve their function through their built form.

The current research project

The broad aim of the current project was to study variants of awe (specifically positive and threat-based awe) as evoked through architecture, and to compare these effects to awe evoked through nature. My research questions guiding my experiments were: How do buildings that inspire awe shape our sense of ourselves as members of a social collective, and how does this effect differ between structures that provoke positive awe, and those that provoke fear-based or threat-based awe? How does this effect differ from awe evoked through natural imagery?

These questions are guided by previous empirical work on threat-based awe and the small-self effect. Despite the divergent outcomes between threat-based and positive awe, both forms of awe result in a small sense of self in the face of a vast stimulus (Bai et al., 2017; Gordon et al., 2017; Hornsey et al., 2018; Piff et al., 2015; Shiota et al., 2007). One consequence of a diminished sense of self as having arisen from feeling positive awe is that the small self facilitates integration into larger social collectives through shifting one’s attention away from the self (Bai et al., 2017; Hornsey et al., 2018). Because both positive and threat-based awe result in a diminished self, this social effect of increased feelings of collective engagement should also hold true for threat-based awe. This is one hypothesis we planned to test in Study 3. However, while both positive and threat-based awe should promote integration into a larger social collective, the particular kind of social group into which these variants of awe promote integration may differ based on the particular form of small self accompanying the experience of awe. Specifically, whereas positive awe results in a small self without an accompanied sense of reduced rank or status (Bai et al., 2017), threat-based awe has been found to be associated with feelings of powerlessness and loss of control (Gordon et al., 2017). Thus, if threat-based awe results in a reduced sense of power, it should result in distinct effects from positive awe: Threat-based awe and positive awe should facilitate integration into distinct social groups. It has been found that collective engagement does differ culturally (Bai et al., 2017), so it has been established that this collective engagement effect can differ between groups. In the current project, we wished to see whether the size of community one feels a part of (e.g., one's immediate community vs. the world), as well as feelings of universality and being connected to the world, differs between positive and threat-based awe.

In addition to comparing effects of positive awe to effects of threat-based awe, we sought to compare the effects of awe elicited by nature to awe elicited through architecture. In previous work, the effect of stronger collective engagement after experiencing awe was based on positive awe elicited through nature (Bai et al., 2017). In addition to replicating this effect, we sought to compare this effect found in positive awe elicited through natural environments to positive awe elicited through architectural environments. We also wished to compare effects between threat-based awe elicited through nature and architecture. We predicted that the inherent social aspect of architecture would enhance the feeling of being connected to a more immediate social collective (e.g., one's community), compared to feeling awe through nature, which should, as found in previous work, enable integration into to a larger collective (e.g., the world).

This research project comprises three main experiments: In Study 1, we sought to replicate and establish extant effects of perceived self size, powerlessness, and fear associated with positive and threat-based awe in nature using a new measure and different experimental design. In Study 2, we extended these effects to new awe-evoking architectural stimuli. In Study 3 we then used these stimuli to test social effects of awe between natural and built environments.

In summary, this project, through three experiments, sought to examine how the kinds of social networks into which awe promotes integration systematically differs between threat-based and positive awe, as well as how this effect is facilitated through natural and built environments. I predicted that, whereas positive awe would lead to increased feelings of universality and connection to the larger world (as has been demonstrated in past work, e.g., Shiota et al., 2007), threat-based awe would lead to increased feelings of connection to more immediate social groups. This effect should be enhanced in architectural settings, which carry more social meaning than natural environments.

The following chapters present three experiments on positive and threat-based awe in the built environment. Chapter 2 presents the first experiment, a replication of effects of positive and threat-based awe in natural settings. Chapter 3 presents an extension of this work to the built environment. Chapter 4 presents an experiment exploring the social effects of positive and threat-based awe in natural and built environments. Finally, Chapter 5 summarizes the findings across chapters to discuss implications and future directions.

Chapter 2, Experiment 1a: Replicating perceived self-size and powerlessness effects of positive and threat-based awe in natural environments

Experiment 1 seeks to replicate and establish extant findings of positive and threat-based awe using natural environments as elicitors to establish cognitive and affective effects with a new measure of awe and an online, within-subjects design, before extending these findings to the built environment. Specifically, in Experiment 1, we sought to answer the question, how will threat-based and positive awe, as elicited by natural environments, affect participants' self-size and feelings of powerlessness?

Results from Experiment 1 should replicate previous findings from previous work on awe. Specifically, environments or phenomena such as mountains, waterfalls, and canyons should elicit positive awe, as measured through a new video classification task and replicating previous studies that have used the same (or similar) awe inductions (e.g., Gordon et al., 2017). Environments or phenomena with an element of threat such as lightning storms and tornados should elicit threat-based awe using the same new awe measure, replicating Gordon et al. (2017). Both positive awe and threat-based awe should lead to a smaller sense of self, as compared to a control condition, replicating previous positive and threat-based awe effects found in Gordon et al. (2017) as well as positive awe small-self effects found in in Bai et al. (2017), Piff et al. (2015), and Hornsey et al. (2018). Threat-based awe should lead to greater feelings of powerlessness, as compared to positive awe, replicating findings from Gordon et al. (2017).

Experiment 1 introduces a new measure of positive and threat-based awe, novel to the field and a departure from most extant work on awe. Our new measure, outlined in the Measures section below ("video classification task"), attempts to address the methodological challenge detailed in Chapter 1 of measuring a complex emotion with a precise but complicated psychological definition which does not necessarily map onto a colloquial understanding of the term.

Another difference between our study and previous work is our use of a within-subjects design. Although most empirical work on awe uses between-subjects designs, in which participants are exposed to just one experimental condition, we wished to use a within-subjects design primarily because within-subjects designs generally have the benefit of greater statistical power (Keren & Lewis, 1993) and to see if existing between-subjects results would replicate in a within-subjects design. Furthermore, we were fully transparent with participants about the purpose of the study, which would plausibly make demand characteristics equal between a between-subjects and within-subjects design (although within-subjects designs still carry the possibility of carryover or sensitization effects [Greenwald, 1976] which could clue participants to our study hypothesis and thus alter their response). Lastly, in some cases, participant judgments can be difficult to compare across conditions without the context of the experimental conditions in a within-subjects design (Birnbaum, 1999). Between- and within-subjects experimental designs both have strengths and weaknesses (Keren & Lewis, 1993); ultimately, we felt that a within-subjects design was appropriate and had greater benefits than disadvantages for this study. Importantly, the ability to replicate previous effects found in the literature with a within-subjects design would allow for continued use of within-subjects designs, which offer greater statistical power by controlling for between-subjects variability.

In addition to our study measures, demographic information (age, gender, racial background) was measured to get a sense of our participant sample (the online platform used for participant recruitment is available to anyone over 18 years of age). These demographic data were not analyzed beyond descriptive statistics. No effects of these demographic variables related to awe have been reported in the literature, nor has any theory suggested that any effects of awe would differ for these specific individual differences.

Methods

Participants

Participants were recruited through Amazon Mechanical Turk for the online study, which was run on the Qualtrics platform. A power analysis based on d = .84 from Study 2 in Gordon et al. (2017) comparing threat between the positive and threat-based awe conditions showed that we would need 23 participants in a within-subjects design with 98% power and an alpha level of .05. An initial sample of 100 Mechanical Turk workers with a 95% approval rating (i.e., at least 95% of their Human Intelligence Tasks, or jobs through Mechanical Turk, had been approved) participated in the study for $1.00 USD. A total of 47 participants were excluded due to failure to answer attention checks correctly, reporting technical problems watching any of the three videos in the study, and/or for having an average compliance rating (from the end-of-survey compliance questionnaire, see Materials below) of less than 4.5 (on a 7-point scale; Meade & Craig, 2011). This exclusion rate for participants recruited from Amazon Mechanical Turk seems to be higher than is typical, or at least on the high end of the range of typical exclusion rates. Exclusion rates for failing attention checks are typically about 10-15%, as reported in Barends and de Vries (2019). However, a review of different data collection methods shows that in Amazon Mechanical Turk samples, attention check failure rates range from 2-52% (Thomas & Clifford, 2017); and that this rate of problematic responding is similar across Amazon Mechanical Turk participants, other online samples, and in-lab studies (Necka et al., 2016; Thomas & Clifford, 2017). Although researchers do not always exclude all participants who fail attention check questions (Thomas & Clifford, 2017), a review of previously published work suggests that exclusions based on attention check failures result in lower statistical noise without introducing sampling bias (Thomas & Clifford, 2017). Still, such a high exclusion rate is a concern and our subsequent studies incorporate additional attempts to retain data. The final sample in Experiment 1a consisted of 53 participants (*M* age = 33, *SD* = 11, range 18-71; 37.7% female; 60.40% White/Caucasian, 11.30% South Asian, 5.66% Black/African, 22.63% other/multiracial).

Procedure

In order to ensure that participants saw similarly sized video presentations, participants were instructed to complete the study on a computer monitor of at least 12 inches across. Participants were also instructed to silence or turn off cell phones to minimize distractions, and to give their full attention to the two-minute videos.

After giving informed consent and going through the study instructions, participants viewed a series of three videos intended to elicit positive awe, threat-based awe, or neither, presented one at a time. After watching each video, participants indicated whether they felt positive awe, threat-based awe, or neither; and rated how small they felt and how powerless they felt as they watched the video. This study used a within-subjects design; all participants viewed all three videos representing the three awe conditions (i.e., positive awe, threat-based awe, and no awe). The order of the video presentation was counterbalanced to control for order effects.

After watching the three videos and completing the associated surveys, participants completed a demographic questionnaire and compliance questionnaire. The study took approximately 20 minutes to complete. This study, and all studies presented in this dissertation, was approved by the University of Waterloo's Office of Research Ethics.

Materials

The three videos used in this study were used to evoke awe in previously published work. The videos were all used in studies in Gordon et al. (2017), and some were also used in other previously published work. The video intended to elicit feelings of positive awe consisted of a montage of shots from BBC's *Planet Earth* series with an uplifting soundtrack. The video intended to elicit feelings of threat-based awe was a clip from the Discovery Channel's *Birth of a Tornado*, set to a more menacing instrumental soundtrack. The video intended to produce a neutral response (neither positive nor threat-based awe) was an instructional video on how to build a concrete garden wall, which included narration set to an instrumental soundtrack (see Figure 1 for film stills from each video). All videos were approximately two minutes in duration. Participants did not have the option to advance to the next part of the study until the duration of the video had elapsed.

Figure 1. Film stills of the positive awe (top), threat-based awe (center), and neutral control (bottom) conditions in Experiment 1a.

Measures

After each video, participants completed the video classification task, perceived self-size measures, and powerlessness measures in random order. After these measures, participants answered a video check question before advancing to the next part of the study to ensure they were paying attention to the video content. These measures are discussed in detail below.

Video classification task. To measure whether participants were feeling positive awe, threat-based awe, or neither in response to the videos, we presented participants with a forced-choice questionnaire designed to ensure participant understanding of these potentially ambiguous terms, as well as to avoid the pitfall of leading participants to the answer we had in mind (as discussed in the General Introduction).

The classification task asked participants to "Please select the definition which you feel best describes how the video you just viewed made you feel." Participants were presented with three options, including a definition of positive awe, a definition of threat-based awe, and an option of "Neither of the above." The positive awe and threat-based awe definitions are provided below. These definitions are amended versions of positive and threat-based awe definitions presented to participants in Study 2b of Gordon et al. (2017), into which we incorporated a version of a definition used in Bai et al. (2017). Notably, we removed prototypical examples of awe in nature (specifically, "vast, beautiful landscapes and natural wonders such as tall mountains, expansive vistas, or large waterfalls" for positive awe and "natural disasters such as earthquakes, hurricanes, or volcanic eruptions" for threat-based awe) to avoid leading participants to endorse either definition based on the content of the video matching an example listed in the definition.

Positive awe: "People sometimes experience the emotion of 'awe' when they are in the presence of something that is so vast that their current understanding of the world, their surroundings, or themselves is expanded in some way.

Sometimes, we might feel awe in response to people who cause large-scale change such as Nelson Mandela and his role in ending apartheid in South Africa.

Other times, we might feel awe towards an idea that is amazing and wondrous—such as the mysteries of space."

Threat-based awe (changes from positive awe noted in bold here; no words were bolded when presented to participants): "People sometimes experience the emotion of 'awe' when they are in the presence of something that is so vast that their current understanding of the world, their surroundings, or themselves is **challenged** in some way.

Sometimes, we might feel awe in response to people who cause large-scale **devastation, such as Hitler and the vast horrors of the Second World War.**

Other times, we might feel awe towards an idea that is **amazing and scary at the same time**—such as the mysteries of space."

Perceived self-size. Perceived self-size was assessed using two separate measures, both taken from Bai et al. (2017). The first consisted of two statements that participants were asked to rate their agreement with on a 7-point scale from *strongly agree* to *strongly disagree*: "In general, I feel relatively small," and "In general, I feel insignificant." These statements reflect the physical and abstract aspects of a small sense of self.

The other measure asked participants to choose a circle out of an array of seven circles increasing in size (see Figure 2). Participants were instructed: "Think about one of the circles below as representing yourself. Please choose the circle that best describes how big or small you feel about yourself."

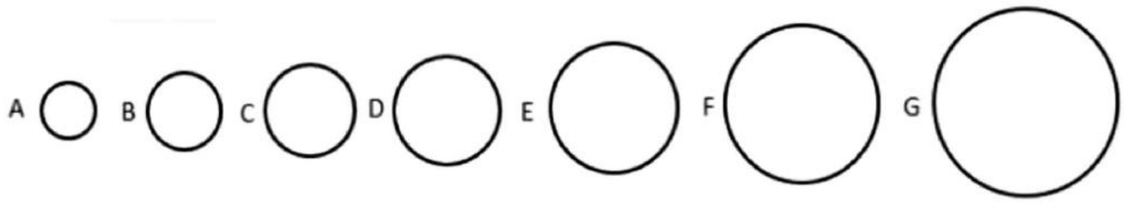


Figure 2. The array of circles shown to participants as one measure of perceived self-size.

These measures were both included in the study in order to examine the relationship between them, and to determine which one may be used in following studies if the two measures sufficiently correlate. In Bai et al. (2017), from which these measures were drawn, the circle self-size measure correlated strongly with other measures of self-size and was used in five out of the six studies as a stand-alone measure of perceived self-size. The statement ratings were also included in the present study in order to confirm that participants understood the somewhat ambiguous circle-selection task.

A repeated-measures correlation (Bakdash & Marusich, 2017) showed that the statements and circle measures did indeed correlate, $r_{rm}(103) = 0.63$, $p < .001$, 95% CI [0.50, 0.74], with α ranging from .73 to .77 across the three conditions. A composite score averaging these two measures (with higher values indicating larger perceived self-size) was used to analyze perceived self-size (*M* perceived self-size = 4.18; *SD* = 1.24).

Powerlessness. Powerlessness was measured using four statements, all taken from Study 5 in Gordon et al. (2017). Participants were asked to rate the statement, “While watching that video, how much did you feel like you had control over your life?” on a scale from 1 (*no control at all*) to 7 (*complete control*) (this item was reverse-coded). Participants were also asked “How much did you feel the following while watching the video?” on a scale from 1 (not at all) to 7 (completely): “I felt powerless,” “I felt that what happens in my life is beyond my control,” and “I felt like I have little control over the things that happen to me.”

The four statements measuring powerlessness showed good reliability (α ranging from .83 to .85 across conditions), and were averaged to create a composite measure of powerlessness, with higher values indicating greater feelings of powerlessness (*M* powerlessness = 3.19; *SD* = 1.22).

Video check. To ensure participants watched the video in the online study, participants were first asked whether they experienced any technical difficulties while watching the video. Participants were then asked the question, “What was the video you just watched about?” Participants selected out of three possible answers: the correct answer (e.g., the geography of the earth) and two false lures (e.g., figure skating, laundry). Most of the false lures came from content of other neutral videos used in studies on awe (e.g., a figure skating video was used in a general positive emotion condition in Study 1 of Danvers & Shiota, 2017). Participants were also asked, “Is there anything else you’d like to tell us?” and were given a short text-response box to type in their response. These three video-check questions were adapted from Gordon et al. (2017).

Demographic information. After participants watched the three videos and completed the associated questionnaires, participants were asked to provide brief demographic information on their age, gender, and racial background.

Compliance questionnaire. The items used to measure participant compliance were five self-report statements with factor loadings over .6 from the diligence factor of participant engagement items developed by Meade and Craig (2011) in their study of screening online survey data (due to experimenter error, only four of these five statements were used in Experiment 1a). Statements were rated on a Likert-type scale from 1 (*strongly agree*) to 7 (*strongly disagree*) (see Appendix A for a list of statements used). Meade and Craig's (2011) cutoff value of 4.5 (after reverse-coding appropriate items) was used as a minimum level of participant engagement.

Results

All analyses were performed using IBM SPSS Statistics 25 unless otherwise specified (among the exceptions, repeated-measures correlations were run in R version 3.6.2). For dependent variables measured on a Likert-type scale (perceived self-size and powerlessness), tests of normality showed all skew < 3.00 and kurtosis < 10.00, indicating normally distributed data (Kline, 1998). The data showed no univariate outliers, with all z-scores within 3.29 standard deviations from the mean (see Table 1 for means and standard deviations per condition as well as the correlation between variables). For each of these dependent variables, both a 3 (awe condition) x 6 (counterbalance order) mixed-factorial analysis of variance (ANOVA) and a more complex quasi-analysis of covariance (ANCOVA) model (Huitema, 1980/2011; see this study's Discussion for details) were run to examine how these variables differed among the three experimental conditions, as well as to account for shared variance between study variables.

The quasi-ANCOVA models reported here were run as multilevel regression models using R version 3.6.2 to enable analyses across the three within-subjects conditions. All quasi-ANCOVAs were run using the lme4 package in R with an unstructured covariate matrix and with participant modeled as a random effect to account for the repeated-measures design. Awe condition was dummy coded with the control condition serving as the reference group.

Counterbalance order was also dummy-coded and included in all models (no interaction terms were included in the quasi-ANCOVAs).

Table 1

Repeated-measures correlation and descriptive statistics of dependent measures in Experiment 1a

	Perceived self-size	Powerlessness
Perceived self-size	—	-.70***
Positive awe condition	3.89 (1.55)	3.55 (1.52)
Threat-based awe condition	3.87 (1.60)	3.60 (1.51)
Neutral control condition	4.79 (1.36)	2.40 (1.40)

Note. 105 degrees of freedom for the repeated-measures correlation. Means per condition are shown with standard deviations in parentheses.

Awe definition

A chi-square test of independence to examine the difference in what kind of awe was felt between conditions revealed a significant difference between groups, $\chi^2(4, N = 158) = 31.40$, $p < .001$. As shown in Figure 3, the positive awe definition was selected more often than others in response to the positive awe video; the threat-based awe definition was selected over others in response to the threat-based awe video (though this condition showed greatest variability in response); and the option "neither of the above" was selected significantly more than the other options in response to the neutral (non-awe-eliciting) video. That some participants did select one of the awe definitions for the neutral control video is of slight concern; it is likely that some of these endorsements were a result of careless responding that our attention checks did not catch. However, generally, these results validate and confirm the videos as inducing the type of awe they were meant to induce.

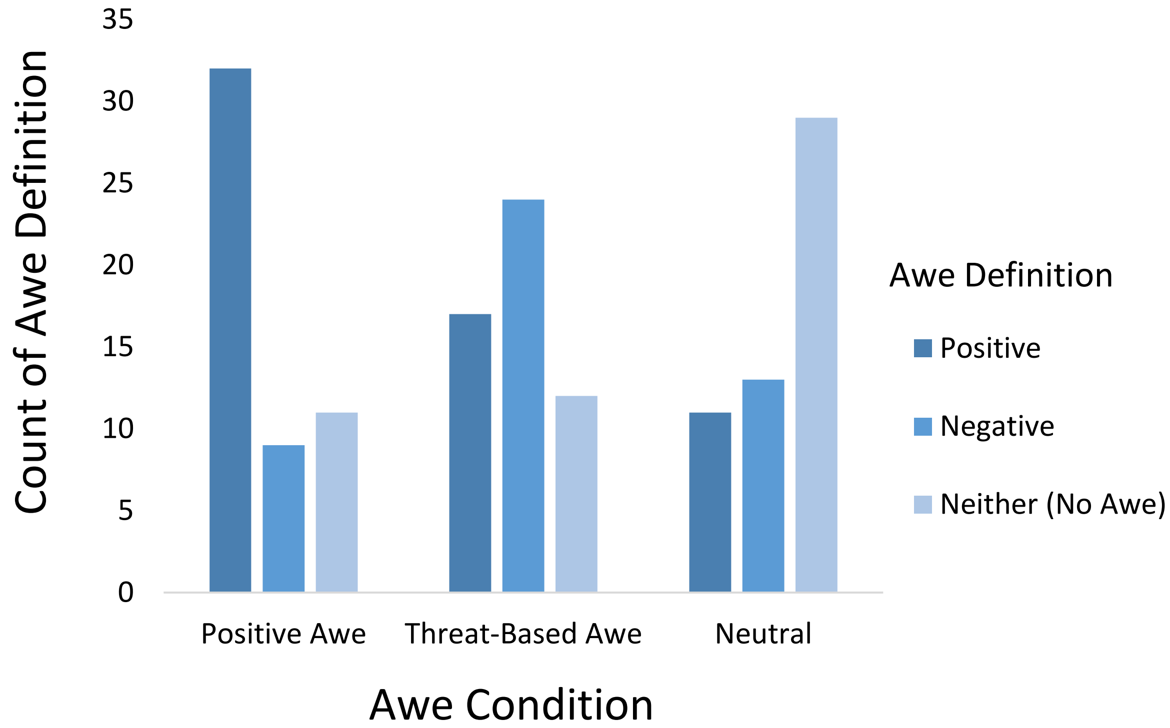


Figure 3. Frequencies of awe definition endorsements for each of the three conditions in Experiment 1a.

Perceived self-size

The differences between conditions in perceived self-size, controlling for counterbalance order, were examined through a 3 (awe condition) x 6 (counterbalance order) mixed-factorial ANOVA (see Table 2 and Figure 4). This analysis showed no significant interaction between awe condition and counterbalance order, but significant main effects of both awe condition and counterbalance order, indicating a significant difference among awe conditions in perceived self-size as well as a significant difference among the six counterbalance orders. Because of the low and uneven distribution of participants in each counterbalance order (ranging from six to 12 participants across the six counterbalance orders), post-hoc tests investigating the significant main effect of counterbalance order were not pursued in Experiment 1a. Post-hoc tests of least significant difference (LSD) investigating the significant main effect of awe condition showed that the positive awe condition did not significantly differ from the threat-based awe condition, $p = .657$; but both awe conditions were associated with significantly smaller perceived self size than the control condition, both *p*s < .001. This result replicates previous work on perceived self-size resulting from both positive and threat-based awe (Gordon et al., 2017; Bai et al., 2017).

Table 2

Effects of awe condition and counterbalance order on perceived self-size (mixed-factorial ANOVA) in Experiment 1a

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	10	94	0.88	.552	.09
Main effect of awe condition	2	94	13.50	<.001	.22
Main effect of counterbalance order	5	47	2.89	.023	.24

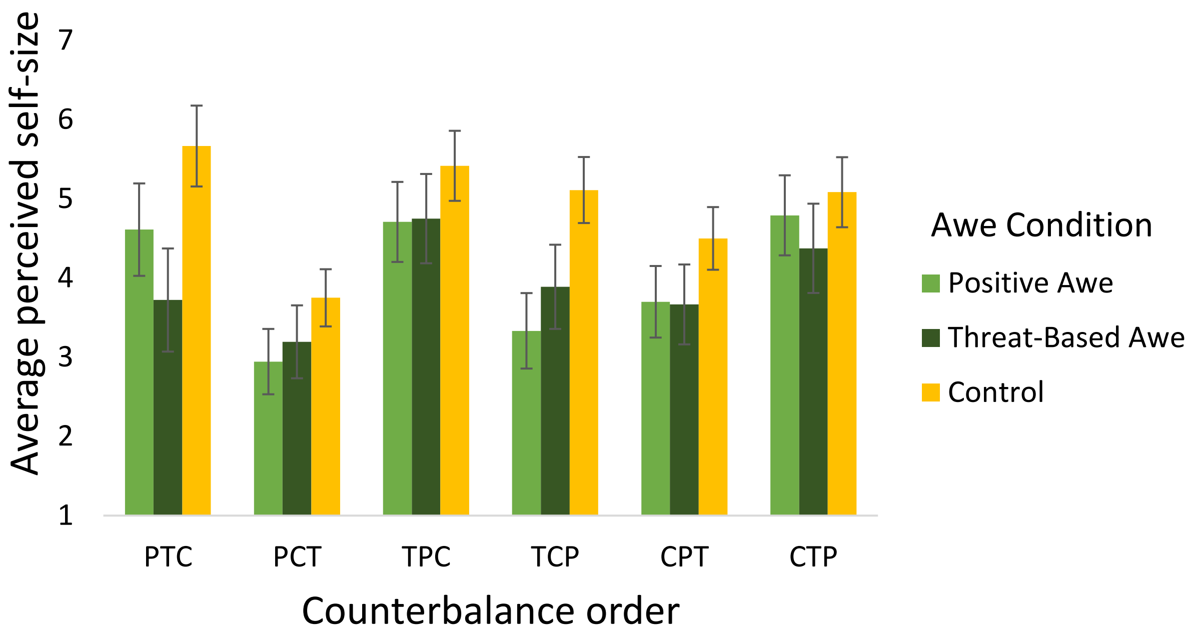


Figure 4. Average perceived self-size across awe conditions and counterbalance orders in Experiment 1a. Error bars represent ±1 standard error (SE). Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

A quasi-ANCOVA examining the effect of awe condition, counterbalance order, and powerlessness on perceived self-size showed that when controlling for powerlessness and counterbalance order, there was a significant difference in perceived self-size between the positive awe condition and control condition, $b = -0.91$, $SE = 0.16$, $t(102.59) = -5.50$, $p < .001$, as well as between the threat-based awe condition and control condition, $b = -0.92$, $SE = 0.16$, $t(102.59) = -5.58$, $p < .001$. This finding shows that the effect of awe condition on perceived self-size shown in the mixed-factorial ANOVA persists after accounting for shared variance with powerlessness.

Powerlessness

Powerlessness showed similar findings to perceived self-size (see Table 3 and Figure 5). Powerlessness differed significantly among awe conditions, but there was no significant main effect of counterbalance order, nor a significant interaction between awe condition and counterbalance order. Post-hoc LSD tests showed that the positive and threat-based awe conditions did not significantly differ from each other in powerlessness, $p = .796$, though both awe conditions resulted in greater feelings of powerlessness than the control condition, both *p*s < .001.

Table 3

Effects of awe condition and counterbalance order on feelings of powerlessness (mixed-factorial ANOVA) in Experiment 1a

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	8.74	82.14	1.02	.433	.10
Main effect of awe condition	1.75	82.14	24.46	<.001	.34
Main effect of counterbalance order	5	47	0.86	.515	.08

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 53) = 7.18$, $p = .028$, $\varepsilon = .87$; a Greenhouse-Geisser correction is used for within-subjects results.

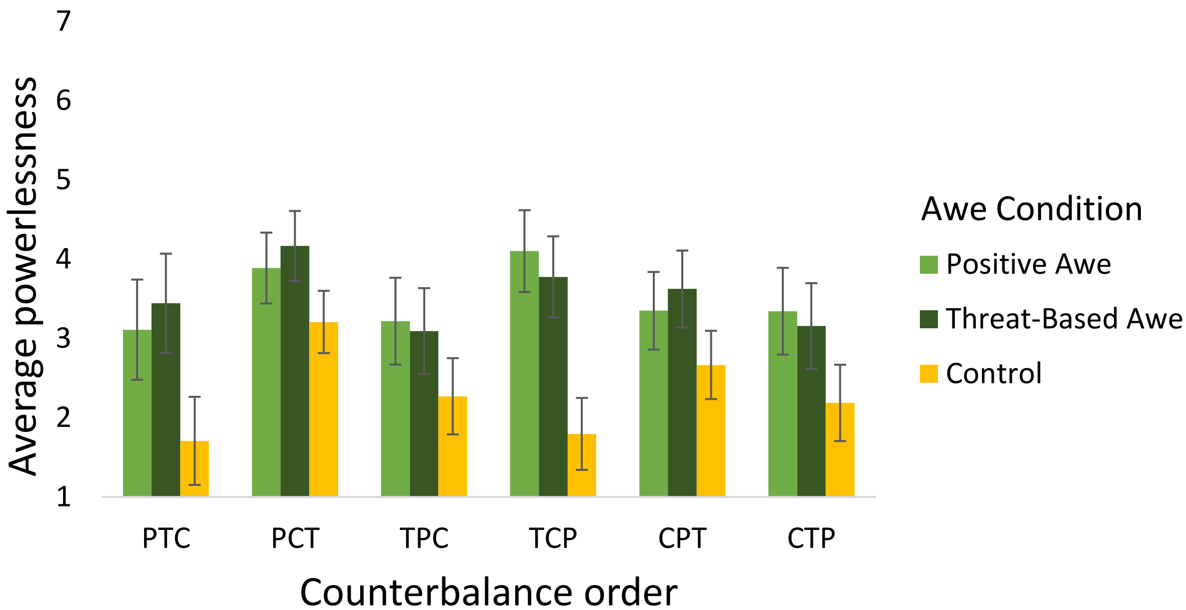


Figure 5. Average powerlessness across conditions and counterbalance orders in Experiment 1a. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

A quasi-ANCOVA examining the effect of awe condition, counterbalance order, and perceived self-size on feelings of powerlessness showed significant effects of awe conditions on powerlessness. Both the positive awe (b = 1.15, SE = 0.16, t(102.69) = 7.30, p < .001) and threat-based awe (b = 1.20, SE = 0.16, t(102.69) = 7.62, p < .001) conditions were associated with significantly greater feelings of powerlessness compared to the control condition when controlling for perceived self-size and counterbalance order. This finding suggests that awe condition has a significant effect on powerlessness over and above the variance in powerlessness accounted for by perceived self-size.

Discussion

These results confirm that the videos showing natural scenery and phenomena, selected to induce different variants of awe, did indeed induce the type of awe intended, supporting our classification method of measuring awe in response to the videos, which is novel in the awe literature.

Replicating previous effects found in the literature on perceived self-size and powerlessness entailed adapting statistical models used in previous work to fit our data. The study on which much of this experiment was based, Gordon et al. (2017), found no effect of condition on perceived self-size or powerlessness when these measures were examined separately. But because these measures correlated significantly with each other, Gordon et al. (2017) controlled for each measure to find significant unique effects of the other (i.e., after accounting for shared variance). For example, when examining the effect of condition on perceived self-size, Gordon et al. (2017) found no significant effect. However, after including powerlessness as a covariate in the statistical model, a significant effect of condition emerged on perceived self-size. This suggests that in their data, the effect of condition on perceived self-size was obscured by the variance in perceived self-size attributable to powerlessness.

Typically, analyses of covariance (ANCOVA) use a variable that has not been experimentally manipulated as the covariate. Dependent measures are not commonly used as covariates as they were in Gordon et al. (2017), as doing so runs the risk of having the differences in the dependent measure created by experimental condition bias the ANCOVA results. In Gordon et al. (2017) the data meet the assumptions of ANCOVA, at least as far as can be gleaned from the information included in the published work. Notably, in their case, the covariates (i.e., the dependent measures of perceived self-size and powerlessness) do not differ by condition.

In our data, we found a significant correlation between perceived self-size and powerlessness (such that smaller perceived self-size was associated with greater feelings of powerlessness, see Table 1), indicating that similar ANCOVAs would be appropriate. However, as detailed in the Results section, and in contrast to Gordon et al. (2017), we also found significant effects of each individual measure (i.e., the dependent variables varied significantly by condition when modeled without covariates). Because a replication of the Gordon et al. (2017) ANCOVAs would entail using each dependent variable as a covariate when examining the other, this would mean that the covariates also differ significantly by condition. A traditional ANCOVA analysis would not be appropriate when the treatment (i.e., experimental) condition affects the covariate (Evans & Anastasio, 1968; Huitema 1980/2011; Smith, 1957); at the very least, caution must be used in interpreting such results (Howell, 2010/2013; Maxwell & Cramer, 1975). This is because in a conventional ANCOVA model, when the treatment condition affects the covariate, adding the covariate in the model removes some of the treatment effect, obscuring results (Huitema, 1980/2011; Smith, 1957). Moreover, some extrapolation of covariate means along the regression line to unknown or off-the-scale values may occur when dependent means are adjusted by the covariate (Smith, 1957).

To address these limitations, a quasi-ANCOVA approach (Huitema, 1980/2011) was used on our data, which is suggested for cases in which the covariate differs significantly by treatment condition. In a quasi-ANCOVA model, residual values of a one-way ANOVA applied to the covariate are used in place of the covariate, thus reducing the error term as in a traditional ANCOVA, but eliminating bias by using unadjusted treatment means of the dependent variable

(Huitema, 1980/2011). In our data, residual values of powerlessness and perceived self-size extracted from one-way ANOVAs were used in each quasi-ANCOVA examining the other variable.

In this first study, we were able to replicate the finding of a smaller sense of self in response to both the positive and threat-based awe videos, as compared to the control video, including after accounting for shared variance with powerlessness. However, in contrast to our predictions, we did not find a significant difference in feelings of powerlessness between the positive and threat-based awe conditions. Instead, we found significantly greater feelings of powerlessness in response to both the positive and threat-based awe videos as compared to the control video, both when examining powerlessness alone as well as when controlling for the effect of perceived self-size. To us, this indicates that the distinction between positive awe and threat-based awe may perhaps be smaller or more ambiguous than currently theorized. To try to clarify this finding, we ran a replication of the current experiment with an additional measure to attempt to better distinguish the positive awe condition from the threat-based awe condition.

Experiment 1b: Replicating perceived self-size, powerlessness, and fear effects of positive and threat-based awe in natural environments

The results from Experiment 1a showed similar findings between the positive and threat-based awe conditions. Specifically, whereas the similarity in perceived self-size between these conditions was expected, the similarity in powerlessness was not. Because fear was found to be positively correlated with threat-based awe but not positive awe (Gordon et al., 2017), fear could be an additional measure to distinguish these two awe conditions. In an attempt to better distinguish these two conditions, as well as to ameliorate the poor retention rate of Experiment

1a, we ran an additional 100 participants through the Amazon Mechanical Turk platform, replicating the Experiment 1a measures but with the inclusion of a measure of fear.

Methods

The methods for Experiment 1b replicate the methods of Experiment 1a with the notable exception of measuring fear in response to each video, as well as a few additional changes (detailed below) aimed to retain participants or ensure that responses are legitimate.

Participants

As in Experiment 1a, 100 Amazon Mechanical Turk workers participated for $1.00 USD. In addition to the 95% approval rating eligibility criteria, only workers who had not participated in Experiment 1a and who were located in the U.S. or Canada were eligible to participate. In addition, the recruitment posting asked for fluent English speakers. These eligibility criteria were included to avoid cultural differences in understandings of awe, as well as to ensure that participants fully understood task instructions and measures.

A total of 37 participants were excluded due to failure to answer attention checks correctly, for reporting technical problems watching the study videos, for having an average compliance rating of less than 4.5 (Meade & Craig, 2011), or for completing the study on a mobile phone (this information was collected in this sample). The final sample consisted of 63 participants (*M* age = 37, *SD* = 11, range 18-61; 58.7% female; 73% White/Caucasian, 7.94% Black/African, 6.35% Latino, 12.70% other/multiracial).

Procedure

The procedure for this study was the same as Experiment 1a with two additions: In addition to the measures from Experiment 1a, participants were also asked how much fear they felt in response to each video. Additionally, a Captcha question was added to the beginning of the online questionnaire to ensure all participants were human workers with usable data and thus to retain as many participants as possible.

Measures

All measures from Experiment 1a were collected in Experiment 1b. As in Experiment 1a, the two statements measuring perceived self-size were averaged to create a composite measure. In this sample, the two methods of measuring perceived self-size—through statements and through circle representations—also significantly correlated across all awe conditions, $r_{rm}(124) = 0.67$, $p < .001$, 95% CI [0.56, 0.75]. Alphas for the composite perceived self-size measure ranged from .82 to .89 for the three conditions (for this sample, *M* perceived self-size = 4.10; *SD* = 1.44). Alphas for powerlessness ranged from .72 to .84 (for this sample, *M* powerlessness = 2.83; *SD* = 1.07).

The additional measure of fear asked participants to rate how much fear they felt while watching the video on a Likert-type scale from 1 (*not at all*) to 7 (*very much*) (*M* fear = 2.07; *SD* = 1.12). The compliance questionnaire asked one additional question that was omitted in Experiment 1a (see Appendix A). Additional information on operating system, screen resolution, and browser was collected through the Qualtrics platform to check that participants were using monitors of appropriate size.

Results

All analyses from Experiment 1a were replicated here. Univariate tests of normality showed seven high univariate outliers across four participants (ranging from $z = 3.53$ to $z = 4.55$) on the measures of powerlessness and fear for the control condition and fear for the positive awe condition. These variables were winsorized to within 3.29 standard deviations from the mean.

After winsorizing, skew for all variables was < 3.00 and kurtosis < 10.00, indicating normally distributed data (Kline, 1998).

Because of significant correlations among all three dependent measures in this study (see Table 4 for correlations and descriptive statistics of Experiment 1b dependent variables), quasi-ANCOVAs for all three variables include the other two as covariates, using residual values in place of the covariate itself in cases where the covariate differs significantly across conditions.

Table 4

Repeated-measures correlations and descriptive statistics of dependent measures in Experiment 1b

	Perceived self-size	Powerlessness	Fear
Perceived self-size	—	-.67***	-.45***
Powerlessness		—	.63***
Positive awe condition	3.73 (1.53)	3.02 (1.41)	1.41 (0.87)
Threat-based awe condition	3.68 (1.81)	3.57 (1.63)	3.35 (1.83)
Neutral control	4.89 (1.51)	1.87 (0.91)	1.10 (0.30)

Note. Degrees of freedom for all repeated-measures correlations 125. ***$p < .001$. Means per condition are shown with standard deviations in parentheses.

Awe definition

As in Experiment 1a, we found a significant difference in the selected awe definition through a Chi-square test of independence, $\chi^2(4, N = 189) = 96.51$, $p < .001$ (see Figure 6).

Participants again selected the predicted definition for each condition. Again, the threat-based awe condition showed the most variability in response. The neutral control condition showed fewer endorsements for either awe condition as compared to Experiment 1a, perhaps indicating more careful responding in this sample.

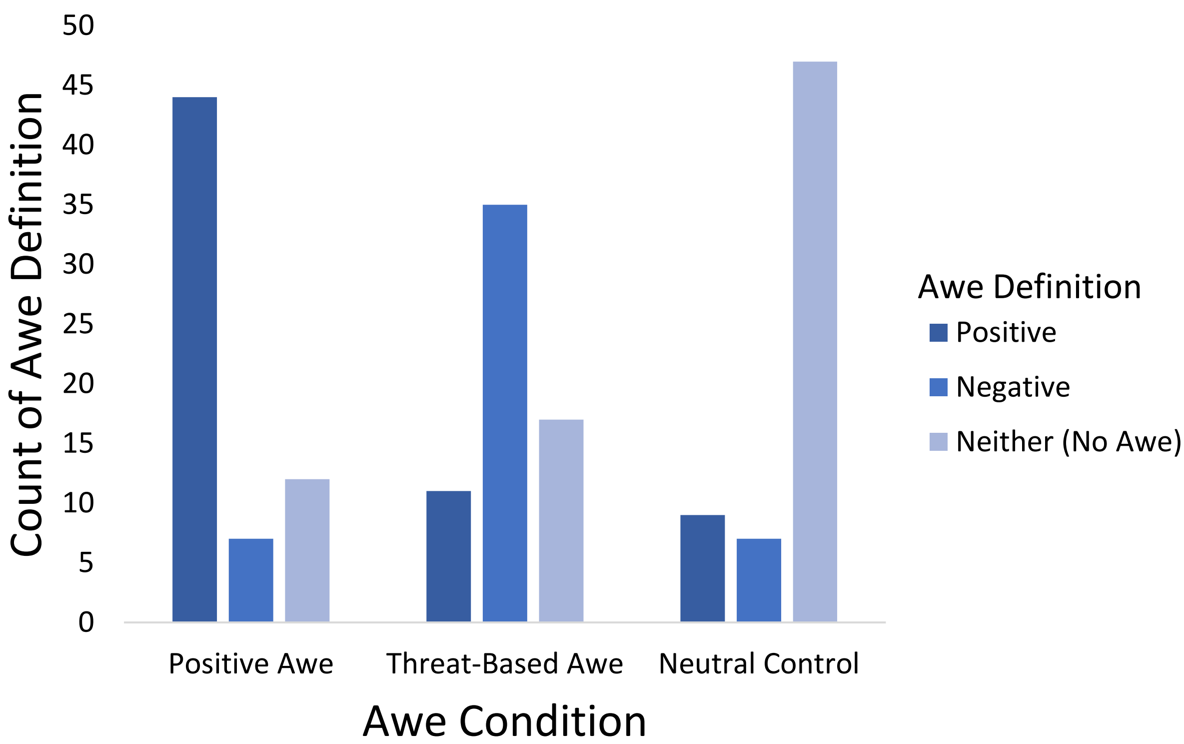


Figure 6. Frequencies of awe definition endorsements for each of the three conditions in Experiment 1b.

Perceived self-size

A mixed-factorial ANOVA of awe condition on perceived self-size, controlling for counterbalance order, showed that perceived self-size differed significantly between awe conditions (see Table 5 and Figure 7). There was no significant main effect of counterbalance order, nor a significant interaction between awe condition and counterbalance order. Post-hoc LSD tests investigating the significant main effect of condition showed that both awe conditions were associated with significantly smaller perceived self-size than the control condition, both *p*s $< .001$, but that the positive awe and threat-based awe conditions did not significantly differ from each other, $p = .686$.

Table 5

Effects of awe condition and counterbalance order on perceived self-size (mixed-factorial ANOVA) in Experiment 1b

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	8.87	101.10	0.78	.636	.06
Main effect of awe condition	1.77	101.10	32.60	<.001	.36
Main effect of counterbalance order	5	57	0.79	.564	.07

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 63) = 7.65$, $p = .022$, $\varepsilon = .89$; a Greenhouse-Geisser correction is used for within-subjects results.

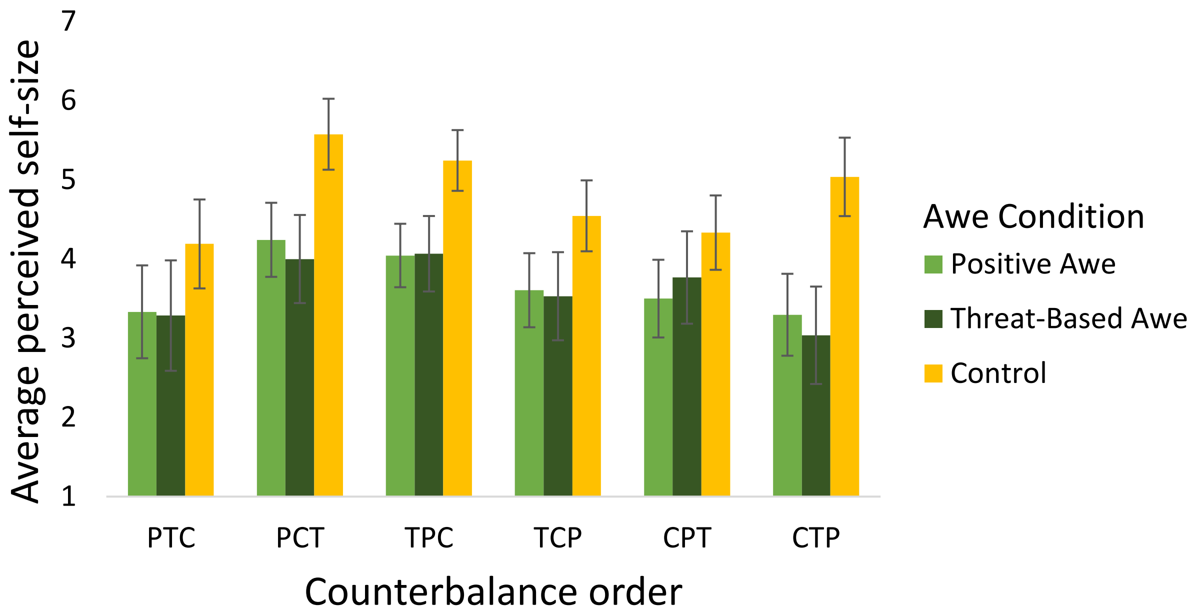


Figure 7. Average perceived self-size across awe conditions and counterbalance orders in Experiment 1b. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

When examining the effect of awe condition on perceived self-size, controlling for powerlessness, fear, and counterbalance order through a quasi-ANCOVA, both the positive and threat-based awe conditions were associated with smaller perceived self-size than the control condition (b = -1.16, SE = 0.14, t(121.84) = -8.17, p < .001 for positive awe compared to control and b = -1.21, SE = 0.14, t(121.84) = -8.53, p < .001 for threat-based awe compared to control), confirming that the effect of awe condition on perceived self-size persists when controlling for shared variance between perceived self-size and both powerlessness and fear.

Powerlessness

A mixed-factorial ANOVA examining the effect of awe condition and counterbalance order on powerlessness showed a significant main effect of awe condition, qualified by a significant interaction between awe condition and counterbalance order (see Table 6 and Figure 8). There was no significant main effect of counterbalance order (again, the significant interaction between counterbalance order and awe condition was not pursued further because the low distribution of participants across the six counterbalance conditions – ranging from seven to 15 participants per group – and low power would not yield meaningful interpretations of the data). Post-hoc LSD tests on the main effect of awe condition showed significant differences between each pair of conditions. The threat-based awe condition was associated with significantly greater feelings of powerlessness than the positive awe condition, $p = .005$, as well as the control condition, $p < .001$. The positive awe condition was also associated with significantly greater feelings of powerlessness than the control condition, $p < .001$.

Table 6

Effects of awe condition and counterbalance order on feelings of powerlessness (mixed-factorial ANOVA) in Experiment 1b

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	10	114	2.35	.015	.17
Main effect of awe condition	2	114	46.11	<.001	.45
Main effect of counterbalance order	5	57	0.53	.753	.04

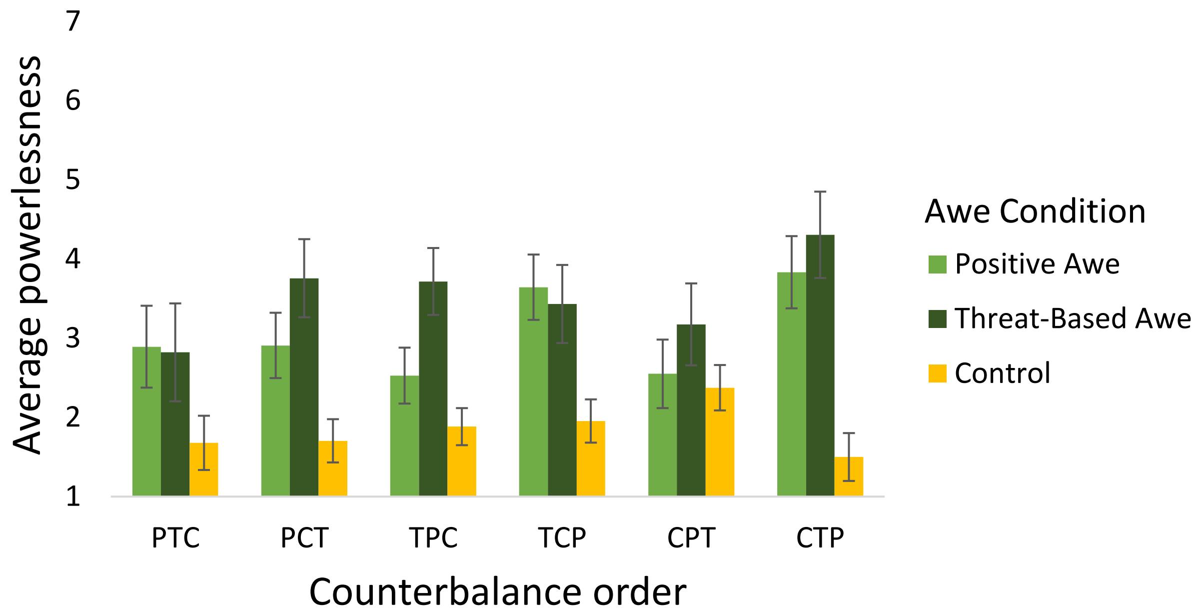


Figure 8. Average feelings of powerlessness across conditions and counterbalance orders in Experiment 1b. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

When examining the effect of awe condition on powerlessness, controlling for perceived self-size, fear, and counterbalance order, both awe conditions were associated with greater feelings of powerlessness than the control condition (b = 1.68, SE = 0.15, t(119.33) = 11.01, p < .001 for threat-based awe compared to control and b = 1.13, SE = 0.15, t(119.33) = 7.40, p < .001 for positive awe compared to control). Again, this result suggests that the main effect of awe condition on powerlessness from the mixed-factorial ANOVA persists when controlling for shared variance between powerlessness and perceived self-size as well as between powerlessness and fear.

Fear

A mixed-factorial ANOVA of awe condition and counterbalance order on fear showed a significant main effect of awe condition (see Table 7 and Figure 9). There was no significant main effect of counterbalance order, nor a significant interaction between counterbalance order and awe condition. Post-hoc LSD tests on the main effect of condition showed significant differences between all three awe conditions. The threat-based awe condition was associated with greater fear than both the positive awe condition and the control condition, both *p*s < .001. The positive awe condition was also associated with significantly greater fear than the control condition, $p = .002$, though both means were quite low (see Table 4).

Table 7

Effects of awe condition and counterbalance order on fear (mixed-factorial ANOVA) in Experiment 1b

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	6.39	72.84	0.97	.454	.08
Main effect of awe condition	1.28	72.84	69.57	<.001	.55
Main effect of counterbalance order	5	57	0.66	.658	.05

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 63) = 46.64, p < .001, \varepsilon = .64$; a Greenhouse-Geisser correction is used for within-subjects results.

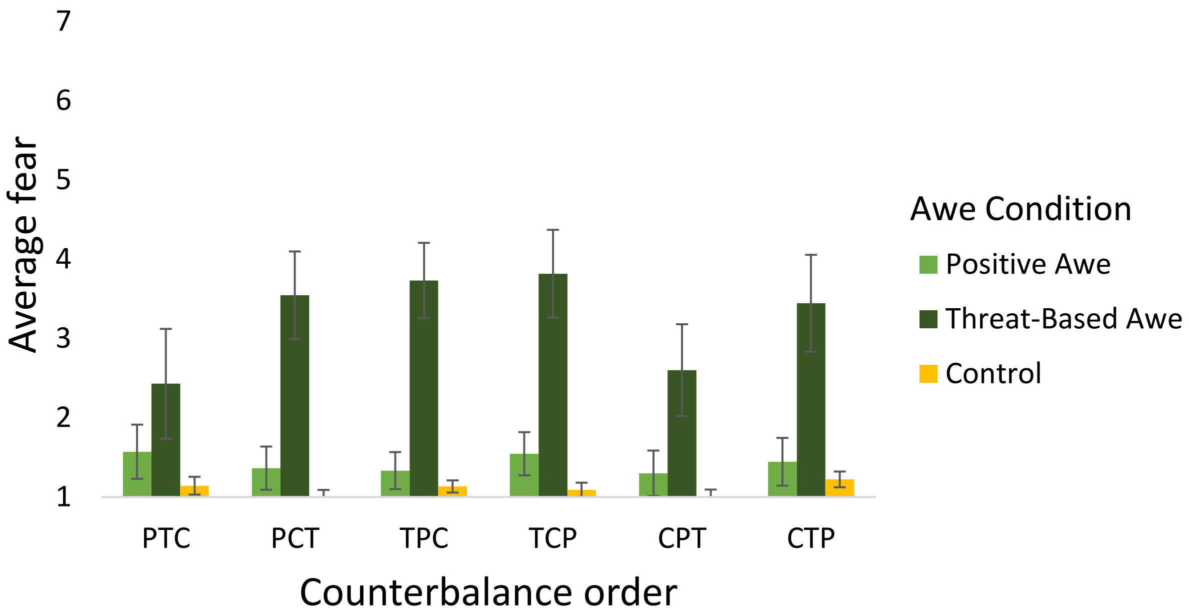


Figure 9. Average fear across awe conditions and counterbalance orders in Experiment 1b. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

A quasi-ANCOVA examining the effect of awe condition on fear, controlling for counterbalance order, perceived self-size, and powerlessness, found that the threat-based awe condition was associated with significantly greater levels of fear than the control condition, b = 2.25, SE = 0.17, t(119.30) = 13.11, $p < .001$, confirming the result from the mixed-factorial ANOVA. However, the difference in levels of fear between the positive awe and control condition became non-significant when controlling for shared variance between fear and perceived self-size and between fear and powerlessness, b = 0.32, SE = 0.17, t(119.30) = 1.85, p = .067. This result suggests that the difference in levels of fear between the positive awe and control condition seen in the mixed-factorial ANOVA may be explained by differences in perceived self-size and powerlessness.

Combined Data Sets

Data from Experiments 1a and 1b were combined to examine the effect of awe condition on the variables shared between the two samples (awe definition, perceived self-size, and powerlessness). Analyses of these variables are repeated below with the combined data set. Tests of normality showed skew < 3.00, kurtosis < 10.00, and no univariate outliers. The final set of participants in the combined sample was 49.1% female (N = 116; M age = 35 years, SD = 11, range 18-71; 67.2% White/Caucasian, 6.9% Black/African, 6.9% South Asian, 18.97% other/multiracial).

In the combined sample, the two measures of perceived self-size correlated significantly, $r_{rm}(228) = 0.65$, $p < .001$, 95% CI [0.57, 0.72]. Again, a composite measure of the two survey questions and circle representation was created for analysis (M = 4.41, SD = 1.35, with α ranging from .80 to .85 between conditions).

In the combined sample, perceived self-size correlated significantly with powerlessness, with smaller perceived self-size associated with greater feelings of powerlessness (see Table 8 for correlation and descriptive statistics; in this combined sample, M powerlessness = 3.00, SD = 1.15, with α ranging from .82 to .84). In addition to the mixed-factorial ANOVAs, quasi-ANCOVAs, controlling for each dependent variable and using the same parameters as before, are reported below. A Bonferroni correction was applied for all tests below using the data from Experiments 1a and 1b (α = .05/11 = .005).

Table 8

Repeated-measures correlation and descriptive statistics of dependent measures in combined sample

	Perceived self-size	Powerlessness
Perceived self-size	—	-.68***
Powerlessness		—
Positive awe condition	3.80 (1.53)	3.26 (1.48)
Threat-based awe condition	3.77 (1.71)	3.59 (1.57)
Neutral control	4.84 (1.44)	2.12 (1.21)

Note. 231 degrees of freedom for the repeated-measures correlation. Means per condition are shown with standard deviations in parentheses.

Awe definition. A chi-square test of independence to examine the difference in what kind of awe was felt between conditions revealed a significant difference between groups, $\chi^2(4, N = 347) = 119.56$, $p < .001$, with participants selecting the predicted definition most often for each condition across the combined samples (see Figure 10).

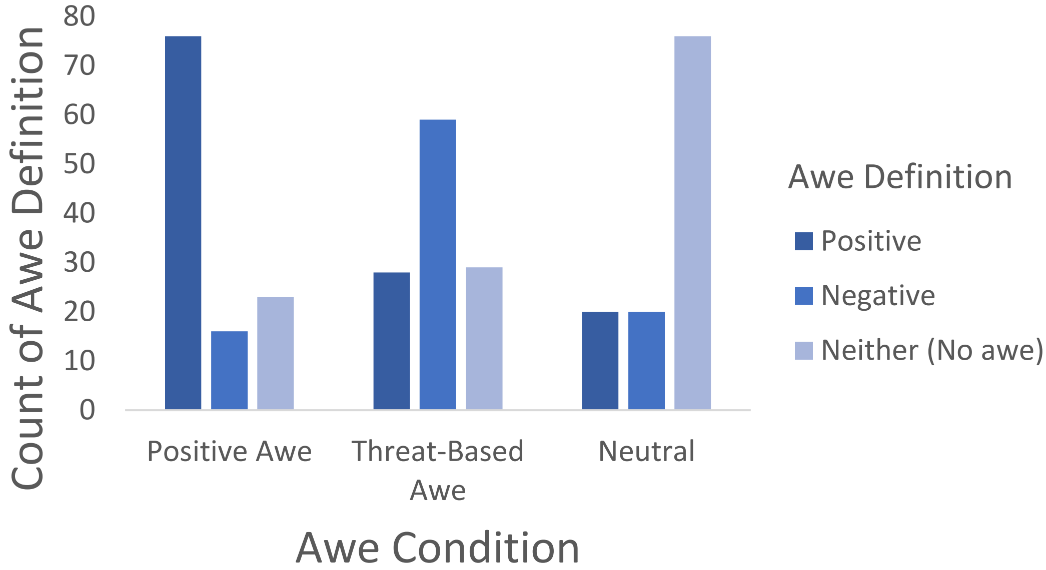


Figure 10. Frequencies of awe definition endorsements for each of the three conditions across both studies 1a and 1b.

Perceived self-size. A mixed-factorial ANOVA examining the effect of awe condition and counterbalance order on perceived self-size showed a significant main effect of awe condition (see Table 9 and Figure 11). There was no main effect of counterbalance order and no significant interaction between counterbalance order and awe condition. Post-hoc LSD tests on the main effect of awe condition showed that both awe conditions were associated with smaller perceived self-size than the control condition, both *p*s < .001, but that the two awe conditions did not significantly differ from each other in perceived self-size, $p = .548$.

Table 9

Effects of awe condition and counterbalance order on perceived self-size (mixed-factorial ANOVA) across Experiments 1a and 1b

	df_{effect}	df_{error}	*F*	*p*	η_p^2
Awe condition * counterbalance order	9.08	199.84	0.47	.892	.02
Main effect of awe condition	1.82	199.84	43.53	<.001	.28
Main effect of counterbalance order	5	110	0.91	.479	.04

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 116) = 11.59$, $p = .003$, $\varepsilon = .91$; a Greenhouse-Geisser correction is used for within-subjects results.

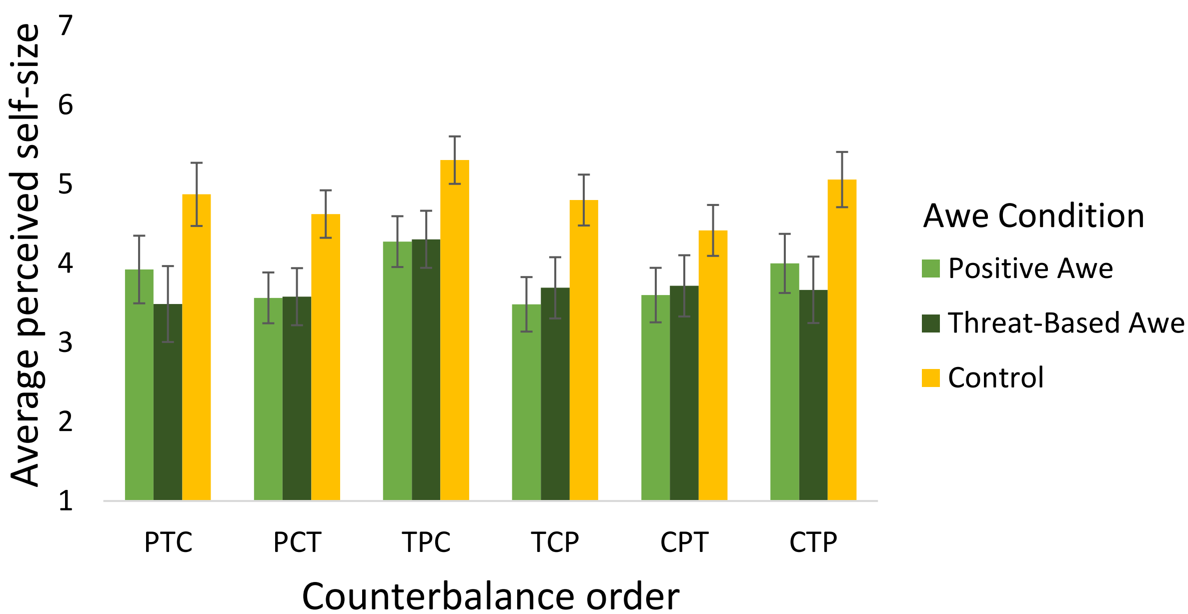


Figure 11. Average perceived self-size across awe conditions and counterbalance orders across studies 1a and 1b. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

A quasi-ANCOVA run as a multiple regression of perceived self-size on awe condition, counterbalance order and powerlessness showed significant effects of both awe conditions compared to the control condition. The positive awe condition was associated with significantly smaller perceived self-size than the control condition, *b* = -1.04, *SE* = 0.11, *t*(228.41) = -9.66, *p* < .001; and the threat-based awe condition was also associated with significantly smaller perceived self-size than the control condition, *b* = -1.08, *SE* = 0.11, *t*(228.41) = -9.97, *p* < .001, after accounting for shared variance with powerlessness.

Powerlessness. A mixed-factorial ANOVA examining the effect of awe condition and counterbalance order on powerlessness also showed a significant main effect of awe condition on powerlessness (see Table 10 and Figure 12). There was no main effect of counterbalance order, nor a significant interaction between counterbalance order and awe condition. Post-hoc LSD tests showed that both awe conditions were associated with significantly greater feelings of powerlessness than the control condition, both *p*s < .001, but that the threat-based awe condition was not associated with significantly greater feelings of powerlessness than the positive awe condition, *p* = .014 (non-significant after a Bonferroni correction).

Table 10

Effects of awe condition and counterbalance order on feelings of powerlessness (mixed-factorial ANOVA) across Experiments 1a and 1b

	df_{effect}	df_{error}	*F*	*p*	η_p^2
Awe condition * counterbalance order	9.21	202.55	1.86	.058	.08
Main effect of awe condition	1.84	202.55	65.53	<.001	.37
Main effect of counterbalance order	5	110	0.88	.500	.04

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 116) = 9.82$, $p = .007$, $\varepsilon = .92$; a Greenhouse-Geisser correction is used for within-subjects results.

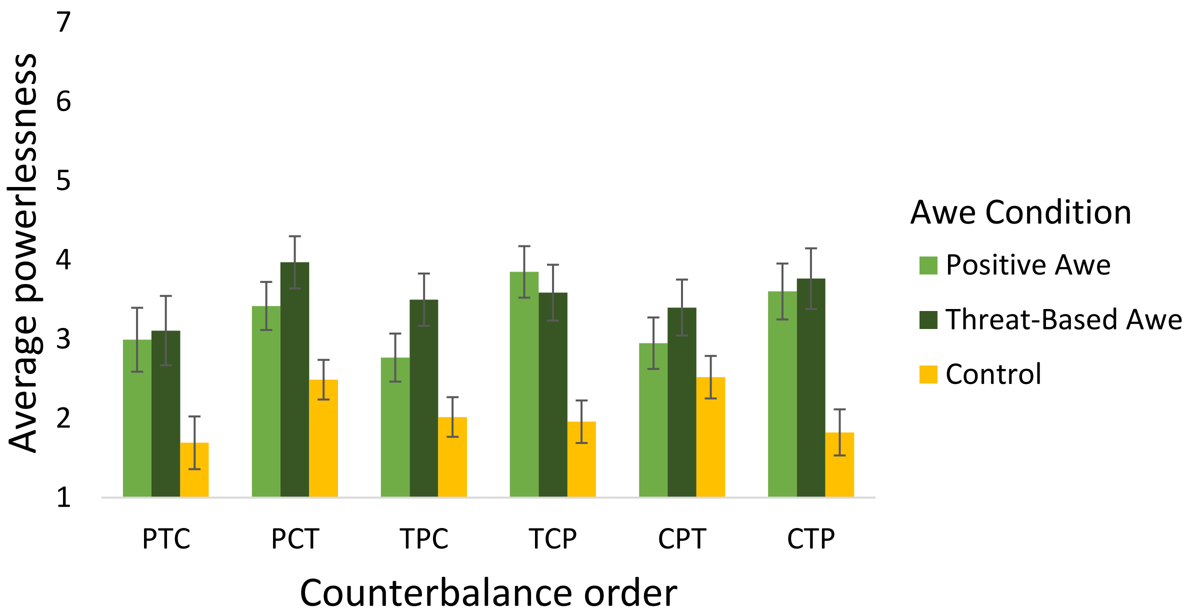


Figure 12. Average powerlessness across awe conditions and counterbalance orders across studies 1a and 1b. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

A quasi-ANCOVA run as a multilevel regression of powerlessness on awe condition, counterbalance order, and perceived self-size showed significant differences between both awe conditions and the control condition when controlling for perceived self-size. The positive awe condition was associated with significantly greater feelings of powerlessness than the control condition, $b = 1.14$, $SE = 0.11$, $t(228.41) = 10.00$, $p < .001$; and the threat-based awe condition was also associated with significantly greater feelings of powerlessness than the control condition, $b = 1.46$, $SE = 0.11$, $t(228.41) = 12.83$, $p < .001$, after accounting for shared variance with perceived self-size. These results further confirm that after accounting for the variance shared between powerlessness and perceived self-size, both awe conditions were associated with significantly greater feelings of powerlessness than the control condition.

Discussion

The results from Experiment 1b further confirm the use of the three videos to induce positive awe, threat-based awe, or neither, in terms of awe definitions and effects of perceived self-size, powerlessness, and the new fear measure. Although we did find significant differences between all three conditions in powerlessness with this sample, adding a measure of fear was a further distinguishing factor between the two awe conditions.

The full combined sample of 116 participants further confirmed the results seen across Experiments 1a and 1b. Notably, results from the combined sample reinforce the use of the awe definition measure, showing that we successfully elicited positive and threat-based awe with the videos in most participants. Whereas most awe research relies on participants' own understanding of the term and assumes that their understanding matches the definition of awe as defined in the psychological literature, our awe definition measure ensures mutual understanding of both positive and threat-based awe between participants and the researchers. Across these first two studies, we have shown that participants can use this new measure to report on the type of awe they feel in response to positive and threat-based awe video stimuli that have been validated in past work.

Across the individual and combined samples, the threat-based awe condition led to the most variable responses in awe definition endorsement, which perhaps suggests that the threat-based awe video was not as effective in eliciting the desired emotion as the other conditions. However, the threat-based awe condition was associated with significantly more fear than either the positive awe or control condition, replicating the threat-based awe results from Gordon et al. (2017). The neutral control condition also showed several unexpected endorsements for both awe definitions, perhaps a reflection of some amount of careless responding that cannot be avoided completely in an online study. Overall, however, the pattern of results for the awe definition endorsements was consistent across Experiments 1a and 1b, pointing to the validity of our measure.

Mixed-factorial ANOVAs using the full (combined) sample showed significant effects of awe condition on perceived self-size and powerlessness; and these results were confirmed through quasi-ANCOVAs which demonstrate that awe condition affects these variables uniquely, beyond any shared variance with other dependent measures. In other words, our data show that both positive and threat-based awe are associated with a significantly smaller sense of self and significantly greater feelings of powerlessness compared to feeling no awe, and that there is no statistical difference in levels of perceived self-size between the positive and threat-based awe conditions. The full sample also showed no significant effects of video viewing (i.e., counterbalance) order, suggesting that these effects of awe condition are independent of the order of video presentation.

Although the results from Experiment 1b showed a significant difference in powerlessness between threat-based and positive as predicted (with threat-based awe being associated with significantly greater feelings of powerlessness than positive awe), results from Experiment 1a and the combined sample showed no significant differences in levels of powerlessness between the two conditions. Instead, results showed that both conditions were associated with greater feelings of powerlessness than the control condition. This was unexpected, given that Gordon et al. (2017) showed that threat-based awe was associated with greater feelings of powerlessness than positive awe. In our data, the direction of the contrast between threat-based and positive awe was in the predicted direction (i.e., threat-based awe was associated with descriptively higher levels of powerlessness than the positive awe condition); perhaps we would see the predicted effect with more power. Nevertheless, this finding complicates previous findings and theory around variants of awe: Perhaps positive awe, while not provoking the same levels of fear as threat-based awe, is associated with a lower sense of control or power (compared to feeling no awe) as a result of the failure to assimilate the awe-inducing experience, a feature of awe common to both variants.

In conclusion, the data here suggest that different forms of awe can be elicited with videos of natural scenery; and that these variants of awe led to expected results in terms of perceived self-size and fear (with mixed results on powerlessness). Most importantly, we replicated these effects using a new self-report measure of awe, as well as employing a within-subjects design, both new elements to research on awe. The replication of these effects allows us to extend these effects to awe elicited through the built environment in the next experiment. Although the retention rate was improved for Experiment 1b over Experiment 1a, it could be further improved in the next study by increasing the Amazon Mechanical Turk approval rating.

Chapter 3, Experiment 2a: Positive and threat-based awe in built environments

Experiment 2a extends the findings from Experiment 1 to establish the capacity of built environments to elicit threat-based and positive awe, and in turn, examine how these emotions affect participants' self-size and feelings of powerlessness and fear. This study serves to validate stimuli for Experiment 3.

The method for Experiment 2a mirrors that of Experiment 1b, with videos of built environments taking the place of videos of natural environments. Results from Experiment 2a should mirror results from Experiment 1b: Although no previous work has established perceived self-size or powerlessness effects of awe in the built environment, videos of the built environment should have the capacity to elicit awe, following both theoretical (Joye & Verpooten, 2013) and empirical (Joye & Dewitte, 2016) work on awe in the built environment. In Experiment 2a, we predicted that the three videos would elicit three distinct emotions: Positive awe, threat-based awe, and no awe. We predicted that both positive and threat-based awe elicited by built environments would lead to a smaller sense of self, as compared to the control condition. Further, we predicted that threat-based awe elicited by a built environment would lead to greater feelings of powerlessness, as compared to positive awe elicited by a built environment, as well as compared to the control condition. Threat-based awe elicited by a built environment was also predicted to result in higher ratings of fear than positive awe elicited by a built environment and the control condition.

Because architectural video stimuli meant to provoke positive and threat-based awe did not yet exist in the literature, we created the built environment videos in Experiment 2a (see Materials for details on stimuli selection). The two videos contained shots of buildings that differed by condition. Specifically, the positive awe built environment video included shots of religious buildings (e.g., cathedrals), whereas the threat-based awe built environment video included shots of skyscrapers. We thought it possible that individual differences may affect participants' responses to awe-inducing architecture. For example, a church may have more awe-inspiring meaning to someone who is deeply religious, compared to someone who is not religious. Similarly, a skyscraper may be more awe-inducing to someone unfamiliar with very tall structures, compared to someone who lives in a dense urban environment.

To assess whether personal religiousness or familiarity with skyscrapers would affect participants' reactions to these stimuli, we measured personal religiousness and current urban living, a variable referring to whether participants reside in an urban, suburban, or rural environment (with the assumption that participants in urban areas have the greatest exposure to skyscrapers, followed by participants in suburban and rural areas). Although we had no specific predictions about either of these variables, any significant interactions between these variables and awe condition would suggest that the effect of the video content (i.e., type of building) on a dependent measure is affected by how religious a participant is (in the case of personal religiousness) or how familiar participants are with skyscrapers (in the case of current urban living). Finally, because most of the religious buildings in the positive awe video were Catholic or Protestant churches, we also measured participant religious affiliation as an additional demographic variable to see if participant religious affiliation matched the affiliations of the religious buildings.

Methods

In Experiment 2a, we developed our own video stimuli of the built environment for the positive and threat-based awe conditions. The measures used in Experiment 2a were the same as Experiment 1b, with the inclusion of new demographic information.

Participants

Participants were recruited through Amazon Mechanical Turk for the online study. For this sample, we restricted participants to Mechanical Turk workers with a 99% approval rating, up from 95% in previous samples, to increase the number in our final sample. We aimed for a final sample size comparable to the combined dataset in Experiment 1 (N = 116). An initial sample of 130 participants completed the 20-minute study for $1.00 USD. Using the same screening criteria as previous samples, our final sample consisted of 100 participants (M age = 38, SD = 13, range 22-71; 60.0% male, 39.0% female, 1% other; 82% White/Caucasian, 8% Black/African, 10% other/multiracial).

Procedure

The procedure for Experiment 2a was the same as that of Experiment 1b. Participants were again randomly assigned to one of six video counterbalance orders; for this sample, counterbalance numbers were more evenly distributed (ranging from 15 to 19 participants per counterbalance order; see Table 11).

Materials

As in Experiments 1a and 1b, three videos were used to induce positive awe, threat-based awe, or neither. The control video used to induce neutral emotion was the same video used in Experiments 1a and 1b. The videos of built settings for the positive and threat-based awe conditions were created using existing footage found online. The selection of the architectural threat-based awe environment was based on previous work on awe and threat in the built environment (Joye & Dewitte, 2016) which used digital renderings and photographs of tall, imposing skyscrapers as awe-inducing stimuli. Although we recognize that many different architectural styles may help facilitate a feeling of threat-based awe, we felt that relying on previous work on awe and threat would be the most reliable to way to induce threat-based awe through architecture. The final video was mostly composed of shots of tall skyscrapers with blank and monotonous façades filmed from ground level, meant to mimic the stimuli seen in Joye and Dewitte (2016).

Because no extant experimental work on awe had used architectural stimuli to induce positive awe when stimuli for this study were being developed, the video selection for Experiment 2a was based on work outside the awe literature linking architectural styles or elements to positive emotions (such as Vartanian et al., 2013, which found that contour in architectural spaces is associated with beauty ratings). Videos of buildings were also chosen based on our previous work (Negami, 2016) which found relationships between architectural features of building interiors—namely, immensity and adornment—and elicited awe (though this work did not distinguish between variants of awe).

Video clips were found online using the photo and video-sharing websites Flickr (www.flickr.com), YouTube (www.youtube.com), PixaBay (www.pixabay.com), and Vimeo (www.vimeo.com). All videos used were either licensed per the terms of Creative Commons Attribution 3.0 or were sent to the researcher by the owner with permission to use the video for academic research. Movie clips from these downloads were edited and spliced together using iMovie version 9.0.4. The positive and threat-based awe conditions were matched as closely as possible on elements such as perspective and video length (see Figure 13 for film stills from each condition). All videos were approximately two minutes long, approximately the same length as the videos from Experiment 1.

Figure 13. Film stills of the positive awe (top) and threat-based awe (bottom) conditions in Experiment 2a. Still are from videos by Azzurra Music Srl. and Stupendastic.

Music selection. The videos from Gordon et al. (2017) used in Experiment 1 not only differed by visual content (e.g., tornados, landscapes) but also by soundtrack. Because the purpose of the Gordon et al. (2017) studies was to evoke certain emotions (namely, positive and threat-based awe), regardless of the content of the video or accompanying music, the use of stimuli that varied in both visual and audio content was justified. However, the aim of the present study is to induce these emotions specifically using architectural stimuli. Thus, to ensure that any difference we find between conditions is due to visual content of the video (i.e., different architectural stimuli), and not due to audio content, we kept music consistent between conditions in Experiment 2a.

We decided to use music at all, rather than no soundtrack, for several reasons: First, to keep participants' attention engaged in the online study; second, because the effects we found in Experiment 1 and wished to replicate in Experiment 2 were elicited from videos with audio soundtracks; and third, because the use of a soundtrack would make the movies more emotionally salient. Music is theorized to evoke affective response on its own (Juslin & Västfjäll, 2008; Kreutz et al., 2008; Vuoskoski & Eerola, 2012; but see Konečni, 2008 for more discussion), and has been found to modulate emotional response to paired stimuli of a different modality (e.g., gustation, North, 2012).

We selected a piece of instrumental music that was ambiguous in valence in order for the same soundtrack to be appropriate across both the positive awe and threat-based awe conditions. Music with conflicting cues of tempo and mode has been found to lead to mixed-valence responses (Hunter et al., 2008; Larsen & Stastny, 2011). Music with ambiguous valence can be interpreted positively or negatively depending on paired stimuli (Maes & Leman, 2013; Margulis et al., 2017).

We found an appropriate soundtrack that had conflicting cues of a fast tempo and minor mode by searching the term "neutral" on a stock-music website (www.audiojungle.net). This music accompanied all three videos (positive awe, threat-based awe, and neutral control). The use of a movie soundtrack, such as the one accompanying a video used in Study 3 in Gordon et al. (2017) which elicited varying levels of awe with varying levels of fear across participants, was avoided to prevent associative responses to the music.

Measures

All measures from Experiment 1b were replicated here. In this study, the three items measuring perceived self-size all showed high reliability (α ranging from .83 to .87 between awe conditions). The statements measuring perceived self-size and the graphic measure of perceived self-size using pictures of circles correlated significantly, $r_{rm}(199) = 0.50$, $p < .001$, 95% CI [0.50, 0.74], and were averaged together to create a composite measure of perceived self-size (*M* = 4.58, *SD* = 1.37). Powerlessness also showed good reliability (α ranging from .80 to .85 between conditions; *M* = 2.53, *SD* = 1.25). The measure of fear was also included in this study (*M* = 1.70, *SD* = 1.22).

Because the two new videos included shots of skyscrapers in the threat-based awe condition and religious buildings in the positive awe condition, and because this content differed between conditions, we included additional demographic questions measuring variables that might influence participants' responses to these two groups of stimuli. Specifically, we asked participants what kind of area they currently reside in (urban, suburban, or rural) as a measure of how familiar they might be with skyscraper buildings. Of our final sample, 31% indicated they reside in an urban area, 46% indicated they reside in a suburban area, and 23% indicated they reside in a rural area (see Table 11 for participant numbers per counterbalance order and current urban living).

We also asked participants how religious they were by asking them to rate two statements, "God is important in my life" and "Religion is important in my life," on a 7-point Likert-type scale (1 = *not at all important* and 7 = *very important*). This two-item scale was replicated from other work that found good reliability between the items (Van Cappellen et al., 2013; Van Cappellen et al., 2011). In our sample, the reliability between the statements was very high, α = .95 (M = 3.60, SD = 2.46). These two items were averaged together for analyses. Finally, we asked participants to indicate their religious affiliation through a multiple-choice question following the methods of the Pew Research Center (Pew Research Center, 2018; see Table 12 for the religious affiliations of our sample).

Table 11

Participant numbers by counterbalance order and current urban living category in Experiment 2a

	Urban	Suburban	Rural	Total
PTC	5	7	4	16
PCT	4	8	3	15
TPC	2	10	4	16
TCP	8	8	3	19
CPT	5	7	5	17
CTP	7	6	4	17
Total	31	46	23	100

Note. Counterbalance orders are indicated by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

Table 12

Religious Affiliations of Participants in Experiment 2a

Religious Affiliation	Count
Protestant	26
Roman Catholic	21
Agnostic	20
Atheist	18
Nothing in particular	8
Something else [text entry; e.g., “spiritual”]	4
Mormon	1
Jewish	1
Muslim	1

Results

Tests of normality showed no univariate outliers, with all z-scores within 3.29 standard deviations from the mean; as well as skew for all variables < 3.00 and kurtosis < 10.00, indicating normally distributed data (Kline, 1998).

The demographic variable religiousness was examined to determine whether it should be included in analyses of the continuous dependent measures (perceived self-size, powerlessness, and fear). Modeled as a predictor with awe condition as a covariate, religiousness did not significantly predict perceived self-size, $b = .11$, $SE = .06$, $t(98.00) = 1.95$, $p = .054$; powerlessness, $b = .02$, $SE = .05$, $t(98.00) = 0.31$, $p = .758$; or fear, $b = .05$, $SE = .05$, $t(98.11) =$

1.05, p = .296. Because religiousness showed no association with any of the dependent measures, it was not included in any subsequent analyses.

All mixed-factorial ANOVAs from Experiment 1b were replicated with the inclusion of current urban living, a between-subjects variable representing the environment (urban, suburban, or rural) that best describes where participants currently reside.

In this study, as with Experiments 1a and 1b, powerlessness and perceived self-size correlated significantly, with greater feelings of powerlessness associated with smaller perceived self-size (see Table 13 for correlations and descriptive statistics by condition for Experiment 2a variables). Quasi-ANCOVAs were run with the same parameters as in Experiment 1 to account for this shared variance, with the addition of the current urban living variable.

Table 13

Repeated-measures correlations and descriptive statistics of dependent measures in Experiment 2a

	Perceived self-size	Powerlessness	Fear
Perceived self-size	—	-.52***[a]	-.12[b]
Powerlessness		—	.12[b]
Positive awe condition	4.41 (1.57)	2.63 (1.37)	1.69 (1.38)
Threat-based awe condition	4.41 (1.59)	2.66 (1.39)	1.81 (1.4)
Neutral control	4.91 (1.51)	2.29 (1.34)	1.61 (1.28)

Note. [a]199 degrees of freedom. [b]198 degrees of freedom. ***$p < .001$. Means per condition are shown with standard deviations in parentheses.

Awe definition

As can be seen in Figure 14, while there was a significant difference among awe conditions in endorsement of awe definition, $\chi^2(4, N = 300) = 53.86$, $p < .001$, the definitions endorsed between the positive and threat-based awe conditions were nearly identical. Participants were more likely to endorse the positive awe definition than the threat-based awe definition or "neither of the above" in response to both awe videos. Participants were significantly more likely to endorse "neither of the above" in response to the neutral control video than either awe definition.

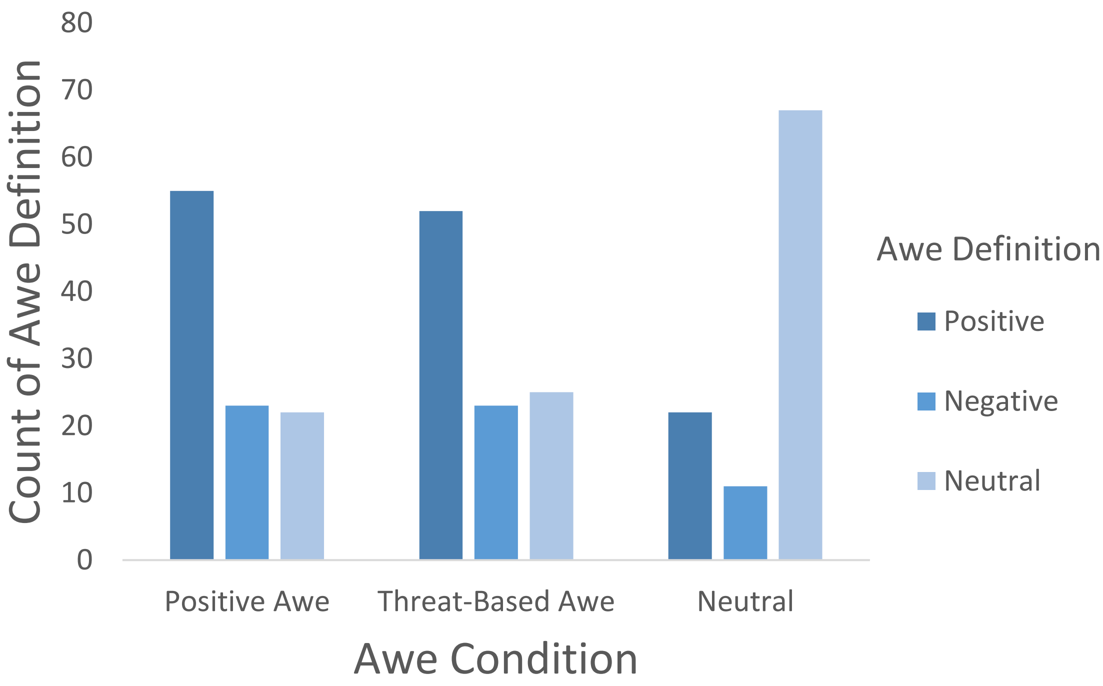
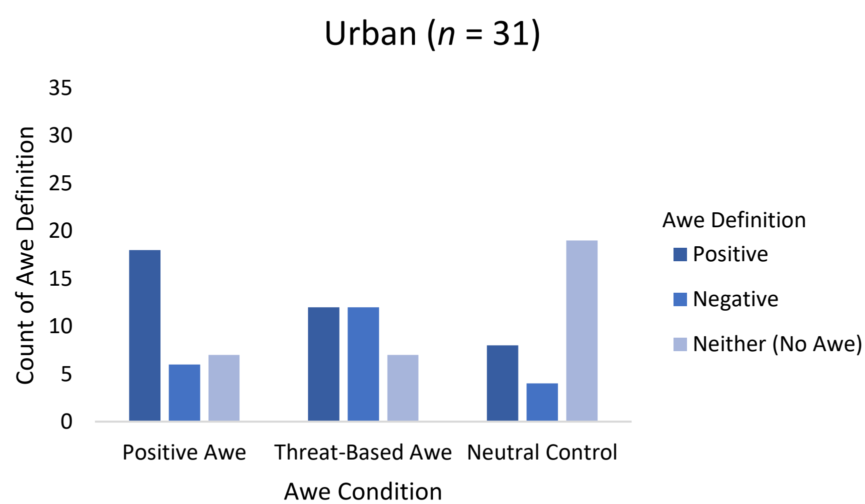
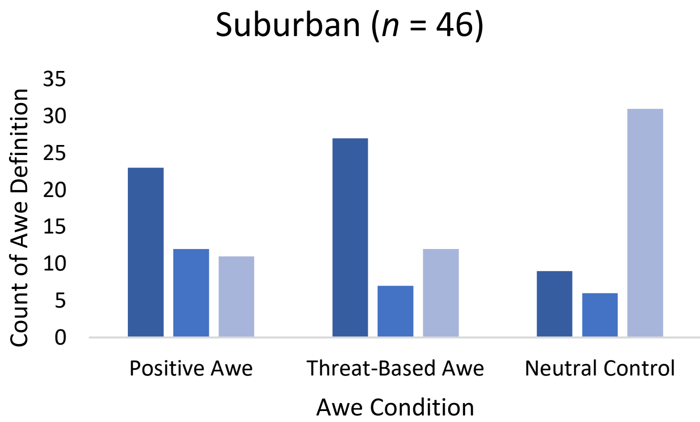


Figure 14. Frequencies of awe definition endorsements for each of the three conditions in Experiment 2a.

When this analysis was repeated separately for urban, suburban, and rural residents, the pattern was similar to the overall results for suburban and rural residents (see Figure 15). However, while urban dwellers also were more likely to select the positive awe definition for the positive awe condition, they were equally likely to select the positive awe and threat-based awe definition for the threat-based awe condition. While this result comes closest to what was predicted (i.e., that participants would endorse the positive awe definition most often for the positive awe condition, the threat-based awe definition most often for the threat-based awe condition, and "neither of the above" most often for the control condition), no group of participants was more likely to select the threat-based awe definition for the threat-based awe video.





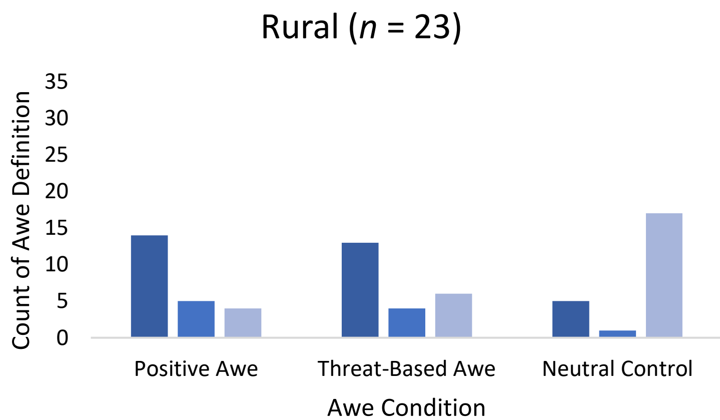


Figure 15. Frequencies of awe definition endorsements by current urban living category (urban, $\chi^2(4, N = 93) = 17.46, p = .002$; suburban, $\chi^2(4, N = 138) = 25.68, p < .001$; and rural, $\chi^2(4, N = 69) = 18.05, p = .001$) for each of the three conditions in Experiment 2a.

Perceived self-size

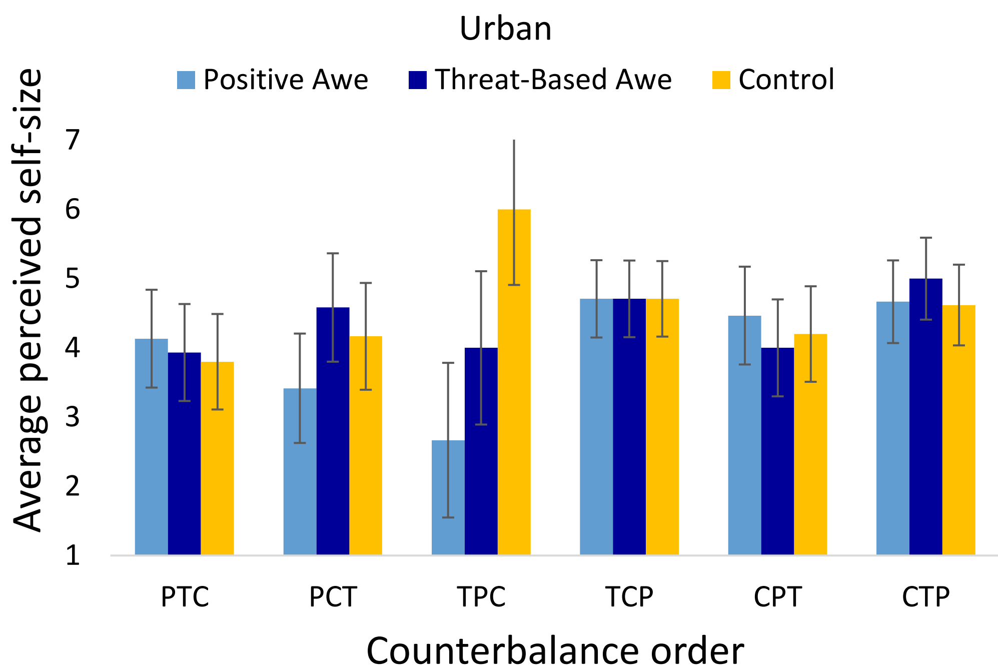
A 3 (awe condition) x 6 (counterbalance order) x 3 (current urban living) mixed-factorial ANOVA examining perceived self-size showed a significant interaction between counterbalance order and awe condition, as well as a significant main effect of awe condition (see Table 14 and Figure 16). No other effects were significant.

Table 14

Effects of awe condition, counterbalance order, and current urban living on perceived self-size (mixed-factorial ANOVA) in Experiment 2a

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order * current urban living	16.30	133.62	1.47	.119	.15
Awe condition * counterbalance order	8.15	133.62	2.95	.004	.15
Awe condition * current urban living	3.26	133.62	1.20	.315	.03
Counterbalance order * current urban living	10	82	1.03	.429	.11
Main effect of awe condition	1.63	133.62	13.23	<.001	.14
Main effect of counterbalance order	5	82	0.31	.906	.02
Main effect of current urban living	2	82	0.57	.570	.01

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 100) = 20.89$, $p < .001$, $\varepsilon = .82$; a Greenhouse-Geisser correction is used for within-subjects results.


Urban
Positive Awe
Threat-Based Awe
Control
Average perceived self-size
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PTC
PCT
TPC
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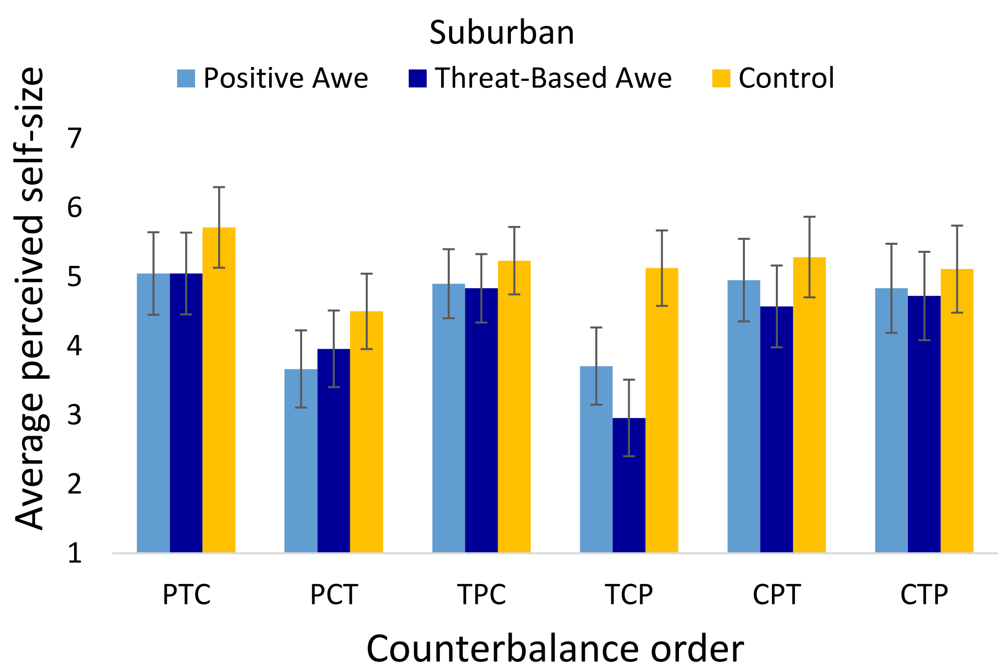
CTP
Counterbalance order


Suburban
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Threat-Based Awe
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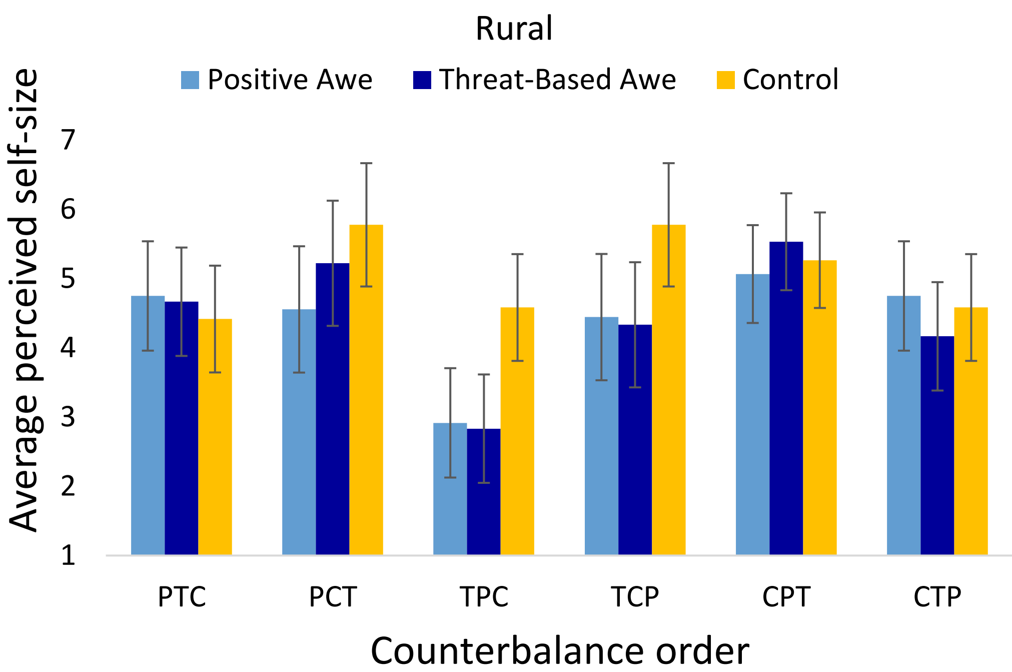
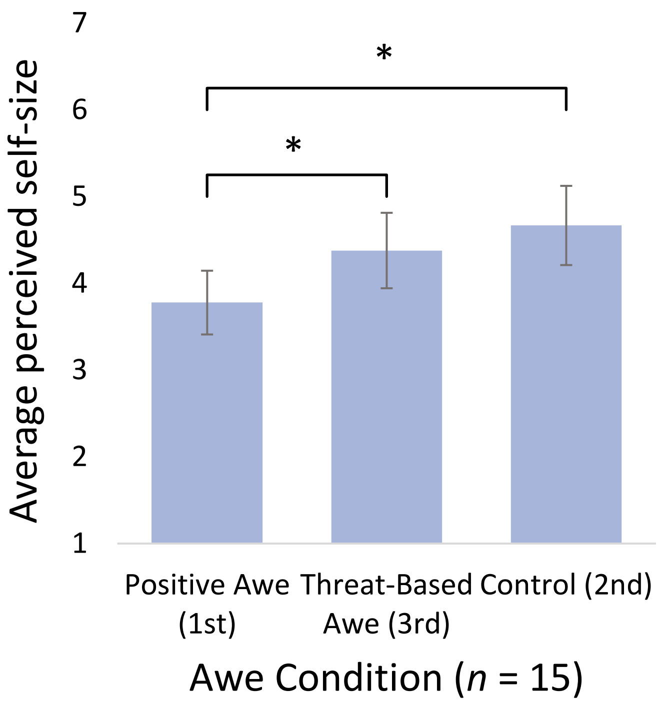
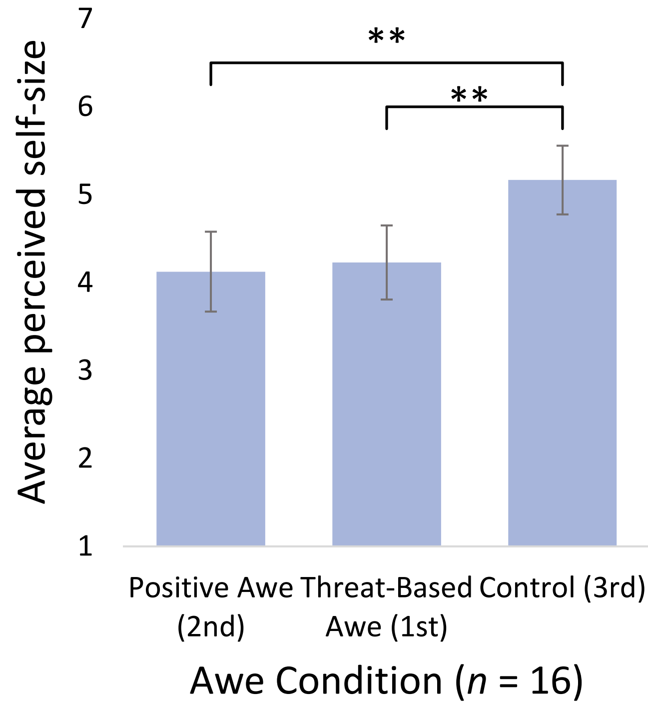


Figure 16. Average perceived self-size across awe conditions, counterbalance conditions, and current urban living categories in Experiment 2a. Counterbalance orders are indicated on the x-axes by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

The significant interaction between counterbalance order and awe condition was followed up with one-way repeated-measures ANOVAs for each counterbalance group. These post-hoc analyses showed significant simple effects of awe condition among participants in three counterbalance orders. There were significant simple effects of awe condition among participants who viewed the videos in order of positive awe, neutral control, threat-based awe, $F(2, 28) = 5.31$, $p = .011$, $\eta_p^2 = .28$; threat-based awe, positive awe, neutral control, $F(2, 30) = 9.66$, $p = .001$, $\eta_p^2 = .39$; and threat-based awe, neutral control, positive awe, $F(2, 36) = 4.44$, $p = .019$, $\eta_p^2 = .20$. One-way repeated-measures ANOVAs among the other three counterbalance conditions were not significant, all $p > .608$. As can be seen in Figure 17, participants in the two counterbalance conditions who viewed the threat-based awe video first showed the predicted pattern of results, feeling significantly smaller in response to both awe conditions, compared to the control condition, with no significant difference in perceived self-size between the two awe conditions.





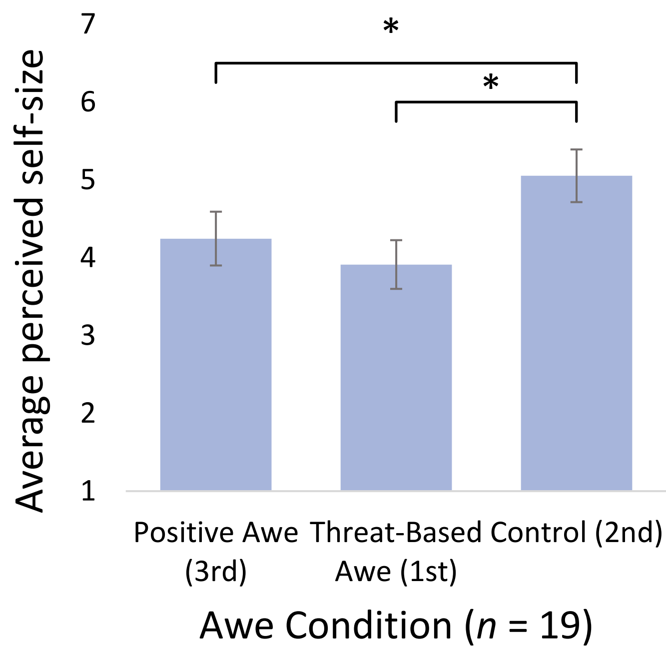


Figure 17. Results from post-hoc LSD tests on simple effects of awe condition per counterbalance order, following up on the significant omnibus interaction between awe condition and counterbalance order for perceived self-size in Experiment 2a. Viewing order is indicated on each x-axis, along with the number of participants per counterbalance order.

Post-hoc LSD tests probing the significant main effect of awe condition from the omnibus ANOVA showed that while there was no significant difference in perceived self-size between the positive and threat-based awe conditions, $p = .410$, both conditions were associated with significantly smaller perceived self-size compared to the control condition, both $p < .001$. In other words, on average, across all counterbalance conditions, participants felt significantly smaller while watching both awe videos as compared to while watching the neutral control video.

A quasi-ANCOVA of perceived self-size showed that when controlling for powerlessness, counterbalance order, and current urban living, perceived self-size was significantly smaller in the positive awe condition compared to the control condition, $b = -0.50$, $SE = 0.11$, $t(196.81) = -4.39$, $p < .001$, as well as significantly smaller in the threat-based awe condition compared to the control condition, $b = -0.50$, $SE = 0.11$, $t(196.81) = -4.42$, $p < .001$. These results lend further statistical support to the main effect of awe condition seen in the mixed-factorial ANOVA.

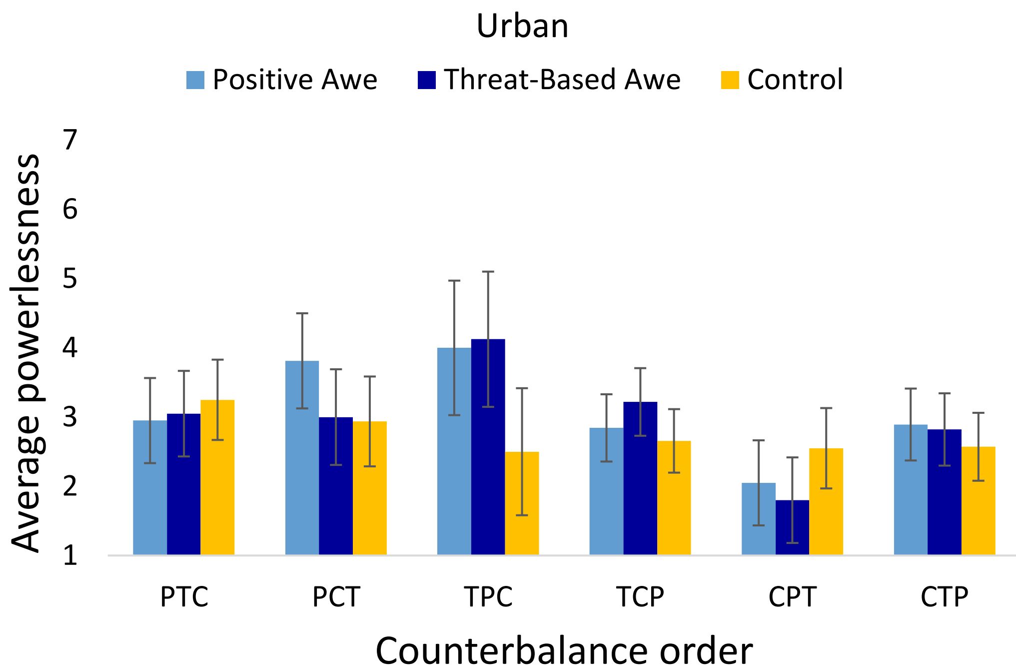
Powerlessness

A mixed-factorial ANOVA examining the effect of awe condition, counterbalance order, and current urban living on powerlessness showed a significant three-way interaction, a significant interaction between counterbalance order and awe condition, and main effects of awe condition and current urban living (see Table 15 and Figure 18). No other effects were significant.

Table 15

Effects of awe condition, counterbalance order, and current urban living on feelings of powerlessness (mixed-factorial ANOVA) in Experiment 2a

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order * current urban living	20	164	1.67	.043	.17
Awe condition * counterbalance order	10	164	2.60	.006	.14
Awe condition * current urban living	4	164	0.62	.642	.02
Counterbalance order * current urban living	10	82	0.31	.977	.04
Main effect of awe condition	2	164	9.85	<.001	.11
Main effect of counterbalance order	5	82	1.39	.237	.08
Main effect of current urban living	2	82	3.65	.030	.08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Threat-Based Awe
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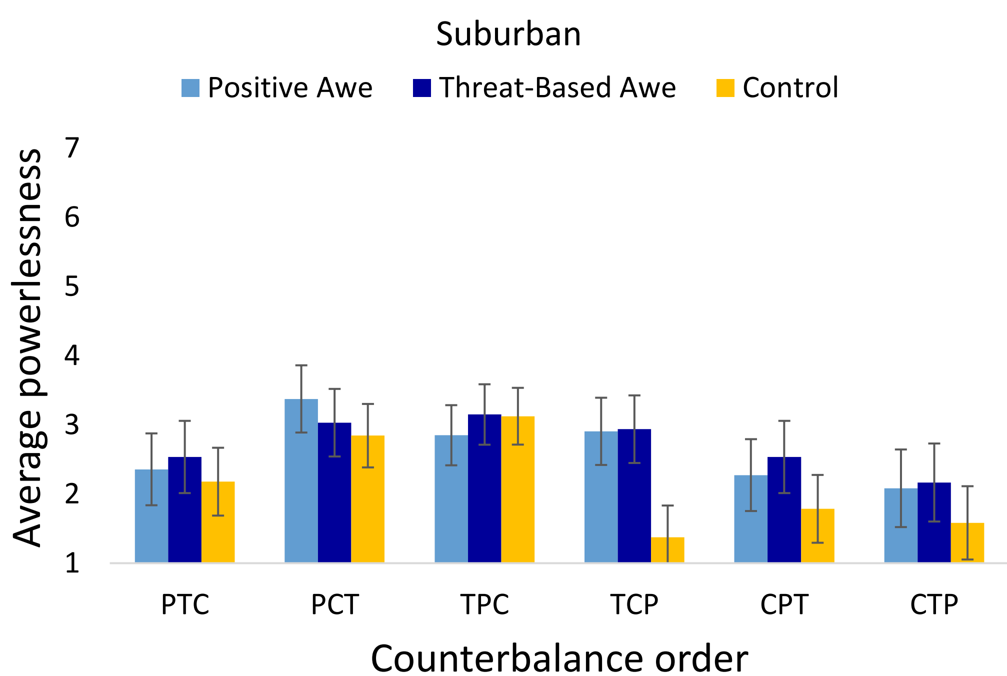
Counterbalance order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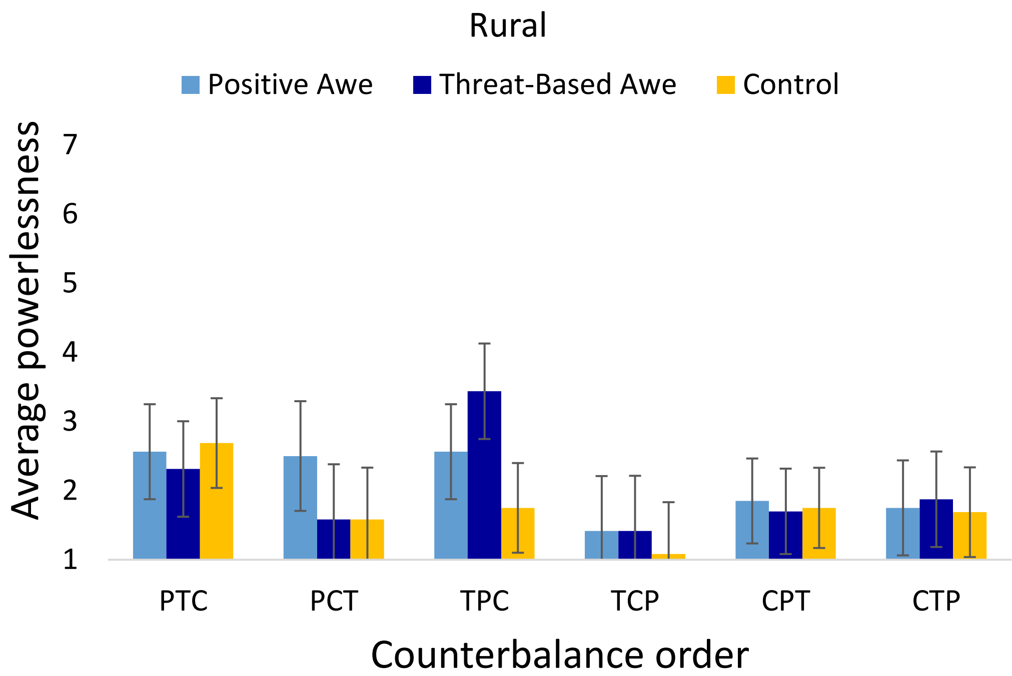


Figure 18. Average powerlessness across awe conditions, counterbalance conditions, and current urban living categories in Experiment 2a. Counterbalance orders are indicated on the x-axes by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

Simple effects analyses investigating the three-way interaction examined the effects of awe condition and counterbalance order by each current urban living category (see Table 16). Among urban dwellers, there was a significant simple interaction between awe condition and counterbalance order. However, in following up this interaction, post-hoc one-way repeated-measures ANOVAs examining the effect of awe condition on powerlessness per counterbalance group among urban dwellers showed no significant simple effects, all *ps* > .078. There was no significant simple effect of awe condition on powerlessness among urban dwellers, nor a significant simple effect of counterbalance order. Among suburban dwellers, there was a significant simple effect of awe condition. Post-hoc LSD tests following up this significant effect showed that among suburban dwellers, both the positive awe and threat-based awe conditions were associated with increased feelings of powerlessness than the neutral control condition, *p*s = .008 and < .001, respectively. Powerlessness between the positive awe and threat-based awe conditions did not significantly differ for suburban dwellers, $p = .577$. There was no significant simple interaction between awe condition and counterbalance order, nor a significant simple effect of counterbalance order for suburban dwellers. There were no significant effects of awe condition or counterbalance order among rural residents.

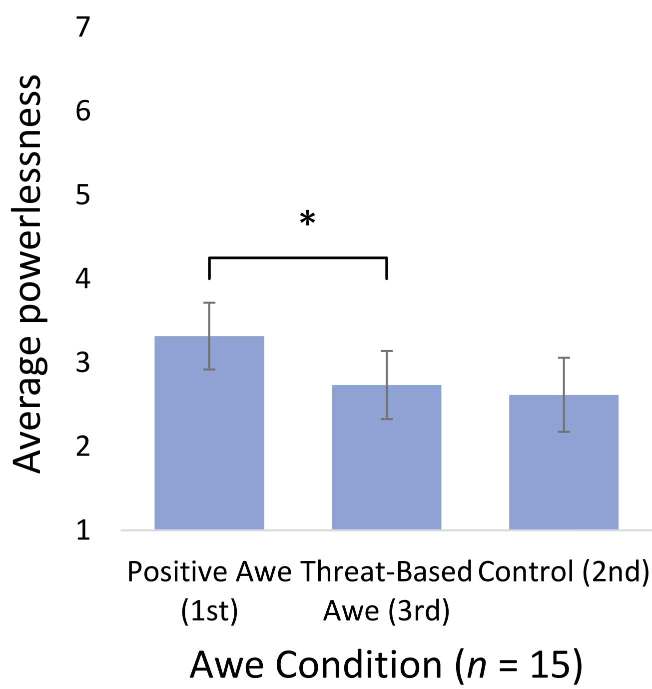
Table 16

Simple effects of awe condition and counterbalance order on feelings of powerlessness among urban, suburban, and rural residents in Experiment 2a

		df_{effect}	df_{error}	F	p	η_p^2
Urban residents	Awe condition * counterbalance order	10	50	2.73	.009	.35
	Main effect of awe condition	2	50	2.87	.066	.10
	Main effect of counterbalance order	5	25	0.50	.774	.09
Suburban residents	Awe condition * counterbalance order	10	80	1.83	.068	.19
	Main effect of awe condition	2	80	7.98	.001	.17
	Main effect of counterbalance order	5	40	1.06	.399	.12
Rural residents[a]	Awe condition * counterbalance order	6.79	23.10	1.83	.131	.35
	Main effect of awe condition	1.36	23.10	2.20	.146	.11
	Main effect of counterbalance order	5	17	0.78	.577	.19

Note. [a]Mauchly's test showed a sphericity violation, $\chi^2(2, N = 23) = 10.22$, $p = .006$, $\varepsilon = .68$; a Greenhouse-Geisser correction is used for within-subjects results.

The significant interaction between counterbalance order and awe condition from the omnibus ANOVA was followed up with one-way repeated-measures ANOVAs, which showed significant simple effects of awe condition among participants in three counterbalance orders (the same counterbalance orders that showed significant effects of the same simple-effects analysis for perceived self-size). There were significant simple effects of awe condition on powerlessness among participants who viewed the videos in order of positive awe, neutral control, threat-based awe, $F(1.16, 16.18) = 4.55$, $p = .044$, $\eta_p^2 = .25$; threat-based awe, positive awe, neutral control, $F(1.40, 20.99) = 4.18$, $p = .025$, $\eta_p^2 = .22$; and threat-based awe, neutral control, positive awe, $F(2, 36) = 6.55$, $p = .004$, $\eta_p^2 = .27$. Post-hoc LSD tests showed different patterns of results for all three counterbalance conditions (see Figure 19). One-way repeated-measures ANOVAs among the other counterbalance conditions were not significant, all *p*s > .223.



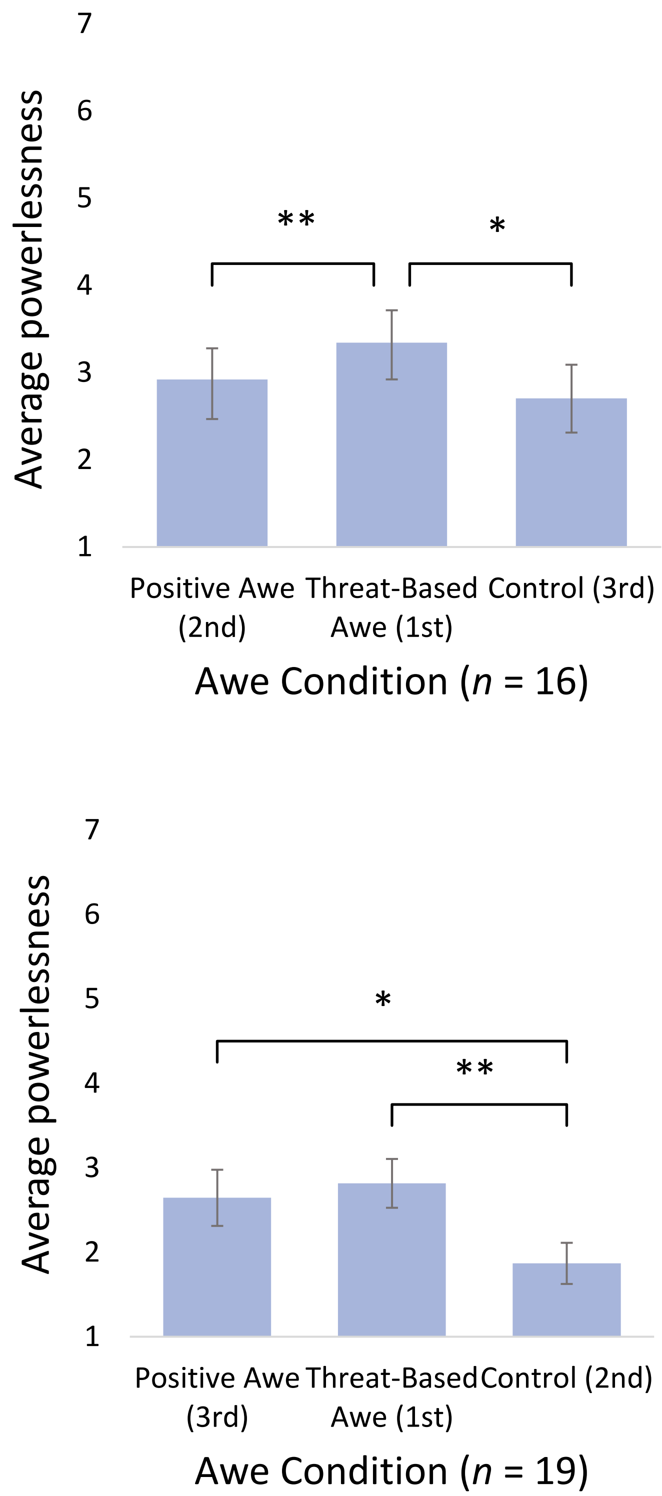


Figure 19. Results from post-hoc LSD tests on simple effects of awe condition per counterbalance order, following up on the significant omnibus interaction between awe condition and counterbalance order for powerlessness in Experiment 2a. Viewing order is indicated on each x-axis, along with the number of participants per counterbalance order.

Post-hoc LSD tests investigating the significant main effect of awe condition on powerlessness from the omnibus ANOVA showed that on average, participants felt significantly more powerless in response to both awe conditions compared to the control condition (p = .001 for positive awe compared to control and p < .001 for threat-based awe compared to control). There was no significant difference in powerlessness between the positive awe and threat-based awe conditions, p = .837.

The omnibus ANOVA also showed a significant main effect of current urban living on powerlessness, showing that powerlessness overall varied significantly across urban, suburban, and rural participants. Post-hoc LSD tests probing the significant main effect of current urban living showed that participants from urban areas showed significantly greater feelings of powerlessness overall than participants from rural environments, p = .008, but not greater than participants from suburban areas, p = .157. There was no difference between participants from suburban areas and participants from rural areas, p = .102.

A quasi-ANCOVA examining the effect of awe condition on powerlessness, controlling for perceived self-size, counterbalance order, and current urban living showed that powerlessness was significantly greater in the positive awe condition compared to the control condition, b = 0.35, SE = 0.09, t(196.76) = 4.01, p < .001; and that powerlessness was also significantly greater in the threat-based awe condition compared to the control condition, b = 0.37, SE = 0.09, t(196.76) = 4.27, p < .001. Again, this analysis confirms that participants felt more powerless in response to both awe conditions compared to the control condition, beyond any effect of perceived self-size.

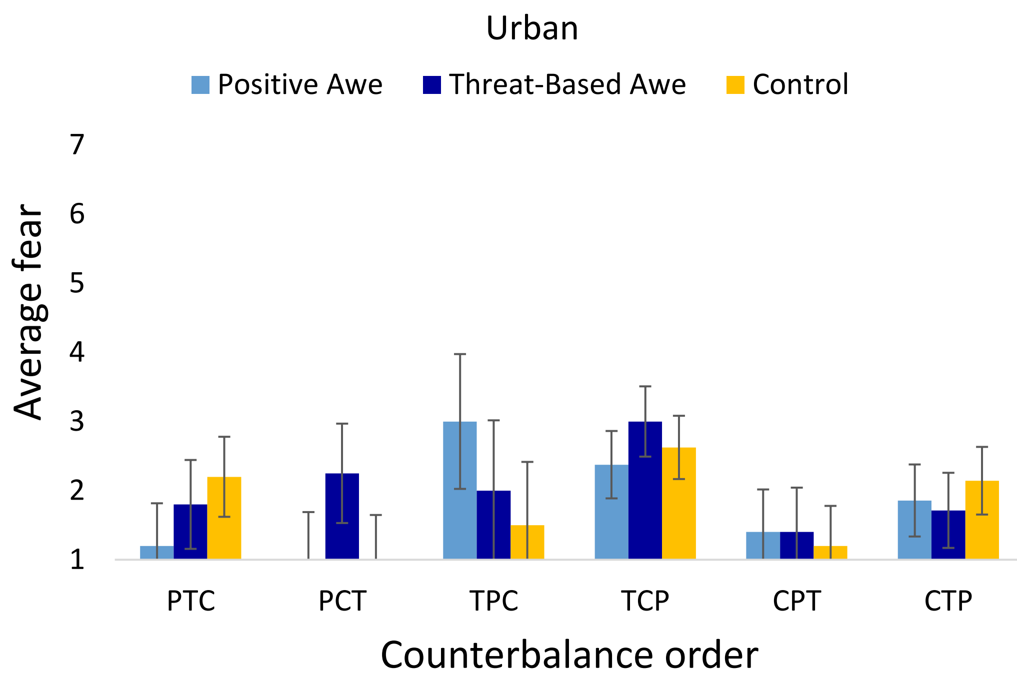
Fear

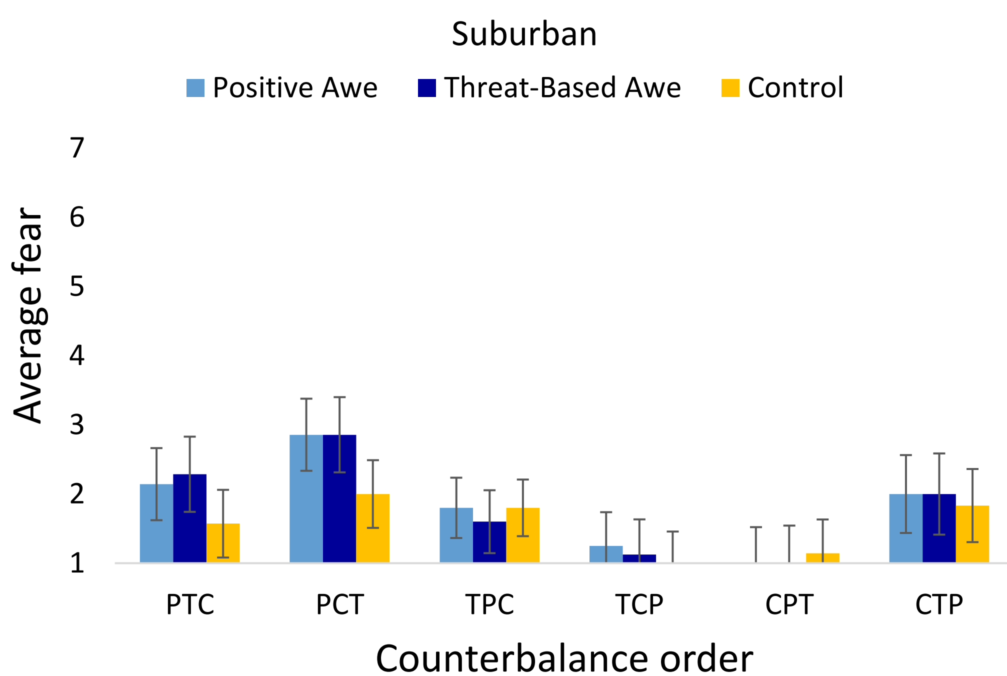
A mixed-factorial ANOVA examining the effect of awe condition, counterbalance order and current urban living on fear found no significant main effects or interactions (see Table 17 and Figure 20).

Table 17

Effects of awe condition, counterbalance order, and current urban living on fear (mixed-factorial ANOVA) in Experiment 2a

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order * current urban living	20	162	0.99	.479	.11
Awe condition * counterbalance order	10	162	0.78	.652	.05
Awe condition * current urban living	4	162	0.34	.853	.01
Counterbalance order * current urban living	10	81	1.14	.346	.12
Main effect of awe condition	2	162	1.77	.174	.02
Main effect of counterbalance order	5	81	0.78	.570	.05
Main effect of current urban living	2	81	1.16	.318	.03


Urban
Positive Awe
Threat-Based Awe
Control
Average fear
1
2
3
4
5
6
7
PTC
PCT
TPC
TCP
CPT
CTP
Counterbalance order


Suburban
Positive Awe
Threat-Based Awe
Control
Average fear
1
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PTC
PCT
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CTP
Counterbalance order

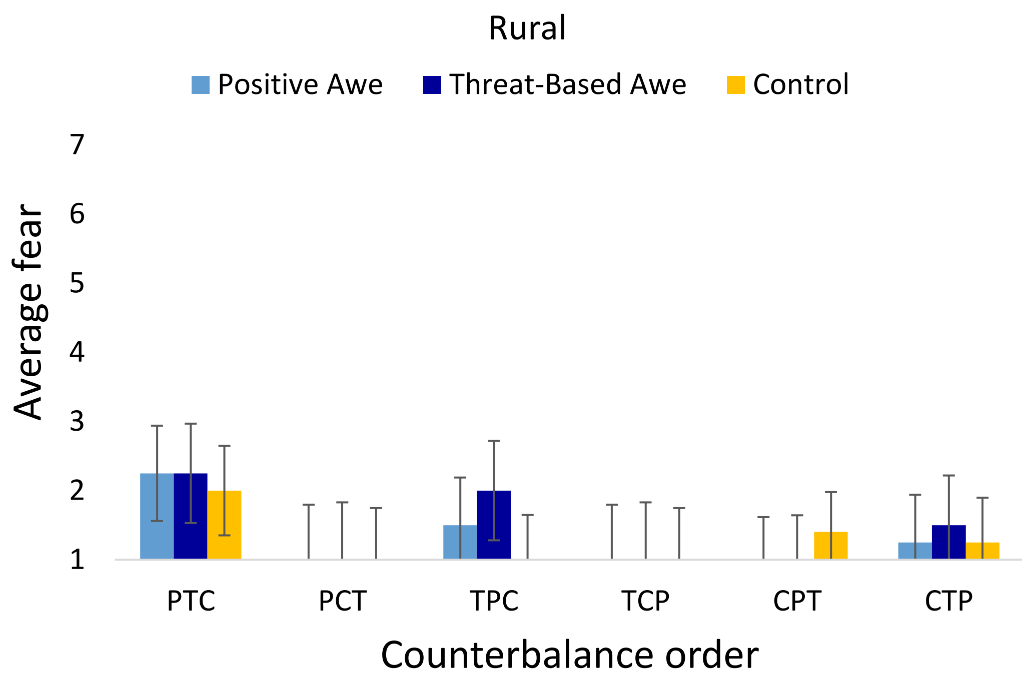


Figure 20. Average fear across awe conditions, counterbalance conditions, and current urban living categories in Experiment 2a. Counterbalance orders are indicated on the x-axes by letter: P = positive awe condition; T = threat-based awe condition; C = control condition.

Discussion

In general, there were no differences found between the positive awe and threat-based awe conditions in any of the dependent measures: Awe definition, perceived self-size, powerlessness, and fear all were rated similarly between the two conditions in this study (on average, across current urban living groups and counterbalance orders). In other words, we did not successfully validate the threat-based awe stimulus using video of architectural settings.

This finding was particularly unexpected because it did not replicate past work which elicited threat-based awe using imagery of skyscrapers (Joye & Dewitte, 2016), and on which we based our experimental stimuli. There are several reasons our results may have differed. At a stimulus level, our study was not a direct replication and used video, whereas Joye and Dewitte (2016) used still images of different buildings. Accordingly, the ratings in Joye and Dewitte (2016), as well as the current study, may have been influenced by low-level or global perceptual properties of the stimulus (Redies et al., 2020), perhaps partially accounting for differences between our findings. Furthermore, and more notably, Joye and Dewitte's (2016) dependent measure of freezing behavior was an indirect measure of threat; their direct measure of self-reported fear showed no significant differences between the high and low-building conditions. The only self-reported emotions that showed differences between conditions in Joye and Dewitte (2016) were awe and wonder; no other self-reported positive or negative emotion differed between conditions, including fear. Therefore, it is possible that the freezing behavior measured in response to the awe-provoking buildings in their study is present in response to positive awe as well as threat-based awe, as their data does not directly differentiate between the two emotions.

Yet, although our skyscraper stimulus did not elicit threat-based awe, it did elicit a different variant of awe; positive awe was induced in both experimental conditions. This result may suggest that architecture, unlike nature, poses no inherent threat, at least in its visual form. Whereas architecture has the ability to *represent* a threat, such as an oppressive political regime, this representation may always be abstract, requiring additional context besides the visual stimulus. On the other hand, our findings are somewhat limited in their generalizability because of the narrow range of stimuli used. We relied on images of skyscrapers to elicit threat-based awe based on past findings by Joye and Dewitte (2016). Although we included a variety of buildings in our video (i.e., our results were not driven by one particular building), we may have limited our ability to induce threat-based awe by restricting our selection of buildings for the threat-based awe video to skyscrapers. It is still a possibility that architecture (even the kinds of buildings presented in Experiment 2a) has the ability to inspire threat-based awe, perhaps especially with accompanying context or among different populations. Ultimately, we conclude from Experiment 2a that among a general Western (US/Canada) population, images of architecture alone (i.e., isolated from explicit sociocultural context or history) have the capacity to inspire positive awe but not threat-based awe using our particular paradigm.

None of the videos presented in this study provoked any fear. This was a surprising finding for the threat-based awe condition, again because of the attempt to emulate the skyscraper stimuli in Joye and Dewitte (2016) which provoked a freezing response. However, this was also somewhat of a surprise finding for the positive awe condition, since we did see a difference between positive awe and control conditions in fear in Experiment 1 (at least when not controlling for other variables), which we did not replicate here. Our findings, however, do replicate past work by Gordon et al. (2017), which found no difference in levels of fear between their positive awe and neutral control conditions.

We measured participants' current residential environment in this study to examine whether familiarity with skyscrapers (measured as current urban living) would influence participants' responses to the threat-based awe video, which was composed of shots of skyscrapers. The lack of any significant two-way omnibus interactions between awe condition and current urban living on any of the continuous dependent variables (perceived self-size, powerlessness, or fear) suggests that the effect of awe condition on these dependent measures is not influenced by familiarity with skyscrapers. The fact that we did not see any significant effects of religiousness further suggests that although our built environment awe conditions had distinct types of buildings (i.e., religious buildings and skyscrapers), the effect of video content on our dependent measures was not affected by related individual differences.

Although there were no significant effects of current urban living for perceived self-size or fear, there were two significant effects of current urban living on ratings of powerlessness. The three-way interaction between awe condition, current urban living and counterbalance order seemed to be mostly driven by suburban dwellers feeling more powerless in response to the two awe conditions compared to the control condition. Perhaps this result is a function of the neutral control video portraying a suburban, and hence familiar, environment. (This result was one effect of familiarity with skyscrapers that influenced the effect of awe condition; however, across counterbalance orders, we found no interactions between current urban living and awe condition.) In addition, the data show that on average (across conditions), urban dwellers indicated feeling significantly more powerless than rural residents. Although it is not possible to conclude what led to these results from our available data, it is interesting to speculate on a number of possible reasons: for instance, income disparities among the participants, greater exposure to powerful entities such as institutions and corporations in urban environments, or even more frequent use of unreliable public transportation in urban settings, which could decrease an individual's sense of control.

It is somewhat concerning that for the dependent variables of perceived self-size and powerlessness, participants in some counterbalance orders (i.e., video viewing orders) did not show any effect of awe condition on the dependent measure. For both variables, participants who viewed the neutral control video first (as well as participants who viewed the positive awe video first, followed by threat-based awe and control) did not show any differences in responses across the three videos. These results present the possibility that the carryover effect of a previous video influenced participant responses for subsequent videos. This possibility will be addressed in Experiment 2b. However, on average (across counterbalance orders and current urban living groups), the two awe conditions resulted in smaller perceived self-sizes and greater feelings of powerlessness when compared to the control condition.

Experiment 2b: Positive and threat-based awe in built environments, between-subjects replication

In Experiment 2a, counterbalance viewing order of the awe-inducing videos produced a significant interaction with awe condition for two of our dependent measures, perceived self-size and powerlessness. This effect may have been due to carryover effects of previous videos influencing responses to subsequent conditions. In Experiment 2b, we replicate Experiment 2a using a between-subjects design in order to test whether the main effects (i.e., across counterbalance orders) would differ or stay consistent.

Methods

Participants

In addition to collecting new data using a between-subjects design, participants from Experiment 2a were also included in the sample for Experiment 2b, using only data from the first videos viewed. Between-subjects data from 125 additional participants were collected using Amazon Mechanical Turk (with the same inclusion criteria as Experiment 2a) in order to give a total sample of 225, based on a power analysis yielding 25 participants per cell for a 3 (awe condition) x 3 (current urban living) design with a large effect size. Participants completing the between-subjects study were paid $0.50 USD (the between-subjects study only showed one condition, as opposed to three; it was therefore a shorter study).

Using the same exclusion criteria as in all previous studies, 181 participants (*M* age = 39 years, *SD* age = 13 years, range 22-73; 57.5% male, 41.4% female, 0.6% other; 77.9% White/Caucasian, 8.29% Black/African, 4.97% Latino, 8.84% other/multiracial) remained in our final sample (44 out of the 125 new participants were excluded due to failed attention checks, reporting problems watching the videos, low compliance, or for completing the study on a smartphone) (see Table 18 for awe condition and current urban living frequencies; see Table 19 for participants' religious affiliations).

Table 18

Participant numbers by awe condition and current urban living category in Experiment 2b

	Urban	Suburban	Rural	Total
Positive Awe	20	30	12	62
Threat-based Awe	17	30	11	58
Neutral Control	22	27	12	61
Total	59	87	35	181

Table 19

Religious Affiliations of Participants in Experiment 2b

Religious Affiliation	Count
Protestant	46
Roman Catholic	44
Agnostic	30
Atheist	35
Nothing in particular	12
Something else [text entry; e.g., "spiritual"]	5
Mormon	2
Jewish	2
Muslim	2
Buddhist	2
Orthodox, such as Greek or Russian Orthodox	1

Procedure

Participants were randomly assigned to one of the three awe conditions. After viewing the movie, they completed the same measures as presented in Experiment 2a (including an attention check, compliance questionnaire and demographic questionnaire). For this experiment, the two measures of perceived self-size again correlated significantly, $r(179) = .43$, $p < .001$, and were combined into one variable ($M = 4.19$, $SD = 1.52$; α for the three ratings = .78). Powerlessness also showed good reliability (α = .85; $M = 2.82$, $SD = 1.49$). Current urban living and religiousness ($M = 3.69$, $SD = 2.48$; α = .95 across the two items) was measured in this study as in Experiment 2a, again to see whether these variables would interact with awe condition (i.e., to determine whether the discrepant stimuli between the positive and threat-based awe conditions would be influenced by related individual differences).

Results

Data from Experiment 2b were analyzed using 3 (awe condition) x 3 (current urban living) ANOVAs. Fear had one high univariate outlier (z = 3.45) which was winsorized to within 3.29 standard deviations from the mean (M = 1.85, SD = 1.48 after winsorization). After winsorization, skew for all variables < 3.00 and kurtosis < 10.00, indicating normally distributed data (Kline, 1998); and all z-scores were within 3.29 standard deviations from the mean.

As in all previous experiments, perceived self-size and powerlessness were examined with quasi-ANCOVAs to account for shared variance between the two variables. Because of the between-subjects design, the quasi-ANCOVA was carried out in SPSS, using residuals from one-way ANOVAs on each of these dependent measures in place of the covariate. In addition to the residuals of each of these measures, current urban living was added to both models, as well as other variables that significantly correlated with the dependent variable (religiousness and fear did not significantly vary by condition, so the variables themselves were used as covariates; see Table 20 for correlations between variables as well as descriptive statistics by condition).

Table 20

Correlations and descriptive statistics of dependent measures in Study 2b

	Perceived self-size	Powerlessness	Fear	Religiousness
Perceived self-size	—	-.45**	-.09	.15*
Powerlessness		—	.42**	.12
Fear			—	.22**
Positive awe condition	4.05 (1.48)	3.20 (1.54)	2.03 (1.71)	3.60 (2.38)
Threat-based awe condition	3.85 (1.48)	3.03 (1.44)	1.78 (1.35)	3.52 (2.53)
Neutral control	4.64 (1.52)	2.25 (1.32)	1.72 (1.33)	3.94 (2.54)

Note. $N = 181$. *$p < .05$. **$p < .01$. Means per condition are shown with standard deviations in parentheses.

Awe definition

There was a significant difference among awe conditions in endorsement of awe definition, $\chi^2(4, N = 180) = 41.94$, $p < .001$ (see Figure 21). More participants endorsed the positive awe definition than the threat-based awe definition or “neither of the above” in response to both awe videos, though there was more heterogeneity in endorsements for the positive awe condition here than in Experiment 2a. Similarly, just as in the within-subjects analysis, participants were significantly more likely to endorse “neither of the above” in response to the neutral control video than either awe definition.

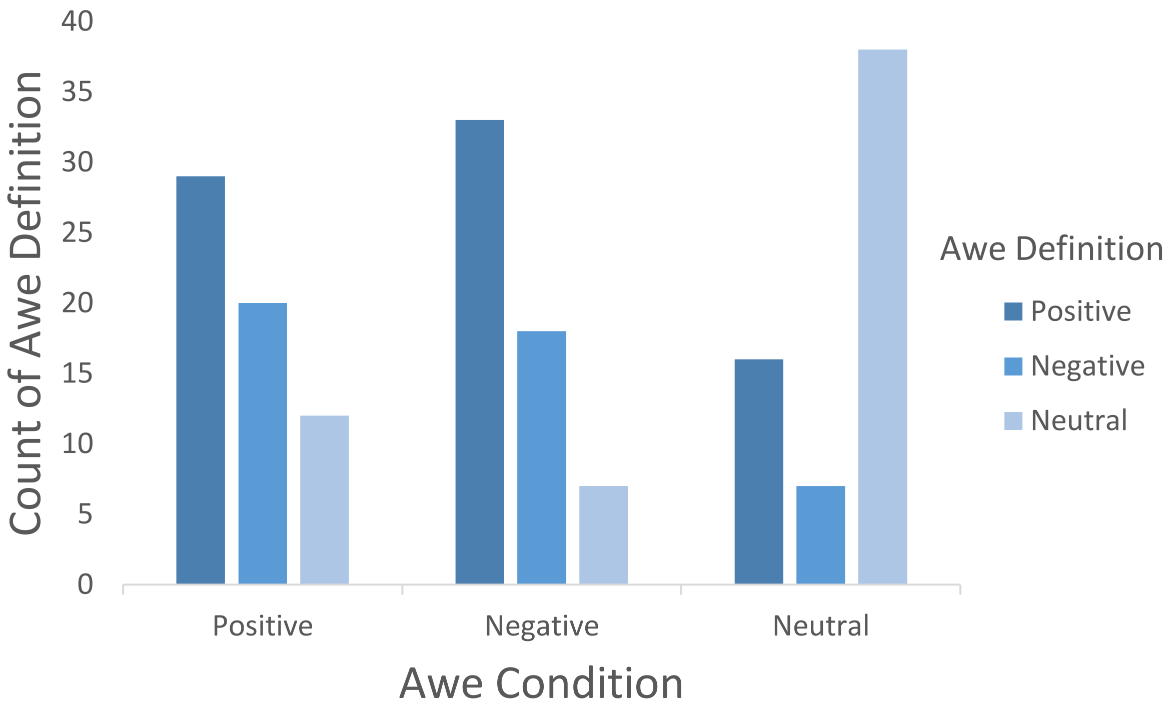
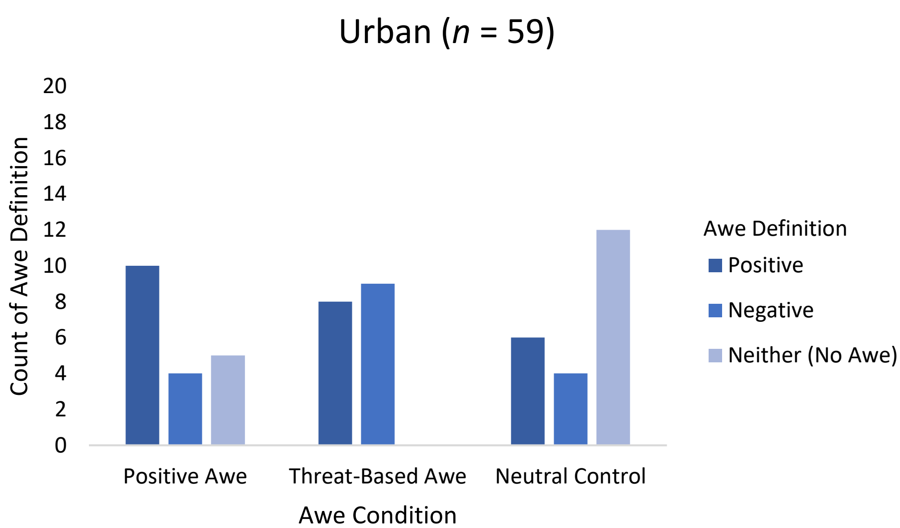
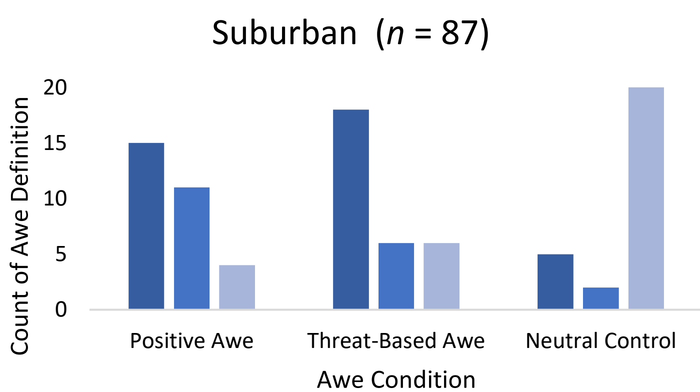


Figure 21. Frequencies of awe definition endorsements for each of the three conditions in Experiment 2b.

When examining awe definition by current urban living category, the results begin to diverge somewhat from Experiment 2a, though not for urban dwellers (see Figure 22). Among urban dwellers, the distribution of awe definition endorsements is remarkably similar to those of urban dwellers in Experiment 2a. Suburban dwellers also show similar results to Experiment 2a, with the exception of awe definition endorsements for the positive awe video, for which slightly more endorsements were made for the threat-based awe definition than in Experiment 2a. The pattern of awe definition endorsements is quite different for rural residents between Experiments 2a and 2b. Specifically, whereas rural residents were more likely to endorse the threat-based awe definition than the other two options for the threat-based awe video, definition endorsements did not seem to significantly differ for the positive awe video; and endorsements for both the positive awe definition and "neither of the above" were almost equal for the neutral control video. Because of the small sample of rural participants, however, this analysis could be underpowered; with a larger sample, the pattern might more closely resemble results from the other current urban living categories.





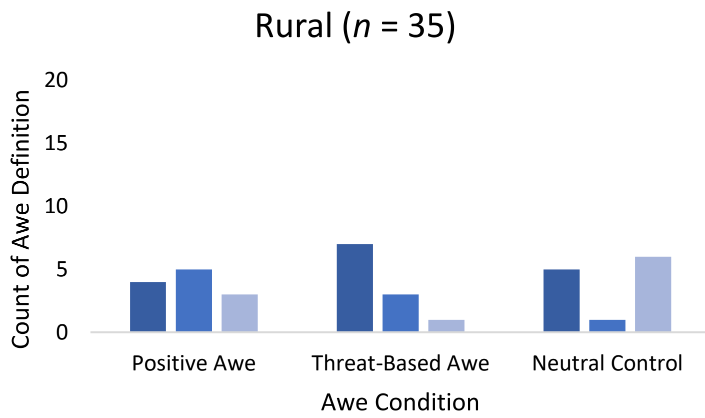


Figure 22. Frequencies of awe definition endorsements by current urban living category (urban, $\chi^2(4, N = 58) = 16.20$, $p = .003$; suburban, $\chi^2(4, N = 87) = 29.65$, $p < .001$; and rural, $\chi^2(4, N = 35) = 7.27$, $p = .122$) for each of the three conditions in Experiment 2b.

Perceived self-size

An omnibus ANOVA on perceived self-size showed a significant main effect of awe condition but no significant interaction between awe condition and current urban living, and no significant main effect of current urban living (see Table 21). Post-hoc LSD tests on the significant main effect of awe condition showed that the positive awe condition was associated with a significantly smaller perceived self-size than the control condition, $p = .027$, and that the threat-based awe condition was also associated with a smaller perceived self-size than the control condition, $p = .004$. The two awe conditions did not differ significantly in perceived self-size, $p = .465$ (see Figure 23).

Table 21

Effects of awe condition and current urban living on perceived self-size (factorial ANOVA) in Experiment 2b

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * current urban living	4	172	2.23	.067	.05
Main effect of awe condition	2	172	4.25	.016	.05
Main effect of current urban living	2	172	0.14	.873	.002

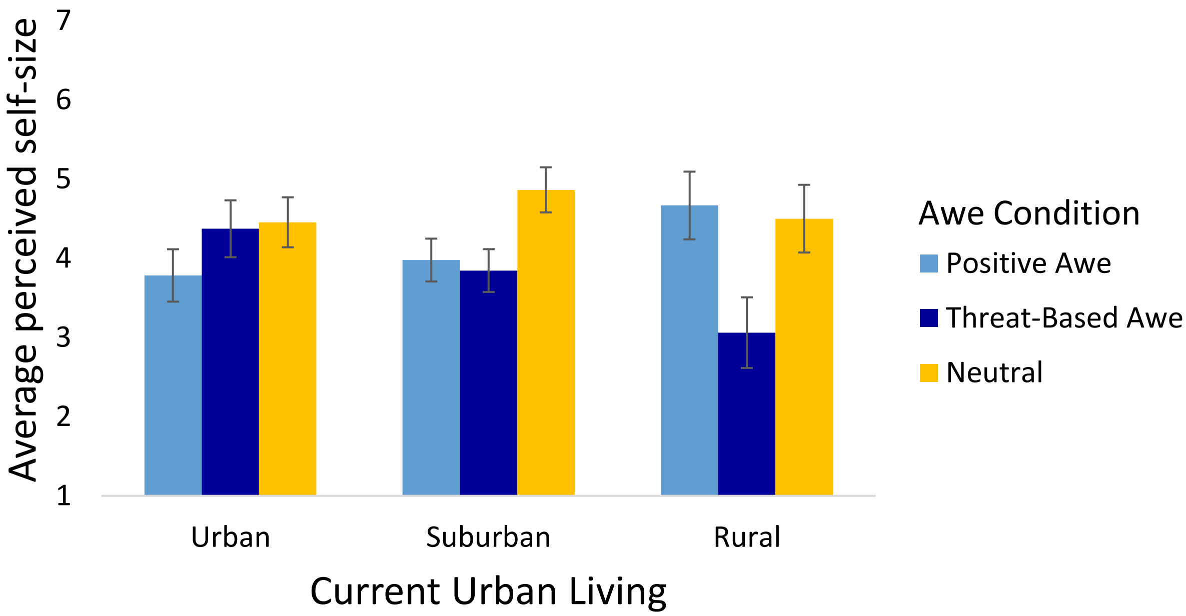


Figure 23. Average perceived self-size across awe conditions and current urban living categories in Experiment 2b. Error bars represent ±1 SE.

A quasi-ANCOVA examining the effect of awe condition on perceived self-size, controlling for powerlessness, religiousness, and current urban living found a significant main effect of awe condition, $F(2, 170) = 4.53$, $p = .012$, $\eta_p^2 = .05$. Post-hoc LSD tests showed that participants in the threat-based awe condition reported feeling significantly smaller than those in the control condition, $p = .003$, and there was no significant difference in perceived self-size between the threat-based and positive awe conditions, $p = .427$. However, unlike the factorial ANOVA, and diverging from our within-subjects results, this quasi-ANCOVA showed that participants in the positive awe condition did not feel significantly smaller than those in the control condition, $p = .089$. This analysis suggests that the variance shared between perceived self-size and powerlessness and religiousness accounts for the significant difference in perceived self-size seen between the positive awe and control condition in the factorial ANOVA.

Powerlessness

A between-subjects factorial ANOVA examining the effect of awe condition and current urban living on powerlessness showed a significant main effect of awe condition but no significant interaction between awe condition and current urban living, nor a significant main effect of current urban living (see Table 22). Post-hoc LSD tests on the significant main effect of awe condition showed that participants in both awe conditions felt significantly more powerless than participants in the control condition ($p < .001$ between positive awe and control; $p = .004$ between threat-based awe and control conditions). Feelings of powerlessness did not differ significantly between the positive awe and threat-based awe conditions, $p = .504$ (see Figure 24).

Table 22

Effects of awe condition and current urban living on feelings of powerlessness (factorial ANOVA) in Experiment 2b

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * current urban living	4	172	0.63	.643	.01
Main effect of awe condition	2	172	7.43	.001	.08
Main effect of current urban living	2	172	1.60	.204	.02

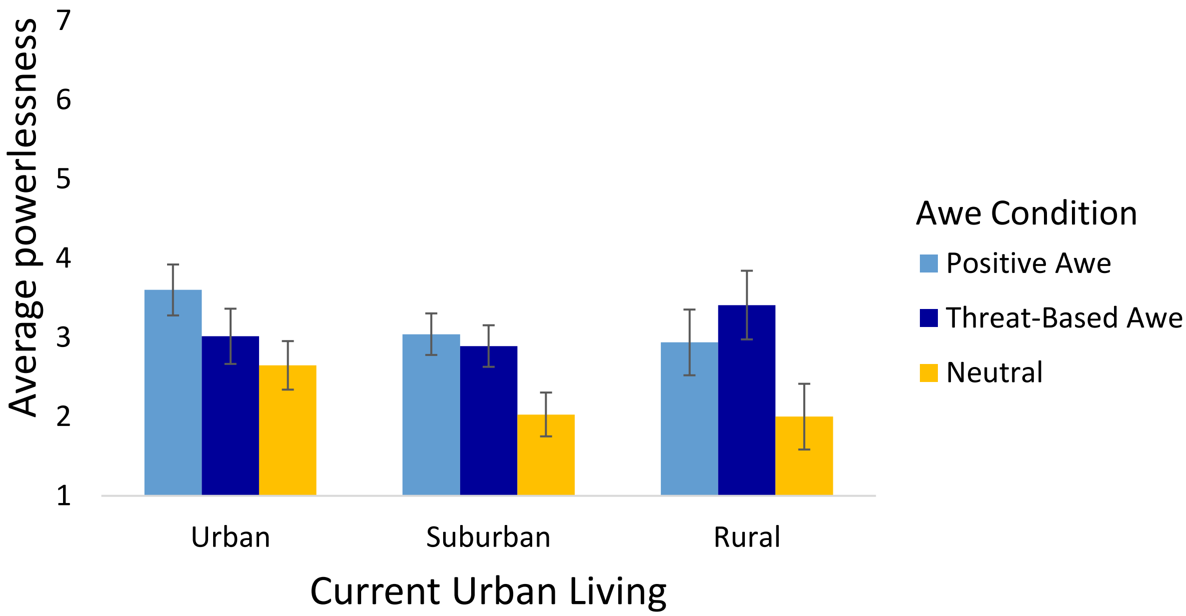


Figure 24. Average ratings of powerlessness across awe conditions and current urban living categories in Experiment 2b. Error bars represent ±1 SE.

A quasi-ANCOVA examining the effect of awe condition on powerlessness, controlling for perceived self-size, fear, and current urban living found a significant main effect of awe condition, $F(2, 170) = 10.37$, $p < .001$, $\eta_p^2 = .11$, with both the positive awe and threat-based awe conditions associated with significantly higher ratings of powerlessness than the control condition (both *p*s < .001). The two awe conditions did not significantly differ in powerlessness, $p = .714$. This analysis confirms the factorial ANOVA results, as well as the main effect of awe condition from the within-subjects results.

Fear

A between-subjects factorial ANOVA examining effects of awe condition and current urban living on fear showed no significant main effects or interactions, replicating our within-subjects results (see Table 23 and Figure 25).

Table 23

Effects of awe condition and current urban living on fear (factorial ANOVA) in Experiment 2b

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * current urban living	4	172	0.63	.639	.02
Main effect of awe condition	2	172	0.29	.748	.003
Main effect of current urban living	2	172	1.68	.189	.02

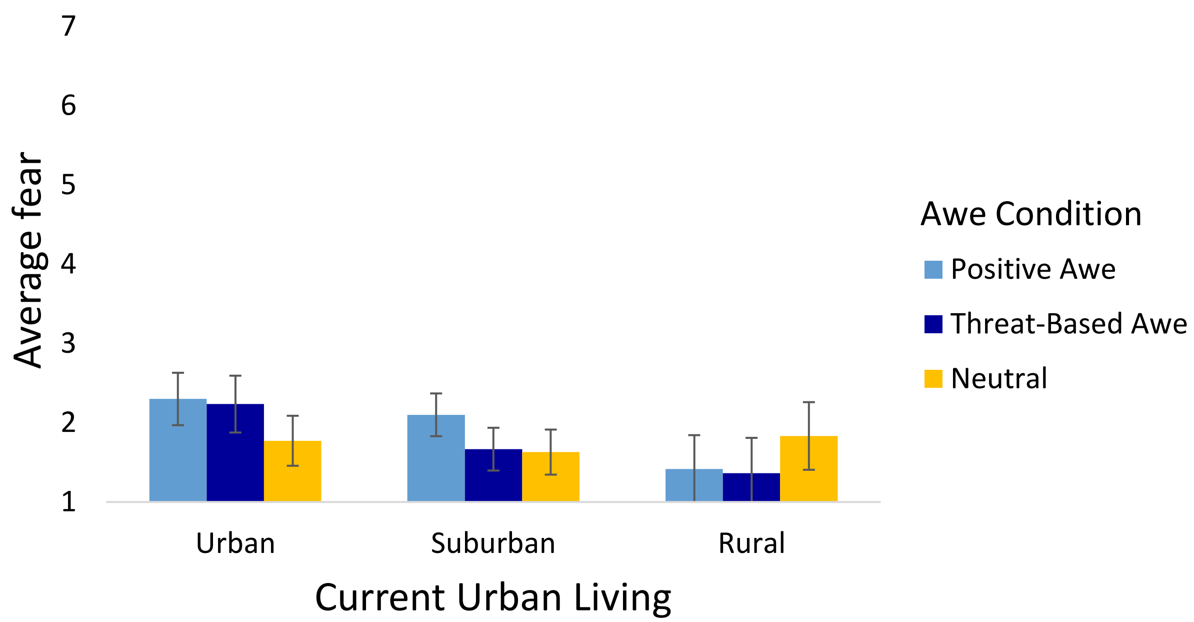


Figure 25. Average fear by awe condition and current urban living category in Experiment 2b. Error bars represent ±1 SE.

Discussion

In summary, the between-subjects replication of Experiment 2a mostly confirmed our main within-subjects results: Both awe videos induced positive awe, with both videos resulting in greater feelings of powerlessness than the neutral control video, and at least one video resulting in smaller perceived self-size (when controlling for powerlessness, religiousness and current urban living, the difference in perceived self-size between the positive awe condition and the control condition became non-significant, though participants did feel at least descriptively smaller in the positive awe condition). Unlike Experiment 2a, we found no significant effects of current urban living in Experiment 2b. However, the general consistency in results, especially those pertaining to awe condition, between Experiments 2a and 2b suggests that continuing with a within-subjects design for Experiment 3 is suitable.

Yet while Experiment 2b findings confirm our within-subjects results from Experiment 2a, they likewise point to the inconsistency between our data and previous findings by Joye and Dewitte (2016) on which we based our threat-based awe stimuli. Again, these divergent findings could be explained by the possibility that while participants may have experienced positive awe in Joye and Dewitte (2016), they yet evinced freezing behavior, which could be a feature of positive awe. More work is needed to clarify this finding, as well as on factors (such as current urban living) which might moderate the type of awe experienced through certain environments, including urban ones.

In comparing main effects of awe condition across Experiments 1 and 2, we also found generally consistent results, highlighting the ability of our architectural video stimuli to elicit positive awe, using the same design as Experiment 1 which replicated past work on positive and threat-based awe in natural environments. While we found that both natural and architectural positive awe-inducing environments (across Experiments 1 and 2) were not associated with greater levels of fear than the control condition in each study, replicating past findings by Gordon et al. (2017), the smaller sample size in Experiment 1b ($N = 63$) (as well as the divergent results in that sample between the ANOVA and ANCOVA) and the restricted use of the fear measure in Experiment 2, particularly Experiment 2b, limits our ability to draw firm conclusions on fear associated with positive awe. A comparison of fear between positive-awe-eliciting natural and built environments, as well as how these compare to the control condition, will thus be of interest in Experiment 3.

As in Experiment 1, in Experiment 2 we found diverging results from previous work on powerlessness in positive and threat-based awe. In Experiments 2a and 2b, both awe conditions showed similar levels of powerlessness; although this was not a priori what we had predicted, this result supports previous findings, given that both conditions provoked positive awe. However, we also found that both conditions were associated with significantly greater feelings of powerlessness than the control condition, which replicated our Experiment 1 findings but again differed from previously published work by Gordon et al. (2017). Experiment 2, with its new class of awe-eliciting stimuli and replication of effects across within and between-subjects designs, further complicates the theorized distinction between positive and threat-based awe, and moves positive awe away, perhaps, from a purely positive characterization.

In summary, across Experiments 2a and 2b, we find support for the ability of video stimuli of architectural environments to elicit positive awe in an online study. This finding thus adds to a small set of studies (e.g., Study 2 in Bai et al., 2017) that expand the variety of awe-evoking stimuli used in empirical research, which normally relies on nature imagery to provoke awe.

The results from Experiments 1 and 2 lay the groundwork for Experiment 3, in which we explore social effects of awe in natural and built environments.

Chapter 4, Experiment 3: Social effects of positive awe in built and natural settings

Across Experiments 1 and 2, we validated the ability of natural and architectural environments to elicit positive awe. In Experiment 3, we compared social effects of positive awe as elicited by built and natural environments. Because our architectural stimuli in Experiment 2 did not elicit threat-based awe, our research questions have been pared down to only examine positive awe between natural and built environments. Specifically, we examined how the kinds of social networks into which awe promotes integration differ between awe-inducing natural and built environmental stimuli.

Beyond replicating our results from Experiments 1 and 2, the main aim of Experiment 3 was to examine feelings of universality and identification with humanity between awe elicited by the natural environment and awe elicited by the built environment, and how these effects compare to a neutral control condition. Previous work has established that a small perceived self-size leads to greater feelings of universality or identification with larger social collectives (Bai et al., 2017; Hornsey et al., 2018). Because we have found through Experiments 1 and 2 that feeling awe evoked through both nature and architecture leads to a small perceived self-size, we predicted that both awe conditions in Experiment 3 should lead to greater feelings of universality as compared to the control condition. Additionally, while we predicted that awe-evoking nature should lead to greater universality than the control condition, we also predicted that awe-evoking nature should lead to greater universality than awe-evoking architecture because of architecture's stronger social significance, which may make more immediate social groups more salient.

Beyond feelings of universality, we also measured integration into social groups of different sizes through three subscales of a measure of identification with all humanity (see Measures below for details on this scale). The subscales measured identification with one's community, identification with Americans, and identification with people all over the world. We chose to analyze these subscales separately as an indication of the size of the social group participants felt they belonged to as a result of the awe inductions, with the assumption that one's community is a smaller group than Americans, which is a smaller group than people all over the world. We predicted that architectural awe-inducing environments would promote integration into smaller social groups than natural awe-inducing environments because the social significance of architecture (compared to natural environments) would make smaller social groups more salient. Specifically, we predicted that the built environment condition would lead to greater identification with one's community, compared to both other conditions. We also predicted that the natural environment condition would lead to greater identification with one's community, compared to the control condition, as has been found in previous work (Bai et al., 2017). We expected to see a similar pattern of results for identification with Americans, but perhaps less pronounced than identification with one's community because of its larger size. We predicted the same pattern of results for identification with people all over the world as for feelings of universality: The natural environment condition should facilitate stronger identification with people all over the world than the other two conditions, and the built environment condition should also result in stronger identification with people all over the world than the control condition.

In our original research question (outlined in Chapter 1), we included a comparison of the social effects between feeling positive and threat-based awe. While we did not include a threat-based awe condition in Experiment 3, in both Experiments 1 and 2, we found that the positive awe conditions resulted in greater feelings of powerlessness than the control condition. A direct comparison of levels of powerlessness between the nature and built environment conditions was tested in Experiment 3. We predicted that if powerlessness was equal between the two awe conditions, awe-inducing nature should lead to greater universality than the awe-inducing architecture condition. If there were distinct levels of powerlessness between the two awe conditions (for instance, if the awe-inducing built environment condition was associated with significantly greater feelings of powerlessness than the awe-inducing natural environment condition), it is possible that the effect of the social significance of the awe-inducing architecture condition would be confounded with the effect of powerlessness, obscuring the results. Because we had no reason to predict that either awe condition would lead to greater feelings of powerlessness than the other, this comparison was exploratory.

To summarize the predictions for Experiment 3, we predicted that both awe conditions (natural and built environment) would successfully elicit positive awe. We predicted that awe elicited by both types of environments would lead to a smaller sense of self than the control condition, replicating previous work, as well as our own results from Experiments 1 and 2. Based on our previous findings across Experiments 1 and 2, we predicted that both the natural and built environment awe conditions would be associated with stronger feelings of powerlessness as compared to the control condition. Based on our results from Experiments 1 and 2, we predicted that the natural environment condition would result in greater feelings of fear than the control condition, but that the built environment condition would not result in greater feelings of fear than the control condition. We predicted that participants in the natural environment awe condition would show greater levels of universality and identification with people all over the world than participants in the built environment and control conditions; and that participants in the built environment awe condition would show greater levels of universality and identification with people all over the world than participants in the control condition. Finally, we predicted that the built environment condition would be associated with higher ratings of identification with smaller social groups (e.g., one's community) than the natural environment and control conditions; and that the natural environment condition would be associated with higher ratings of identification with smaller social groups than the control condition.

Because the threat-based awe built environment stimulus (which was composed of shots of urban skyscrapers) from Experiment 2 was not included in Experiment 3, current urban living was not included in any analyses in this study. However, because the positive awe built environment video (which showed religious architecture) was included, we did examine whether religiousness interacted with awe condition on any of the dependent measures. Again, we did not have specific predictions about this variable, but included it to determine whether it should be included as a covariate in any analyses.

Methods

Participants

Participants were recruited through Amazon Mechanical Turk for the online study using the same eligibility requirements as Experiment 2. All participants were paid $1.00 USD for their participation. We again aimed for a sample size comparable to those in our previous studies. Using the same exclusion criteria as Experiments 2a and 2b, 95 participants were excluded from our initial sample of 180 participants. Because a new measure in Experiment 3 asks participants about identification with Americans (see Measures below), we intended to restrict our sample to those based in the U.S. Due to experimenter error, the US/Canada eligibility requirement used in Experiments 1b, 2a, and 2b was used for the current sample; two further participants (one participating from Canada and one from India, based on geographic coordinate data collected from Qualtrics) were excluded for a final sample of 83 (53% men, 42% women, 5% gender nonbinary/prefer not to answer; *M* age = 39, *SD* = 12, range 21-72; 74.7% White/Caucasian, 14.5% Black/African, 10.84% other/multiracial; see Table 24 for participant religious affiliations). The exclusion rate for the sample in Experiment 3 (53.89%) was higher than the exclusion rates in Experiments 1b, 2a, and 2b (37.00%, 30.00%, and 35.20%, respectively) and closer to the exclusion rate in Experiments 1a (47.00%). The higher exclusion rate in Experiment 3 could perhaps be due to the slightly longer study design (compared to Experiment 2, with the addition of the universality and identification with all humanity measures for each condition); or could perhaps be due to factors relating to the COVID-19 pandemic, during which data collection took place (April 2020).

Procedure

As in Experiments 1a, 1b, and 2a, we employed a within-subjects design in which all participants viewed all three awe-condition videos in counterbalanced order (the number of participants in each counterbalance order in this sample ranged from 11-16). The measures after each video were the same as Experiments 1b and 2a, with the addition of two scales measuring universality and identification with all humanity (see Measures below). The order of the measures after each video was randomized.

Table 24

Religious Affiliations of Participants in Experiment 3

Religious Affiliation	Count
Roman Catholic	41
Protestant	15
Agnostic	11
Atheist	5
Nothing in particular	5
Orthodox, such as Greek or Russian Orthodox	2
Jewish	2
Hindu	1
Something else [text entry; e.g., “spiritual”]	1

Materials

The positive awe videos from Experiment 1 (clips from BBC’s *Planet Earth* series) and Experiment 2 (clips of monumental architecture such as museums, parliament buildings and churches) were used in Experiment 3 as the natural and built environment positive awe conditions, respectively. We chose to employ the positive awe built environment video from Experiment 2, rather than the threat-based awe video (as they equally elicited positive awe) because the variety of buildings was greater in the positive awe video and thus closer matched the positive awe natural environment video. The neutral control video for Experiment 3 was the same used as in Experiments 1 and 2 (an instructional video on building patio walls). The soundtrack for all three videos was the same soundtrack used for videos in Experiment 2. Again, as in Experiment 2, a consistent soundtrack was used in order to avoid confounding effects of visual content with those of sound.

Measures

All measures from Experiment 2 were used in Experiment 3, with the addition of two new measures of universality and identification with humanity which participants rated for each video. Our measure of universality was the universality subscale from Piedmont's (1999) spiritual transcendence scale, which has been used in previous work on awe (Negami, 2016; Van Cappellen & Saroglou, 2012). This universality measure includes nine items, such as "All life is interconnected," rated on a 1 (*not at all*) – 7 (*very much*) Likert-type scale ($M = 4.75$, $SD = 1.42$ across conditions, with α ranging from .94-.97 between conditions; see Appendix B for full list of items).

Participants also completed the Identification with All Humanity (IWAH) scale, originally from McFarland, Webb, and Brown (2012) and used in Hornsey et al. (2018), after viewing each video. The original IWAH scale consists of nine questions, such as "How close do you feel to each of the following groups?" for which participants are asked to rate to what extent they identify with each of three groups—their community, Americans, and people all over the world—on a 1-5 scale. We modified the scale to be more appropriate for a within-subjects measure (i.e., one that participants would complete multiple times) by removing two questions that asked about past behavior, which we felt would not change based on condition and might confuse participants (these questions were: "How often do you use the word 'we' to refer to the following groups of people?" and "How much would you say you care (feel upset, want to help) when bad things happen to…"). For the same reason, we also specified in the instructions for the scale to "answer the following questions based on how the video you just viewed made you feel." With three ratings per question for the seven remaining questions, participants made 21 ratings on the IWAH scale following each video (see Appendix C for full list of IWAH items). Responses for each group (my community, Americans, and the world) were averaged separately to create three IWAH scores for each experimental condition: an IWAH community subscale (*M* = 3.62, *SD* = 0.90 across conditions, with α ranging from .91-.93 between conditions), an IWAH Americans subscale (*M* = 3.65, *SD* = 0.89 across conditions, with α ranging from .91-.92 between conditions), and an IWAH world subscale (*M* = 3.56, *SD* = 0.81 across conditions, with α ranging from .87-.90 between conditions).

As in Experiments 1 and 2, perceived self-size was created by averaging the rated statements and pictorial measure ($r_{rm}(164) = .28$, $p < .001$, 95% CI [0.13, 0.41]; *M* = 4.16, *SD* = 1.21; α ranging from .61 to .71 between awe conditions for the three items). Powerlessness was computed as in previous experiments (α ranging from .68 to .73 between conditions; *M* = 3.36, *SD* = 1.17). Fear (*M* = 2.70, *SD* = 1.86) and religiousness (α for two statements = .93, *M* = 4.54, *SD* = 2.26) were also measured and computed as in Experiment 2.

Results

All dependent variables measured on a Likert-type format were normally distributed, with skew < 3, kurtosis < 10 (Kline 1998), and z-scores between -3.29 and 3.29. As in the previous chapters, both repeated-measures ANOVAs and quasi-ANCOVAs were run on each of these dependent variables. The repeated-measures ANOVAs included awe condition as a three-level within-subjects variable and counterbalance order as a six-level between-subjects variable, as well as their interaction term. In addition to counterbalance order, quasi-ANCOVAs included only dependent variables or residuals of dependent variables as covariates if these dependent variables correlated significantly with the dependent variable of interest (see Table 25 for correlations among dependent variables in Experiment 3 and their descriptive statistics). Again, as in previous chapters, residuals were extracted and used in the place of covariates for dependent variables that varied significantly by condition (the only variable for which this was not the case was identification with one's community). Religiousness was also included as a covariate in all quasi-ANCOVAs because we found significant associations between religiousness and all dependent variables. Modeled as a predictor with awe condition as a covariate, religiousness significantly predicted perceived self-size, $b = .11$, $SE = .06$, $t(81.00) = 2.06$, $p = .043$; powerlessness, $b = .15$, $SE = .06$, $t(81.00) = 2.77$, $p = .007$; fear, $b = .33$, $SE = .08$, $t(81.00) = 3.95$, $p < .001$; universality, $b = .47$, $SE = .05$, $t(81.00) = 10.00$, $p < .001$; identification with one's community, $b = .26$, $SE = .03$, $t(81.00) = 7.87$, $p < .001$; identification with Americans, $b = .26$, $SE = .03$, $t(81.00) = 7.70$, $p < .001$; and identification with people all over the world, $b = .18$, $SE = .03$, $t(81.00) = 5.17$, $p < .001$.

Table 25

Repeated-measures correlations and descriptive statistics of dependent measures in Experiment 3

	Perceived self-size	Powerlessness	Fear	Universality	IWAH -community	IWAH - Americans	IWAH - world
Perceived self-size	—	-.43***	-.16*	-.27***	-.05	.003	-.15*
Powerlessness		—	.32***	.39***	.12	-.01	.18*
Fear			—	.13	.05	.04	.13
Universality				—	.20**	.22**	.43***
IWAH - community					—	.50***	.40***
IWAH - Americans						—	.55***
Natural environment	3.99 (1.48)	3.72 (1.45)	3.02 (2.15)	4.97 (1.41)	3.65 (0.90)	3.68 (0.92)	3.62 (0.90)
Built environment	4.09 (1.32)	3.42 (1.35)	2.53 (1.95)	4.86 (1.55)	3.61 (0.93)	3.70 (0.91)	3.63 (0.80)
Neutral control	4.41 (1.28)	2.93 (1.36)	2.55 (2.11)	4.42 (1.78)	3.60 (0.98)	3.57 (0.95)	3.44 (0.92)

Note. Degrees of freedom for all repeated-measures correlations 165. *$p < .05$. **$p < .01$. ***$p < .001$. Means per condition are shown with standard deviations in parentheses.

Awe definition

A chi-square test showed a significant difference among awe conditions in endorsement of awe definition, $\chi^2(4, N = 249) = 18.78, p = .001$ (see Figure 26). Participants were more likely to select the positive awe definition than the threat-based awe definition or "neither of the above" for both the natural and built environment awe conditions. Participants were also more likely to select the threat-based awe definition for the built environment awe condition than for the natural environment awe condition. There were nearly equal numbers of endorsements for the positive awe definition and for "neither of the above" for the neutral control video, which again could possibly reflect the effect of the soundtrack used for all three videos, in addition to statistical noise.

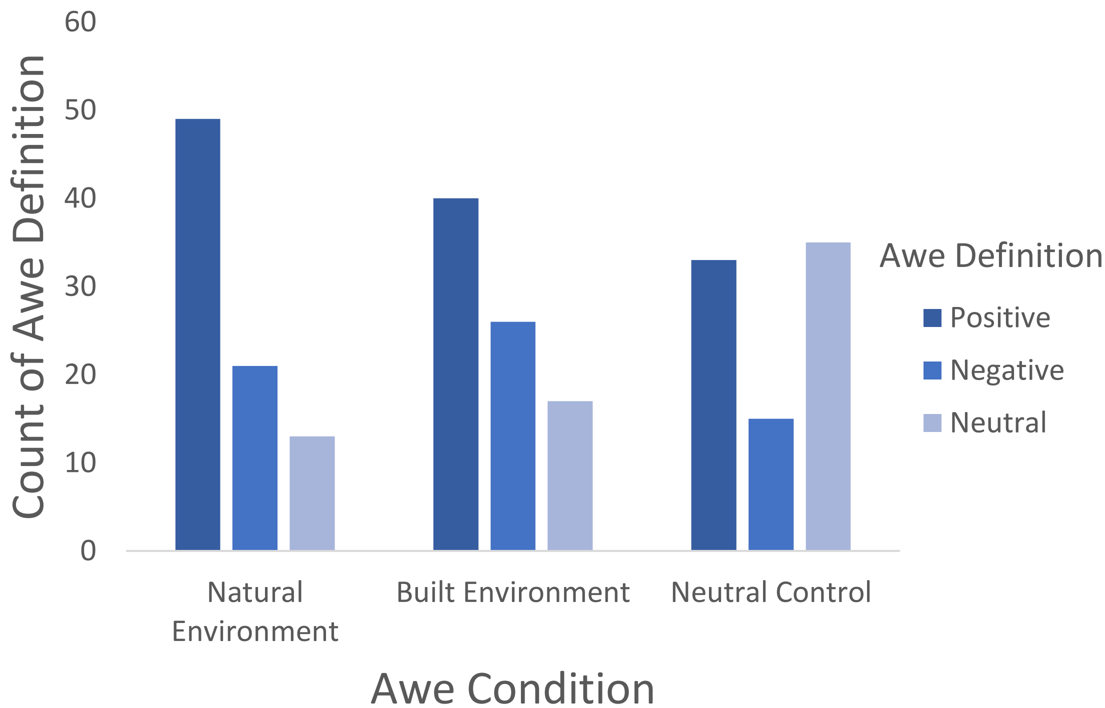


Figure 26. Frequencies of awe definition endorsements for each of the three conditions in Experiment 3.

Perceived Self-Size

Results of a 3 (awe condition) x 6 (counterbalance order) mixed-factorial ANOVA showed a significant interaction and main effects of both independent variables (see Table 26 and Figure 27).

Table 26

Effects of awe condition and counterbalance order on perceived self-size (mixed-factorial ANOVA)

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	7.63	117.495	2.21	.034	.13
Main effect of awe condition	1.53	117.49	7.53	.002	.09
Main effect of counterbalance order	5	77	2.41	.044	.14

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 83) = 28.28$, $p < .001$, $\varepsilon = .76$; a Greenhouse-Geisser correction is used for within-subjects results.

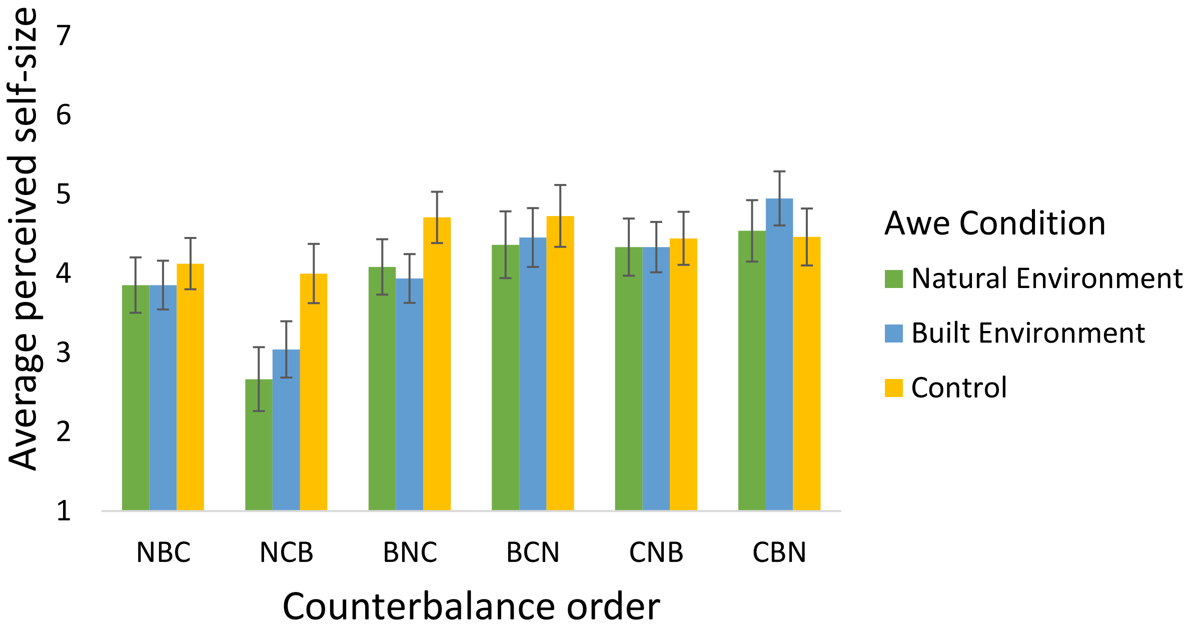
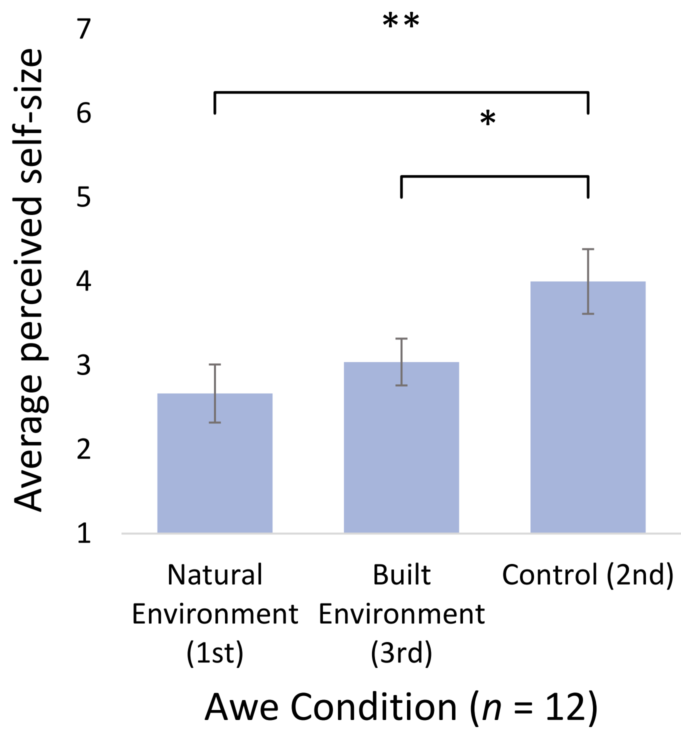


Figure 27. Average perceived self-size across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition.

The significant two-way interaction (as seen in Table 26) was followed up by examining one-way repeated-measures ANOVAs for each counterbalance condition and found significant simple effects for two counterbalance conditions. Significant simple effects of awe condition were found for participants whose video presentation order was natural environment, neutral control, and built environment, $F(2, 22) = 7.41$, $p = .003$, $\eta_p^2 = .40$; and for participants whose viewing order was built environment, natural environment, and neutral control, $F(1.47, 22.06) = 3.79$, $p = .050$, $\eta_p^2 = .20$ (adjusted with the Greenhouse-Geisser correction due to a sphericity violation). Post-hoc LSD tests showed the predicted pattern of results for the first counterbalance condition, but only a statistically significant difference between the built environment and control conditions for the second counterbalance condition (see Figure 28). No other counterbalance condition showed a significant simple effect of awe condition, all *ps* > .146.



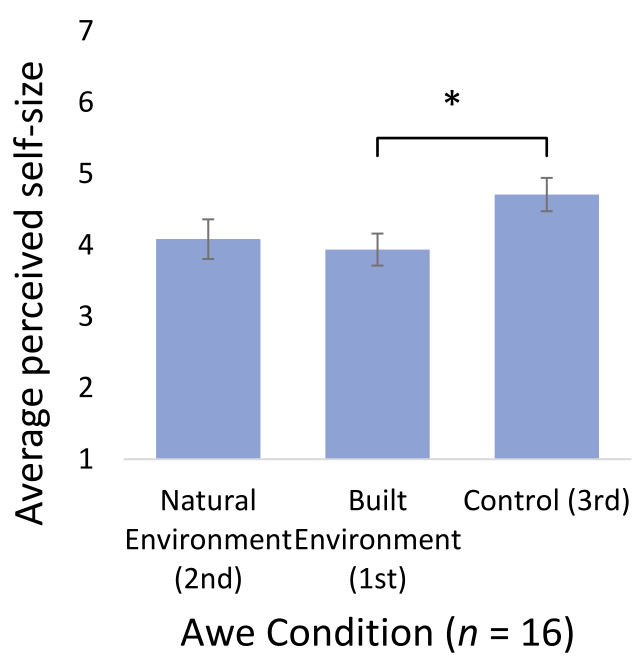


Figure 28. Results from post-hoc LSD tests on simple effects of awe condition per counterbalance order, following up on the significant omnibus interaction between awe condition and counterbalance order for perceived self-size in Experiment 3. Viewing order is indicated on each x-axis, along with the number of participants per counterbalance order.

Investigating the main effect of awe condition from the omnibus ANOVA on perceived self-size with follow-up LSD tests showed no significant difference in perceived self-size between the natural and built environment awe conditions, $p = .146$, but significantly smaller perceived self-size in the natural environment condition compared to control, $p = .003$; as well as significantly smaller perceived self-size in the built environment condition compared to control, $p = .009$. Both awe conditions were associated with significantly smaller perceived self-size than the control condition, replicating our results from Experiments 1 and 2 and confirming our hypothesis for Experiment 3, albeit conditionally on the interaction between awe condition and counterbalance order.

Tukey's post-hoc tests investigating the main effect of counterbalance order from the omnibus ANOVA (as seen in Table 26) showed only one significant difference among counterbalance orders, with participants with viewing order natural environment, neutral control, and built environment reporting significantly smaller perceived self-size across awe conditions than participants with viewing order neutral control, built environment, natural environment, $p = .037$; all other comparisons *p*s > .100. This main effect could possibly be a function of anchoring one's responses to the first presented video.

A quasi-ANCOVA of awe condition on perceived self-size controlling for counterbalance, religiousness, powerlessness, fear, universality, and identification with people all over the world showed that both the natural and built environment conditions were associated with significantly smaller perceived self-size than the neutral control condition (b = -0.42, SE = 0.11, $t(159.85) = -3.76$, $p < .001$ for natural environment compared to control; b = -0.32, SE = 0.11, $t(159.85) = -2.85$, $p = .005$ for built environment compared to control). Controlling for any shared variance between other dependent measures, this analysis supports our prediction as well as the main effect from the mixed-factorial ANOVA.

Powerlessness

A mixed-factorial ANOVA on feelings of powerlessness found a significant two-way interaction between awe condition and counterbalance order, as well as a significant main effect of awe condition (see Table 27 and Figure 29).

Table 27

Effects of awe condition and counterbalance order on feelings of powerlessness (mixed-factorial ANOVA)

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	9.03	138.99	1.95	.049	.11
Main effect of awe condition	1.81	138.99	17.76	< .001	.19
Main effect of counterbalance order	5	77	1.47	.208	.09

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 83) = 8.69$, $p = .013$, $\varepsilon = .90$; a Greenhouse-Geisser correction is used for within-subjects results.

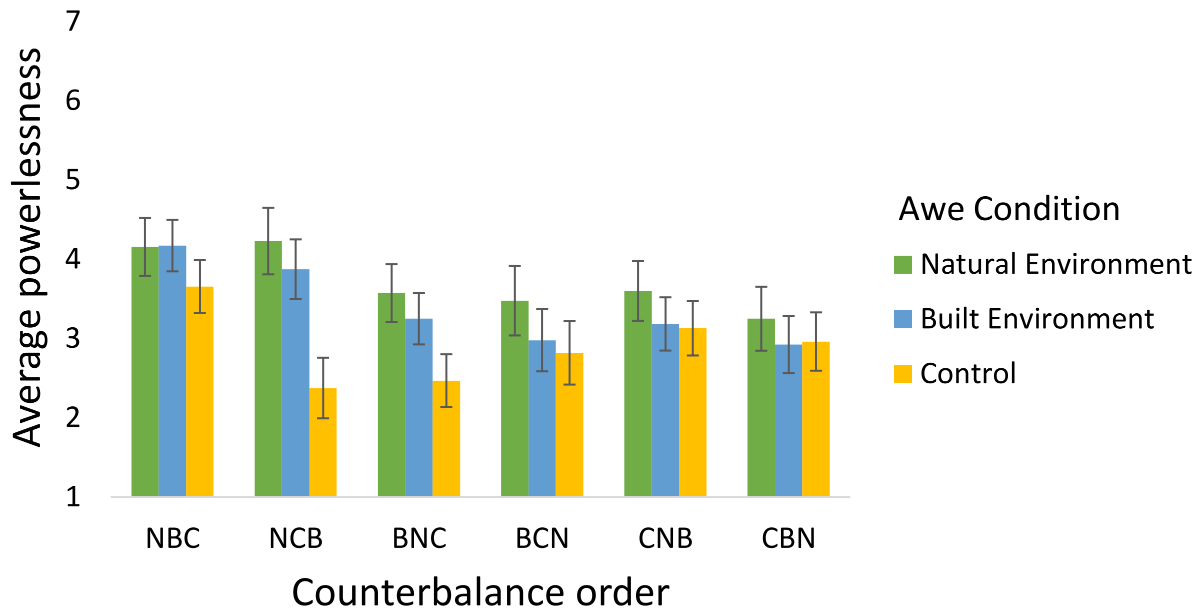
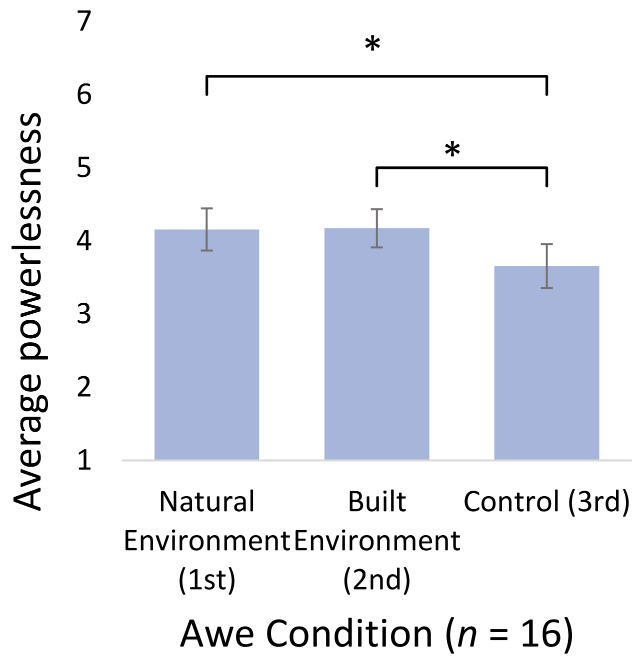
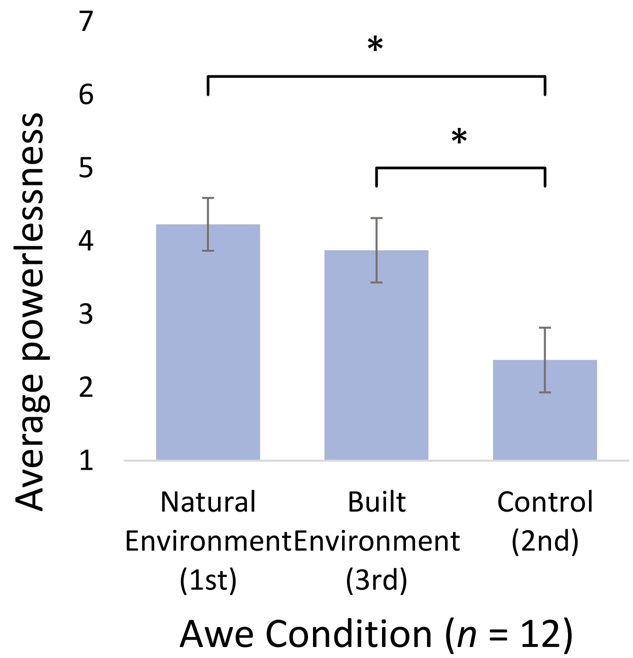


Figure 29. Average feelings of powerlessness across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition).

Simple one-way repeated-measures ANOVAs for each counterbalance condition revealed significant simple effects for three of the six counterbalance conditions. There were significant simple effects of awe condition for participants whose viewing order was natural environment, built environment, and neutral control, $F(2, 30) = 3.41$, $p = .046$, $\eta_p^2 = .19$; for participants whose counterbalance order was natural environment, neutral control, and built environment, $F(2, 22) = 6.76$, $p = .005$, $\eta_p^2 = .38$; and for participants whose counterbalance order was built environment, natural environment, and neutral control, $F(1.47, 22.05) = 6.58$, $p = .010$, $\eta_p^2 = .31$ (adjusted with a Greenhouse-Geisser correction because of a sphericity violation). Post-hoc LSD tests showed the same pattern for participants in all three counterbalance conditions reported above: There was no significant difference in feelings of powerlessness between the natural and built environment conditions, but both awe conditions were associated with greater feelings of powerlessness than the control condition (see Figure 30). The other three counterbalance conditions did not show a significant simple effect of awe condition, all $p > .152$.





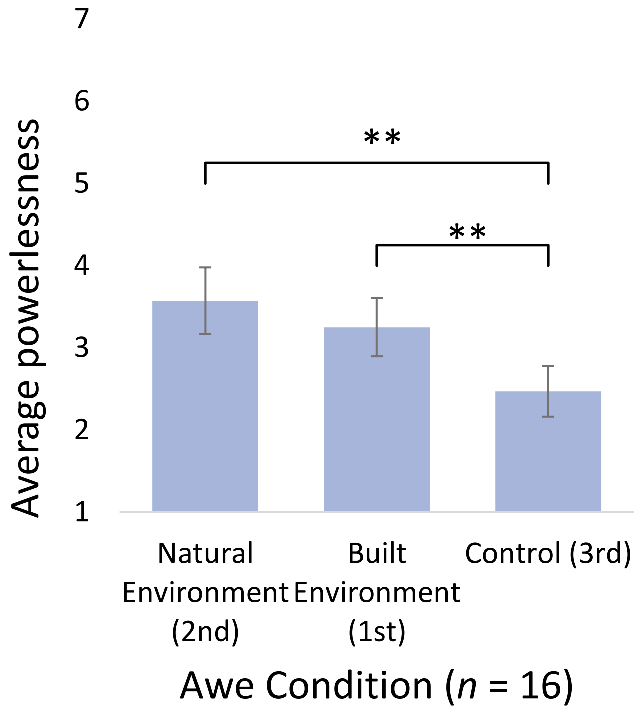


Figure 30. Results from post-hoc LSD tests on simple effects of awe condition per counterbalance order, following up on the significant omnibus interaction between awe condition and counterbalance order for powerlessness in Experiment 3. Viewing order is indicated on each x-axis, along with the number of participants per counterbalance order.

The significant main effect of awe condition in the omnibus ANOVA was followed up with post-hoc LSD tests, which found significant differences between all three conditions. Across all counterbalance conditions, the natural environment condition was associated with the greatest levels of powerlessness, significantly different from both the built environment (p = .023) and neutral control ($p < .001$) conditions. The built environment condition was also associated with significantly higher feelings of powerlessness than the neutral control condition, $p < .001$. Thus, our prediction that both awe conditions would be associated with greater feelings of powerlessness compared to the control condition was supported; and our exploratory comparison between the natural and built environment conditions showed greater feelings of powerlessness associated with the natural environment condition.

A quasi-ANCOVA of awe condition on powerlessness, controlling for counterbalance order, religiousness, perceived self-size, fear, universality, and identification with people all over the world, showed that both the natural environment (b = 0.80, SE = 0.12, t(159.34) = 6.41, p < .001) and built environment (b = 0.49, SE = 0.12, t(159.34) = 3.97, p < .001) conditions were associated with significantly greater levels of powerlessness than the neutral control condition, further supporting our prediction.

Fear

A mixed-factorial ANOVA examining the effect of awe condition and counterbalance order on fear found a significant main effect of awe condition (see Table 28 and Figure 31). Post-hoc LSD tests on the main effect of awe condition showed that participants felt more fear in the natural environment condition compared to both the built environment (p = .004) and neutral control (p = .016) conditions; but that there was no significant difference in feelings of fear between the built environment and neutral control conditions, p = .997. The comparisons between each awe condition and the neutral control condition replicate our findings from Experiments 1 and 2.

A quasi-ANCOVA examining the effect of awe condition on fear, controlling for counterbalance order, religiousness, perceived self-size, and powerlessness further confirmed the mixed-factorial ANOVA findings. This model showed that the natural environment condition was associated with significantly greater fear than the control condition, b = 0.47, SE = 0.17, t(161.23) = 2.79, p = .006; but no significant difference in fear between the built environment and neutral control conditions, b = -0.02, SE = 0.17, t(161.23) = -0.14, p = .886.

Table 28

Effects of awe condition and counterbalance order on fear (mixed-factorial ANOVA)

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	8.93	137.58	0.82	.594	.05
Main effect of awe condition	1.79	137.58	5.42	.007	.07
Main effect of counterbalance order	5	77	1.07	.385	.07

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 83) = 9.66$, $p = .008$, $\varepsilon = .89$; a Greenhouse-Geisser correction is used for within-subjects results.

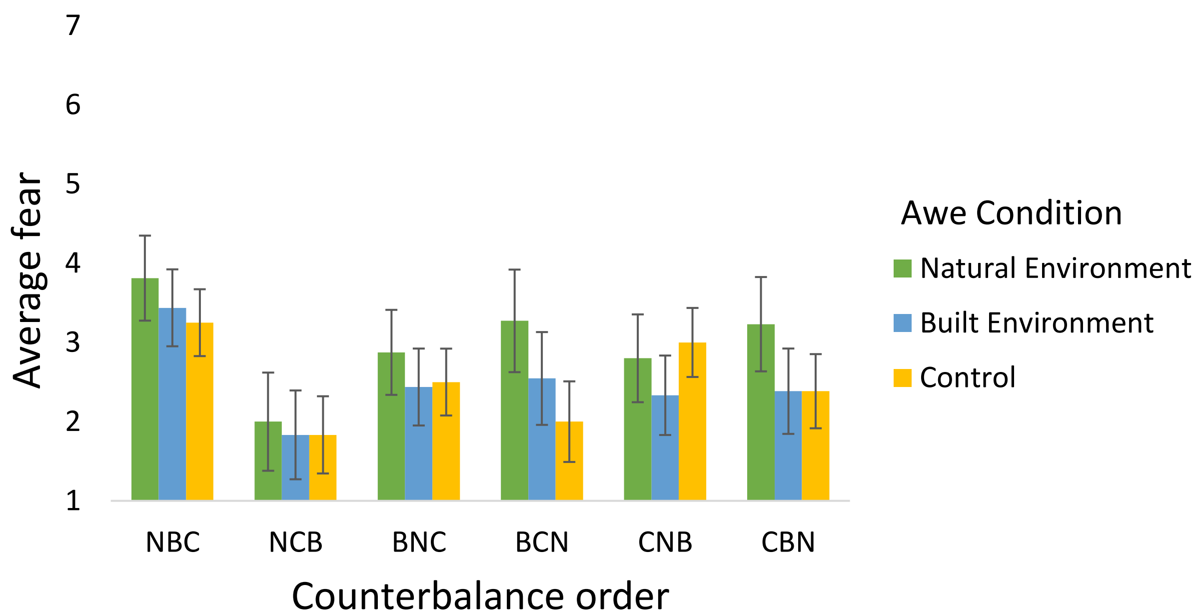


Figure 31. Average feelings of fear across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition).

Universality

A mixed-factorial ANOVA examining the effect of awe condition and counterbalance order on feelings of universality showed a significant interaction as well as a significant main effect of awe condition (see Table 29 and Figure 32).

Table 29

Effects of awe condition and counterbalance order on feelings of universality (mixed-factorial ANOVA)

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	8.43	129.74	2.10	.027	.12
Main effect of awe condition	1.69	129.74	10.34	< .001	.12
Main effect of counterbalance order	5	77	1.67	.153	.10

Note. Mauchly's test showed a sphericity violation, $\chi^2(2, N = 83) = 15.73$, $p < .001$, $\varepsilon = .84$; a Greenhouse-Geisser correction is used for within-subjects results.

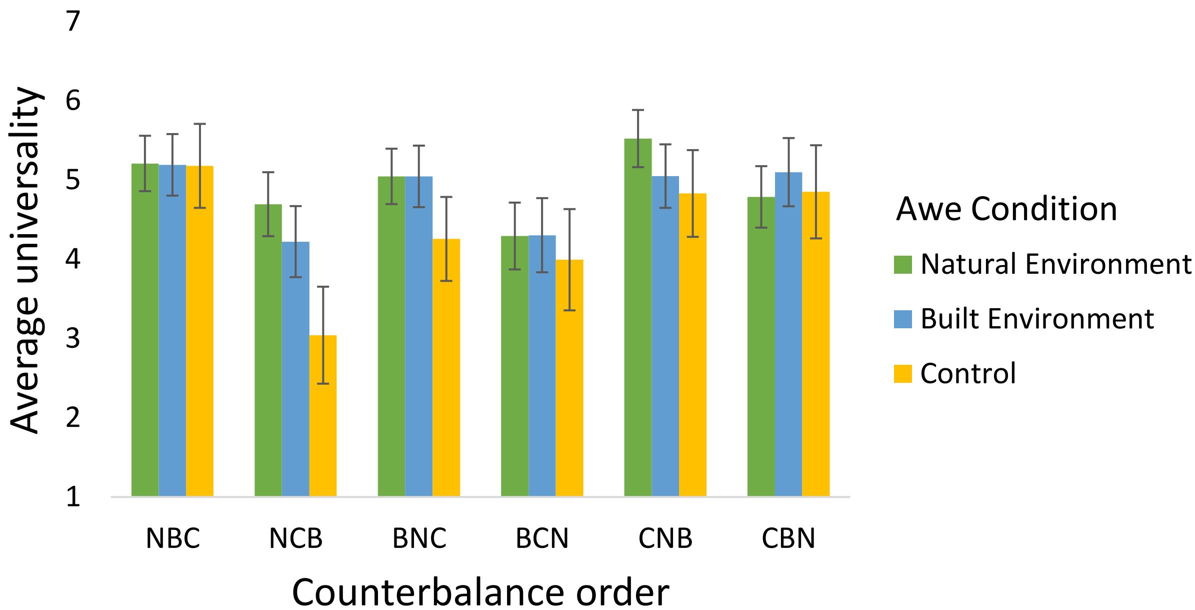


Figure 32. Average feelings of universality across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition).

The significant interaction was followed up with one-way repeated-measures ANOVAs for each counterbalance condition, which found a significant simple effect of awe condition for participants whose viewing order was natural environment, neutral control, and built environment, $F(1.26, 13.81) = 7.53$, $p = .012$, $\eta_p^2 = .41$ (adjusted with a Greenhouse-Geisser correction due to a sphericity violation). Post-hoc LSD tests following up on this significant simple effect showed significant differences in feelings of universality between all three conditions (see Figure 33). No other counterbalance condition showed a significant simple effect of awe condition, all $p > .083$.

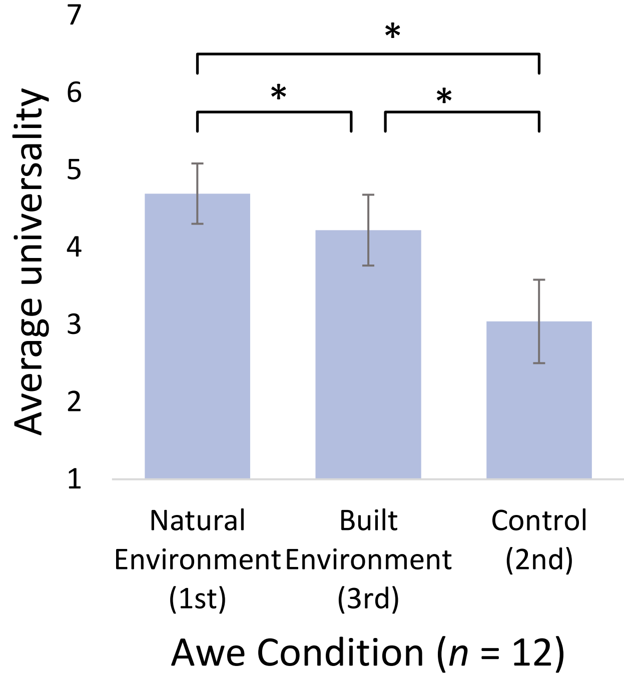


Figure 33. Results from post-hoc LSD tests on simple effects of awe condition per counterbalance order, following up on the significant omnibus interaction between awe condition and counterbalance order for universality in Experiment 3. Viewing order is indicated on the x-axis, along with the number of participants per counterbalance order.

Post-hoc LSD tests following up on the significant main effect of awe condition from the omnibus ANOVA showed no significant difference between the natural and built environment conditions, $p = .304$, but significantly greater feelings of universality in the natural environment condition compared to the control condition, $p < .001$, as well as in the built environment condition compared to the control condition, $p = .001$. On average, then, controlling for counterbalance order effects, both the natural and built environment awe conditions led to greater feelings of universality as compared to the control condition, as predicted. However, the difference between the natural and built environment conditions was not significant, failing to support our prediction that the natural environment condition would provoke greater feelings of universality than the built environment condition.

A quasi-ANCOVA examining the effect of awe condition on feelings of universality, controlling for counterbalance order, religiousness, perceived self-size, powerlessness, and identification with one's community, identification with Americans, and identification with people all over the world further confirmed the mixed-factorial ANOVA results, finding that the natural environment condition was associated with significantly greater feelings of universality than the neutral control condition, $b = 0.53$, $SE = 0.12$, $t(159.10) = 4.31$, $p < .001$; and that the built environment condition was also associated with significantly increased feelings of universality compared to the control condition, $b = 0.44$, $SE = 0.12$, $t(158.54) = 3.59$, $p < .001$.

Identification With All Humanity – Community subscale

A mixed-factorial ANOVA of the effect of awe condition and counterbalance order on feelings of identification with one's community found no significant main effects or interactions (see Table 30 and Figure 34). A quasi-ANCOVA controlling for counterbalance order, religiousness, identification with Americans and identification with people all over the world also found no significant differences between the natural environment condition and the neutral control condition, $b = 0.05$, $SE = 0.04$, $t(160.93) = 1.28$, $p = .204$; and no significant difference between the built environment condition and the neutral control condition, $b = 0.01$, $SE = 0.04$, $t(160.93) = 0.33$, $p = .742$. These findings thus do not support our prediction that the built environment condition would facilitate engagement with smaller social groups than the natural environment condition.

Table 30

Effects of awe condition and counterbalance order on identification with one's community (mixed-factorial ANOVA)

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	10	154	0.89	.541	.06
Main effect of awe condition	2	154	0.95	.388	.01
Main effect of counterbalance order	5	77	1.48	.205	.09

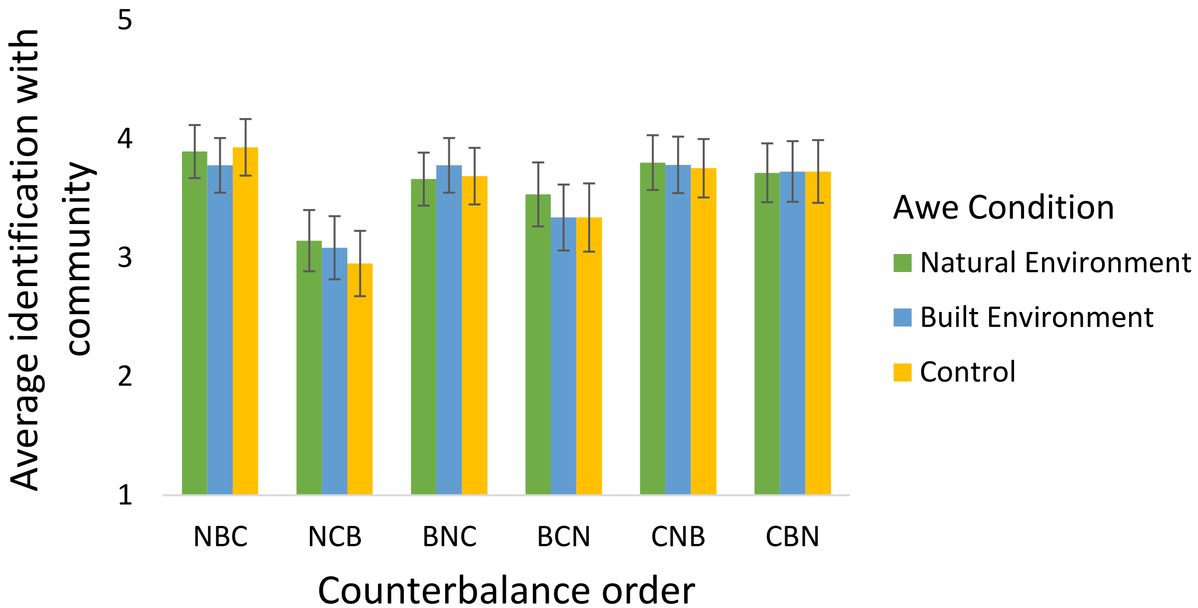


Figure 34. Average feelings of identification with one's community across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition).

Identification With All Humanity – Americans subscale

A mixed-factorial ANOVA of awe condition and counterbalance order on identification with Americans found significant main effects of awe condition and counterbalance order (see Table 31 and Figure 35). Post-hoc LSD tests following up on the main effect of awe condition found no significant difference between the natural and built environment conditions, $p = .776$, but significantly higher identification with Americans in both the natural environment ($p = .025$) and built environment ($p = .012$) conditions compared to the neutral control condition.

Tukey's post-hoc tests following up on the main effect of counterbalance condition found two significant pairwise comparisons between counterbalance conditions. Participants whose counterbalance condition was natural environment, neutral control, and built environment reported on average lower identification with Americans than both participants whose viewing order was natural environment, built environment, and neutral control ($p = .005$) and participants whose viewing order was neutral control, natural environment, and built environment ($p = .024$). No other pairwise comparison was significant, all $p > .080$.

A quasi-ANCOVA of awe condition on identification with Americans, controlling for counterbalance order, religiousness, universality, and identification with one's community, found that identification with Americans was significantly higher for the natural environment condition compared to the control condition, $b = 0.08$, $SE = 0.04$, $t(158.10) = 2.01$, $p = .046$; and that identification with Americans was significantly higher in the built environment condition than the control condition, $b = 0.12$, $SE = 0.04$, $t(157.43) = 3.06$, $p = .003$. This finding thus supports our mixed-factorial ANOVA results, but does not support our prediction that the natural and built environment conditions would facilitate integration into social groups of different sizes.

Table 31

Effects of awe condition and counterbalance order on identification with Americans (mixed-factorial ANOVA)

	df_{effect}	df_{error}	*F*	*p*	η_p^2
Awe condition * counterbalance order	10	154	0.77	.660	.05
Main effect of awe condition	2	154	4.32	.015	.05
Main effect of counterbalance order	5	77	3.40	.008	.18

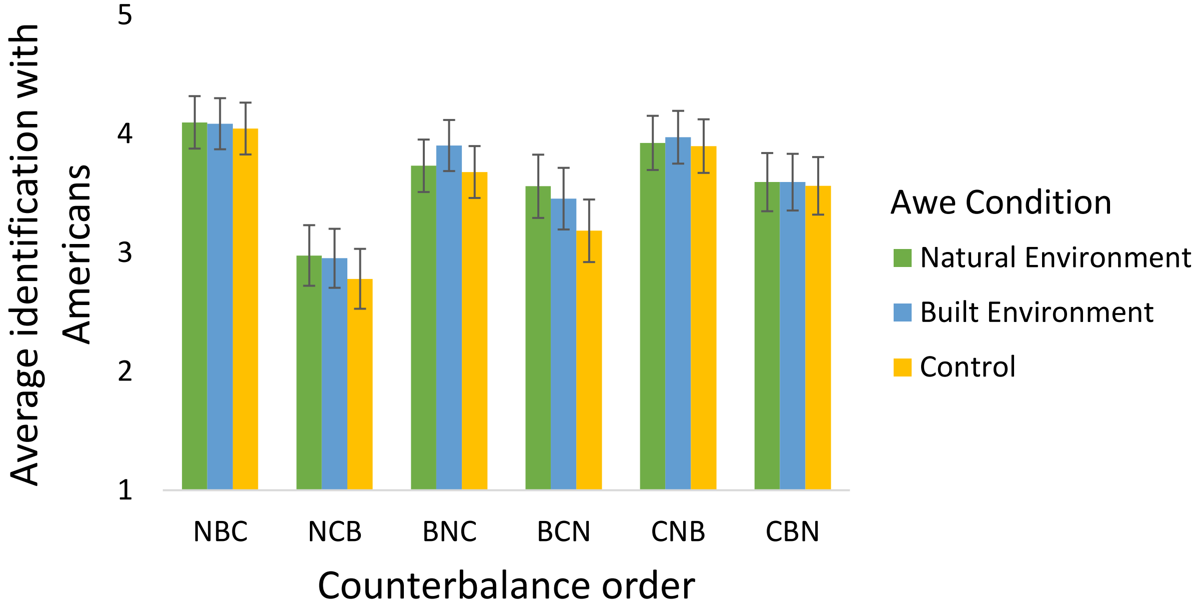


Figure 35. Average feelings of identification with Americans across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition).

Identification With All Humanity – People all over the world subscale

A mixed-factorial ANOVA on the effect of awe condition and counterbalance order on identification with people all over the world (IPAW) found significant main effects of awe condition and counterbalance order (see Table 32 and Figure 36). Post-hoc LSD tests on the main effect of awe condition found no significant difference in IPAW between the natural and built environment conditions, $p = .948$, but significantly greater IPAW in both awe conditions compared to the control condition ($p = .004$ between the natural environment and control conditions and $p = .002$ between the built environment and control conditions).

Post-hoc Tukey tests on the significant main effect of counterbalance order found that participants whose viewing order was built environment, neutral control and natural environment reported on average significantly lower feelings of IPAW than participants whose viewing order was neutral control, natural environment and built environment, $p = .025$. No other pairwise comparison was significant, all $p > .057$.

A quasi-ANCOVA of awe condition on IPAW, controlling for counterbalance order, religiousness, perceived self-size, powerlessness, universality, identification with one's community and identification with Americans found that IPAW was significantly higher in the natural environment condition than in the neutral control condition, $b = 0.17$, $SE = 0.05$, $t(158.55) = 3.38$, $p = .001$; and that IPAW was also significantly higher in the built environment condition than the neutral control condition, $b = 0.19$, $SE = 0.05$, $t(157.80) = 3.66$, $p < .001$. This finding replicates the main effect found in the mixed-factorial ANOVA, and supports our prediction that both awe conditions would result in greater IPAW than the control condition. Contrary to our prediction, however, the natural environment condition was not associated with significantly greater IPAW than the built environment condition.

Table 32

Effects of awe condition and counterbalance order on identification with people all over the world (mixed-factorial ANOVA)

	df_{effect}	df_{error}	F	p	η_p^2
Awe condition * counterbalance order	10	154	1.45	.165	.09
Main effect of awe condition	2	154	7.19	.001	.09
Main effect of counterbalance order	5	77	3.17	.012	.17

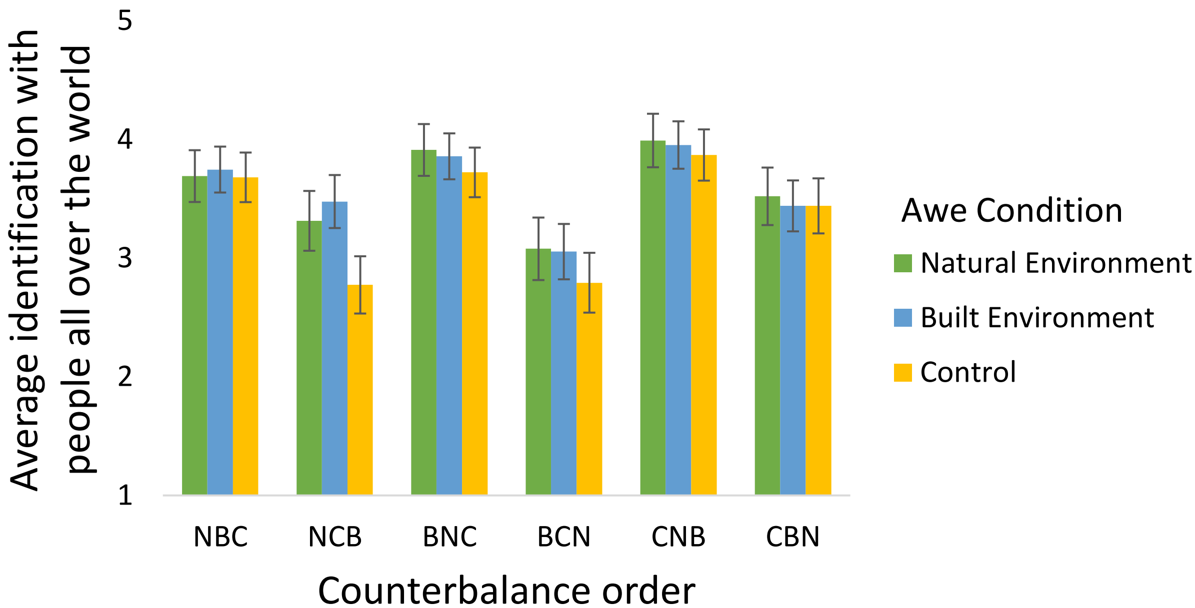


Figure 36. Average feelings of identification with people all over the world across awe conditions and counterbalance orders. Error bars represent ±1 SE. Counterbalance orders are indicated on the x-axis by letter: N = natural environment; B = built environment; C = control condition).

Discussion

To summarize, the findings from Experiment 3 suggest that positive awe induced by nature promotes both universality and identification with people all over the world. This finding supports previous work on awe and collective engagement (Bai et al., 2017; Hornsey et al., 2018), and extends this work to new measures. More notably, Experiment 3 also shows that positive awe induced by architecture also promotes universality and identification with others, a novel finding in the awe literature. We show that the effects of the natural and built environment conditions on measures of universality and identification with people all over the world perform similarly, compared to a control condition. Moreover, we show that the effects of awe condition on universality and identification with people all over the world each persist when controlling for the other, indicating that both the natural and built environment conditions promote feelings of universality over and above feelings of connection to other people, as well as feelings of identification with others over and above feelings of connection to or oneness with the world.

Participants performed similarly in all three conditions on the measure of identification with one's community, failing to support our prediction that the built environment condition would promote greater integration into smaller social groups compared to the natural environment condition. We were also surprised to see no significant difference between the natural environment and control conditions, given previous work on awe promoting identification with one's community (Bai et al., 2017). This inconsistency between findings could be a function of our IWAH measure, which presented all three groups (one's community, Americans, and people all over the world) to participants, and which could have made these distinctions more salient; the Bai et al. (2017) task was a single-item measure in which participants indicated how much they felt a part of their community.

We also found that the natural and built environment conditions were similarly associated with greater identification with Americans, compared to the control condition. Along with our other findings, this result suggests that natural and built awe-inducing environments promote collective engagement in similar ways. Contrary to our predictions, awe-inducing architecture did not facilitate integration into smaller groups than awe-inducing natural environments: The social significance of architectural environments, compared to natural ones, does not appear to affect collective engagement effects of awe. Rather, we show that previous findings on awe and feelings of universality, which were studied using awe-evoking natural imagery, extend to awe-evoking built environments.

The natural and built environment conditions showed differences in two measures, powerlessness and fear. Our comparison between the two conditions on powerlessness was exploratory and affected our hypothesis on collective engagement: As noted in the introduction to this chapter, had there been a threat-based awe condition (as originally intended), we would have predicted that threat-based awe, because of the associated powerlessness, would facilitate engagement with smaller social groups than positive awe. At the same time, we predicted that positive awe induced through architecture would also promote engagement with smaller groups, compared to positive awe induced through nature. Yet rather than confounding these two effects, the results from Experiment 3 suggest that despite lower levels of powerlessness and fear in the built environment condition compared to the natural environment condition, the built environment condition descriptively, if not significantly, facilitates greater identification with a smaller social group (Americans) than the natural environment condition.

Several of the significant main effects of awe condition found throughout Experiment 3 were qualified by significant interactions between awe condition and counterbalance order.

Based on our findings in Experiment 2, which also saw counterbalance effects in the within-subjects design, we would predict that the findings here would replicate with a between-subjects sample. However, of some concern is that there were fewer counterbalance conditions in the present study that showed significant effects of awe condition than in Experiment 2; for the variables perceived self-size and universality, for example, only one counterbalance condition showed a significant effect of awe condition. Yet descriptively, the patterns for these variables appear to follow the results of the main effect of awe condition. A larger within-subjects sample, which we struggled to attain, would also allow for greater numbers of participants in each counterbalance condition and more power for follow-up tests on the counterbalance order effects.

Although the neutral valence of our control condition allowed for its use across all three experiments, allowing for replication of results, one limitation with this control condition is that it did not control for positive valence in Experiment 3 (the endorsements of the positive awe definition for the neutral control video do hint that it elicited positive emotion for some participants, but positive valence was not matched between videos in a preliminary study). Controlling for positive valence would allow us to isolate the specific effect of positive awe, over and above its positive valence. Furthermore, rather than the control condition being perceptually matched to either awe condition, it functioned as a comparison for both other conditions, as it included both natural and architectural elements. Having two control conditions, each more perceptually matched to the experimental awe conditions, might help better isolate the effect of the content of the experimental videos (e.g., an architectural control video with tall buildings). It would be difficult to find an appropriate control in this respect (e.g., tall structures that reliably do not provoke awe), as perceptual vastness does predict awe; however, future work might incorporate multiple control conditions to address these limitations.

Chapter 5: General Discussion

Summary of findings

Staggeringly immense or beautiful awe-inspiring structures, such as religious monumental architecture, have long been important to human culture and society. With the emerging psychological literature on awe, a nascent avenue of research is beginning to uncover specific psychosocial and physiological effects of feeling awe through architecture. Most psychological work relies on nature imagery to evoke awe; yet architecturally-induced awe, which is studied very little, has enormous implications for how awe-eliciting architecture—such as cultural and religious sites—facilitate their sociocultural functions through built form. Across three studies, we probed the psychological effects of feeling awe from video stimuli of natural and built environments.

Across all studies, we successfully elicited positive awe through videos of nature and architecture and threat-based awe through videos of nature to study the effects of these emotions on perceived self-size, feelings of powerlessness, and fear; as well as universality and identification with all of humanity for positive awe. In Studies 1a and 1b, we successfully replicated previous work on positive and threat-based awe elicited through natural stimuli. In these studies, we employed the same video stimuli used in previous work (Gordon et al., 2017) to replicate their findings on perceived self-size, powerlessness, and fear using an online, within-subjects design. Our measure of awe also differed from previous work: Rather than have participants rate to what extent they feel "awe," which may not carry the same meaning across participants or between participants and researchers, we presented participants with definitions (adapted from Gordon et al., 2017) of both positive and threat-based awe, which they were asked to endorse based on how the videos they watched made them feel. By validating this measure and the online within-subjects methodology, the findings from Experiments 1a and 1b allowed us to then extend these findings to awe elicited by the built environment in Studies 2a and 2b. Study 2a employed an essentially identical design to Study 1b, with researcher-created videos of architectural environments in place of the positive and threat-based nature videos used in Studies 1a and 1b. Studies 2a and 2b showed that when architectural environments were used in place of natural ones, both awe conditions (meant to differentially elicit positive awe and threat-based awe) elicited positive awe. Although we were unable to elicit threat-based awe as intended with architectural environments, we were able to replicate positive awe findings on perceived self-size (from previous work, and from our Experiment 1) and powerlessness (from Experiment 1) with architectural stimuli, which are understudied in the awe literature.

By establishing the capacity of natural and architectural environments to elicit positive awe in an online format, Studies 1 and 2 allowed for the design of Study 3, in which we directly compared effects of positive awe elicited through nature to positive awe elicited through architecture on feelings of universality and identification with all of humanity. We found that both awe-eliciting natural and architectural environments led to feelings of universality and identification with people all over the world. Contrary to our predictions, we found no evidence that the architectural environment facilitates greater engagement with smaller social groups compared to the natural environment. This finding suggests that although these environmental stimuli differ in intrinsic social meaning, this collective engagement effect of awe, which has been demonstrated in previous work using nature imagery (Bai et al., 2017; Hornsey et al., 2018), extends to architectural stimuli.

Importance of the work

This work extends existing findings to new awe-inducing stimuli, challenging the methodological bias in the awe literature of overwhelmingly using natural stimuli, whether through visual stimuli or by prompting memories of experiences in nature, to elicit awe. This work thus adds to the few existing examples (e.g., Bai et al., 2017) that the effects of awe found in the literature are not strictly limited to awe induced by nature. This project also, through Study 3, adds to the growing body of empirical work demonstrating positive, prosocial effects of feeling awe (Piff et al., 2015; Prade & Saroglou, 2016; Rudd et al., 2012; Stellar et al., 2017).

This project furthers the work of awe in architecture specifically, an important area of study both because of time spent in the built environment as well as because of the important functions awe-inducing architectural spaces hold. Our work suggests that architecture can function as a social connector through the emotions it elicits, besides the literal physical function of bringing people together; and that this effect of facilitating social connectedness occurs with awe-inducing architectural stimuli to a similar extent as awe-inducing natural stimuli.

However, we were only able to extend this work to positive awe elicited by the built environment. It seems that images of nature, but not of architecture, can reliably elicit threat-based awe, at least in an online experimental setting. This finding somewhat contradicts previous work on awe and threat in the built environment (Joye & Dewitte, 2016). More work is needed to clarify this discrepancy, and on architectural awe in general. Our project, being one of very few empirical studies on awe in the built environment (Collado & Manrique, 2019; Joye & Dewitte, 2016; Negami, 2016), offers an initial understanding of how awe is experienced through architecture.

A consistent yet surprising finding throughout most of the studies in this project was greater feelings of powerlessness associated with the positive awe condition, compared to the control condition. This finding was unexpected given that previous work found no difference in levels of reported powerlessness between positive awe and control conditions (Gordon et al., 2017), and especially given that we used the same video stimuli and powerlessness measure as this previous work. Our contradictory results thus complicate the relationship between positive and threat-based awe and point to the need for more work to understand and distinguish these variants of awe. These distinct findings raise the possibility that powerlessness may in fact be a core outcome of feeling awe, similar to the small-self effect. Consequences of this feeling of powerlessness may perhaps be moderated by individual differences, akin to the way the small self effect was moderated by self-esteem in Hornsey et al. (2018), which might explain some of these divergent results.

Thus, the findings of this research project question the current theoretical distinction between variants of awe, and more broadly, challenge the current framing of awe. However, although we were not able to elicit threat-based awe using architectural stimuli, the precedent in previous work to demonstrate the prevalence of threat-based awe in daily life and induce it experimentally (Gordon et al., 2017), as well as our own results from Study 1, suggests that threat-based awe is conceptually and subjectively distinct from positive awe. Our inability to elicit threat-based awe may have been due primarily to relying on a narrow set of stimuli; but our more general pattern of results, particularly regarding powerlessness, points to the need for further work disentangling variants of awe. Keltner and Haidt’s 2003 paper helped galvanize a new field of research on awe in psychology; yet as this body of work progresses, more work will be needed to reassess the definition of awe as proposed by Keltner and Haidt (2003), as well as to further investigate the threat-based variant of awe.

Limitations

Although our measure of awe allowed us to measure awe exactly as intended (i.e., we ensured participants' understandings of positive and threat-based awe), our measure is somewhat limited in it being a categorical measurement. As a result, we do not have data on the intensity of positive or threat-based awe felt by participants. Differences in intensity of each emotion may also be related to differences in physiological arousal, which could be controlled if measured (either through self-report or electrodermally). Future work may include a separate scale for participants to indicate the degree to which they feel the type of awe endorsed. Yet as discussed in the general introduction, although it is assumed in the awe literature that awe exists and may be measured on a continuum, this assumption has not been fully explored. Adding a scale measurement may help clarify whether participants conceptualize awe as existing on a gradient or dichotomy.

The use of a scale to measure positive and threat-based awe may also help clarify whether participants felt immersed in the videos or whether they experienced aesthetic distance. Aesthetic distance refers to the emotional distance that is cognitively constructed during aesthetic experiences as a result of evaluating the stimulus as an aesthetic or art object (Leder et al., 2014; Rabb et al., 2016). On the one hand, if participants did experience aesthetic distance, perhaps they did not feel awe to the extent that they would have, had they experienced the environments depicted in the video stimuli directly. On the other hand, to a certain extent at least, aesthetic distance may be fundamental to the experience of awe, or to threat-based awe specifically: On the sublime, Burke posited that "When danger or pain press too nearly, they are incapable of giving any delight, and are simply terrible; but at certain distances, and with certain modifications, they may be, and they are delightful" (1757/1990, pp. 36–37). In other words, with no aesthetic distance at all, the overwhelming feeling provoked by an experience may be fear, and not awe. In the current study, the endorsements of positive and threat-based awe in Study 1 suggest that even if participants did experience some amount of aesthetic distance, they also experienced each of these emotions as we defined them, at least enough to make these endorsements. Nevertheless, immersion could be increased in future studies through the use of virtual reality and real spaces.

A further limitation of this project concerns the use of different soundtracks across the studies, which slightly restricts the ability to inform comparisons across the three studies. Study 1 used the original soundtracks associated with each video, which were different for all three conditions, to ensure replication of the effects of those specific stimuli. However, we were able to replicate findings of perceived self-size, powerlessness, and fear from Studies 1a and 1b with the use of the neutral-awe soundtrack accompanying the positive awe nature video in Study 3. The more frequent endorsement of the threat-based awe definition for the positive awe natural environment video in Study 3, compared to the same video in Study 1, may be a reflection of the contrast between the soundtracks used in the two studies: The soundtrack used in Study 1 for that video was specifically chosen to be uplifting, whereas the soundtrack used in Study 3 was specifically chosen to be neutral in valence. Additionally, presenting video content in the neutral control condition (neutral valence, low arousal) with an incongruent soundtrack (neutral valence, high arousal) could have contributed to unanticipated affective responses.

As mentioned in the Experiment 3 discussion, the control conditions could have been chosen to allow for more specific conclusions about the source of the effect (i.e., how much of the effect was due to awe specifically, beyond positive valence). However, employing one neutral control condition allowed us to compare this condition to both natural and architectural environment conditions; as well as allowed us to compare positive to threat-based awe with the same neutral stimulus, thus allowing for easier comparisons across studies. Furthermore, the neutral control condition we used was used in previous work on awe (Gordon et al., 2017); it is not uncommon for experimental work on awe to use control conditions with neutral valence, as opposed to a positive-valence control.

A final limitation of the current work is the underpowering of effects due to smaller than expected sample sizes. Particularly with Experiment 3, we struggled to reach our desired final sample size due to a high exclusion rate. Although excluding problematic responders (e.g., those who fail attention check questions) from Amazon Mechanical Turk studies has been found to result in higher quality data without introducing sampling bias (Thomas & Clifford, 2017), such a high exclusion rate is a concern that should be addressed in the next steps of this work, either through adjusting eligibility criteria on the Amazon Mechanical Turk platform or by recruiting participants using a different method (e.g., university students recruited through psychology courses).

Future directions

The design of Study 3 did not include a threat-based awe condition as originally intended because we were unable to elicit threat-based awe through the built environment in Study 2. Therefore, one future direction of this research will be to compare universality and identification with all humanity between positive and threat-based awe elicited through the natural environment. While threat-based awe may lead to greater feelings of universality and identification with all humanity than a control condition, these feelings may still be to a significantly lesser extent than feelings of universality and identification with humanity resulting from positive awe. Studying the social and psychological effects of feeling threat-based awe, especially provoked through nature, is unfortunately becoming increasingly relevant with the accelerating development of human activity driven climate disasters.

Another future direction will be to compare our results from Study 2 to a sample of participants with an understanding of and appreciation for architecture. We are currently pursuing this question, recruiting a sample of architecture students for the online study. It will be interesting to see whether our architectural stimuli affect architecture students differently from a general-population sample; and whether the effects of the type of awe felt and resulting perceived self-size, powerlessness, and fear persist or differ between the two samples.

Although we were unable to elicit threat-based awe through architecture, future work may seek empirically to understand the conditions (if any) that lead to feeling threat-based awe through the built environment, including how perceptual and contextual (e.g., associative, historical, cultural) factors may interact to make architectural awe positive or threat-based. To address the limited generalizability of the current results, future studies could expand to study different forms of architecture, as well as incorporate multiple trials per condition. Additionally, whereas the current project used building façades to study awe, future work could include building interiors, as they have also been used to study architecturally induced awe (Negami, 2016). Understanding what factors in architecture give rise to positive awe or threat-based awe would have important implications for design, as well as for understanding historical use of architecture, such as architecture used to promote fascist regimes. For instance, Gordillo (2015) argues that Adolf Hitler, together with his architect Albert Speer, intentionally used monumental, awe-evoking architecture to politically pacify people; to “stun” them and thus “decrease the body’s capacity for action” (Gordillo, 2015), as Joye and Dewitte (2016) found in their study of awe-evoking skyscrapers in which they measured freezing behavior. If the architectural features or circumstances which facilitate a threat-based awe response can be identified, resulting psychological effects could also be studied, as well as how any negative effects may be challenged or subverted.

Finally, because the experience of architecture is often dynamic and multisensory, another future direction of this work will be to study effects of awe-eliciting architecture in real spaces. Field studies offer less control than laboratory or online studies, but much higher ecological validity. A field study or case study could complement experimental work to offer valuable insight into how awe-eliciting architecture shapes how people feel about themselves and their place in the world.

Conclusion

Across all studies, we show that positive awe elicited through nature and architecture leads to feeling small and powerless, yet more connected to the universe and people all over the world. We show that threat-based awe elicited through nature also leads to feeling small and powerless compared to a control condition, as well as more fearful compared to positive awe elicited through nature. We also show that video stimuli of awe-eliciting architectural environments elicit positive awe, and not threat-based awe as intended. By extending work on awe to architectural environments, this project broadens the range and understanding of awe-eliciting stimuli and offers an initial insight into how awe-eliciting buildings shape our psychology.

References

Appleton, J. (1996). *The experience of landscape*. Wiley.

Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J., McNeil, G. D., Peng, K., & Keltner, D. (2017). Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. *Attitudes and Social Cognition, 113*(2), 185–209. https://doi.org/10.1037/pspa0000087

Bakdash, J. Z., & Marusich, L. R. (2017). Repeated measures correlation. *Frontiers in Psychology, 8*, 1–13. https://doi.org/10.3389/fpsyg.2017.00456

Barends, A. J., & de Vries, R. E. (2019). Noncompliant responding: Comparing exclusion criteria in MTurk personality research to improve data quality. *Personality and Individual Differences, 143*, 84–89. https://doi.org/10.1016/j.paid.2019.02.015

Barrett, L. F. (1998) Discrete emotions or dimensions? The role of valence focus and arousal focus. *Cognition and Emotion*, *12*(4), 579–599. https://doi.org/10.1080/026999398379574

Barrett, L. F. (2017). The theory of constructed emotion: An active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, *12*(1), 1–23. https://doi.org/10.1093/scan/nsw154

Barrett, L. F., & Satpute, A. B. (2019). Historical pitfalls and new directions in the neuroscience of emotion. *Neuroscience letters*, *693*, 9–18. https://doi.org/10.1016/j.neulet.2017.07.045

Bartolo, A., Benuzzi, F., Nocetti, L., Baraldi, P., & Nichelli, P. (2006). Humor comprehension and appreciation: an FMRI study. *Journal of Cognitive Neuroscience, 18*(11), 1789–1798. https://doi.org/10.1162/jocn.2006.18.11.1789

Belfi, A. M., Vessel, E. A., Brielmann, A., Isik, A. I., Chatterjee, A., Leder, H., Pelli, D. G., & Starr, G. G. (2019). Dynamics of aesthetic experience are reflected in the default-mode network. *NeuroImage, 188*, 584–597. https://doi.org/10.1016/j.neuroimage.2018.12.017

Birnbaum, M. (1999). How to show that 9 > 221: Collect judgments in a between-subjects design. *Psychological Methods, 4*(3), 243–249. https://doi.org/10.1037/1082-989X.4.3.243

Burke, E. (1757/1990). *A philosophical enquiry into the origin of our ideas of the sublime and beautiful*. Oxford: Oxford University Press.

Chirico A., Yaden D.B. (2018) Awe: A Self-Transcendent and Sometimes Transformative Emotion. In: Lench H. (eds) The Function of Emotions. Springer, Cham. https://doi.org/10.1007/978-3-319-77619-4_11

Collado, S., & Manrique, H. M. (2019). Exposure to Awe-Evoking Natural and Built Scenes Has Positive Effects on Cognitive Performance and Affect. *Environment and Behavior*. https://doi.org/10.1177/0013916519868733

Cotter, K. N., Silvia, P. J., & Fayn, K. (2018). What does feeling like crying when listening to music feel like? *Psychology of Aesthetics, Creativity, and the Arts, 12*(2), 216–227. https://doi.org/10.1037/aca0000108

Cova, F., & Deonna, J. A. (2014). Being moved. *Philosophical Studies, 169*, 447–466. https://doi.org/10.1007/s11098-013-0192-9

Critchley, H. D., Wiens, S., Rotshtein, P., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience, 7*, 189–195. https://doi.org/10.1038/nn1176

Danvers, A. F., & Shiota, M. N. (2017). Going off script: Effects of awe on memory for script-typical and -irrelevant narrative detail. *Emotion, 17*(6), 938–952. https://doi.org/10.1037/emo0000277

Davey, J., Thompson, H. E., Hallam, G., Karapanagiotidis, T., Murphy, C., De Caso, I., Krieger-Redwood, K., Bernhardt, B. C., Smallwood, J., & Jefferies, E. (2016). Exploring the role of the posterior middle temporal gyrus in semantic cognition: Integration of anterior temporal lobe with executive processes. *NeuroImage, 137*, 165–177. https://doi.org/10.1016/j.neuroimage.2016.05.051

Dudek, K. (2017). *Virtual reality and the inducement of awe* [Unpublished undergraduate honors thesis]. University of Waterloo.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66*(3), 183–201. https://doi.org/10.1037/h0047707

Eckert, M. A., Menon, V., Walczak, A., Ahlstrom, J., Denslow, S., Horwitz, A., & Dubno, J. R., (2009). At the heart of the ventral attention system: the right anterior insula. *Human Brain Mapping, 30*(8), 2530–2541. https://doi.org/10.1002/hbm.20688

Eliade, M. (1957/1987). *The sacred and the profane: The nature of religion.* Harcourt Brace Jovanovich.

Ellard, C. (2015). *Places of the heart: The psychogeography of everyday life.* Bellevue Literary Press.

Evans, S. H., & Anastasio, E. J. (1968). Misuse of analysis of covariance when treatment effect and covariate are confounded. *Psychological Bulletin*, *69*(4), 225–234. https://doi.org/10.1037/h0025666

Evans, G. W., & McCoy, J. M. (1998). When buildings don't work: The role of architecture in human health. *Journal of Environmental Psychology, 18*(1), 85–94. https://doi.org/10.1006/jevp.1998.0089

Fingerhut, J., & Prinz, J. J. (2018). Wonder, appreciation, and the value of art. *Progress in brain research*, *237*, 107–128. https://doi.org/10.1016/bs.pbr.2018.03.004

George, J. M., & Brief, A. P. (1992). Feeling good-doing good: A conceptual analysis of the mood at work-organizational spontaneity relationship. *Psychological Bulletin, 112*(2), 310 –329. http://dx.doi.org/10.1037/0033-2909.112.2.310

Gifford R. (2014). Environmental psychology matters. *Annual Review of Psychology*, *65*, 541–579. https://doi.org/10.1146/annurev-psych-010213-115048

Goldhagen, S. W. (2017). *Welcome to your world: How the built environment shapes our lives.* Harper.

Gordillo, G. (2015). Nazi architecture as affective weapon. *The Funambulist Papers, 2,* 54–63. https://doi.org/10.21983/P3.0098.1.00

Gordon, A. M., Stellar, J. E., Anderson, C. L., McNeil, G. D., Loew, D., & Keltner, D. (2017). The dark side of the sublime: Distinguishing a threat-based variant of awe. *Journal of Personality and Social Psychology*, *113*(2), 310–328. https://doi.org/10.1037/pspp0000120

Greenwald, A. (1976). Within-subjects designs: To use or not to use? *Psychological Bulletin*, *83*(2), 314–320. https://doi.org/10.1037/0033-2909.83.2.314

Guan, F., Xiang, Y., Chen, O., Wang, W., & Chen, J. (2018). Neural basis of dispositional awe. *Frontiers in Behavioral Neuroscience*, *12*, 1–7. https://doi.org/10.3389/fnbeh.2018.00209

Guan, F., Zhao, S., Chen, S., Lu, S., Chen, J., & Xiang, Y. (2019). The neural correlate difference between positive and negative awe. *Frontiers in Human Neuroscience*, *13*, 1–9. https://doi.org/10.3389/fnhum.2019.00206

Hesp, C., Smith, R., Parr, T., Allen, M., Friston, K. J., & Ramstead, M. J. D. (2019). Deeply felt affect: The emergence of valence in deep active inference. *PsyArXiv*. https://doi.org/10.31234/osf.io/62pfd

Hillier, B. (1996). *Space is the machine: A configurational theory of architecture.* Cambridge University Press.

Hornsey, M. J., Faulkner, C., Crimston, D., & Moreton, S. (2018). A microscopic dot on a microscopic dot: Self-esteem buffers the negative effects of exposure to the enormity of the universe. *Journal of Experimental Social Psychology*, *76*, 198–207. https://doi.org/10.1016/j.jesp.2018.02.009

Horovitz, S. G., Braun, A. R., Carr, W. S., Picchioni, D., Balkin, T. J., Fukunaga, M., & Duyn, J. H. (2009). Decoupling of the brain's default mode network during deep sleep. *PNAS Proceedings of the National Academy of Sciences of the United States of America, 106*(27), 11376–11381. https://doi.org/10.1073/pnas.0901435106

Howell, D. C. (2010/2013). *Statistical methods for psychology.* Wadworth Publishing.

Huitema, B. E. (1980/2011). *The analysis of covariance and alternatives: Statistical methods for experiments, quasi-experiments, and single-case studies.* Wiley.

Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2008). Mixed affective responses to music with conflicting cues. *Cognition and Emotion, 22*(2), 327–352. https://doi.org/10.1080/02699930701438145

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology*, *52*(6), 1122–1131. https://doi.org/10.1037/0022-3514.52.6.1122

Jabbi, M., Bastiaansen, J., & Keysers, C. (2008). A common anterior insula representation of disgust observation, experience and imagination shows divergent functional connectivity pathways. *PLoS One*, *3*(8), 1–8. https://doi.org/10.1371/journal.pone.0002939

Joye, Y., & Dewitte, S. (2016). Up speeds you down: Awe-evoking monumental buildings trigger behavioral and perceived freezing. *Journal of Environmental Psychology*, *47*, 112–125. https://doi.org/10.1016/j.jenvp.2016.05.001

Joye, Y., & Verpooten, J. (2013). An exploration of the functions of religious monumental architecture from a Darwinian perspective. *Review of General Psychology, 17*(1), 53–68. https://doi.org/10.1037/a0029920

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: the need to consider underlying mechanisms. *The Behavioral and brain sciences*, *31*(5), 559–621. https://doi.org/10.1017/S0140525X08005293

Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and Emotion, 17*(2), 297–314. https://doi.org/10.1080/02699930302297

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(9), 3310–3315. https://doi.org/10.1073/pnas.0306408101

Keren, G., & Lewis, C. (Eds.). (1993). *A handbook for data analysis in the behavioral sciences: Methodological issues.* Lawrence Erlbaum Associates, Inc.

Kjaer, T. W., Nowak, M., & Lou, H. C. (2002). Reflective self-awareness and conscious states: PET evidence for a common midline parietofrontal core. *Neuroimage 17*(2), 1080–1086. https://doi.org/10.1006/nimg.2002.1230

Kline, R. B. (1998). *Principles and practice of structural equation modeling.* New York: Guilford Press.

Koike, T., Kan, S., Misaki, M., & Miyauchi, S. (2011). Connectivity pattern changes in default-mode network with deep non-REM and REM sleep. *Neuroscience research*, *69*(4), 322–330. https://doi.org/10.1016/j.neures.2010.12.018

Konečni, V. J. (2005). The aesthetic trinity: Awe, being moved, thrills. *Bulletin of Psychology and the Arts*, *5*(2), 27–44. http://konecni.ucsd.edu/pdf/2005%20Aesthetic%20Trinity,%20Bulletin%20of%20P.%20and%20A.pdf

Konečni, V. J. (2008). Does music induce emotion? A theoretical and methodological analysis. *Psychology of Aesthetics, Creativity, and the Arts*, *2*(2), 115–129. https://doi.org/10.1037/1931-3896.2.2.115

Kreutz, G., Ott, U., Teichmann, D., Osawa, P., & Vaitl, D. (2008). Using music to induce emotions: Influences of musical preference and absorption. *Psychology of Music, 36*(1), 101–126. https://doi.org/10.1177/0305735607082623

Larsen, J. T., & Stastny, B. J. (2011). It's a bittersweet symphony: Simultaneously mixed emotional responses to music with conflicting cues. *Emotion*, *11*(6), 1469–1473. https://doi.org/10.1037/a0024081

Leder, H., Gerger, G., Brieber, D., & Schwarz, N. (2014). What makes an art expert? Emotion and evaluation in art appreciation. *Cognition & Emotion*, *28*(6), 1137–1147. https://doi.org/10.1080/02699931.2013.870132

Lench, H. C., Flores, S. A., & Bench, S. W. (2011). Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: A meta-analysis of experimental emotion elicitations. *Psychological Bulletin*, *137*(5), 834–855. https://doi.org/10.1037/a0024244

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin*, *131*(6), 803–855. http://dx.doi.org/10.1037/0033-2909.131.6.803

Maes, P. J., & Leman, M. (2013). The influence of body movements on children's perception of music with an ambiguous expressive character. *PLoS One*, *8*(1), 1–11. https://doi.org/10.1371/journal.pone.0054682

Margulis, E. H., Levine, W. H., Simchy-Gross, R., & Kroger, C. (2017). Expressive intent, ambiguity, and aesthetic experiences of music and poetry. *PLoS ONE, 12*(7), 1–16. https://doi.org/10.1371/journal.pone.0179145

Maxwell, S., & Cramer, E. M. (1975). A note on analysis of covariance. *Psychological Bulletin, 82*(2), 187–190. https://doi.org/10.1037/h0076378

McFarland, S., Webb, M., & Brown, D. (2012). All humanity is my ingroup: A measure and studies of identification with all humanity. *Personality Processes and Individual Differences*, *103*(5), 830–853. https://doi.org/10.1037/a0028724

Meade, A. W., & Craig, S. B. (2012). Identifying careless responses in survey data. *Psychological Methods, 17*(3), 437–455. https://doi.org/10.1037/a0028085

Menninghaus, W., Wagner, V., Wassiliwizky, E., Schindler, I., Hanich, J., Jacobsen, T., & Koelsch, S. (2019). What are aesthetic emotions? *Psychological Review*, *126*(2), 171–195. http://dx.doi.org/10.1037/rev0000135

Merriam-Webster. (n.d.). Awe. In *Merriam-Webster.com dictionary*. Retrieved June 6, 2020, from https://www.merriam-webster.com/dictionary/awe

Morelli S. A., Lieberman M. D. (2013). The role of automaticity and attention in neural processes underlying empathy for happiness, sadness and anxiety. *Frontiers in Human Neuroscience, 7*, 1–15. https://doi.org/10.3389/fnhum.2013.00160

Necka, E. A., Cacioppo, S., Norman, G. J., Cacioppo, J. T. (2016). Measuring the prevalence of problematic respondent behaviors among MTurk, campus, and community participants. *PLoS ONE, 11*(6), 1–19. https://doi.org/10.1371/journal.pone.0157732

Negami, H. (2016). *Awe-Inducing Interior Space: Architectural Causes and Cognitive Effects* [Master's thesis, University of Waterloo]. UWSpace.

Negami, H., Mazumder, R., Reardon, M., & Ellard, C. G. (2018). Field analysis of psychological effects of urban design: A case study in Vancouver. *Cities & Health, 2*(2), 106–115. https://doi.org/10.1080/23748834.2018.1548257

North, A. C. (2012). The effect of background music on the taste of wine. *British Journal of Psychology, 103*(3), 293–301. https://doi.org/10.1111/j.2044-8295.2011.02072.x

Nusbaum, E. C., Silvia, P. J., Beaty, R. E., Burgin, C. J., Hodges, D. A., & Kwapil, T. R. (2014). Listening between the notes: Aesthetic chills in everyday music listening. *Psychology of Aesthetics, Creativity, and the Arts, 8*(1), 104–109. https://doi.org/10.1037/a0034867

Öhman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130*(3), 466–478. https://doi.org/10.1037/0096-3445.130.3.466

Otto, R. (1923/1958). *The idea of the holy*. Oxford University Press.

Oxford English Dictionary. (2019). Awe, n.1. In *OED Online.* www.oed.com/view/Entry/13911

Paulus, M. P., & Stein, M. B. (2006). An insular view of anxiety. *Biological Psychiatry 60*(4), 383–387. https://doi.org/10.1016/j.biopsych.2006.03.042

Perry, D., Hendler, T., & Shamay-Tsoory, S. G. (2012). Can we share the joy of others? Empathic neural responses to distress vs joy. *Social cognitive and affective neuroscience*, *7*(8), 909–916. https://doi.org/10.1093/scan/nsr073

Pew Research Center. (2018). *How does Pew Research Center measure the religious composition of the U.S.? Answers to frequently asked questions.* https://www.pewforum.org/wp-content/uploads/sites/7/2018/07/FAQ-on-Measuring-Religion-FOR-FINAL-REVIEW-AND-PRODUCTION.pdf

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: a meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage*, *16*(2), 331–348. https://doi.org/10.1006/nimg.2002.1087

Phelps, E. A. (2004). Human emotion and memory: Interactions of the amygdala and hippocampal complex. *Current Opinion in Neurobiology, 14*(2), 198–202. https://doi.org/10.1016/j.conb.2004.03.015

Piaget, J., & Inhelder, B. (1969). *The psychology of the child* (H. Weaver, Trans.). New York, NY: Basic Books, Inc. (Original work published 1966).

Piedmont, R. (1999). Does spirituality represent the sixth factor of personality? Spiritual transcendence and the Five-Factor Model. *Journal of Personality*, *67*(6), 985–1013. https://doi.org/10.1111/1467-6494.00080

Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., & Keltner, D. (2015). Awe, the small self, and prosocial behavior. *Journal of Personality and Social Psychology*, *108*(6), 883–899. https://doi.org/10.1037/pspi0000018

Prade, C., & Saroglou, V. (2016). Awe's effects on generosity and helping. *The Journal of Positive Psychology*, *11*(5), 522–530. https://doi.org/10.1080/17439760.2015.1127992

Rabb, N., Nissel, J., Alecci, A., Magid, L., Ambrosoli, J., & Winner, E. (2016). Truths about beauty and goodness: Disgust affects moral but not aesthetic judgments. *Psychology of Aesthetics, Creativity, and the Arts*, *10*(4), 492–500. https://doi.org/10.1037/aca0000051

Redies, C., Grebenkina, M., Mohseni, M., Kaduhm, A., & Dobel, C. (2020). Global image properties predict ratings of affective pictures. *Frontiers in Psychology*, *11*, 1–16. https://doi.org/10.3389/fpsyg.2020.00953

Riek, B. M., Mania, E. W., & Gaertner, S. L. (2006). Intergroup Threat and Outgroup Attitudes: A Meta-Analytic Review. Personality and Social Psychology Review, 10(4), 336–353. https://doi.org/10.1207/s15327957pspr1004_4

Rudd, M., Vohs, K. D., & Aaker, J. (2012). Awe expands people's perception of time, alters decision making, and enhances well-being. *Psychological Science*, *23*(10), 1130–1136. https://doi.org/10.1177/0956797612438731

Schienle, A., Stark, R., Walter, B., Blecker, C., Ott, U., Kirsch, P., Sammer, G., & Vaitl, D. (2002). The insula is not specifically involved in disgust processing: an fMRI study. *Neuroreport*, *13*(16), 2023–2026. https://doi.org/10.1097/00001756-200211150-00006

Schindler, I., Hosoya, G., Menninghaus, W., Beermann, U., Wagner, V., Eid, M., & Scherer, K. R. (2017). Measuring aesthetic emotions: A review of the literature and a new assessment tool. *PLoS ONE, 12*(6), 1–45. https://doi.org/10.1371/journal.pone.0178899

Sheline, Y. I., Barch, D. M., Price, J. L., Rundle, M. M., Vaishnavi, S. N., Snyder, A. Z., Mintun, M. A., Wang, S., Coalson, R. S., & Raichle, M. E. (2009). The default mode network and self-referential processes in depression. *Proceedings of the National Academy of Sciences*, *106*(6), 1942–1947. https://doi.org/10.1073/pnas.0812686106

Shiota, M. N., Keltner, D., & Mossman, A. (2007). The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition and Emotion*, *21*(5), 944–963. https://doi.org/10.1080/02699930600923668

Smith, H. F. (1957). Interpretation of adjusted treatment means and regressions in analysis of covariance. *Biometrics*, *13*(3), 282–308. https://doi.org/10.2307/2527917

Stark, R., Schienle, A., Walter, B., Kirsch, P., Sammer, G., Ott, U., Blecker, C., & Vaitl, D. (2003). Hemodynamic responses to fear and disgust-inducing pictures: an fMRI study. *International Journal of Psychophysiology*, *50*(3), 225–234. https://doi.org/10.1016/s0167-8760(03)00169-7

Stellar, J. E., Gordon, A., Anderson, C. L., Piff, P. K., McNeil, G. D., & Keltner, D. (2018). Awe and humility. *Journal of Personality and Social Psychology*, *114*(2), 258–269. https://doi.org/10.1037/pspi0000109

Stellar, J. E., Gordon, A. M., Piff, P. K., Cordaro, D., Anderson, C. L., Bai, Y., Maruskin, L. A., Keltner, D. (2017). Self-Transcendent Emotions and Their Social Functions: Compassion, Gratitude, and Awe Bind Us to Others Through Prosociality. *Emotion Review*, *9*(3), 200–207. https://doi.org/10.1177/1754073916684557

Stellar, J. E., John-Henderson, N., Anderson, C. L., Gordon, A. M., McNeil, G. D., & Keltner, D. (2015). Positive affect and markers of inflammation: Discrete positive emotions predict lower levels of inflammatory cytokines. *Emotion*, *15*(2), 129–133. http://dx.doi.org/10.1037/emo0000033

Tanako, R., & Nomura, M. (in press). Neural representations of awe: Distinguishing common and distinct neural mechanisms. *Emotion.* https://doi.org/10.31234/osf.io/qk8dn

Thomas, K. A., & Clifford, S. (2017). Validity and Mechanical Turk: An assessment of exclusion methods and interactive experiments. *Computers in Human Behavior*, *77*, 184–197. https://doi.org/10.1016/j.chb.2017.08.038

Um, E. "R.", Plass, J. L., Hayward, E. O., & Homer, B. D. (2012). Emotional design in multimedia learning. *Journal of Educational Psychology*, *104*(2), 485-498. http://dx.doi.org/10.1037/a0026609

Vago, D. R., & Silbersweig, D. A. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): a framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in human neuroscience*, *6*, 1–30. https://doi.org/10.3389/fnhum.2012.00296

Valdesolo, P., & Graham, J. (2014). Awe, uncertainty, and agency detection. *Psychological Science*, *25*(1), 170–178. https://doi.org/10.1177/0956797613501884

Van Cappellen, P., Corneille, O., Cols, S., & Saroglou, V. (2011). Beyond mere compliance to authoritative figures: Religious priming increases conformity to informational influence among submissive people. *The International Journal for the Psychology of Religion*, *21*, 97–105. https://doi.org/10.1080/10508619.2011.556995

Van Cappellen, P., & Saroglou, V. (2012) Awe activates religious and spiritual feelings and behavioral intentions. *Psychology of Religion and Spirituality*, *4*(3), 223–236. https://doi.org/10.1037/a0025986

Van Cappellen, P., Saroglou, V., Iweins, C., Piovesana, M., & Fredrickson, B. L. (2013). Self-transcendent positive emotions increase spirituality through basic world assumptions. *Cognition and emotion*, *27*(8), 1378–1394. https://doi.org/10.1080/02699931.2013.787395

Van Elk, M., Arciniegas Gomez, M. A., van der Zwaag, W., van Schie, H. T., & Sauter, D. (2018). The neural correlates of the awe experience: Reduced default mode network activity during feelings of awe. *Human Brain Mapping*, *40*(12), 3561–3574. https://doi.org/10.1002/hbm.24616

Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Gonzalez-Mora, J. L., Leder, H., Modroño, C., Nadal, M., Rostrup, N., & Skov, M. (2015). Architectural design and the brain: Effects of ceiling height and perceived enclosure on beauty judgments and approach-avoidance decisions. *Journal of Environmental Psychology*, *41*, 10–18. https://doi.org/10.1016/j.jenvp.2014.11.006

Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Leder, H., Modroño, C., Nadal, M., Rostrup, N., & Skov, M. (2013). Impact of contour on aesthetic judgments and approach-avoidance decisions in architecture. *Proceedings of the National Academy of Sciences, U.S.A.*, *110*(Suppl. 2), 10446–10453. https://doi.org/10.1073/pnas.1301227110

Vessel, E. A., Starr, G. G., & Rubin, N. (2012). The brain on art: intense aesthetic experience activates the default mode network. *Frontiers in human neuroscience*, *6*, 66. https://doi.org/10.3389/fnhum.2012.00066

Vessel, E. A., Starr, G. G., & Rubin, N. (2013). Art reaches within: aesthetic experience, the self and the default mode network. *Frontiers in neuroscience*, *7*, 258. https://doi.org/10.3389/fnins.2013.00258

Vuoskoski, J. K., & Eerola, T. (2012). Can sad music really make you sad? Indirect measures of affective states induced by music and autobiographical memories. *Psychology of Aesthetics, Creativity, and the Arts, 6*(3), 204–213. http://dx.doi.org/10.1037/a0026937

Yaden, D. B., Haidt, J., Hood, R. W. Jr., Vago, D. R., & Newberg, A. B. (2017). The varieties of self-transcendent experience. *Review of General Psychology, 21*(2), 143–160. https://doi.org/10.1037/gpr0000102

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology, 18*(5), 459–482. https://doi.org/10.1002/cne.920180503

Appendices

Appendix A

Compliance check questionnaire

The following questions are about the surveys you just completed. Please answer honestly.

As a reminder, you do not have to answer these questions. The answers to these questions will only be used to screen the data for random or careless responding: The data you provide is confidential, and your responses will not affect your remuneration or participation in future studies.

1. I carefully read every survey item.
2. I could have paid closer attention to the items than I did.
3. I probably should have been more careful during this survey.[a]
4. I worked to the best of my abilities in this study.
5. I put forth my best effort in responding to this survey.

Statements rated on a 1 – 7 Likert-type scale (1 = *Strongly Agree* to 7 = *Strongly Disagree*)

[a]This statement was omitted from Experiment 1a

Appendix B

Universality questionnaire

Please rate the extent to which you agree with each statement below, based on how the video you just watched made you feel.

1. I feel that on a higher level all of us share a common bond
2. All life is interconnected
3. There is a higher plane of consciousness or spirituality that binds all people
4. Although individual people may be difficult, I feel an emotional bond with all of humanity
5. I believe that there is a larger meaning to life
6. I believe that death is a doorway to another plane of existence
7. I believe there is a larger plan to life
8. There is an order to the universe that transcends human thinking
9. I believe that on some level my life is intimately tied to all of humankind

Statements rated on a 1-7 Likert-type scale from *Not at all* to *Very much*

Appendix C

Identification with All Humanity questionnaire

Please answer the following questions based on how the video you just viewed made you feel.

1. How close do you feel to each of the following groups?
   1 = not at all close
   2 = not very close
   3 = just a little or somewhat close
   4 = pretty close
   5 = very close

   a. People in my community
   b. Americans
   c. People all over the world

2. How much would you say you have in common with the following groups?

   1 = almost nothing in common
   2 = little in common
   3 = some in common
   4 = quite a bit in common
   5 = very much in common

   a. People in my community
   b. Americans
   c. People all over the world

Please answer all remaining questions using the following choices:

1 = not at all
2 = just a little
3 = somewhat
4 = quite a bit
5 = very much

3. Sometimes people think of those who are not a part of their immediate family as “family.” To what degree do you think of the following groups of people as “family”?

a. People in my community
b. Americans
c. All humans everywhere

4. How much do you identify with (that is, feel a part of, feel love toward, have concern for) each of the following?

a. People in my community
b. Americans
c. All humans everywhere

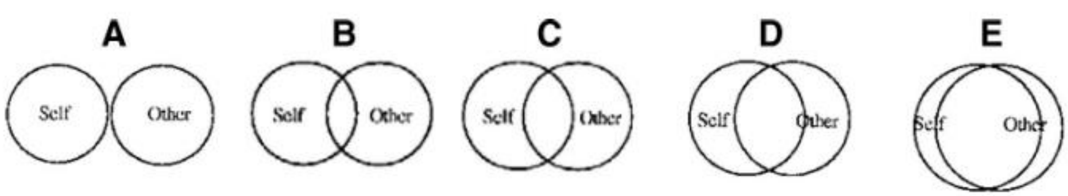
5. How much do you want to be:

a. a responsible citizen of my community
b. a responsible American citizen
c. a responsible citizen of the world

6. How much do you believe in:

a. being loyal to my community
b. being loyal to America
c. being loyal to all mankind

7. Please mark the letter for the pair of circles that best describes your relationship with each group.



a. People in my community
b. Americans
c. People all over the world