

The Underview Effect: Awe Under the Sea, Diving for Well-being

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Abstract

This capstone seeks to explore the complex emotion of awe and the effects of flow and anxiety on the experience of awe in scuba diving. Scuba diving is a strong elicitor of awe and is a challenging, high risk activity requiring both technical skill and a calm mind. In this mixed methods study, awe elicited by scuba diving was studied immediately following a scuba dive (Study 1) and via the internet through recollection tasks (Study 2). Results of Study 1 indicate that in the context of scuba diving, flow is correlated with the connectedness component of awe. Results of Study 2 indicate that when scuba diving experiences are recalled using a writing task (1) awe is experienced differently based on context, (2) flow is correlated with Composite Awe and negatively correlated with anxiety, (3) flow is correlated with the vastness, altered time perception and connectedness components of awe, when recalling a positive dive experience, and (4) anxiety is correlated with the small-self and accommodation components of awe when recalling a negative dive experience. This study reveals additional complexity in the study of awe, leads to further understanding of the subcomponents of the experience of awe, and provides evidence that in the experience of awe – context matters.

Keywords: Awe, Flow, Anxiety, Scuba Diving, Vastness, Accommodation, Small-Self, Time Perception, Connectedness, Biophilia, Self-transcendence

Preface

May 1986, Austin Texas: I've just started my final semester in law school and I'm excited to finally be done, although the bar exam looms large at the end July. I'm starting a great job in October, and I decide to travel to Australia after the bar exam. It's exotic and far away, and I'm ready for adventure. Once that decision is made, it occurs to me that I should get certified to scuba dive, so that I can see the Great Barrier Reef in all its glory. I sign up for a class, easily master the skills in the pool, and do my checkout dives in Lake Travis, where it's cold and dark. I am now a certified open water diver, ready to explore the underwater world.

September 1986, Great Barrier Reef, Australia: I've done three dives from the beach, which have been amazing. It's warm, sunny, beautiful, and I've never seen so many different fish – they are all colors, shapes, and sizes. I'm about to board my first liveaboard dive boat that will take us further out onto the reef. This will be my 6th dive including my two checkout dives in the lake. The plan for the first dive from the boat is to descend to 90 feet, swim a circuit around a massive coral pillar, ascend to 60 feet, swim another circuit around the pillar, ascend to 30 feet, swim the last circuit around the pillar, complete a three-minute safety stop at 15 feet, and then surface at the boat. The maximum dive time is 1 hour. I shimmy into my wet suit, don my dive gear, do my buddy check, and I'm ready to go. As I jump off the boat, I feel great – I start my descent and I am in the zone. Everything is working just right, and I am completely in the moment. As I make my way down, the first thing I notice is the diversity of color which blows my mind. I have never seen anything like it. My brain literally cannot take in what I am seeing. As I arrive at 90 feet and wait for the rest of the group, I focus on one area of the coral pillar. There is so much life on this one little spot and it occurs to me that it is all connected – the coral, the fish, the invertebrates, the plants, everything. As I continue to watch the little neon blue fish

dart in and out of the coral, this feeling comes over me, that although I am a visitor in their world, I am connected to them in the enormous web of life.

The divemaster breaks me out of my reverie and we begin the first circuit around the pillar. I am enthralled and don't know where to look first. It is all too much to take in, the beauty goes on forever. I follow the divemaster through the 90 foot circuit and then the 60 foot circuit, all the while trying to absorb the scene. It's almost as if it doesn't make sense in my brain. As I approach 30 feet for the final circuit, I start feeling strange, as if my body is dissolving into the water. I feel oneness with the ocean and everything in it. We complete the dive and at the safety stop, I watch my fellow divers wondering if they had a similar experience. I'm uncharacteristically quiet on the boat and the dive master asks if I'm OK. I'm completely overwhelmed, a bit embarrassed by what I've just experienced, and can't really articulate what I'm feeling, but tears are streaming down my face. I manage to tell him that I want to do another dive.

April 2016, Cayman Brac, Cayman Islands: I'm on my first solo dive trip and I've met the most incredible group of divers. They've adopted me and helped me get back into diving after my divorce. I've had 5 great dives so far. We're getting ready for our second night dive, dive #91 in my logbook, and I'm excited because the first night dive was incredible, and I saw lots of new night critters. As I suit up, I feel rushed and a bit out of control. I check my gear, and everything seems fine, but I still feel off. Just before we jump in, I realize I only have one flashlight, and someone quickly slips another into my pocket. As I jump off the boat I try to relax, but as soon as I hit the water and start to descend, I feel anxious. All the lights flashing as other divers get organized and the strobe flashing at the safety stop line under the boat are disorienting, I can't get my buoyancy right, and I feel as though I'm free falling. I can't locate

my dive buddy, and I can't find my depth gauge, which is not in its usual place. I know it's still connected, so I start the roll maneuver to bring it over my shoulder. As I roll, I land on something – my buddy – and I've pinned her onto the reef. My heart is beating fast as I try to recover my buoyancy, get off my buddy, make sure she's OK, which thankfully she is, and locate my depth gauge. It takes me a minute, my buddy is checking in with me to make sure that I'm OK, and I finally manage to pull it together.

I stay close to my buddy for the rest of the dive and try to enjoy the experience. I can't quite get into it and am relieved when it's over and I'm back on the boat. Everyone else is talking about what an amazing dive it was, all the wildlife they saw, the perfect conditions, how they felt connected to everything in the blackness of the ocean. I feel nothing except embarrassment and relief that I didn't hurt anyone, get hurt, or cause any damage. I can't remember a single creature that I saw. I'm just trying to figure out what happened. I go to the back of the boat to check my gear. As I pull my weight pockets, I realize that I had someone else's weights in my gear and so I was wildly overweighted, which explains much, although not all, of what happened on the dive. I talk to one of the divemasters who reassures me that I am a good diver who just made some mistakes on this dive. She promises to help me with my weighting before the next dive in the morning.

May 2021, Red Sea, Egypt: This is the last dive of 21 dives on a week-long liveaboard dive trip, and dive #256 in my logbook. It's early morning, calm, and sunny. The entry is easy and as I approach the reef, I am immediately struck by the amount and variety of wildlife. On this trip I've seen hammerhead sharks, mobula rays, turtles, tuna, and other large animals, but this morning I am overwhelmed by the small fish and the coral reef. The reef seems to go on forever with bright red coral, orange and yellow anemones, blue clams and purple soft coral. And

there are so many different schools of fish, each with tens if not hundreds of individuals. Each species, a different size and shape, different color, and different role in the ecosystem. I am struck by how they all co-exist. As we swim along the reef, I start to feel as if my body is dissolving into the water and that I am one with the ocean. I feel a deep connection to all life that I see, and as I swim, the feeling expands to include all life on the planet. I feel small and insignificant, in the vast ocean. At the same time, I feel a deep responsibility to help care for and save the planet from ongoing human destruction. I notice tiny fish living their lives without taking more than they need or creating any waste. I'm acutely aware of the web of life. And I'm smiling. I come back into myself as the divemaster signals the end of the dive. At the safety stop, I acknowledge privately that I have had another transcendent awe experience. As it often does, the experience feels spiritual.

For my capstone, I chose to explore the positive emotion of awe that is elicited by the underwater world. I've been diving for more than 30 years and have had countless experiences of awe. It doesn't happen on every dive, but it's one of reasons that I continue to seek out underwater adventures and jump into oceans around the world. It has changed the way that I see and interact with the world. It brings me joy, meaning, and a sense of wonder. I've long wondered about those awe experiences, even before I had words for them. What is happening to me? Is it just me? What triggers these experiences? What impedes them?

In this capstone, I had the opportunity to merge my scientific training with my spiritual experiences, by conducting an empirical study focused on awe. It is the perfect conclusion to my MAPP journey.

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The last year has been one of remarkable transformation. In the crucible of MAPP and the COVID-19 pandemic I made incredible new friends, expanded my mind, and connected with my deep desire to spend time in nature. It has been life changing. That it all happened on Zoom is truly astounding.

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The Underview Effect – Awe Under the Sea,
Diving for Well-being

“In the upper reaches of pleasure and on the boundary of fear is a little studied emotion – awe” (Keltner & Haidt, 2003, p. 297). I have experienced awe in a variety of circumstances, including in meditation and yoga, during the birth of both of my children, on snowy mountains, at the Grand Canyon, the Taj Mahal, and at the temples of Angkor Wat. I have most often felt awe underwater while scuba diving and have experienced both the pleasure and the fear described by Keltner and Haidt. These underwater awe experiences inspired this empirical capstone which focuses on awe in scuba diving.

This capstone has three aims: (1) provide a brief introduction to the field of positive psychology (2) review the literature on positive emotions, with an emphasis on the emotion of awe and the state of flow; and (3) describe an empirical study that explored the impact of flow and anxiety on the experience of awe in scuba diving.

Part I. Introduction to Positive Psychology

Positive psychology is a relatively new discipline dedicated to the scientific study of what makes life worth living, the positive qualities of individuals, and what makes people thrive and flourish (Seligman & Csikszentmihalyi, 2000). Prior to World War II, psychology had three distinct objectives: to cure mental illness, to make the lives of all people more productive and fulfilling, and to identify and nurture high talent. In the period following World War II however, the focus of psychology was almost entirely on the first objective, and very little attention was paid to the other two (Seligman & Csikszentmihalyi, 2000). As part of his address to the American Psychological Association when he assumed the presidency, Martin Seligman, the father of positive psychology, articulated the goal of the new discipline of positive psychology,

as the identification of those “actions [that] lead to well-being, to positive individuals, and to flourishing communities, and to a just society” (Seligman, 1999, p. 562).

Positive psychology focuses on increasing well-being and is viewed as complementary to mainstream psychology which largely retains its focus on treating people with mental health concerns (Seligman & Csikszentmihalyi, 2000). Using a number line analogy, mainstream psychology can be viewed as moving people who are suffering from some form of mental illness from -5, representing people with a severe form of mental disease, towards zero, or a neutral state, whereas positive psychology aims to help people move from zero, or a neutral state, towards +5, or a state of greater well-being. Positive psychology distinguishes itself from wisdom traditions, happy-ology, and self-help, as a discipline rooted in science. Research in positive psychology utilizes the scientific method to help ensure that claims are evidence based. It is the emphasis on empiricism that sets positive psychology apart from related disciplines and practices which share the same goal of promoting well-being.

Positive psychology focuses on well-being, but what exactly is well-being? Health has been defined to include mental, social, and physical well-being, rather than simply the absence of disease (World Health Organization, 1948). Since the publication of the definition, researchers have proposed a number of frameworks for well-being, several of which are described below. Historically, as far back as Aristotle, there have been two general approaches to well-being: (1) hedonic well-being or feeling good, including elements such as happiness and positive affect, and (2) eudemonic well-being which is functioning well and includes elements such as meaning. Flourishing, the goal of positive psychology requires the pursuit and accumulation of both (Keyes & Annas, 2009; Seligman, 2011).

Prior to the introduction of positive psychology in 1999, several models of well-being

were being used by researchers. Subjective well-being was initially proposed as a construct suggesting that those with the most advantages were happiest (Wilson, 1967). In 1984, Diener proposed a definition of subjective well-being that included positive emotions, life satisfaction, and happiness, along with a scale to measure it scientifically called the *Satisfaction with Life Scale (SWLS)* (Diener, 1984). In 1989, Ryff proposed a model of psychological well-being, that included six dimensions: purpose in life, personal growth, positive relationships, self-acceptance, environmental mastery, and autonomy (Ryff, 1989). More recently, Prilleltensky (2015) suggested a theory of well-being based on mattering, using the acronym I COPPE. The I COPPE model has six domains of well-being – interpersonal, community, occupational, physical, psychological, and economic well-being. According to Prilleltensky, overall life satisfaction is the result of mattering, defined as both feeling valued and adding value. Mattering results from overall satisfaction in each of the six domains (Prilleltensky et al., 2015).

One of the most widely used models of well-being was proposed by Martin Seligman in 2011. The *PERMA* model of well-being is comprised of five distinct elements: positive emotions, engagement, relationships, meaning, and accomplishment, each of which is pursued for its own sake and can be defined and measured independently of the others (Seligman, 2011). Each of the elements contributes to well-being, however no one element defines it. *Positive emotions* reflect the hedonic or pleasurable element, which is one indicator of subjective well-being (Seligman, 2011). *Engagement* involves flow, or optimal experience, a state in which action and awareness merge, resulting in enjoyment without conscious attention to self, time, or emotions. In a flow state, one uses strengths and skills to meet the challenges of an activity (Csikszentmihalyi, 1990). *Positive relationships*, or the capacity to love and be loved, is an inherently human tendency that contributes to well-being across the lifespan. In the oft quoted

words of Christopher Peterson, “other people matter” (Peterson, 2006, p. 249). *Meaning* connotes having a sense of mattering and purpose in life, and serving something larger than oneself (Seligman, 2004, 2011). The fifth element, *accomplishment* involves pursuing goals, seeking mastery, and persevering through difficulties for the sake of achievement without any motivation of external rewards (Seligman, 2011).

According to Seligman (2011), the underpinning of each of the five elements of PERMA is character strengths. Character strengths are positive personality traits, that when used, lead to positive outcomes and contribute to the collective good (Niemiec, 2017). They are capacities of being, which include identity and self-understanding, and of doing, which include behaviors and actions (Niemiec & Pearce, 2020). People who use their character strengths are more likely to flourish than those who do not (Hone et al., 2015; Niemiec, 2017, 2019; Peterson et al., 2007; Peterson & Seligman, 2004) and using one’s top character strengths in new ways can lead to increased flourishing (Niemiec, 2017).

A useful approach to positive psychology was proposed in 2006 by Chris Peterson who suggested that the field could be conceptualized as three related domains which he called the “Pillars of Positive Psychology” (Peterson, 2006, p. 20). The first pillar, positive subjective experiences, includes sensory pleasures, positive emotions, and other positive states. Sensory pleasures, such as taste, smell, and other pleasures of the body are fleeting and momentary. Emotions are more complex and involve patterns of physiological arousal, thoughts, and behaviors. Emotions further differ from sensory pleasure in that they are longer-lasting. Positive states, such as engagement or flow, are similar to positive emotions, but may be nonconscious (Peterson, 2006). The second pillar, positive individuals, includes positive traits such as character strengths, talents, interests, and values. These traits are intrinsic qualities of an

individual and are more enduring and persistent over time. The third pillar, positive institutions, or organizations that enable well-being, addresses families, schools, businesses, communities, and societies. These three pillars provide a lens through which to describe and understand the good life, or well-being (Peterson, 2006). Positive traits and positive institutions are outside the scope of this capstone. Positive emotions and states are considered in further detail in the next section.

Part II. Positive Emotions and States

As described in the previous section, positive subjective experiences, including positive emotions and positive states form one of three pillars of positive psychology (Peterson, 2006). Emotions have been defined as “complex, patterned, organismic reactions to how we think we are doing in our lifelong efforts to survive and flourish and to achieve what we wish for ourselves.” (Lazarus, 1991, p. 6). Emotions are viewed as multidimensional response tendencies that occur over a short time period and they are usually related to a personally meaningful situation or circumstance. Emotions have traditionally been seen as fitting into specific categories of emotion families (Fredrickson, 2001). Affect, a more general concept, describes consciously accessible feelings and is the component of subjective experience of emotion. Affect varies along the dimension of positive and negative emotional activation (Fredrickson, 2001; Tellegen et al., 1999; Watson & Tellegen, 1985). Those experiencing positive affect tend to engage with the environment and continue the activity in which the experience is occurring (Carver & Scheier, 1990).

The ten most common positive emotions have been identified as joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe, and love (Fredrickson, 2009). Benefits of experiencing positive emotions include the building of psychological strengths and social

connections and the improvement and maintenance of physical health (Fredrickson, 2009; Seligman, 2011). Positive affect, which includes both positive emotion and positive mood has been correlated with success in marriage, friendship, career, and mental and physical health (Peterson, 2006).

In addition, positive emotions both signal and produce flourishing, or optimal well-being (Fredrickson, 2001). According to the *broaden and build theory*, positive emotions lead to novel thoughts, activities and relationships which lead to the building of enduring personal resources, including resilience, skills, and knowledge (Fredrickson, 1998, 2001). These resources lead to better health and fulfillment, which produce positive emotions resulting in an upward spiral. Positive emotions create the urge to play, create, explore, savor, integrate or envision future achievement, or broaden ways of thinking and/or acting and these changes lead to enduring personal resources which can be used to counter future threats or challenges (Fredrickson, 1998, 2001). Positive emotions can also drive prosocial behavior (Fredrickson, 2000), including environmentally responsible behavior (Wang & Lyu, 2019).

Several positive emotions, including love, gratitude, compassion, awe, elevation, and admiration, along with the positive state of flow have been further characterized as self-transcendent, resulting from *self-transcendent experiences (STEs)* (Algoe & Haidt, 2009; Haidt, 2003; Yaden et al., 2017). Other elicitors of STEs include mindfulness, peak experiences, and mystical experiences. STEs are characterized by two components: (1) an *annihilational* component which is defined by a sense of bodily dissolution and a reduced sense of boundaries and situational awareness, or self-salience (Yaden et al., 2017), and (2) a *relational* component which is defined as an increased feeling of connectedness with other people, with all of humanity and/or with the environment (Fredrickson, 2009; Yaden et al., 2017). It is suggested that the

annihilational component may serve to reduce the negative aspects of excessive self-focus, including depression, anxiety, and the narrow self-focus of negative emotions (Fredrickson, 2001; Yaden et al., 2017). The relational component may be linked to the processes related to perceived social connection and similarity to other people, leading to increased well-being and pro-social behavior (Yaden et al., 2017). Both components of the self-transcendent experience may occur to varying degrees and may vary independently from one another along a continuum of intensity known as the unitary continuum (Newberg & d'Aquili, 2000; Yaden et al., 2017). Awe, a self-transcendent positive emotion, and flow, a self-transcendent positive state, will be discussed below, as both are explored in the empirical study in Part III of this capstone.

Awe

In this section, I will (1) provide an introduction to the emotion of awe, (2) describe Keltner and Haidt's (2003) conceptual definition of awe, (3) describe the particular characteristics of awe elicited by nature, (4) consider the influence of personality and culture on the experience of awe, (5) discuss methods and scales used in the study of awe, and (6) briefly survey the physical, psychological and social effects of awe, and awe as a self-transcendent experience.

Introduction to Awe

Awe is a complex emotion that is difficult to define. It has been classified as a basic emotion that originates from a combination of wonder and fear (Ekman, 1992). It can be elicited by a wide variety of stimuli and can feel either positive or negative (Gordon et al., 2017; Yaden et al., 2019). While awe can have both a positive or negative valence, it is most often classified as a positive emotion, as the experience is most often positive (Chirico & Yaden, 2018; Shiota et al., 2003). Experiences of awe generally include a perception of vastness and a need to

accommodate the experience into one's mental schemas as it is outside the normal frame of reference (Keltner & Haidt, 2003). The experience also often includes a sense of self-diminishment (also known as the small self), feelings of connectedness to others, and a sense of being in the presence of something greater than oneself, leading researchers to describe awe as a self-transcendent experience (Yaden et al., 2017).

While awe has only recently become the subject of scientific study, philosophers and religious scholars have been studying awe for centuries (Allen, 2018). The epic stories in the world's early religions contain descriptions of awe-inspiring experiences from Moses' encounter with God in the burning bush, to Arjuna's vision of God through the cosmic eye. Each experience was described as initially causing confusion and amazement, followed by transformation and the embrace of new values, characteristics of awe experiences (Keltner & Haidt, 2003). Edmund Burke, a 17th century Irish philosopher proposed that the *sublime* was a feeling of expanded thought produced by viewing landscapes, among other elicitors. He proposed that stimuli that are simultaneously powerful and obscure are most likely to produce sublime experiences (Burke, 1757/1990). Charles Darwin wrote about the grandeur of the view of life wherein countless wonderful and beautiful beings have and continue to evolve from a simple beginning (Darwin, 1859/2004). Early explanations from psychologists include descriptions that approach the concept of awe. McDougall (1910) described admiration as a combination of wonder and power and in describing the feelings that people had towards an object that they admired, included a perception of being in the presence of a higher power, something greater than oneself (McDougall, 1910). In 1964, Maslow described peak experiences as including alterations of space and time, self-forgetfulness, and transcendence (Maslow, 1964).

Conceptual Definition of Awe

Awe can be elicited by a wide range of stimuli, including grand vistas, charismatic people, musical performances, works of art, or epic human achievements such as the Great Wall of China or the Taj Mahal (Allen, 2018). In their seminal paper offering a conceptual approach to awe Keltner and Haidt (2003) propose that the common features of these types of stimuli are (1) perceived vastness, or the feeling of something much larger than oneself, and (2) the need for accommodation, or the need to adjust one's mental structures because of an inability to assimilate the experience (Keltner & Haidt, 2003). A stimulus is considered to be vast if it expands one's normal frame of reference in a particular domain (Shiota et al., 2007). Vastness may be physical, such as the sheer geographical and geological magnitude of the Grand Canyon, or it may be perceptual such as a particularly moving performance of a piece of music. Vastness may also be conceptual such as a complex scientific theory or mathematical equation (Chirico & Yaden, 2018; Yaden et al., 2016).

Accommodation is necessary in cases where mental structures are challenged in the face of an experience of vastness. In the examples from religion described above, each observer was unable to make sense of the experience that he was having, requiring an adjustment in his way of thinking about higher power. When witnessing a virtuoso performance or a panoramic vista, one may feel as if the experience does not fit into one's view of how the world operates, requiring a change to one's way of thinking or viewing the world. If one is able to accommodate the experience, it may lead to feelings of enlightenment; if not, it may lead to feelings of terror (Keltner & Haidt, 2003). However, not all instances of awe require accommodation; in some cases, novelty and/or surprise may be involved (Chirico & Yaden, 2018) and habituation may

play a role as mental structures are updated to incorporate the vastness of the experience (Piff et al., 2015).

In addition to proposing the two central characteristics of awe, Keltner and Haidt also proposed five “flavors” of awe – threat, beauty, ability, virtue, and the supernatural. While these flavors proposed by Keltner and Haidt (2003) are a useful conceptual tool to better distinguish various awe experiences, they have not yet been empirically validated (Chirico & Yaden, 2018).

Awe in Nature

According to E.O. Wilson’s biophilia hypothesis, humans have an “innate tendency to focus on life and lifelike processes” (p. 1) and it has been proposed that exposure to nature increases psychological well-being, including positive emotions (Gullone, 2000; Ulrich, 1993; Wilson, 1984). Nature is a leading elicitor of awe, likely because of its inherent vastness, complexity, and beauty (Allen, 2018; Keltner & Haidt, 2003; Shiota et al., 2007). According to Keltner and Haidt (2003, p. 310), “Nature produced awe involves the diminished self, the giving way of previous conceptual distinctions, and the sensed presence of a higher power.” Natural objects that are vast in relation to the self are more likely to produce awe, as are natural objects that transcend one’s previous knowledge (Keltner & Haidt, 2003).

Individuals who report feeling connected to the natural world also report that the connection is an important part of their sense of self (Mayer & Frantz, 2004) and connectedness with nature has been associated with feelings of community, psychological well-being, and openness to experience (Mayer & Frantz, 2004; Zhang, Howell, et al., 2014; Zhang, Piff, et al., 2014). Those who are more engaged with nature’s beauty are more likely to be prone to dispositional awe (Güsewell & Ruch, 2012b; Zhang & Keltner, 2016).

In a recent study, researchers found that living in an area where more land was dedicated to wilderness was associated with reduced levels of materialism (Joye et al., 2020). When researchers directed participants' attention towards a grove of trees rather than a building, they found that participants were less focused on materialistic values, and after watching videos of awe inspiring scenes, participants were less interested in money, social status or image (Joye et al., 2020). In a separate study, people who watched positive awe inducing videos of nature showed greater improvements in well-being than those watching neutral or threat-based nature videos (Gordon et al., 2017). And in an exploration into the role of awe in nature's power to heal, participants that experienced awe while white water rafting showed increases in well-being and decreases in stress related symptoms one week later (Anderson et al., 2018). It appears then that nature as an awe-inducing stimulus is a powerful lever that can be used to increase well-being.

One specific instance of awe in nature, termed the overview effect, is the profound reaction to viewing the Earth from space (White, 2014; Yaden et al., 2016). Astronauts who have had the experience described deep feelings of awe, self-transcendence, a sense of oneness and connectedness, and an explosion of awareness. An analysis of their writings about the experience indicates feelings of wonder, reverence, humility, and unity. In addition, astronauts who have experienced the overview effect have felt compelled to attempt to change the state of the world (Yaden et al., 2016).

Awe, Personality, and Culture

The emotion of awe is fairly common and has been observed in people of many diverse cultures (Allen, 2018; Bai et al., 2017; Razavi et al., 2016). It is possible for anyone to experience awe however certain personality traits seem to predispose people to the experience.

Those who are more open to experience appear to experience more awe (Shiota et al., 2006; Silvia et al., 2015), while those who are uncomfortable with ambiguous situations tend to experience less awe (Pilgrim et al., 2017; Shiota et al., 2007). People who are more open to experience and more comfortable with ambiguous situations will likely be more comfortable revising their ways of thinking to accommodate novel, complex information, consistent with the need for accommodation component of awe.

On the personality dimension of extraversion/introversion, one study found that people who reported being more extroverted also reported a greater tendency to experience awe (Shiota et al., 2006) while another study found no effect of extraversion on the tendency to feel awe in response to specific situations (Silvia et al., 2015). Self-reported wisdom also seems to correlate with more awe experiences, possibly due to comfort with the unknown and ambiguous situations (Krause & Hayward, 2015). In several studies, dispositional awe has been associated with the emotional character strengths of love, hope, and zest, the intellectual character strengths of love of learning, creativity, and curiosity, and the spiritual character strengths of gratitude and appreciation of beauty (Güsewell & Ruch, 2012a, 2012b). A recent study found that dispositional awe was positively correlated with increased levels of curiosity, and that the increased levels of curiosity predicted academic success in a sample of high school students (Anderson et al., 2020).

The majority of studies on awe have been conducted in Western countries (Allen, 2018), however culture may be important in defining the elicitors of awe. In a multi-country study, researchers found different levels of dispositional awe in adults from the United States, Iran, Malaysia and Poland, with American adults reporting the highest levels and Iranian adults reporting the lowest levels (Razavi et al., 2016). In a study of Chinese and American students,

the most common awe elicitors in both groups were experiences involving another person or nature. However, personal accomplishments were common for the American participants but exceedingly rare for the Chinese students. There were also differences in the number of students from each culture that reported feeling in awe of another person (Bai et al., 2017). While this is a single study, it is critical to understand the implications of culture when considering various types of awe elicitors.

Studying Awe

Awe has been elicited in the lab environment in a variety of ways including asking people to recall an experience of awe and then talk or write about it (Piff et al., 2015; Shiota et al., 2007), showing slides or videos of stimuli likely to induce awe (Piff et al., 2015; Saroglou et al., 2008; Shiota et al., 2011; Silvia et al., 2015), immersing people in an awe inspiring natural environment (Piff et al., 2015), having people read stories that include known elicitors of awe (Piff et al., 2015) and through virtual reality (Chirico et al., 2017; Chirico et al., 2018). A number of scales have been used to measure awe including the awe subscale of the Dispositional Positive Emotion Scale (Shiota et al., 2006). Specific elements of awe including perceived vastness, need for accommodation, and small self, have also been measured using specific survey items and visual representations (Bai et al., 2017; Schurtz et al., 2012; Shiota et al., 2007). More recently, Yaden et al. (2019) developed the *Awe Experience Scale (AWE-S)* which measures six factors including vastness, need for accommodation, time perception, self-diminishment, connectedness, and physical sensations.

Effects of Awe Experiences

Research suggests that feeling awe can lead to a variety of physiological, psychological, and social effects.

Physiological Effects. William James first suggested that physical sensations were an important component of the emotional experience (James, 1884/1948). The emotion of awe has been associated with changes in nervous system activity, chills, and goosebumps (Gordon et al., 2017; Schurtz et al., 2012; Shiota et al., 2011). Physical displays of awe generally include raised inner eyebrows, widening eyes, and dropped jaw. Some people also show a slight forward jutting of the head, and visible inhalation (Darwin, 1872/2015; Shiota et al., 2003).

Using functional MRI researchers have started to explore the neural responses to awe elicited by awe-inspiring videos. The area of the brain involved in matching events with existing knowledge (the middle temporal gyrus or MTG) was deactivated suggesting that accommodation was occurring (Takano & Nomura, 2020). Awe was also associated with connections between the MTG and the posterior cingulate cortex, areas of the brain associated with the pleasure reward process, and the supramarginal gyrus, which is important in the distinction between self and other (Takano & Nomura, 2020). Other researchers using functional MRI have shown down-regulation of key regions of the default mode network, a region of the brain associated with self-referential processing and mind wandering during experiences of awe (van Elk et al., 2019). These results are consistent with the self-reported experience of awe including need for accommodation, changes in time perception, and reduced sense of salience of the self (Yaden et al., 2017).

Psychological Effects. The psychological effects of awe include both cognitive and emotional outcomes (Allen, 2018). One common effect is the feeling of smallness relative to one's surroundings. This effect has been observed in a number of laboratory situations including where participants (1) were asked to describe a time when they observed a beautiful scene in nature (Shiota et al., 2007), (2) wrote about an experience of awe (Campos et al., 2013), (3)

viewed a slide show of spectacular natural scenes (Joye & Bolderdijk, 2015), (4) recalled a time when they felt awe, (5) watched awe-inducing videos, and (6) stood in a grove of tall eucalyptus trees (Piff et al., 2015).

Research has suggested that there are cultural differences in the self-diminishment effect of awe. While all subjects experienced the small-self phenomenon in the presence of grand natural beauty, the effect was greater for tourists from western, individualist cultures than for those from collectivist East Asian cultures (Bai et al., 2017). One possible explanation for the difference is that people in collectivist cultures have a smaller perceived sense of self size than people from individualist cultures, regardless of the presence of awe-inducing stimuli (Kitayama et al., 2009). As an additional consequence of the feeling of self-diminishment, awe may also induce humility through encounters with something larger than oneself, vast, and that challenges one's worldview (Stellar et al., 2018). Feelings of spiritual humility, for religious participants, and intellectual humility, for non-religious participants, was observed following recall of a spiritual experience (Preston & Shin, 2017).

In their conceptual approach to awe, Keltner and Haidt (2003) proposed the need for cognitive accommodation as one of two characteristics common to all prototypical awe experiences. Building on this work, Griskevicius et al. (2010) suggest that awe promotes critical thinking and demonstrated that those who were induced to feel awe were less persuaded by weak arguments. Another study showed that those induced to feel awe were less likely to encode false details into memory suggesting that awe may reduce reliance on internal scripts or prototypes when processing new events (Danvers & Shiota, 2017).

Another effect of feeling awe is an expanded perception of time where one feels immersed in the moment, potentially allowing people to savor the experience (Rudd et al., 2012).

Research also suggests that those experiencing awe feel more connected to others, to humanity in general and to a greater whole (Bai et al., 2017; Shiota et al., 2007). Self-esteem may be a moderator of the feeling of connectedness. People with low self-esteem who were exposed to videos depicting the vastness of the universe reported less identification with others, while those with high self-esteem reported more identification (Hornsey et al., 2018).

Awe experiences may improve mood and life satisfaction. Extraordinary natural scenes that elicited awe led to improved mood (Joye et al., 2020) as did virtual reality experiences of high snowy mountains (Chirico et al., 2018;). Gordon et al. (2017) report that people rated their daily well-being higher on days when they experienced positive awe but showed no change in well-being on days when they experienced threat-based awe. Additionally undergraduate students who spent time in nature reported feeling more awe, and greater life satisfaction and well-being (Anderson et al., 2018). In one study, people who read a story about seeing Paris from the top of the Eiffel Tower (an awe inducing event) reported greater life satisfaction in the moment, than those reading a neutral story, suggesting that short experiences of awe may lead to short term increases in life satisfaction (Allen, 2018; Rudd et al., 2012). While awe generally seems to improve life satisfaction, recent research has shown that when considering meaning in life, two conflicting effects of awe may operate simultaneously. The positive effects of awe, including increased positive affect, positively predicted meaning in life, while the self-diminishment component of awe was inversely correlated with feelings of meaning in life, leading the researchers to conclude that the positive experience of awe both positively and negatively affects meaning in life (Rivera et al., 2020).

People who experience awe may feel less materialistic. People experiencing awe were more likely to choose experiences than goods (Rudd et al., 2012). Awe also appears to weaken

the desire for money (Jiang et al., 2018), and may buffer people from negative feelings related to loss of possessions (Koh et al., 2019). One possible explanation for this result is the self-transcendent nature of awe, leading people to attach less importance to the self, to feel more connected to something larger than themselves, and less concerned with the mundane concerns of daily life (Jiang et al., 2018). Awe is an important component of many religions, particularly the foundational stories and rituals, and may be a driving force in awe-based consciousness, or feelings of spirituality in spiritual seekers who do not identify with any formal religion (Schneider, 2018). Experiences of awe may encourage spiritual/religious behavior (Van Cappellen & Saroglou, 2012) and may lead people to consider supernatural explanations to ambiguous or inexplicable events (Valdesolo & Graham, 2014).

Awe experiences prompt people to question and may lead to attempts to revise their understanding their of how the natural world works (Allen, 2018). Albert Einstein and Carl Sagan both considered awe as a driving force in scientific inquiry and discovery (Valdesolo et al., 2017) and awe has been shown to motivate scientists to search for answers about the natural world (Gottlieb et al., 2018). Further, it has been theorized that awe facilitates scientific learning in children by opening a gap between their knowledge and the awe experience, thus forcing a need for accommodation (Valdesolo et al., 2017). Recent research has shown that induced awe leads to a greater awareness of knowledge gaps which was associated with a greater interest in science (McPhetres, 2019). People who have a greater disposition for awe are more likely to reject scientifically dubious explanations about the world, including, for example creationism (Gottlieb et al., 2018).

Prosocial Effects. In addition to the physical and psychological effects described, awe experiences have been correlated with pro-social behavior (Piff et al., 2015; Prade & Saroglou,

2016; Stellar et al., 2017) and with decreased aggressive attitudes (Yang et al., 2016). People who have written about awe experiences are more willing to volunteer their time, but not money, for a worthy cause or charity. The researchers speculate that the experience may make people feel as if they have additional time for prosocial activity (Rudd et al., 2012). In another study, participants who were induced to feel awe were more generous with money and provided more ethical responses to scenarios that involved amoral behavior (Piff et al., 2015). However other researchers have found, that in different laboratory circumstances, people experiencing awe did not feel more connected or more caring, and were not more willing to donate food, clothing, money, or blood to victims of a natural disaster (Joye & Bolderdijk, 2015). In a recent study where awe was induced by showing awe-inspiring video clips to Chinese undergraduate students, researchers confirmed that individuals higher in dispositional awe had more prosocial tendencies and wanted to donate more money whether they had been induced by either positive- or negative-awe based scenes. Interestingly, those students who were induced with positive awe were more likely to volunteer time than either the students induced with negative awe or the control group of students (Guan et al., 2019).

Awe includes a number of characteristics of STEs, including changes in time perception (Rudd et al., 2012) and changes in self-concept, including self-diminishment (Piff et al., 2015). As described above, awe experiences often result in pro-social behavior, another characteristic of STEs. Additional evidence for the self-transcendent nature of awe comes from a study where awe was induced using a virtual reality experience of a spacewalk along with scenes of earth from space. Participants experienced the vastness and need for accommodation characteristic of awe experiences, along with increases in other self-transcendent emotions including compassion, gratitude, love, optimism, connectedness, and self-relevant thoughts, including self-

diminishment (Nelson-Coffey et al., 2019). Based on investigations into the awe experiences induced by psychedelic substances, it has been proposed that awe experiences induced by other elicitors, if sufficiently intense, may be not only transcendent, but transformative as well (Chirico & Yaden, 2018).

Flow

“A good life is characterized by complete absorption in what one does” (Nakamura & Csikszentmihalyi, 2009, p. 195). This experience, characterized as the flow model of optimal experiences, has been studied since the 1960’s when Csikszentmihalyi strove to understand the intrinsic motivation of artists, who were motivated by the process of creating art itself without interest in any extrinsic reward that the final product might produce (Nakamura & Csikszentmihalyi, 2009). In positive psychology, flow has been conceptualized as a component of eudaimonia (Nakamura & Csikszentmihalyi, 2009) and as the primary manifestation of engagement in the PERMA model of well-being (Seligman, 2011). In this section, I will (1) introduce flow, (2) review the literature on flow and personality, (3) discuss various methods for studying flow, and (4) review the effects of flow on well-being.

Introduction to Flow

Flow is the positive state of being completely absorbed in an enjoyable activity, that is intrinsically motivated (Nakamura & Csikszentmihalyi, 2009). In his seminal work on flow, Csikszentmihalyi identified nine dimensions of the state of flow: (1) identified perceived challenges that match existing skills, (2) merging of action and awareness, (3) clear proximal goals, (4) immediate feedback regarding progress, (5) focused concentration on the present, (6) a sense of control over the situation, (7) loss of awareness of oneself as the actor, (8) a sense that time has passed more quickly than normal, and (9) enjoyment of the activity for its own sake

without consideration of the end goal (Csikszentmihalyi, 1975/2000; Csikszentmihalyi, 1990; Csikszentmihalyi, 1997).

The flow state is characterized by a balance between skill and challenge, where both are just above personal average levels. If the activity is too challenging, one will experience anxiety. If the activity is not challenging enough, one will experience boredom. Feelings of anxiety and/or boredom provide feedback which encourages either improvement of the level of skill and/or an increase in the level of challenge, to achieve the flow state. As people master particular activities or challenges, they must engage in more challenging aspects of the activity, or more complex activities in order to continue experiencing flow. The experience of flow is so enjoyable, that those experiencing it want to repeat it (Nakamura & Csikszentmihalyi, 2009).

Flow is often described as an emotionless state, although individuals often report positive emotions following a flow experience (Csikszentmihalyi & LeFevre, 1989; Jackson, 2000; Rogatko, 2009). It has been argued that the experience of flow leads to positive affect, which leads to subjective well-being, including having a sense of meaning and purpose in daily life (Maddux, 1997). In the flow state, the self fades away and merges with the activity that one is engaged in. The self re-emerges following the experience, feeling enhanced in some way (Csikszentmihalyi, 1990). This loss of self-salience is consistent with the annihilational component of STEs described earlier. There has been little research on the ability of flow to increase pro-social behavior, one of the downstream effects of STEs (Yaden et al., 2017), however, one study established that people enjoy the experience of flow with other people (social flow) rather than the same experience alone (solitary flow) (Walker, 2010), leaving open the possibility that flow may in fact have a pro-social impact.

Flow, Personality, and Culture

Flow has been reported by people of all classes, genders, ages, and cultures and in countless types of activities including amateur and professional sports (Jackson & Csikszentmihalyi, 1999; Jackson & Kimiecik, 2008), academia, education, art creation and performance, games, and mundane activities of daily life (Asakawa, 2004; Dell Fave & Massimini, 2004; Nakamura & Csikszentmihalyi, 2009). While the capacity to experience flow seems to be almost universal, there is significant variability in how often people experience it and in the quality of the flow experience itself (Nakamura & Csikszentmihalyi, 2009). Those that are generally motivated by intrinsic rewards due to curiosity and interest, persistence, tenacity, and low levels of self-absorption, more easily enter and remain in the flow state. These traits are characteristic of the autotelic personality, or someone who enjoys life or engages in activities for their own sake, rather for an external reward (Csikszentmihalyi, 1997).

Research has suggested that facilitators of flow include both self-efficacy, or a belief in one's ability to accomplish a task (Basom & Frase, 2004) and resources, such as performance feedback and training (Bakker, 2005). People that have higher levels of intrinsic motivation are less likely to focus on time and are more likely to lose track of it (Conti, 2001), one of the characteristics of the flow state. In addition, a stronger relationship between challenge and task enjoyment is observed in those with higher levels of intrinsic motivation (Nakamura & Csikszentmihalyi, 2009). People who were motivated by achievement (rather than avoiding failure) were more likely to experience flow in a laboratory task (Puca & Schmalt, 1999), and a need for achievement was found to moderate the relationship between having a highly challenging job and task enjoyment (Eisenberger et al., 2005)

Culture may also be an important factor in whether people experience flow. Cultures have been broadly defined as either individualist, emphasizing the individual, personal values, goals and attitudes, or collectivist where the focus is on the needs, values and goals of the group (Hofstede, 1980). In a study comparing Chinese (collectivist culture) and American (individualist culture) students, researchers found that the Chinese students experienced higher levels of intrinsic motivation in low challenge/high skill conditions rather than the high challenge/high skill conditions characteristic of the flow experience. The researchers attributed this variation partially to collectivist values, specifically interdependent self-construal (Moneta, 2004). In comparing levels of flow in university students in Argentina (an individualist culture) and the Philippines (a collectivist culture), researchers found that students in the individualist culture experienced more flow (Mesurado et al., 2016). While these studies are limited to the academic environment, they suggest that culture may be an important factor in the flow experience.

Studying Flow

Flow has historically been measured using a variety of self-report tools including interviews, scales, and the experience sampling method (Nakamura & Csikszentmihalyi, 2009). A number of different flow scales have been developed, including the 10-item Flow Scale, which measures the frequency with which participants experience flow, and the Flow Questionnaire and Flow Scale, which have been used together to identify particular flow activities and the frequency with which a person engages in their preferred activity (Nakamura & Csikszentmihalyi, 2009). The Dispositional Flow Scale (DFS-2) measures the frequency of flow, and the Flow State Scale (FSS-2) measures the flow dimensions of a just-completed activity (Jackson & Eklund, 2002; Jackson & Marsh, 1996; Jackson et al., 2008).

The *experience sampling method (ESM)* provides in the moment sampling of the participants' experiences and takes samples at random times during the day (Csikszentmihalyi & Larson, 2014; Hektner et al., 2007). ESM has been used to study when the conditions for flow exist, including levels of challenge and skill, and the flow state, by analyzing levels of concentration, enjoyment, and intrinsic motivation (Nakamura & Csikszentmihalyi, 2009). Flow has also been studied in the laboratory setting where levels of challenge and skill can be controlled and manipulated in online learning and gaming, and self-reports of flow dimensions can be measured (Nakamura & Csikszentmihalyi, 2009; Pearce et al., 2005).

Effects of Flow

Research has demonstrated a variety of physiological, cognitive, and psychological effects of the flow experience. Csikszentmihalyi has proposed that those with an autotelic personality can shut down all mental activities except for those that are relevant to the activity in which the person is engaged (Csikszentmihalyi, 1990). Flow has also been described as a state of effortlessness, with a corresponding decrease in activity in the cerebral cortex and with dopamine as a likely key neurotransmitter (Goleman, 1995; Marr, 2001). Other researchers have suggested that during flow, practiced activities are performed automatically, without conscious control, making the process both fast and efficient (Peifer, 2012). Still other research has linked the flow experience with cortisol levels suggesting that moderate physiological arousal may facilitate flow, but excessive arousal may hinder it (Peifer et al., 2014). Following a study of the physiology of pianists performing in a state of flow, researchers suggest that increased activation of the sympathetic nervous system, and deep breathing are both characteristic of the flow experience (Ullén et al., 2010). Lastly, it has been reported that experimentally induced flow is

associated with decreased activation in key regions of the default mode network, the region of the brain most active during passive moments (Ulrich et al., 2014).

Experiencing flow has been linked to cognitive and psychological effects as well. The experience has been associated with student achievement and commitment in high school (Carli et al., 1988; Csikszentmihalyi et al., 1997), academic performance in university students (Engeser et al., 2005), and work satisfaction (Bryce & Haworth, 2002). Teachers' experiences of flow has been associated with student engagement, and to students' experience of flow (Bakker, 2005; Basom & Frase, 2004). In addition, frequent flow experiences have been correlated with positive self-esteem (Nakamura & Csikszentmihalyi, 2009) and experiencing flow regularly has been associated with higher self-determination and intrinsic motivation (Kowal & Fortier, 1999).

Part III. Empirical Study on Scuba Diving and Awe

Scuba diving is a popular recreational activity with between 2.7 and 3.5 million divers in the United States as of 2019 (Diving Equipment and Marketing Association, 2021), although it is perceived as a high risk activity requiring both technical skill and a calm state of mind (Pedersen, 1997). People dive for a variety of reasons including recreation, learning, adventure, social interaction, and excitement (Kaur Kler & Tribe, 2012). It has also been proposed that scuba diving may encourage flourishing through eudemonic means (Kaur Kler & Tribe, 2012), which Ryan and Deci (2001) would argue include personal growth, developing one's potential, pursuit of excellence, and contributing to society (Kaur Kler & Tribe, 2012; Ryan & Deci, 2001).

Eudemonia results when people develop their virtues and strengths in activities about which they are passionate (Fredrickson, 2001; Ryan & Deci, 2001; Seligman, 2011). When seen through the lens of PERMA, scuba diving offers many opportunities to increase strengths and virtues and thereby increase eudemonia and flourishing. As a recreational activity, scuba diving

may increase positive emotions including joy, interest, pride, and awe. It may increase engagement through training and certification leading to increased self-efficacy. Relationships are important to divers whether on a dive boat, at a dive resort, or in local communities. Divers are encouraged to always dive with a buddy, and the number of dive clubs in coastal communities is on the rise (MacCarthy et al., 2006). The social experience also encourages divers to consider their responsibility for protecting the marine environment, and one study found an association between increased specialization in scuba diving and an increase in environmentally responsible behaviors (Thapa et al., 2006).

Scuba diving is a strong elicitor of awe (Lottes & Fleischman, 1982). As described by Albert Tillman “creatures below move casually out of your way as you glide almost effortlessly down to.... a living coral reef, there to look in awe at a gigantic natural kaleidoscopic scene that until that moment could have been touched by only the hand of God” (Tillman, 1966, p. 4). Awe elicited by tourism, such as dive tourism, has a strong positive impact on environmentally responsible behavior. It is suggested that this behavior is driven by the perception of small self, and experimental evidence, using promotional tourism videos, indicates that the effect of awe on behavior is causal (Wang & Lyu, 2019).

The Current Study

This study seeks to determine whether awe elicited by scuba diving is influenced by states of flow and/or anxiety. Scuba diving requires technical skill that must be mastered to survive in, enjoy, and appreciate the underwater environment. Divers must maintain a state of focused attention to ensure that equipment is functioning properly, that appropriate depth, and descent and ascent rates are maintained during a dive, that they are navigating the seascape appropriately and not damaging the environment, and that oxygen levels are being managed. It

has been hypothesized that flow is one important pathway to positive sport experiences (Jackson, 2000). Furthermore, performance in scuba diving requires a calm state of mind (Pedersen, 1997). State anxiety has been inversely correlated with standard underwater scuba skills (Steinberg & Doppelmayr, 2015). High anxiety has been correlated with panic behavior (Bachrach & Egstrom, 1987; Morgan, 1995) and trait anxiety predicts panic behavior in scuba students (Morgan et al., 2004). Avoiding panic underwater is critical as it is a significant factor contributing to diving accidents, injuries, and fatalities (Edmonds & Walker, 1989; Morgan et al., 2019).

Given the positive effects of awe experiences including improved mood, increased life satisfaction, prosocial behavior, and increased environmentally responsible behavior, it would be beneficial to the dive community to have a better understanding of what enables divers to experience awe. Understanding the context which enables awe experiences in scuba diving may lead to further understanding of the awe experience in general and may help to clarify aspects of the awe experience including why some people are more prone to experience the emotion. Lastly, understanding awe in the underwater environment may provide additional understanding of human functioning in other isolated, confined and extreme environments (National Aeronautics and Space Administration, 2014), including space exploration.

This two-part, mixed-methods study seeks to answer the following question: To what extent, if any, do flow and anxiety influence the awe experience for scuba divers? Study 1 was a pilot study conducted with divers on a seven-day liveaboard dive cruise. Study 2 was an internet-based study conducted using recollection tasks. The Institutional Review Board at University of Pennsylvania approved this study.

Study 1 - Pilot Study

Method

Participants

This study was conducted in May 2021 on a liveaboard scuba dive cruise in the Red Sea. A total of 22 participants were recruited: 59% female, mean age 51.41 ($SD=14.05$), and 86% white. The sample was largely experienced with diving: 1 participant had completed less than 100 dives, 10 had completed between 101-500 dives, 6 had completed between 501-1000 dives, and 5 had completed over 1000 dives. All participants were US citizens.

Materials

Recollection Task

Using a recollection task prompt adapted from previous research (Rudd et al., 2012), participants were first asked to describe the dive that they had just completed as follows:

In the course of their dive careers, divers experience good dives, great dives, dives that they don't enjoy, and dives that don't go well. Please describe your experience on the last dive. Try to tell the story exactly as you experienced it, from your point of view, in as much detail as possible. Feel free to write as much as you'd like.

Of the 22 participants, 9 completed the prompt and the remainder did not write a reflection. Following completion of the written prompt, participants were asked to complete scales measuring the components of awe, flow, and anxiety, as further described below.

Awe Scale

The Awe Experience Scale (AWE-S) contains six subscales containing five items each, that measure altered time perception, self-diminishment, connectedness, vastness, physical sensations, and need for accommodation (Yaden et al., 2019). All subscales were administered in their entirety with the exception of the physical sensations subscale. Given the underwater environment and the limitations imposed by scuba equipment (mask, wetsuit, mouthpiece on the

second stage of the regulator), the items on this subscale were deemed irrelevant. Participants were asked to evaluate the degree to which they agreed with each statement on a 7-point scale ranging from 1 (“Strongly Disagree”) to 7 (“Strongly Agree”). Scores for each subscale were calculated by averaging the scores from each item in that subscale, and could range from 1-7, with higher scores indicating greater intensity of the awe experience. The time perception subscale is labeled “Time,” the self-diminishment subscale is labeled “Small self,” the connectedness subscale is labeled “Connectedness,” the vastness subscale is labeled “Vastness,” and the need for accommodation subscale is labeled “Accommodation” in all tables and figures. These scales were reliable as indicated by the Cronbach’s alpha shown in Table 1.

A composite of the five subscales of awe measured in this study including the time, small self, connectedness, vastness and accommodation (Composite Awe), was calculated by averaging the scores on all five subscales. Scores could range from 1-7, with higher scores indicating greater intensity of experience. This scale was reliable as indicated by the Cronbach’s alpha shown in Table 1.

Table 1
Scale Reliabilities – Study 1

Scale	Cronbach’s α	N of items
Flow	.761	9
Anxiety	.708	5
Time	.938	5
Small self	.854	5
Connectedness	.939	5
Vastness	.917	5
Accommodation	.896	5
Composite Awe	.870	25

Flow Scale

The short measure of flow scale (FSS-2) (Jackson & Eklund, 2002) was administered in its entirety. The FSS-2 measures nine dimensions of flow: challenge-skill balance, action-

awareness merging, clear goals, unambiguous feedback, concentration on task, sense of control, loss of self-consciousness, time transformation, and autotelic experience (Csikszentmihalyi, 1990). Participants were asked to evaluate the degree to which they agreed with each statement on a 5-point scale ranging from 1 (“Strongly Disagree”) to 5 (“Strongly Agree”). Scores were calculated by averaging the scores from each item and could range from 1-5, with higher scores indicating greater intensity of the flow experience. All participants except Participant 6 completed the FSS-2. Participant 6 was not included in any analysis that included flow. The FSS-2 is labeled “Flow” in all tables and figures and was found to be reliable (see Table 1).

Anxiety Scale

The short form of the State Trait Anxiety Inventory (STAIS-5) (Zsido et al., 2020) was administered in its entirety. The STAIS-5 measures state of anxiety along 5 dimensions: upset, frightened, nervous, jittery, and confused. Participants were asked to evaluate the degree to which they agreed with each statement on a 4-point scale ranging from 1 (“Not at all”) to 4 (“Very much so”). Scores were calculated by averaging the scores from each item and could range from 1-4, with higher scores indicating greater intensity of the experience of anxiety. The STAIS-5 is labeled “Anxiety” in all tables and figures and was found to be reliable (see Table 1).

Procedure

A survey titled “Scuba Diving and Well-being” which included informed consent, questions about scuba diving experience, a recollection task, items from the awe, flow and anxiety scales described above, and demographic questions, was distributed to all participants following the tenth dive of a planned 21 dive trip. The order of three scales was randomized (Awe-Flow-Anxiety, Flow-Anxiety-Awe, Anxiety-Awe-Flow) and approximately one third of participants received the survey in each order. Participants agreed to the informed consent and

completed the survey on paper. Surveys were collected, data was entered into Excel manually, and analyzed using SPSS statistical analysis software.

Study 1 Results

A composite of the five subscales of awe measured in this study including the time, small self, connectedness, vastness, and accommodation subscales (Composite Awe) was analyzed.

Scores of Composite Awe were very high ($M = 4.65$, $SD = .79$) indicating that divers experienced awe on the dive. Written responses from the recollection task indicated experiences of awe:

At 115 feet you could see the entire hillside and the surface above. The hillside was covered in soft corals.... Deep purples and pinks the sun illuminated everything. It was awe inspiring and beautiful... We were shallow... about 25 feet and we came around a corner that has all table top corals – extremely healthy and vibrant. You just don't see that very often. The magnitude and fragility is a bit incomprehensible. They've been growing for hundreds of years protecting juvenile fishes and watching the waves above. (Participant 15)

From the moment I took the giant stride into the water I knew this would be an enjoyable dive. The water was warm, no issues with gear or buoyancy – it all came together easily. Only a few moments later I saw a hammerhead shark patrolling in 5 meters above me and 20 meters in front, its silhouette both menacing and elegant. The rest of the dive was an effortless exploration of a wall, the west side of Daedalus Reef. Sooo many fish – clouds of them and the profusion of vibrant soft corals, kept my attention and filled me with a sense of wonder and awe. That feeling stays with me long after the dive ended. (Participant 20)

As shown in Table 2, Composite Awe was correlated with the time ($r = .625$, $p = .002$), small self ($r = .595$, $p = .004$), connectedness ($r = .658$, $p = .001$), and vastness ($r = .579$, $p = .006$) components of awe, but not with the accommodation component. Scores on the flow scale were very high ($M = 4.16$, $SD = 0.58$), indicating that the divers experienced flow on the dive. Scores on the anxiety scale were very low ($M = 1.25$, $SD = 0.42$), indicating that the divers did

not experience high levels of anxiety on this dive. Analysis did not reveal any significant correlation between Composite Awe and either flow or anxiety.

Scores on the various components of awe scale are available in Table 2. These scores indicate that most of the divers experienced the vastness and connectedness components of awe, some of the divers experienced the time and need for accommodation components, and most of the divers did not experience the small-self components (see further discussion below).

Table 2
Descriptive Statistics and Correlations – Study 1

Measure	1	2	3	4	5	6	7	8
1. Composite Awe	-							
2. Flow	.362	-						
3. Anxiety	.131	-.41	-					
4. Time	.625**	.278	.156	-				
5. Small Self	.595**	.272	.089	.309	-			
6. Connectedness	.658**	.559**	.070	.313	.337	-		
7. Vastness	.579**	.203	.097	.099	.133	.354	-	
8. Accommodation	.340	-.285	.271	-.001	-.132	-.193	.231	-
<i>M</i>	4.65	4.16	1.26	4.90	3.07	5.24	6.22	3.84
<i>SD</i>	.79	0.58	0.43	1.40	1.46	1.60	1.05	1.59

Note. N=21

** Correlation is significant at the 0.01 level (2-tailed)

Correlation analysis indicates that in this sample, flow and the connectedness component of awe are positively correlated ($r = .559, p = .008$). Flow was not correlated with any of the other components of awe, the components of awe were not correlated with each other, and anxiety was not correlated with either flow or any of the components of awe (Table 2).

Regression analysis indicates that flow predicts the connectedness component of awe ($r = .559, p = .008, df = 19$) and that the correlation is somewhat stronger in the absence of anxiety (when anxiety is controlled for via partial correlation; $r = .583, p = .007, df = 18$). This suggests that anxiety may moderate or mediate the connectedness component of awe, however the sample size in this study is likely too small to detect any such interaction.

Further correlation analysis revealed atypical responding for the items comprising the small-self component of awe. The first four items on the small-self scale were correlated with each other, but not with flow or connectedness (Table 3). Awe-SS5, “I felt small compared to everything else,” was not correlated with the other items on the small-self scale, but was correlated with flow ($r = .535, p = .012$) and with the connectedness component of awe ($r = .521, p = .013$; Table 3). This may indicate that the small-self scale may not be an accurate measure of the small-self component of awe in the context of scuba diving.

Table 3
Descriptive Statistics and Correlations – Awe Small Self, Study 1

Measure	1	2	3	4	5	6	7
1. SS1 ^a	-						
2. SS2 ^b	.672**	-					
3. SS3 ^c	.691**	.841**	-				
4. SS4 ^d	.597**	.815**	.867**	-			
5. SS5 ^e	.256	.117	.088	.051	-		
6. Flow	-.014	.264	.134	.248	.535*	-	
7. Connectedness	.312	.144	.496	.496	.521*	.559**	-
<i>M</i>	3.36	2.45	2.59	2.68	4.18	4.16	5.28
<i>SD</i>	2.13	1.71	1.78	1.78	1.71	0.58	1.57

Notes. N=22 for SS1, SS2, SS3, SS4, SS5 and Connectedness; N=21 for Flow

^a “I felt that my sense of self was diminished”

^b “I felt my sense of self shrink”

^c “I experienced a reduced sense of self”

^d “I felt my sense of self become somehow smaller”

^e “I felt small compared to everything else”

** Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

Study 1 Discussion

The purpose of this pilot study was to determine the influence of flow and anxiety on Composite Awe and on five of the components of awe identified in the AWE-S scale – vastness, connectedness, time perception, small-self, and accommodation. The mean score on the flow scale in this study was extremely high and the mean score on the anxiety scale was extremely low, which may indicate both a ceiling and floor effect in the measurement of these variables.

This may also indicate that there was insufficient variability in this sample to detect any interactions between anxiety, flow, and the components of awe. The lack of variability may be explained by the level of experience in this sample of divers. All divers but one had more than one hundred dives, and some had more than 1,000 dives. It seems likely that all divers had the appropriate skill level to meet the challenge of the dive and so entered a state of flow. Similarly, the experience level of the participants in this sample would suggest they have been in a variety of diving situations, including challenging ones, and so this specific dive, which was not out of the ordinary, did not seem to cause anxiety in the divers.

Nevertheless, some noteworthy findings did emerge from the data. The mean score of the vastness component of awe was the highest level of each of the five components. Considering the vastness of the ocean and the thousands of different species observed on this dive, this result is not surprising. The mean score of the connectedness component was also high. One possible explanation for this result is that when diving, one is very aware that as a human, one is a visitor in an environment that functions naturally without waste or excess. Each species has its role in the ecosystem, and the symbiotic connections between species are on full display. Observing this type of interconnectedness of other species may promote feelings of connectedness, or oneness with nature, the environment, or even with all humanity, consistent with the biophilia hypothesis, which is the human instinct to connect with nature and other living beings (Wilson, 1984).

While alterations in time perception are characteristic of many experiences of awe, scuba diving requires strict attention and focus on the amount of time spent at deeper depths and on overall time. Thus, it is not surprising that the mean score of the time component of awe was somewhat lower than that of vastness or connectedness. The data also suggest that this sample

of divers did not have a need for accommodation to their mental structures on this dive. Again, given the experience level of the divers in this sample, this is not surprising. After hundreds of dives, one has become accustomed to the underwater environment and additional accommodation may not be necessary. The impact of habituation on awe experiences remains an area for further research (Piff et al., 2015).

Considering the vastness of the ocean environment, the number of species, and the size, speed, and ferocity of some of the underwater life, the low mean score on the small-self component of awe was somewhat surprising. However further analysis revealed some atypical responses to the items on this scale. Specifically, the mean score of the item “I felt small compared to everything else” was considerably higher than the mean score of the small-self component overall, and this item was not significantly correlated with any of the other items on the small-self scale. This seems to indicate that the participants may have interpreted this item differently from the other items, suggesting that items on this scale may not covary together in the context of scuba diving, as has been observed in the context of awe induced through recollection tasks, videos of nature and virtual reality (Chirico et al., 2017; Yaden et al., 2019).

One of the most interesting findings from this pilot study was the correlation between flow and connectedness. This finding supports the idea of a relational component of awe as part of the overall awe experience (Yaden et al., 2017), that may be moderated by complete absorption in the activity of diving. Communication while diving is severely limited as verbal communication is impossible, leading to a more solitary experience, uninterrupted by talk. It may be that the isolating underwater environment facilitates the flow experience in experienced divers, and that being in a foreign environment, where humans are not the organizing force, leads

to feelings of connectedness. This may be similar to the feelings of connectedness reported by astronauts when viewing the Earth from space (Yaden et al., 2016).

The pilot study was limited by the very small sample size and by the high level of experience of the participants, which led to ceiling and floor effects in responding to the flow and anxiety scales. To attempt to overcome these issues, Study 2 was conducted by recruiting participants through the internet, with the intent of attracting a larger number of participants, and participants with varied levels of experience.

Study 2 – Recollected Dive Experiences

Method

Participants

Participants over the age of 18 were recruited between May 14 and June 18, 2021, using the snowball sampling technique via the investigators' personal network, Facebook posts, and posts on Reddit pages devoted to scuba diving and underwater photography. There were 155 participants initially recruited for the study however 81 participants were excluded from data analyses for failing to complete the survey, or turning in a blank survey, and 14 were excluded from analyses for failing to write at least one sentence for the writing recollection task. Demographic information for the remaining 60 participants is described in Table 4.

Table 4
Demographic Data – Study 2 reported by condition

Best Dive Condition (N=24)						
Number of Dives	<i>< 100</i> 25.0%	<i>101-200</i> 20.8%	<i>201-500</i> 16.7%	<i>501-1000</i> 25.0%	<i>> 1000</i> 12.5%	
Age	<i>< 30</i> 0%	<i>31 – 40</i> 33.3%	<i>41 – 50</i> 8.3%	<i>51 – 60</i> 25.0%	<i>61 – 70</i> 25.0%	<i>> 70</i> 4.2%
Gender	<i>Female</i> 25.0%	<i>Male</i> 70.8%	<i>Non-binary/Other</i> 4.2%			
Race	<i>American Indian/Alaskan Native</i> 4.2%	<i>Asian</i> 8.3%	<i>Black/African American</i> 0%	<i>Native Hawaiian/Pacific Islander</i> 4.2%	<i>White</i> 70.8%	<i>Other</i> 14.7%%

Note. 1 participant declined to answer the age question. The percentages on race total more than 100% as several participants identified as more than one race. One participant (5.9%) identified as Latino.

Worst Dive Condition (N=19)						
Number of Dives	<i>< 100</i> 31.5%	<i>101-200</i> 21.1%	<i>201-500</i> 10.5%	<i>501-1000</i> 15.8%	<i>> 1000</i> 21.1%	
Age	<i>< 30</i> 15.8%	<i>31 – 40</i> 21.1%	<i>41 – 50</i> 26.3%	<i>51 – 60</i> 10.5%	<i>61 – 70</i> 21.1%	<i>> 70</i> 5.2%
Gender	<i>Female</i> 21.1%	<i>Male</i> 73.7%	<i>Non-binary/Other</i> 4.2%			
Race	<i>American Indian/Alaskan Native</i> 0%	<i>Asian</i> 0%	<i>Black/African American</i> 0%	<i>Native Hawaiian/Pacific Islander</i> 0%	<i>White</i> 100%	<i>Other</i> 0%%

Note. None of the participants identified as Latino.

Why Dive Condition (N=17)						
Number of Dives	< 100 29.5%	101-200 17.6%	201-500 23.5%	501-1000 17.6%	> 1000 11.8%	
Age	< 30 23.5%	31 – 40 17.6%	41 – 50 29.5%	51 – 60 23.5%	61 – 70 5.9%	> 70 0%
Gender	Female 11.8%	Male 88.2%	Non- binary/Other 0%			
Race	American Indian/Alaskan Native 0%	Asian 0%	Black/African American 0%	Native Hawaiian/Pacific Islander 0%	White 100%	Other 0%

Note. One participant (5.9%) identified as Latino.

Materials

Recollection Task

Participants were randomly assigned to one of three recollection tasks adapted from previous research (Rudd et al., 2012), using the following prompts:

Best Dive: *In the course of their dive careers, divers experience good dives, great dives, dives that they don't enjoy, and dives that don't go well. Please describe a dive experience that you felt was your best dive of all time. Try to tell the story exactly as you experienced it, from your point of view, in as much detail as possible. Feel free to write as much as you'd like.*

Worst Dive: *In the course of their dive careers, divers experience good dives, great dives, dives that they don't enjoy, and dives that don't go well. Please describe a dive experience that you felt was your worst dive of all time. Try to tell the story exactly as you experienced it, from your point of view, in as much detail as possible. Feel free to write as much as you'd like.*

Why Dive: *In the course of their dive careers, divers experience good dives, great dives, dives that they don't enjoy, and dives that don't go well. Please describe why you decided to become a scuba diver. Please speak from your point of view, in as much detail as possible. Feel free to write as much as you'd like.*

Awe, Flow, And Anxiety Scales

The same scales used in Study 1 were also used for Study 2. All scales were reliable as indicated in Table 5.

Table 5
Scale Reliability – Study 2

Scale	Cronbach's α	N of items
Flow	.865	9
Anxiety	.845	5
Time	.921	5
Small self	.949	5
Connectedness	.955	5
Vastness	.943	5
Accommodation	.847	5
Composite Awe	.939	25

Procedure

Participants were first directed to an informed consent. Once the participant agreed to the informed consent, they were directed to a Qualtrics survey titled “Scuba Diving and Well-being Study” which included questions about scuba diving experience, one of the three recollections tasks described above (Best Dive, Worst Dive, or Why Dive), items from the awe, flow, and anxiety scales described above, and demographic questions, as described above for Study 1. Following completion of the recollection task, participants were asked to complete scales measuring the components of awe, flow and anxiety, as described above for Study 1. The order of three scales (Awe, Flow and Anxiety) was randomized (Awe-Flow-Anxiety, Flow-Anxiety-Awe, Anxiety-Awe-Flow) and approximately one third of participants received the survey in each order. Following the closing of the survey, data was transferred to MS Excel, and analyzed using SPSS.

Study 2 Results

Analysis of Composite Awe

Composite Awe (a composite of the five subscales of awe in this study combining the time, small self, connectedness, vastness, and accommodation subscales) was analyzed in each of the three conditions. While participants experienced awe in all three conditions, a one-way analysis of variance (ANOVA) found significant differences in Composite Awe between the three conditions, $F(2,59) = 3.836, p = .027$ (see Figure 1). Composite Awe scores were significantly higher in the Best Dive condition ($M = 4.53, SD = 1.35$), followed by the Why Dive condition ($M = 4.16, SD = .87$) and lowest in the Worst Dive condition ($M = 3.51, SD = 1.25$). This difference in mean Composite Awe scores was also statistically significant when the Best Dive condition was compared only to the Worst Dive condition using an independent samples t-test, $t(41) = 2.536, p = .015$.

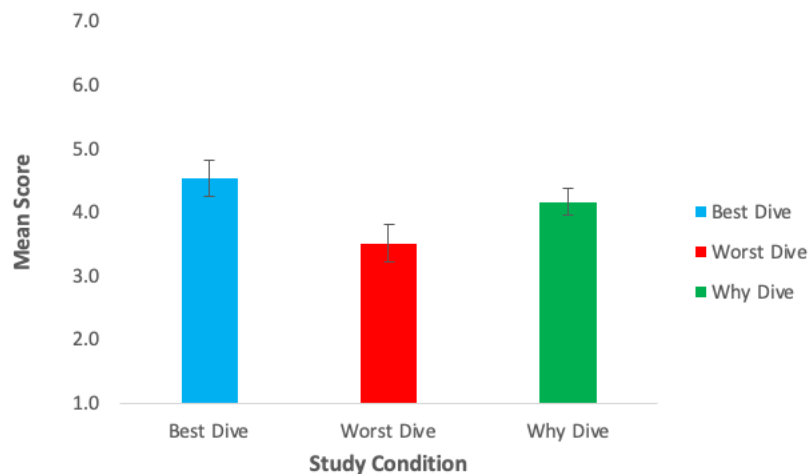


Figure 1. Differences in Composite Awe mean scores for Best Dive, Why Dive, and Worst Dive conditions.

Analyzing the sample as a whole, flow was positively correlated with Composite Awe ($r = .341, p = .008$) and negatively correlated with anxiety ($r = -.566, p = .000$). This means that as scores of flow increased, scores of Composite Awe also increased and scores of anxiety decreased. However, when analyzed by condition, flow was positively correlated with Composite Awe in the Best Dive condition ($r = .477, p = .018$), but not in the Worst Dive or Why Dive conditions. Anxiety was positively correlated with Composite Awe in the Worst Dive condition, but not in the Best Dive or Why Dive conditions. This indicates that for those who recalled their best dive, as scores of flow increased, scores of Composite Awe increased. Contrary to what one might expect, for those in the worst dive condition, as scores of anxiety increased, scores of Composite Awe also increased. This suggests that the element which enabled high scores of Composite Awe was different depending on whether someone wrote about their best dive or their worst dive.

Analysis of Components of Awe

To determine the components of awe that may be important in the awe experience in scuba diving, along with the possible influence of flow and/or anxiety on that experience, the data was analyzed by component and condition. A three-way analysis of variance (ANOVA) revealed significant differences in the flow, anxiety, time, connectedness, and vastness scales between the Worst Dive condition and the Best Dive/Why Dive conditions. No significant differences were observed on either the small self or accommodation scales. Mean score differences are illustrated in Figure 2 and descriptive statistics and ANOVA reported by condition can be found in Table 6.

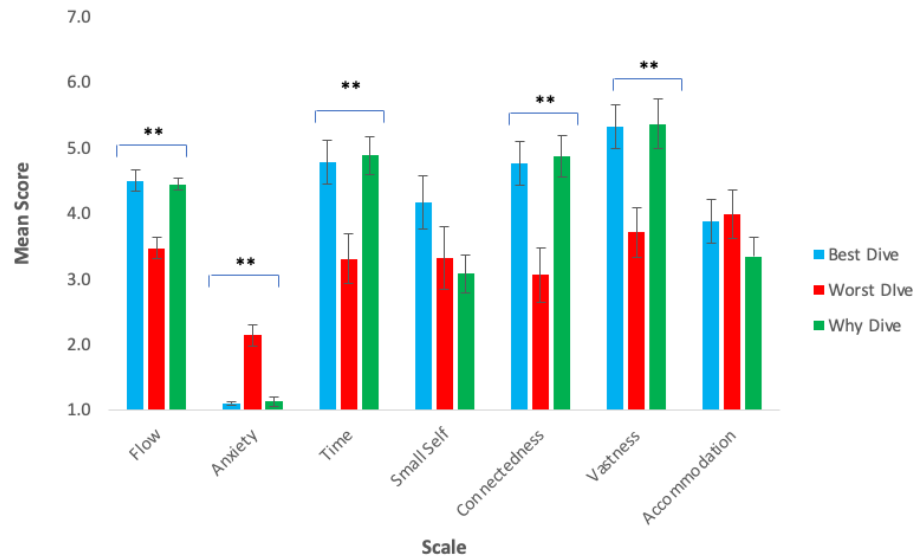


Figure 2. Differences in mean scores for Flow, Anxiety, Time, Small Self, Connectedness, Vastness and Accommodation for Best Dive, Worst Dive and Why Dive conditions. A double asterisk denotes differences found to be statistically significant at the .01 alpha level.

Table 6
Descriptive Statistics and ANOVA (Reported by Condition) – Study 2

Variable Assessed	Experimental Condition			<i>F</i>	η^2
	Best Dive	Worst Dive	Why Dive		
	<i>M</i>	<i>M</i>	<i>M</i>		
1. Flow**	4.50 (.82)	3.47 (.72)	4.44 (.39)	13.809	0.326
2. Anxiety**	1.10 (.17)	2.14 (.74)	1.13 (.29)	33.057	0.537
3. Time**	4.78 (1.68)	3.31 (1.67)	4.88 (1.20)	6.176	0.178
4. Small Self	4.17 (2.02)	3.32 (2.11)	3.08 (1.20)	1.992	0.065
5. Connectedness**	4.76 (1.62)	3.06 (1.77)	4.87 (1.31)	7.803	0.215
6. Vastness**	5.32 (1.70)	3.71 (1.67)	5.36 (1.59)	6.270	0.180
7. Accommodation	3.88 (1.63)	3.98 (1.61)	3.34 (1.24)	0.920	0.031

Note: Best Dive N=24, Worst Dive N=19, Why Dive N=17; Standard deviations appear in parentheses below the means.

* $p < .05$; ** $p < .01$

Participants in the Why Dive condition reported high scores of flow and Composite Awe, comparable to those reported in the Best Dive condition, suggesting that the Why Dive condition did not serve as a control group for Study 2 as planned. Possible reasons will be discussed below. A t-test was conducted to compare only the Best Dive and Worst Dive conditions. Significant differences in the flow, anxiety, time, connectedness, and vastness scales between the Worst Dive condition and the Best Dive conditions were observed. No significant differences were observed on the small self or accommodation scales. The differences in mean scale scores are illustrated in Figure 3. Descriptive statistics and t-test reported by condition can be found in Table 7.

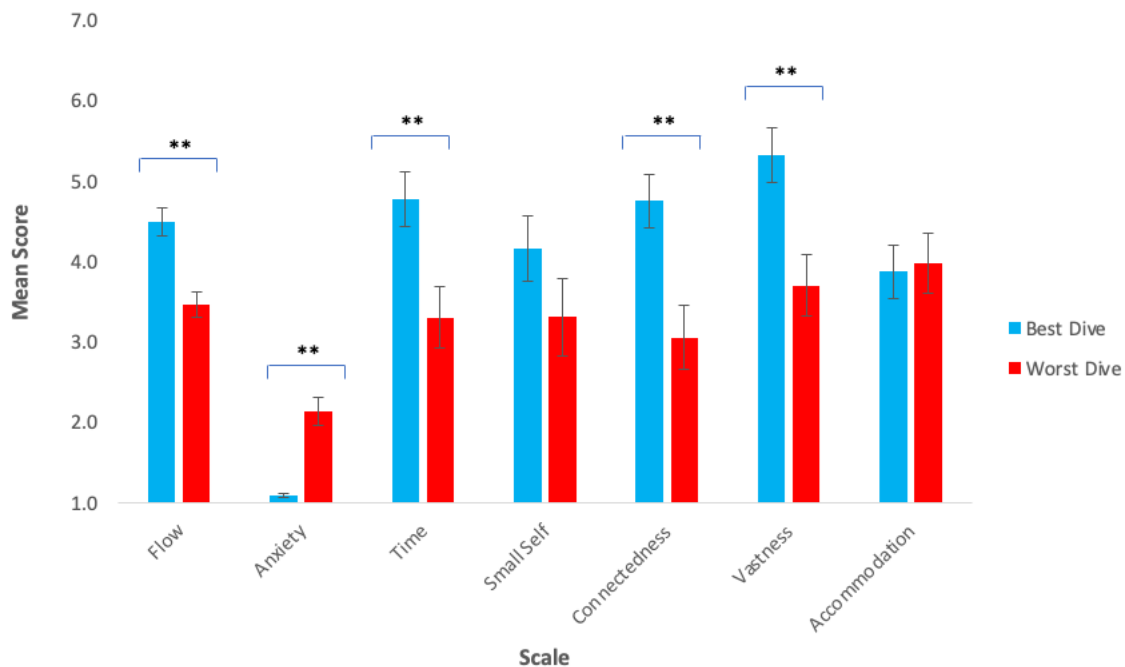


Figure 3. Differences in mean scores for Flow, Anxiety, Time, Small Self, Connectedness, Vastness and Accommodation for the Best Dive and Worst Dive conditions. A double asterisk denotes differences found to be statistically significant at the .01 level.

Table 7
Descriptive Statistics and T-Test (Reported by Condition) – Study 2

Variable Assessed	Experimental Condition		<i>t</i>	<i>D</i>
	Best Dive	Worst Dive		
	<i>M</i>	<i>M</i>		
1. Flow**	4.50 (.82)	3.47 (.72)	4.32	0.78
2. Anxiety**	1.10 (.17)	2.14 (.74)	-6.70	0.50
3. Time**	4.78 (1.68)	3.31 (1.67)	2.86	1.67
4. Small Self	4.17 (2.02)	3.32 (2.11)	1.35	2.06
5. Connectedness**	4.76 (1.62)	3.06 (1.77)	3.27	1.69
6. Vastness**	5.32 (1.70)	3.71 (1.67)	3.11	1.69
7. Accommodation	3.88 (1.63)	3.98 (1.61)	-.192	1.61

Note. Best Dive N = 24, Worst Dive N = 19; Standard deviations appear in parentheses below the mean.

* $p < .05$, ** $p < .01$

The results of both the ANOVA and t-test indicate that the mean scores for flow, time, connectedness, and vastness are higher in the Best Dive condition than in the Worst Dive condition. There is no significant difference between mean scores for small-self or accommodation in the Best Dive and Worst Dive conditions. Mean scores for anxiety are higher in the Worst Dive condition than in the Best Dive condition.

Analyses by Condition

Best Dive. In the Best Dive condition, flow was correlated with the time component ($r = .602, p = .002$), the connectedness component ($r = .595, p = .002$), and the vastness component ($r = .634, p = .001$) of awe. This means that, as flow increases the sense of time alteration, connectedness and the sense of vastness also increase. Additionally, regression analysis

indicates that in the Best Dive condition, flow predicts the time component ($F = 12.516, p = .002$), the connectedness component ($F = 12.074, p = .002$), and the vastness component ($F = 14.792, p = .001$) of awe.

Worst Dive. In the Worst Dive condition, anxiety was correlated with the small-self component ($r = .674, p = .002$) and the accommodation component ($r = .547, p = .002$) of awe. This means that as anxiety increases, the sense of self diminishment and the need for accommodation also increase. Additionally, regression analysis indicates that anxiety predicts the small-self component ($F = 14.176, p = .002$) and the accommodation component ($F = 7.245, p = 0.15$) of awe in the Worst Dive condition. Anxiety was not correlated with the time, connectedness, or vastness components of awe and flow was not correlated with any of the components of awe in the Worst Dive condition.

Why Dive. In the Why Dive condition, flow was inversely correlated with the accommodation component of awe ($r = -.568, p = .017$). This means that as flow increased, the need for accommodation decreased. Regression analysis indicates that low levels of flow predict high levels of the accommodation component of awe, and low levels of the accommodation component predict high levels of flow ($F = 7.126, p = .017$) in the Why Dive condition. Flow was not correlated with the time, small self, connectedness, or vastness components of awe in this condition. Anxiety was not correlated with any of the components of awe in the Why Dive condition.

Exploratory Analyses

Analyses were conducted to determine whether diver experience (number of dives completed), was related to flow, anxiety, and/or any of the components of awe. In the Best Dive condition and the Why Dive condition, number of dives was not correlated with any of the other

factors. In the Worst Dive condition, the number of dives was correlated with anxiety ($r = .472$, $p = .048$) and inversely correlated with flow ($r = -.486$, $p = .041$), but not with any of the components of awe. This means that for participants in the worst dive condition, the greater their number of past dives, the higher their scores of anxiety, and the lower their scores of flow.

Based on the results of the analysis of the small-self component of awe in Study 1, where the AWE-S item *I felt small compared to everything else* (SS-5) was not correlated with any of the other small-self items and was correlated with both flow and the connectedness component of awe, an analysis of the small-self component was undertaken in Study 2. In the Best Dive condition, SS-5 was correlated with all other small-self items but was the only small-self item that was correlated with flow ($r = .478$, $p = .018$) and with the connectedness component of awe ($r = .671$, $p = .000$). SS-5 was not correlated with either flow or the other components of awe in either the Worst Dive or the Why Dive conditions.

Study 2 Discussion

In this study three different recollections tasks – Best Dive, Worst Dive and Why Dive – were used to explore the influence of flow and anxiety on the experience of awe in scuba diving. To consider the effects on the overall awe experience, Composite Awe - consisting of the vastness, connectedness, time, small-self, and accommodation subscales - was used to measure awe, as the physical sensations subscale of the AWE-S scale was deemed irrelevant in the context of scuba diving. Because of this limitation, the Composite Awe measure may have limited usefulness outside of studies on scuba diving.

In the experimental design, the Why Dive condition was intended as the control condition for the Best Dive and the Worst Dive conditions, and it was not expected that this condition would induce awe. However, in comparing the mean Composite Awe scores, awe was in fact

induced in the Why Dive condition, similar to the level of awe induced in the Best Condition. In reviewing the recollection task qualitative data from the Why Dive condition, the participants recollected positive experiences that included components of awe such as:

I felt a level of peace from the moment I first descended... For me it combines my passion for the ocean and being in the water with also a sense of escapism, but also discovery and exploration, as well as also having a progression system where I can continually learn and improve my skills. (Participant 12)

I was hooked to the feeling of weightlessness (actually neutral buoyancy) from the first pool dive I did in my OWD training. After developing my technique a bit and getting used to open water diving, I realized that after every dive I return to the surface with a level of serenity, focus, and calm that's very hard to describe or replicate. The more comfortable I got underwater, the longer that feeling would last after a dive. That feeling would drive me to seek more diving and travel; which in turn brings me to new places and dive sites, giving me a chance to see immense wrecks, float across dramatic underwater landscapes, encounter wildlife that I never expected to see in person - each of which enriches the actual scuba diving experience and perpetually leaves me wanting more. (Participant 53)

These recollections were similar in many ways to the recollections of the participants in the Best Dive condition, who mainly described the specifics of their best dive, but also offered the following:

Resting on the [sand] bar and watching them [sharks], you lose all sense of space and time. The experience is otherworldly. While physically stationary, you are not aware of your physical location. (Participant 59)

One dive that sticks out in my mind was in Bonaire. Many would not claim it as noteworthy, but for me, it showed me how little I am in the world, even so, I belong... The peace and feeling of unity was felt in the depth of my soul. (Participant 38)

It appears then, that the positive experiences recollected by the Why Dive participants were sufficient to induce awe at a level similar to the experiences recollected by the Best Dive

participants. Having no control condition limited the interpretation of the results of this study, nevertheless, some interesting data was observed.

Composite Awe was significantly higher in the Best Dive condition, but was also experienced in the Worst Dive, suggesting that awe in scuba diving may be experienced with either a positive or negative valence, which will be discussed further below.

The data suggest that the Divers in Study 1 and the participants in the Best Dive and Why Dive conditions in Study 2 seemed to have experienced positively-valenced awe elicited by the beauty of nature, awe flavored with aesthetic pleasure (Keltner & Haidt, 2003). While the dive that was the subject of the survey in Study 1 was unlikely to have been a Best Dive for any of the participants, it was an enjoyable dive in one of the top dive locations in the world. Participants in each of these conditions experienced a sense of vastness, connectedness, and an alteration of their perception of time. In the Best Dive condition flow was correlated with, and predicted vastness, connectedness, and alteration in time perception, replicating the results from Study 1. The vastness and connectedness components of awe may indicate an appreciation of the magnitude, majesty of the ocean and an appreciation of the connection among all living things, consistent with the biophilia hypothesis (Wilson, 1984).

On the other hand, participants in the Worst Dive condition in Study 2, may have experienced threat-based awe. The qualitative data revealed that participants in this condition often felt in danger, such as:

I don't remember too much underwater except that I just felt like I didn't really have control. I felt too heavy and I didn't really understand how to stabilize myself. It was a deep dive and I was afraid of sinking and it was also a shipwreck dive so I was afraid of getting lost. In the end, all was ok.... I think it was probably an experience that was beyond my skill and comfort level. (Participant 44)

While teaching an advanced dive class early in my career, my students were working on peak performance buoyancy. My students and I were swimming between two very large rocks in about twenty feet of water. The rocks stuck out of the water about a foot. A large wave crashed on the rocks and a surge rushed under us and between the rocks. The surge picked all of us up, drug us to the surface, and then threw us up on the rocks in one frantic motion. The good news was that we were all fine, not even a scratch on any of us, but we were all shook up. I quickly found that we were all ok and had everyone slide back into the water and then swim to safety so that we did not remain exposed on the rocks. All ended well, but it was a scary situation. (Participant 22)

In the Worst Dive condition, the mean score for Composite Awe was 3.51 (*SD* 1.25), which was well above the minimum possible mean score of 1.00, indicating that these participants did experience awe. In this condition, anxiety was correlated with the small-self and the accommodation components of awe, and anxiety predicted both of these components. In considering the possible dangers participants seemed to experience a sense of diminishment as they confronted the possibility of injury or death. Additionally, anxiety may predict the need for accommodation in this situation, which is unexpected and out of the ordinary. Accommodation may be necessary to maintain calmness and to avoid panic underwater (Edmonds & Walker, 1989; Morgan et al., 2019; Pedersen, 1997). Anxiety was also correlated with number of dives in the worst dive condition. Divers who have completed many dives, who then experience difficult, challenging or unexpected conditions, may experience greater anxiety than those with less experience, who have fewer expectations about what the dive should be like.

In the Why Dive condition, flow and accommodation were inversely correlated and low levels of flow predicted high levels of accommodation. The explanation for this relationship remains unclear, however one possibility is that low levels of flow may indicate a challenge beyond skill level, that is novelty, which might necessitate accommodation of mental schema (Chirico & Yaden, 2018).

Analysis of the small-self component of awe in Study 2, supported the findings from Study 1 in the Best Dive condition. The item “I felt small compared to everything else” was the only item of the five items on the small-self scale that was correlated with flow. This item seems to stand out on this subscale in the context of scuba diving. It may be important, when using the AWE-S scale, to analyze the data at the item level, as items may vary based on the context as they did in this study.

The purpose of Study 2 was to replicate and expand the findings of the Study 1. The Best Dive condition did, for the most part, replicate the Study 1 findings. However, Study 2 was also limited by the very small sample size in each condition and by the lack of a control condition which did not permit analysis of possible interactions between awe, flow and anxiety.

Empirical Study Discussion

One important way to cultivate awe is through engagement with nature. Activities in nature, including scuba diving, can promote a sense of connection with nature and engagement with beauty in nature may lead to awe experiences (Zhang & Keltner, 2016). The studies conducted for this capstone revealed that when considering the experience of awe, context becomes important, as the components of awe may vary independently and may vary depending on the context. The data indicates that, in the context of scuba diving, self-diminishment and the need for accommodation, may be more important in the more negatively valenced experiences, while vastness and connectedness seem to be more important to the positively valenced awe experiences.

Earthquakes, volcanoes, and lightening are all elicitors of awe. Due to the danger associated with each of these stimuli, they are viewed as threats, and the emotion of awe elicited, in addition to the feeling of vastness and the need for accommodation, also includes a component

of fear (Gordon et al., 2017). In these cases, awe has a negative valence (Keltner & Haidt, 2003). Awe elicited by scuba diving in situations where divers feel they are in danger (worst dive condition), was correlated with anxiety, providing evidence for the component of fear in threat-based awe described by Gordon et al. (2017). High levels of self-diminishment, or feeling small, which is consistent with feelings of being in danger or threatened were also noted in the worst dive condition. Additionally, in the worst dive condition, divers had a greater need for accommodation, possibly as a result of attempting to understand the threat that they were facing in the moment. It has been reported that people who are uncomfortable with ambiguous situations tend to experience less awe (Pilgrim et al., 2017; Shiota et al., 2007) and it may be that the confusion or threat experienced by the divers in the worst dive condition is one possible explanation for the lower levels of awe experienced by divers in this condition.

According to Keltner and Haidt (2003) awe may be elicited by beauty – including beauty in nature, proposed to stem from biophilia, an instinctive bond or sense of affinity of human beings with nature (Wilson, 1984, p. 1). In this case, awe is flavored with aesthetic pleasure (Keltner & Haidt, 2003). The empirical studies reported here support this idea. The narratives written by divers in Study 1 and in the best dive and why dive conditions in Study 2 generally described beautiful underwater scenery and interesting or playful marine life. Select examples include:

Suddenly a grouper (mottled in white and dark colors) zoomed around and came head to head with another grouper just below me. He was shaking his head and undulating his body in what I perceived as a show of dominance. We watched them momentarily as we proceeded along the reef getting more shallow. It was quiet except for my breathing and the din of fish chopping on the reef. (Participant 10, Study 1)

To me, the best dives are always when you feel the most immersed in nature. When you forget you're being kept alive by tubes, metal and compressed air. It could be reef/coral formations or animals around you, whatever makes you forget. For me, most recently it was a lot of huge (2 meter+) elephant ear sponges, followed by a couple sea turtles, a

small jellyfish, a whitetip reef shark, and a couple big puffers all in the same dive.”(Participant 6, Study 2 – Best Dive Condition)

I love the ocean and being a part of all the animals and plants that populate the majority of our planet. The oceans are responsible for so much of our existence. It’s amazing to see this up close. One of my most memorable dives was with several hammer head sharks. They simply swam around me. It is so peaceful to see the corals and just lay on the bottom of the ocean and hear the natural sounds of the sea. (Participant 21, Study 2 – Why Dive Condition)

These examples support the biophilia hypothesis through the connection that the divers seemed to feel with the marine wildlife they were observing. Additionally diving and the underwater experience seem to elicit awe through experiences of vastness and accommodation and connection (Keltner & Haidt, 2003). Diving expands one’s normal frame of reference (Shiota et al., 2007) through experiencing an environment in which one is reliant on equipment to breathe, approaching weightlessness and movement in three dimensions, and observing creatures that are unfamiliar, wild, and beautiful.

It became clear through the analysis of the data in this study that the context in which awe is experienced is critical to understanding the experience of the emotion. Divers who were more anxious experienced less awe, and experienced different components of awe than divers who experienced more flow. These findings are consistent with research that indicates other factors, including personality and culture, that may influence the experience of awe. Those who are more open to experience and those who are more comfortable with ambiguity are predisposed to experience more awe (Shiota et al., 2006; Shiota et al., 2007; Silvia et al., 2015). Culture may also influence the experience of awe (Bai et al., 2017) and it may be that the culture of scuba divers is sufficiently different that they experience awe differently. Preliminary evidence for this idea includes the finding that the participants in this study (Study 1 and Best Dive Condition of Study 2) seemed to interpret one of the items of the small-self component on

the AWE-S in an atypical way, indicating that context may be important in understanding the experience of awe in various circumstances.

While this study provided an analysis of the awe experience elicited by both a scuba diving event and a scuba diving recollection task, the study was limited by the small number of participants. Future researchers might attempt to recruit additional participants by distributing the survey on more than one dive cruise, and by allowing an online survey to remain open longer. The participants in the studies reported here were almost all white and all citizens of the United States, a highly individualistic culture. Future research might explore whether race and/or cultural factors influence the awe experience while diving. Awe remains an understudied emotion and future research could include further exploration of the importance of the various subscales of awe in different contexts, including other awe-inducing activities in nature, but also awe experiences elicited by virtuoso performance, spiritual experiences, or charismatic individuals.

Capstone Conclusion

Awe is an understudied positive emotion. It is complex, context dependent, culture-dependent, and challenging to study. In this capstone, I have provided evidence that the awe experienced by scuba divers is consistent with the biophilia hypothesis, which proposes that humans have an affinity for nature and instinctively connect to it (Wilson, 1984). Importantly experiencing awe in nature, including through scuba diving, may be a powerful lever to increase well-being. Considered through the lens of PERMA, awe itself is a positive emotion, so experiencing more awe will lead to greater positive emotion. Awe may lead to increased engagement through interest in scientific inquiry and discovery of the underwater world (Gottlieb et al., 2018; Valdesolo et al., 2017). Awe in nature may improve relationships through

connections with other divers and the dive community. Awe also may increase meaning by promoting critical thinking (Griskevicius et al., 2010), prosocial behavior (Piff et al., 2015; Stellar et al., 2017), and environmentally responsible behaviors (Thapa et al., 2006).

Similar to the overview effect (Yaden et al., 2016), the “underview” effect, experiencing the underwater world as described in this capstone, elicits a remarkable sense of connectedness with nature. Such connectedness with nature may promote psychological well-being through openness to experience (Mayer & Frantz, 2004; Zhang, Howell, et al., 2014; Zhang, Piff, et al., 2014), reduced levels of materialism (Joye et al., 2020), and overall well-being (Anderson et al., 2018; Gordon et al., 2017). While scuba diving is not an activity that is suitable for all, everyone can seek to spend more time in nature, and appreciate it in all of its complexity and beauty. It just might make you feel a little better.

I’ve always loved the idea of exploring an alien world, the ocean is the closest I will get. There’s a thrill of doing something that no one else will get to see or do and I wanted to do that. – Participant 51

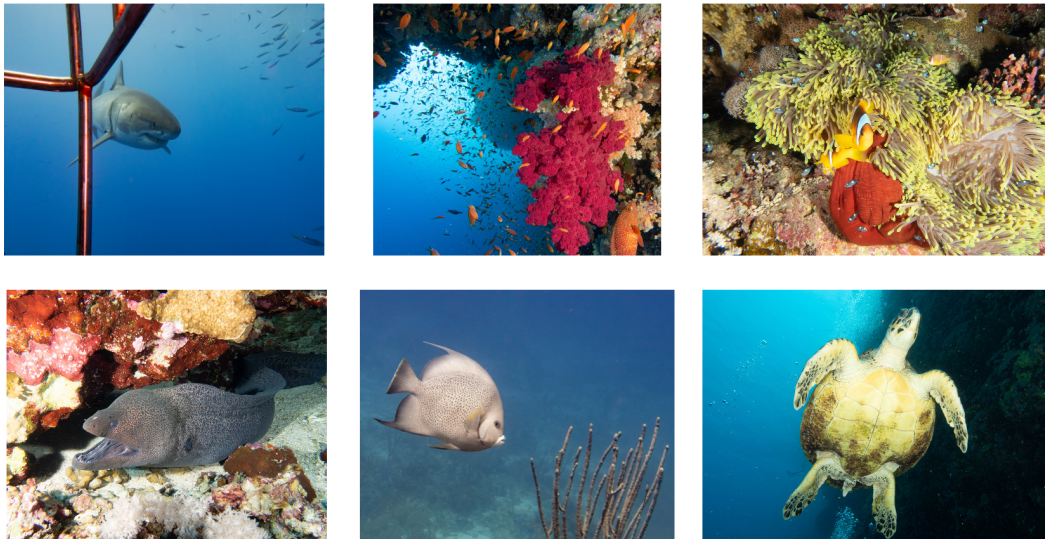


Figure 4. Collage of photos taken by the author in Roatan, Honduras (2017), Guadalupe Island, Mexico (2019) and Red Sea, Egypt (2021).

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