Stress and Brain
https://doi.org/10.26599/SAB.2020.9060003
2021, 1(1): 59–75
ISSN 2709-1325
REVIEW ARTICLE

Psychological research of awe: Definition, functions, and application in psychotherapy

Li Luo[1,2], Jixuan Mao[1], shengdong Chen[1], Wei Gao[1], and Jiajin Yuan[2] (✉)

[1] *Faculty of Psychology, Southwest University, Chongqing 400715, China*
[2] *The Affect Cognition and Regulation Laboratory, Institute of Brain and Psychological Sciences, Sichuan Normal University, Chengdu 610066, China*

ARTICLE INFO

Received: 1 March 2020
Revised: 13 May 2020
Accepted: 22 May 2020

KEYWORDS

awe, self-transcendent emotion, definition, functions, neural basis, application in psychotherapy

ABSTRACT

As a self-transcendent emotion, awe refers to an immediate emotional response or a sustained feeling to various stimuli. The experience of awe is profound and of great significance not only for individual growth but also for social progress. To systematically understand and better conduct future research on awe, this study first illustrates the definition of awe and its widespread functions on prosocial behaviors, well-being, cognition, and self-consciousness. Then, the neuroscientific literature is reviewed, where findings show that the neural basis of awe involves multiple brain regions related to self-consciousness, cognitive control, attention, and emotion. The review also discusses the application of awe in clinical treatments, especially in transpersonal psychotherapy, to inspire individuals to promote spiritual development. Lastly, recommendations on how awe can guide future research are presented.

1 Introduction

When looking up at a starlit sky, facing a remarkable person, listening to wonderful music, or enjoying nature, people may be deeply moved, shocked, and immersed into the object. These feelings can be summarized in one word—awe. The word has a long history in the field of philosophy and religion. It is a complex and mixed emotion, including feelings of wonder, amazement, admiration, shock, fear, and others evoked by an experience that is vast (pragmatically or conceptually). This emotion transcends an individuals' current frame of reference and requires new schema to accommodate that is being perceived [1]. Since Keltner and Haidt offered a systematic proposal of the definition of awe [1], it has received increased attention from psychologists and become an important theme in the field of positive, transcendent, and humanistic psychology [2, 3].

Awe is a self-transcendent emotion that encourages individuals to transcend their day-to-day affairs and shift their attention toward other people's needs and welfare [4, 5]. Therefore, awe is other-focused, which is fundamentally

Address correspondence to yuanjiajin168@126.com

organized by the concern to enhance the welfare of others or by orienting individuals toward a tendency that is better or more important than the usual care [6]. Awe helps individuals to view themselves and the world in a manner unhindered by the boundaries of ego identity [7]. Thus, it plays a crucial role in the spirituality development and behavior formation of individuals.

The central goal of the review is to examine the empirical studies on awe in the field of psychology to systematically understand awe and provide avenues for further research. The study first illustrates the definition of awe and a few of its basic themes. The researchers then provide the psychological consequences of awe on prosocial behaviors, well-being, cognition, and self-consciousness, and illustrate the neural basis of awe and its application in psychotherapy. Finally, recommendations about further avenues for the research on awe are presented.

2 Definition, types, and expression of awe

2.1 Definition

Keltner and Haidt have put forward the most influential definition of awe [1]. The authors approached awe from the perspective of prototype and advanced the prototype theory of awe. They proposed that awe is an emotional response to the vast stimuli that challenge one's accustomed frame of reference in certain domains and demand the perceiver to accommodate. Therefore, two core characteristics, namely, perceived vastness and need for accommodation, are noted when experiencing the feeling of awe. Perceived vastness pertains to an experience as being larger than the self or strongly challenged by the existing experience or frame of reference of the perceiver [1], including physical size and social size, such as fame, authority, and prestige [1]. Need for accommodation, which is inspired by Piaget's work, posits that individuals should adjust their cognition when they fail to make meaning of an experience of a vast concept. When individuals experience the feeling of awe, they feel small, powerless, confused, enlightened, and even rebirthed [1]. Meanwhile, five other non-necessary characteristics are related to awe, namely, threat, beauty, ability, virtue, and supernatural causality, because of the variety and diversity of experiences that elicit awe [1]. These characteristics may play a leading role in the different types of awe.

In contrast to Keltner and Haidt's approach, Bonner and Friedman considered awe using interpretative phenomenological analysis and highlighted the inner feelings in the experience of awe [3]. Through analysis of participants' experiences of and thoughts about awe, Bonner and Friedman revealed ten themes related to awe in the book *Awakening to Awe* by Schneider [8]. These themes can be grouped into three psychological categories, namely, emotional component (fear, connectedness, numinosity, and profoundness), sensory component (heightened perception and presence), and cognitive component (vastness, ineffable wonder, openness and acceptance, and existential awareness) [3]. The authors also discovered that profoundness, connection, and existential awareness are the three most prevalent themes. Bonner and Friedman argued that overlap (e.g., characteristic of openness and acceptance have cognitive and emotional aspects) and reciprocal influences exist among the themes [3]. The majority of researches on awe are based on the definition formulated by Keltner and Haidt [1], who mainly illustrated the state of awe elicited by vast stimuli that can be accommodated but not assimilated.

Keltner and Haidt presented an explanatory model of awe [1], whereas Bonner and Friedman [3] described the experiential aspects of awe. Hence, the work done by Bonner and Friedman complements the prototype model to a certain

extent. Moreover, all authors considered awe as an emotional state.

However, debate regarding the definition of awe as given by Keltner and Haidt is ongoing. First, Schneider proposed that certain stimuli of awe, such as religion, could not be integrated into one's cognitive or external schemas [9]. Another reason is that the feeling of awe is widespread across cultures, whereas the existing studies are mainly focused on western participants. Thus, the definition proposed by Keltner and Haidt and experiential aspects of awe analyzed by Bonner and Friedman neglected cultural differences. Confucius, a Chinese philosopher and educator, said that "There are three things of which the superior man stands in awe. He stands in awe of the ordinances the Heaven. He stands in awe of great men. He stands in awe of the words of sages". Confucius emphasized the importance of respect and fear of awe in the Chinese culture. A recent study confirmed that awe in the Chinese context comprises four core dimensions, namely, prudence, respect, humility, and appreciation [10]. This finding further highlights two characteristics: prudence and respect. Particularly, prudence does not merely pertain to fear of the object itself (e.g., law), but fear of dishallowing or even going against it. Zhao et al. proposed that awe can be viewed from the perspective of individual differences as a form of psychological quality that is relatively stable, enduring, and independent of specific situations [10]. Therefore, awe can be defined as relatively stable, enduring, and implicit personality traits, which suggests the general tendency of individuals to generate and experience awe.

In summary, Keltner and Haidt emphasized the characteristics of awe-eliciting stimuli; Bonner and Friedman illustrated the specific responses of individuals when awe is produced; and Zhao et al. stressed that awe is a type of personality trait. Through the review, the study purports that awe is an immediate emotional response to a momentous occasion and a sustained feeling, specifically, a personality trait. Therefore, awe is defined as an immediate emotional response or sustained feeling to vast stimuli, which may trigger the perceivers to refresh their current cognitive schema. The reason for adopting the term "refresh" instead of "accommodate" is that perceivers may assimilate new information into their schema to reinforce existing feelings of awe for the stimuli or accommodate themselves to new circumstances.

2.2 Classifications of awe

According to object, awe can be divided into three categories, namely, social awe triggered mainly by powerful leaders, profound virtue, and excellent skills; physical awe frequently triggered by natural disasters, natural sceneries, and picturesque paintings; and cognitive awe triggered by concepts, such as grand theory [1].

According to the valence of awe, the study proposes that awe can be divided into positive, negative, and mixed. Positive awe, which accompanies other positive feelings (e.g., amusement and appreciation), can be induced by magnificent natural landscapes, noble moral events, extraordinary achievements, and so on. In contrast, negative awe, which is associated with other negative feelings (e.g., fear and sadness), may be induced by natural disasters, such as volcanic eruptions, earthquakes, and fire, death, and sacrifice, which are threat-based. Sometimes, several stimuli induce awe of mixed valences, such as the deep universe, black hole, and birth, which may trigger awe mixed with fear and joy. The feeling of awe for different valances may markedly differ in terms of appraisal, affective experience, physiological response, and psychological consequence [11].

2.3 Facial expression and physiological reaction of awe

According to the Facial Action Coding System, researchers have found that the facial expressions of awe typically include raised inner eyebrows (action unit (AU) 1), widened eyes (AU 5), and an open, slightly agape mouth (AU 25 and AU 26 or 27) [12–14]. In addition, a slight forward jutting of the head (AU 57) and visible inhalation are common facial displays of awe. Although awe induces such universal facial expressions, the study speculates that similar to dominant emotions, the facial expressions of different emotion-based forms of awe may vary, which requires further research.

In terms of physiological reaction, the rating of awe is positively correlated with the occurrences of goose bumps, that is, a specific response of the sympathetic autonomic nervous system, and muscle/body stiffness [15–17]. Previous research has shown that goose bumps are a result of coldness, awe, fear, and physiological responses (e.g., sneezing, coughing, or other bodily reactions), and so on [15]. Awe (especially direct social, esthetic, and natural awe) is the second frequently occurring type that induces goose bumps in addition to reactions to cold [15]. Furthermore, the literature has shown that variants of awe differ according to the physiological model. The experience of negative (threat-based) awe predicts increased sympathetic autonomic physiological activities (e.g., faster heart rate and higher skin conductance) than positive awe. In contrast, the experience of positive awe predicts increased parasympathetic autonomic physiological activities (e.g., increased respiratory sinus arrhythmia) [11]. Therefore, different appraisals of the same emotion can influence physiological responses. In general, awe is a variable emotion from the perspective of physiological reaction.

3 Induced methods and measures of awe

3.1 Induced methods of awe

In contrast to other self-focused positive emotions, such as pride and happiness elicited by the anticipation of material or social reward, awe is mainly elicited through information-rich stimuli [13]. Existing research has shown that panoramic nature views, extraordinary works of art or music, and one's or another's remarkable accomplishment are the commonly reported triggers of the feeling of awe [13]. The literature also observed the consistency of these elicitors across cultures. For example, interpersonal events and nature are the common elicitors of awe in China and the United States [4, 18].

The induced methods of awe vary across experimental studies. Recalling and writing require participants to recall their personal experiences of awe [11, 13, 19–21]. Conversely, watching videos frequently requires participants to watch awe-eliciting videos, such as clips from Planet Earth depicting various landforms, such as mountains, waterfalls, canyons, and plains [20, 22–24]. In addition, reading relevant materials (e.g., story about ascending the Eiffel Tower and viewing Paris from the tower) and inspecting photographs have been adopted to induce awe [11, 19, 20, 25, 26]. Importantly, these methods can be used simultaneously. For example, Koh et al. required participants to watch a one-minute awe-eliciting video, then wrote about their experience of the theme of the video [27]. Recently, many researchers suggested that awe is not only an emotion but also a deep experience that places the participants in a physical or imaginary place [23]. Hence, many researchers suggest that virtual reality, which is a technology for creating an interactive navigable environment, can be a particularly effective means for inducing awe [23, 24, 28, 29]. Manipulation checks indicated

that all methods can trigger the feeling of awe, but studies that compared differences in the effects of such methods are lacking.

3.2 Measurement of awe

Although complex, many instruments have been developed to measure awe. In terms of the measure of dispositional awe, the most commonly used questionnaire is the dispositional positive emotion scales (DPES) [30]. It is a 38-item, self-report instrument that measures seven dispositional positive emotions, namely, joy, contentment, pride, love, compassion, amusement, and awe. Six items are intended to measure awe (e.g., "I often feel awe" and "I see beauty all around me"). Participants report their level of agreement with each statement on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). High scores indicate high proneness to experience this emotion. Recently, Chinese researchers have compiled the vocabulary assessment scale of dispositional awe (VASDA) [10]. It is a 24-item scale that includes four factors, namely, prudence, respect, humility, and appreciation. Participants are asked to report their level of agreement with each item on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). High scores show increased tendency to experience awe. Clearly, the measurement of awe is extremely different between DPES and VASDA, which may reflect the different understanding of awe across cultures.

The awe experience scale (AWE-S) was developed to measure the state of awe [31]. It is a 30-item multifactorial measurement and includes six factors, namely, altered time perception (e.g., "I sensed things momentarily slow down"), self-diminishment (e.g., "I felt that my sense of self was diminished"), connectedness (e.g., "I had the sense of being connected to everything"), perceived vastness (e.g., "I felt that I was in the presence of something grand"), physical sensations (e.g., "I had goosebumps"), and need for accommodation (e.g., "I felt challenged to mentally process what I was experiencing"). Participants are required to report their level of agreement with each item on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Additionally, experimental studies frequently use a single item to measure the extent of awe felt by participants.

Although several tools are used to measure awe, these scales mainly focus on the general awe of individuals. Remarkably, individuals' awe for a certain area is valuable for research. First, researchers can measure the individual level of awe for a certain object and make better predictions about corresponding behaviors. For example, awe of law and life may be related to crimes. Second, such measurement tools can be used to assess the effect of awe intervention on a certain object. Thus, questionnaires based on elicitors of awe (e.g., law and life) can be developed in the future.

4 Empirical research on awe and psychological consequences

Awe is a product of evolutionary heritage [5] and has a plausible adaptive function for individuals and the society [4, 8]. Keltner and Haidt proposed two methods for promoting the adaption of awe [1]. At the individual level, the cognitive and behavioral effects of awe can broaden openness to new information, which may help people to integrate information and refresh their schemas for survival and development. Second, at the group level, feelings of awe toward powerful leaders provide a nonviolent mechanism, which may facilitate the stabilization of social hierarchies by encouraging submissive and cooperative behavior among subordinates [5]. Numerous studies have explored the psychological outcomes of awe and found the widespread influence of

awe on prosocial behaviors, well-being, cognition, and self-consciousness.

4.1 Awe and prosocial behavior

Prosocial behavior represents a broad category of actions defined by a certain significant segment of society and/or one's social group as generally beneficial to other people [32]. The majority of existing studies have revealed that awe can promote prosocial behaviors. Several researchers have found that participants under the awe condition are more willing to help others in need [19, 33, 34] and more generous to allocate raffle tickets [20] or hypothetical gains in a dictator game [34] compared with those under neutral or self-focused positive conditions (e.g., pride and amusement). Other studies have also shown that participants experiencing awe conduct in a more ecological manner [35, 36] and are more likely to advocate green consumption compared with those under the neutral condition [37]. Moreover, awe can weaken the detrimental effects of a number of factors (e.g., exertion of self-control) on prosocial behaviors [38]. Additionally, awe can decrease aggressive motivation and behavior [33].

Several reasons for why awe can increase prosocial behavior are cited. First, as an other-focused and self-transcendent emotion, awe facilitates the diminishing of individuals' focus on personal concerns and self-interest [34], which can encourage them collectively and prosocial behaviors [18, 20, 33]. Second, studies have found that awe changes the time perspective and consciousness, such that participants under the awe condition are considered to believe that they have more available time and are more patient toward others [19]. Considering that people with plenty of time tend to engage in prosocial behaviors [39], the time-expansion effect of awe is a facilitator of prosocial behaviors [19]. Third, as a spiritual emotion, awe decreases the excessive importance placed on materials or money [21] and increases spiritual-type beliefs [19, 22]. Hence, awe can change values and world views, which enables people to adopt a broad approach for observing and experiencing life, thus transcending the self to behave in a collected manner. Finally, awe triggered by nature or other vast stimuli can bring an experience of oneness, where perceivers integrate themselves into a large group and entity [3]. The experience of oneness reduces the distance between the individual and others and increases feelings of connection [3, 40], which encourages individuals to empathize with the need and welfare of others. Therefore, cultivating awe will help people to improve morality, regulate behavior, and contribute to the harmonious development of society.

4.2 Awe and well-being

Subjective well-being, which is an extremely crucial theme in the field of positive psychology, is one measurement of quality of life of individuals and the society [41]. Evaluations of well-being include emotional reactions to events, moods, and judgments that people form about their life satisfaction, fulfillment, and satisfaction within discrete domains (e.g., marriage, studies, and work) [41]. Therefore, a high level of subjective well-being is considered to include more positive emotions, less negative emotions, and increased satisfaction with life [42].

Research has demonstrated that individuals with high levels of dispositional awe are happier and less anxious as they await performance feedback [26, 43]. In terms of state of awe, studies have shown that participants in the awe group felt more satisfied with their current life compared with participants in the neutral group [19]. Moreover, participants in the awe group felt less negative toward an imagined or actual possession-loss and negative feedback on performance in work from supervisors or colleagues [26, 27]. Furthermore, positive emotion is increased and

anxiety decreased while waiting for performance feedback from others [43]. Meanwhile, Yaden et al. [40] found that individuals can feel inner peace when experiencing awe.

Several reasons account for the relationship between awe and well-being. The broaden-and-build theory of positive emotions suggests that positive emotions can broaden people's momentary thought–action repertoire (i.e., attention, thinking, play, exploration, and similar activities) compared with negative emotions. In addition, the personal resources of such individuals are established, which range from physical and intellectual resources to social and psychological resources [44]. A cumulative experience of positive emotions in life constructs high levels of self-resilience and social bond [44], which are beneficial for improving the possibilities of successful coping and survival. Therefore, positive awe not only provides individuals with pleasurable emotions [45], but also influences mental processes and helps people cope with negative events in life via appropriate actions. Second, the experience of awe has a great and profound influence on observers via the encouragement of self-reflection, which brings people in touch with elements that are not typically considered in routine daily activities. In this manner, awe helps such individuals find meaning in life and create the potential for existential growth and crisis [3]. An empirical study has also shown that the meaning of life mediates the association between awe and well-being [46]. In addition, Bonner and Friedman [3] have suggested that awe increases existential awareness, which brings individuals into the current time and situation. In this regard, individuals can transform into their authentic and unconditioned self, which is positively correlated with well-being [47, 48]. Finally, as previously mentioned, the time-expansion effect of awe renders individuals more patient and slow down the pace of life, which then improves happiness. Conversely, feeling time-starved may result in high stress, negative emotions, and psychosomatic symptoms [49, 50].

Notably, the abovementioned studies focused on the effect of positive awe on momentary well-being. A recent study showed that threat-based awe experiences, which are characterized by greater feelings of fear, decreased this effect [11]. The reason for this phenomenon was partially due to the tendency of threat-based awe to increase the sense of powerlessness. Meanwhile, compared with positive awe, threat-based awe resulted in lower appraisals of personal control/responsibility, less certainty, and higher appraisals of situational uncertainty, which were consistent with the theoretical claim that awe may originate from submissive responses [1]. Accordingly, of equal note is that not all types of awe-eliciting stimuli are advantageous. Therefore, future research should investigate the dark side of awe.

4.3 Awe and cognition

Emotion is closely associated with cognition [51]. Research has shown that participants in the awe group broaden their attention by adopting a more global processing style compared with those in the interest group [52]. In addition, awe influences creative thinking, which is defined as the ability to explore new connections among ideas, thus finding new possible combinations [53]. Chirico et al. [54] have found that participants in the awe group scored higher in the verbal tasks of the Torrance Tests of Creative Thinking compared with participants in the neutral group. The test measures key creative thinking components, such as fluency, flexibility, and elaboration. Moreover, awe is the basis of great scientific achievements and magnificent works of art. Researchers have discovered that awe is positively linked to scientific thinking, which is uncommon among other positive emotions [55].

The reasons for the results are as follows. First, the theory of cognitive dissonance suggests that if someone holds two types of cognition that are psychologically inconsistent, then that person will experience dissonance and find means to change one or both kinds of cognition to render them consonant [56]. Frequently, awe motivates perceivers to accommodate vast stimuli, instead of simply assimilating, which urges people to adjust their cognitive frame through in-depth processing of information [25]. Such a process is beneficial for creative thinking and problem solving. Second, awe decreases cognitive closure [13], and improves the tolerance for uncertainty and openness to experience [30, 57, 58]. These aspects encourage individuals to ponder magnificence, seek answers to the unknown, and find new connections between objects or ideas. Moreover, awe contributes to the cultivation of interest in the unknown. McPhetres [59] has found that participants in the awe condition report high levels of interest in science and high levels of awareness of knowledge gaps compared with those in the amusement condition. Anderson et al. also showed that awe-prone individuals displayed increased curiosity [60]. Consequently, many scholars considered awe as a scientific and epistemological emotion [55, 61].

4.4 Awe and self-consciousness

Feelings of awe can challenge the current worldview of perceivers and help them view themselves and the world in a different manner. A large body of studies have shown that participants experiencing awe can feel small, insignificant, and humbled [17, 20, 33, 62–66]. Compared with participants under other positive emotion conditions, participants under the awe condition present a balanced view of their strengths and weaknesses and admit the contribution of external factors to their personal achievements to a large extent [4]. Additionally, awe increases the emphasis on membership in ''universal'' categories according to the self-concepts of individuals [13]. Through a qualitative study, Yaden et al. [40] examined astronauts who experienced a sense of awe generated by viewing the earth from space and provided evidence that awe enhanced the astronauts' overview effect, that is, feelings of identification with humankind and the planet as a whole. Thus, the cultivation of awe is helpful for long-term changes in individuals in terms of personal outlook and attitude involving their relationship with the outside world.

Although accumulating studies have proved the influence of awe on self-consciousness, researchers should note that the self is a complex concept that includes variable sub-fields, such as self-esteem, self-regulation, self-efficacy, and authenticity. Meanwhile, if awe decreases self-importance, does awe bring negative influence on self-esteem, self-efficacy, and self-regulation and reduce performance? An empirical study has shown that in the face of performance stressors, awe has a positive effect only when participants adopt a self-distancing perspective and focus on the comparative insignificance of obstacles posed by such stressors [66]. Under this circumstance, participants will consider stressors as a challenge. Conversely, if participants focus on the insignificance of one's capabilities, that is, the self-immersion perspective, then awe will become useless, and participants will consider stressors as a threat. Previous studies have shown that the small self induced by awe may become an obstacle during a subsequent performance stressor. Therefore, additional studies should be conducted to explore the relationship between awe and the multiple aspects of self and its consequent influences.

In summary, awe influences how individuals recognize themselves, how they connect with the outside world, and how they behave. It can

bring positive and negative effects, which may be dependent on how the self is appraised and objects perceived when awe is felt.

5 Neural mechanism of awe

Several studies explored the neural basis of awe [67–69]. Research showed that scores for dispositional awe were negatively correlated with regional gray matter volume in the anterior cingulate cortex, middle/posterior cingulate cortex, and middle temporal gyrus [67]. The brain basis differs between positive and negative awe [68]. In one study, participants viewed 15 positive awe, negative awe, and neutral images. The result indicated that positive awe was positively related with gray matter volume (GMV) in the precuneus, which is central to self-reflection and conscious states in humans [69, 70], and negatively related to GMV in the left fusiform and the right calcarine. Negative awe was negatively related with GMV in the left and right insula and the left superior temporal gyrus. Differences in neural basis between positive and negative awe may explain its different influences on psychological and behavioral consequences. Van Elk et al. [71] further investigated the brain networks involved in the experience of awe compared with positive and neutral emotions. In the study, participants watched eight 30-s awe-eliciting, positive, and neutral videos. The result revealed that under the absorption condition (passively observing the video) compared with positive and neutral emotions, awe resulted in less activities in the key regions of the default mode network. This network is related to internally directed attention, including the left frontal pole, left posterior cingulate cortex, left temporal pole, left angular gyrus, and left superior frontal gyrus [72]. In contrast, in the analytic condition (actively counting the number of changes in perspective) compared with positive and neutral emotions, awe resulted in stronger activities of the key regions of the frontoparietal attention network related to externally directed attention, including the supramarginal gyrus, middle frontal gyrus, and the insula [72]. The results suggest that the experience of awe is associated with decreased activities related to self-referential processing and increased activities related to outward processing, which provides neurological evidence that awe is an other-oriented emotion.

In general, these studies have revealed that awe involves multiple brain regions related to self-consciousness, cognitive control, attention, and emotion. This finding provides neural evidences that a key feature of awe is the reduction of attention to self. Notably, Guan et al. [68] and van Elk et al. [71] used only nature-related videos or images to elicit the experience of awe. However, the prototype theory of awe proposes that the elicitors of awe are varied. In addition, Immordino-Yang et al. contrasted the differences of the neural basis of admiration under the ''social'' (admiration for virtue) and ''physical'' (admiration for skill) conditions [73]. The authors found that the social condition results in increased activation in the posterior/inferior posteromedial cortices (PMC), which is involved with introspective processing. In contrast, the physical conditions result in increased activation in the superior/anterior PMC regions involved in the musculoskeletal system.

6 Application of awe in psychotherapy

Although studies on the intervention of awe or using awe as a clinical treatment are lacking, the experimental manipulation of awe has shown its value and potential in psychotherapy and mental health education. Moreover, several psychotherapists stressed the psychotherapeutic approaches that promote awe [8, 74].

In the book *Awakening to Awe*, Schneider paid

particular attention to the nature of awe and its capacity to heal and transform [8]. By interviewing and communicating with various groups, including not only regular individuals but also drug addicts, street gangsters, and chronic patients, Schneider described mental and behavioral changes as an effect of awe. In his view, awe can shape individuals' physical and mental health, as well as positive transformation for humanity development. Moreover, Schneider indicated that the current era is one that lacks awe [8]. However, the experience of awe can be awakened and cultivated in everyday life through various activities, such as mountain climbing, art appreciation, return to nature, and even learning from disasters and depression [75].

Awe may be the primary psychological mechanism underlying several forms of psychotherapy, such as transpersonal psychotherapy, which is an approach used to explore the placement of self in a broad context and to promote the expansion of consciousness and spiritual integration through personal transcendence [74]. Thus, compared with many traditional clinical approaches, transpersonal psychotherapy is concerned not only with the remission of symptoms. It also emphasizes the optimization of personal growth and potential, cultivation of self-transcendence, and connection of individuals with the rest of humanity, the universe, and beyond [74]. Importantly, awe plays a significant role in transpersonal psychotherapy. On the one hand, awe is the core emotional component of spirituality, which is an important aspect of transpersonal psychotherapy [74]. On the other hand, transpersonal psychotherapy involves exercises that can directly potentiate the experience of awe, such as hypnosis and meditation, to promote dissociation of a typical subjective perspective [74]. Moreover, transpersonal psychotherapy can lead to an increased disposition to awe because the subjective experience of modified consciousness can serve as an elicitor of awe [74]. In addition, the expansion of individual states of consciousness in transpersonal psychotherapy augments openness to experience and influences tolerance and creativity [74], where openness and creativity are closely related to awe. Accordingly, guiding clients to increase participation in activities that induce awe may increase the growth of the spiritual dimension, further promoting the realization of transpersonal psychotherapy [74].

Classic psychedelic-assisted psychotherapy is a typical method of transpersonal psychotherapy. Many researchers emphasized that mystical experiences induced by classic psychedelic-assisted psychotherapy has an important role in these positive effects [76, 77]. Hendricks [77] further disclosed that awe may be the core psychological mechanism underlying the effects of such mystical experiences. The reason why this mechanism is proposed is that the feature of the mysterious experiences occasioned by psychedelic-assisted psychotherapy is connectedness or unity with others and/or the external universe [78]. This feature is also a typical characteristic of oneness, which is closely related to awe. In addition, the predictors and outcomes of awe and mystical experiences are consistent to a large extent. Studies have demonstrated that openness is a common and strong predictor of awe and mystical experiences [63, 79]. Meanwhile, awe and mystical experiences have been shown to increase well-being, humility, and prosocial behaviors [19, 20, 76, 80]. Hence, the literature has revealed that awe may be a central emotional characteristic of mystical experiences elicited by psychedelic-assisted psychotherapy. In terms of the role of awe in classic psychedelic-assisted psychotherapy, the model proposed by Hendricks suggested that a psychedelic administration will lead individuals to experience a sense of awe [78], which further produces acute and long-term positive effects through the central mechanism

of the small self, unitive experience, and ego dissociation.

In summary, awe is a critical tool for fostering therapeutic changes. Especially, awe may be the psychological mechanism underlying classic psychedelic-assisted psychotherapy. However, the proposed model previously mentioned remains in the hypothetical stage, and empirical research is required to further prove the role of awe in psychotherapy, which may have a guiding significance for clinical implications.

7 Future directions

The experience of awe can create the potential for adaption and growth [1]. It is central to the experience of nature, social rules and norms, and politics, which encourages people to conform to natural rules or social norms. Therefore, awe is a tool for fostering personal change and for improving public mental health and social order [8]. Since Keltner and Haidt's proposal of a systematic and operational definition of awe [1], the concept has increasingly attracted psychologists to conduct several streams of empirical studies. Furthermore, such studies have accumulated numerous achievements as previously mentioned. However, several limitations remain, which should be further addressed.

First, awe is a less studied emotion. Thus, compared with other emotions, it may be conceptually challenging for many people, including scholars. Researchers have failed to agree on the definition and main characteristics of awe. Therefore, clarifying the definition of awe is necessary for future research.

Second, previous studies were mainly concerned about the beneficial impacts of awe on a series of mental processes and behaviors. However, all topics have a dark side. Aristotle once said that "getting angry … is easy and everyone can do it; but doing it … in the right amount, at the right time, and for the right end, and in the right way is no longer easy, nor can everyone do it". The Zhongyong thinking, which is an important aspect of Confucianism, also underlines the proper extent, proper time, and flexibility in behaviors and emotional expressions. The adaptive value of emotions is dependent on whether or not they are experienced in the right degree, at the right time, and in the right manner [81], which also applies to awe. If the target of awe (e.g., Hitler) is wrong, then it may lead to antisocial behaviors or other terrible results. Consequently, when the benefits of awe are emphasized, boundary conditions should also be explored. Is there a wrong degree of awe? Is there a wrong time for awe? What are the wrong ways to pursue awe? Do wrong types of awe exist? At the same time, eliminating the negative effects of awe is worth investigating. The questions posed are aimed toward the examination of awe in a more comprehensive manner.

Third, at present, the mainstream method for awe is quantitative research, which is economic but will yield commensurately narrow and transient results [9]. Awe is a complex feeling, which cannot simply be measured using certain items and indexed by Arabic numbers. On the contrary, qualitative research, which seeks to answer the "what," "why," and "how" questions, facilitates the understanding of the meaning assigned to the phenomenon under study [82]. Hence, combining quantitative with qualitative methods may considerably broaden the humanistic grasp of the long-term and multi-faceted implications of awe-inspired lives [9].

Fourth, empirical studies on awe intervention are few. Awe is a self-transcendent emotion that can bring a significant influence on one's growth and social development. Awe may help the individual gain deeper knowledge of the self, forsake heresy, return to truth, be tolerant of others, be kind to nature and animals, and even

consider human beings as a community with a shared destiny. As the astronauts said "That's humanity, love, feeling, and thought. You don't see the barriers of color and religion and politics that divide this world." [40] Therefore, in-depth discussions should be made regarding awe intervention in the future to enable people to cultivate awe. On the one hand, the specific approaches for cultivating awe (e.g., writing) should be explored. On the other hand, attention should be paid to the psychological and behavioral effects of awe intervention. For example: Can individual happiness be improved after awe intervention?

Finally, future research should also focus on the influence of the different types of awe. Doing so will not only increase awareness of awe, but also provide better support for interventions. For example: Will intervention in awe of the law reduce the probability of crimes? Will intervention in awe of life alleviate the severity of mental illnesses, such as depression?

8 Conclusions

For humans, spiritual development is one of the most important developmental aspects. Guided by arguments, affective scientists and psychotherapist have shifted their attention to self-transcendent emotions and found that the profound experience of awe is a vital approach for spiritual development. Awe, as illustrated by the review, is a complex and multi-faceted construct. This review has included considerations of awe not only as an emotional state, but also as an attitude toward life, which is a source of human strength. The paper has presented that the influence of awe on life is widespread, and the experience of awe involves multiple brain regions. The incorporation of the awe experience into psychotherapy to help clients grow was also described. However, understanding awe from a distance is impossible. Thus, the construct deserves further exploration via the adoption of multiple perspectives and comprehensive methods. Future research should continue efforts in clarifying the definition and constructs of awe, developing measurement tools for awe, exploring the effects of different types of awe, and expanding the application of awe in life and psychotherapy.

Acknowledgments: This study was funded by the National Natural Science Foundation of China (Nos. NNSF31671164, 31871103, and 31971018), and the Humanity and Social Science Youth Foundation of the Chinese Ministry of Education (No. 17XJC190004).

References

[1] Keltner, D., Haidt, J. Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and Emotion*, **2003**, 17(2): 297–314.

[2] Gable, S. L., Haidt, J. What (and why) is positive psychology? *Review of General Psychology*, **2005**, 9(2): 103–110.

[3] Bonner, E. T., Friedman, H. L. A conceptual clarification of the experience of awe: An interpretative phenomenological analysis. *The Humanistic Psychologist*, **2011**, 39(3): 222–235.

[4] Stellar, J. E., Gordon, A. M., Piff, P. K., Cordaro, D., Anderson, C. L., Bai, Y., Maruskin, L. A., Keltner, D. Self-transcendent emotions and their social functions: Compassion, gratitude, and awe bind us to others through prosociality. *Emotion Review*, **2017**, 9(3): 200–207.

[5] Shiota, M. N., Thrash, T. M., Danvers, A. F., Dombrowski, J. T. Transcending the self: Awe, elevation, and inspiration. In: Tugade, M. M., Shiota, M. N. Kirby, L. D. (eds.), *Handbook of Positive Emotions*. New York: Guilford Press, **2014**: 362–377.

[6] Thrash, T. M., Elliot, A. J. Inspiration: core characteristics, component processes, antecedents, and function. *Journal of Personality and Social Psychology*, **2004**, 87(6): 957–973.

[7] Van Cappellen, P., Rimé, B. Positive emotions and self-transcendence. In: Saroglou, V. (ed.), *Religion,*

Personality, and Social Behavior. New York: Psychology Press, **2014**: 123–145.

[8] Schneider, K. J. Awakening to Awe: Personal Stories of Profound Transformation. Lanham: Jason Aronson, **2009**.

[9] Schneider, K. The resurgence of awe in psychology: Promise, hope, and perils. *The Humanistic Psychologist*, **2017**, 45(2): 103–108.

[10] Zhao, H. H., Xu, Y., Zhang, H. Y. The psychological structure of Chinese trait awe. *Psychological Exploration*, **2019**, 39(4): 345–351. (in Chinese)

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

[12] Shiota, M. N., Campos, B., Keltner, D. The faces of positive emotion. *Annals of the New York Academy of Sciences*, **2006**, 1000(1): 296–299.

[13] Shiota, M. N., Keltner, D., Mossman, A. The nature of awe: Elicitors, appraisals, and effects on self-concept. *Cognition & Emotion*, **2007**, 21(5): 944–963.

[14] Campos, B., Shiota, M. N., Keltner, D., Gonzaga, G. C., Goetz, J. L. What is shared, what is different? Core relational themes and expressive displays of eight positive emotions. *Cognition & Emotion*, **2013**, 27(1): 37–52.

[15] Schurtz, D. R., Blincoe, S., Smith, R. H., Powell, C. A. J., Combs, D. J. Y., Kim, S. H. Exploring the social aspects of goose bumps and their role in awe and envy. *Motivation and Emotion*, **2012**, 36(2): 205–217.

[16] Maruskin, L. A., Thrash, T. M., Elliot, A. J. The chills as a psychological construct: Content universe, factor structure, affective composition, elicitors, trait antecedents, and consequences. *Journal of Personality and Social Psychology*, **2012**, 103(1): 135–157.

[17] Joye, Y., Dewitte, S. Up speeds You down. Awe-evoking monumental buildings trigger behavioral and perceived freezing. *Journal of Environmental Psychology*, **2016**, 47: 112–125.

[18] Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J. E., McNeil, G. D., Peng, K. P., Keltner, D. Awe, the diminished self, and collective engagement: Universals and cultural variations in the small self. *Journal of Personality and Social Psychology*, **2017**, 113(2): 185–209.

[19] Rudd, M., Vohs, K. D., Aaker, J. Awe expands People's perception of time, alters decision making, and enhances well-being. *Psychological Science*, **2012**, 23(10): 1130–1136.

[20] Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., Keltner, D. Awe, the small self, and prosocial behavior. *Journal of Personality and Social Psychology*, **2015**, 108(6): 883–899.

[21] Jiang, L. B., Yin, J., Mei, D. M., Zhu, H., Zhou, X. Y. Awe weakens the desire for money. *Journal of Pacific Rim Psychology*, **2018**, 12: e4, DOI:10.1017/prp.2017.27.

[22] van Cappellen, P., Saroglou, V. Awe activates religious and spiritual feelings and behavioral intentions. *Psychology of Religion and Spirituality*, **2012**, 4(3): 223–236.

[23] Chirico, A., Yaden, D. B., Riva, G., Gaggioli, A. The potential of virtual reality for the investigation of awe. *Frontiers in Psychology*, **2016**, 7: 1766, DOI:10.3389/fpsyg.2016.01766.

[24] Chirico, A., Gaggioli, A. Awe: "more than a feeling". *The Humanistic Psychologist*, **2018**, 46(3): 274–280.

[25] Griskevicius, V., Shiota, M. N., Neufeld, S. L. Influence of different positive emotions on persuasion processing: A functional evolutionary approach. *Emotion*, **2010**, 10(2): 190–206.

[26] Atamba, C. Restorative effects of awe on negative affect after receiving negative performance feedback. *Journal of Psychology in Africa*, **2019**, 29(2): 95–103.

[27] Koh, A. H. Q., Tong, E. M. W., Yuen, A. Y. L. The buffering effect of awe on negative affect towards lost possessions. *The Journal of Positive Psychology*, **2019**, 14(2): 156–165.

[28] Quesnel, D., Riecke, B. E. Are you awed yet? How virtual reality gives us awe and goose bumps. *Frontiers in Psychology*, **2018**, 9: 2158, DOI:10.3389/fpsyg.2018.02158.

[29] Chirico, A., Ferrise, F., Cordella, L., Gaggioli, A. Designing awe in virtual reality: An experimental study. *Frontiers in Psychology*, **2018**, 8: 2351, DOI:10.3389/fpsyg.2017.02351.

[30] Shiota, M. N., Keltner, D., John, O. P. Positive emotion dispositions differentially associated with Big Five personality and attachment style. *The Journal of Positive Psychology*, **2006**, 1(2): 61–71.

[31] Yaden, D. B., Kaufman, S. B., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J. W., Keltner, D. The development of the Awe Experience Scale (AWE-S): A multifactorial measure for a complex emotion. *The Journal of Positive Psychology*, **2019**, 14(4): 474–488.

[32] Penner, L. A., Dovidio, J. F., Piliavin, J. A., Schroeder, D. A. Prosocial behavior: Multilevel perspectives. *Annual Review of Psychology*, **2005**, 56(1): 365–392.

[33] Yang, Y., Yang, Z. Y., Bao, T. X., Liu, Y. Z., Passmore, H. A. Elicited awe decreases aggression. *Journal of Pacific Rim Psychology*, **2016**, 10: e11, DOI:10.1017/prp.2016.8.

[34] Prade, C., Saroglou, V. Awe's effects on generosity and helping. *The Journal of Positive Psychology*, **2016**, 11(5): 522–530.

[35] Yang, Y., Hu, J., Jing, F. J., Nguyen, B. From awe to ecological behavior: The mediating role of connectedness to nature. *Sustainability*, **2018**, 10(7): 2477.

[36] Zhao, H. H., Zhang, H. Y., Xu, Y., Lu, J. M., He, W. Relation between awe and environmentalism: The role of social dominance orientation. *Frontiers in Psychology*, **2018**, 9: 2367, DOI:10.3389/fpsyg.2018.02367.

[37] Wang, L. Y., Zhang, G. L., Shi, P. F., Lu, X. M., Song, F. S. Influence of awe on green consumption: The mediating effect of psychological ownership. *Frontiers in Psychology*, **2019**, 10: 2484, DOI:10.3389/fpsyg.2019.02484.

[38] Li, J., Li, A. K., Sun, Y., e Li, H., Liu, L., Zhan, Y. L., Fan, W., Zhong, Y. P. The effect of preceding self-control on prosocial behaviors: The moderating role of awe. *Frontiers in Psychology*, **2019**, 10: 682, DOI:10.3389/fpsyg.2019.00682.

[39] Darley, J. M., Batson, C. D. "From Jerusalem to Jericho": A study of situational and dispositional variables in helping behavior. *Journal of Personality and Social Psychology*, **1973**, 27(1): 100–108.

[40] Yaden, D. B., Iwry, J., Slack, K. J., Eichstaedt, J. C., Zhao, Y. K., Vaillant, G. E., Newberg, A. B. The overview effect: Awe and self-transcendent experience in space flight. *Psychology of Consciousness: Theory, Research, and Practice*, **2016**, 3(1): 1–11.

[41] Diener, E., Oishi, S., Lucas, R. E. Personality, culture, and subjective well-being: Emotional and cognitive evaluations of life. *Annual Review of Psychology*, **2003**, 54(1): 403–425.

[42] Lyubomirsky, S., King, L., Diener, E. The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin*, **2005**, 131(6): 803–855.

[43] Rankin, K., Andrews, S. E., Sweeny, K. Awe-full uncertainty: Easing discomfort during waiting periods. *The Journal of Positive Psychology*, **2020**, 15(3): 338–347.

[44] Fredrickson, B. L. The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist*, **2001**, 56(3): 218–226.

[45] Fredrickson, B. L. What good are positive emotions? *Review of General Psychology*, **1998**, 2(3): 300–319

[46] Zhao, H. H., Zhang, H. Y., Xu, Y., He, W., Lu, J. M. Why are people high in dispositional awe happier? the roles of meaning in life and materialism. *Frontiers in Psychology*, **2019**, 10: 1208, DOI:10.3389/fpsyg.2019.01208.

[47] Cross, S. E., Gore, J. S., Morris, M. L. The relational-interdependent self-construal, self-concept consistency, and well-being. *Journal of Personality and Social Psychology*, **2003**, 85(5): 933–944.

[48] Cooper, A. B., Sherman, R. A., Rauthmann, J. F., Serfass, D. G., Brown, N. A. Feeling good and authentic: Experienced authenticity in daily life is predicted by positive feelings and situation characteristics, not trait-state consistency. *Journal of Research in Personality*, **2018**, 77: 57–69.

[49] Burke, R. J., El-Kot, G.. (2009). Material affluence, time affluence and well-being among managers in Egypt. *Industrial Relations and Human Resources Journal,* **2009***,* 11(2): 11–24, DOI: 10.4026/1303-2860.2009.0098.x.

[50] Kasser, T., Sheldon, K. M. Time affluence as a path toward personal happiness and ethical business practice: Empirical evidence from four studies. *Journal of Business Ethics*, **2009**, 84(S2): 243–255.

[51] Baas, M., de Dreu, C. K. W., Nijstad, B. A. A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, **2008**, 134(6): 779–806.

[52] Sung, B., Yih, J. Does interest broaden or narrow attentional scope? *Cognition and Emotion*, **2016**, 30(8): 1485–1494.

[53] Torrance, E. P. Understanding creativity: Where to start? *Psychological Inquiry*, **1993**, 4(3): 232–234.

[54] Chirico, A., Glaveanu, V. P., Cipresso, P., Riva, G., Gaggioli, A. Awe enhances creative thinking: An experimental study. *Creativity Research Journal*, **2018**, 30(2): 123–131.

[55] Gottlieb, S., Keltner, D., Lombrozo, T. Awe as a scientific emotion. *Cognitive Science*, **2018**, 42(6): 2081–2094.

[56] Aronson, E., Festinger, L. Back to the future: Retrospective review of Leon festinger's "A theory of cognitive dissonance". *The American Journal of Psychology*, **1997**, 110(1): 127.

[57] Valdesolo, P., Graham, J. Awe, uncertainty, and agency detection. *Psychological Science*, **2014**, 25(1): 170–178.

[58] Silvia, P. J., Fayn, K., Nusbaum, E. C., Beaty, R. E. Openness to experience and awe in response to nature and music: Personality and profound aesthetic experiences. *Psychology of Aesthetics, Creativity, and the Arts*, **2015**, 9(4): 376–384.

[59] Mcphetres, J. Oh, the things You don't know: Awe promotes awareness of knowledge gaps and science interest. *Cognition and Emotion*, **2019**, 33(8): 1599–1615.

[60] Anderson, C. L., Dixson, D. D., Monroy, M., Keltner, D. Are awe-prone people more curious? The relationship between dispositional awe, curiosity, and academic outcomes. *Journal of Personality*, **2019**: jopy.12524.

[61] Simon-Thomas, E. R., Keltner, D. J., Sauter, D., Sinicropi-Yao, L., Abramson, A. The voice conveys specific emotions: Evidence from vocal burst displays. *Emotion*, **2009**, 9(6): 838–846.

[62] Preston, J. L., Shin, F. Spiritual experiences evoke awe through the small self in both religious and non-religious individuals. *Journal of Experimental Social Psychology*, **2017**, 70: 212–221.

[63] van Elk, M., Karinen, A., Specker, E., Stamkou, E., Baas, M. 'standing in awe': The effects of awe on body perception and the relation with absorption. *Collabra*, **2016**, 2(1): 4.

[64] Ruberton, P. M., Kruse, E., Lyubomirsky, S. Boosting state humility via gratitude, self-affirmation, and awe: Theoretical and empirical perspectives. In: Worthington, E., Davis, D., Hook, J. (eds.), *Handbook of Humility*. New York: Routledge, **2016**.

[65] Lee, K. Awe and humility: Intrinsic value in nature. Beyond an earthbound environmental ethics. *Royal Institute of Philosophy Supplement*, **1994**, 36: 89–101.

[66] Le, P. Q., Saltsman, T. L., Seery, M. D., Ward, D. E., Kondrak, C. L., Lamarche, V. M. When a small self means manageable obstacles: Spontaneous self-distancing predicts divergent effects of awe during a subsequent performance stressor. *Journal of Experimental Social Psychology*, **2019**, 80: 59–66.

[67] Guan, F., Xiang, Y. H., Chen, O. T., Wang, W. X., Chen, J. Neural basis of dispositional awe. *Frontiers in Behavioral Neuroscience*, **2018**, 12: 209, DOI:10.3389/fnbeh.2018.00209.

[68] Guan, F., Zhao, S. S., Chen, S. N., Lu, S., Chen, J., Xiang, Y. H. The neural correlate difference between positive and negative awe. *Frontiers in Human Neuroscience*, **2019**, 13: 206, DOI:10.3389/fnhum.2019.00206.

[69] Kjaer, T. W., Nowak, M., Lou, H. C. Reflective self-awareness and conscious states: PET evidence for a common midline parietofrontal core. *NeuroImage*, **2002**, 17(2): 1080–1086.

[70] Vago, D. R., Silbersweig, D. A. Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience*, **2012**, 6: 296, DOI:10.3389/fnhum.2012.00296.

[71] Elk, M., Arciniegas Gomez, M. A., Zwaag, W., Schie, H. T., Sauter, D. The neural correlates of the awe experience: Reduced default mode network activity during feelings of awe. *Human Brain Mapping*, **2019**: hbm.24616.

[72] Raichle, M. E. The brain's default mode network. *Annual Review of Neuroscience*, **2015**, 38(1): 433–447.

[73] Immordino-Yang, M. H., McColl, A., Damasio, H., Damasio, A. Neural correlates of admiration and compassion. *Proceedings of the National Academy of Sciences of the United States of America*, **2009**, 106(19): 8021–8026.

[74] Bonner, E. T., Friedman, H. L. The role of awe in psychotherapy: Perspectives from transpersonal psychology. *Voices the Art & Science of Psychotherapy*, **2016**, 52(1): 62–71.

[75] Schneider, K. J. Rediscovering awe: A new front in humanistic psychology, psychotherapy, and society. *Canadian Journal of Counseling and Psychotherapy*, **2008**, 42(1): 67–74.

[76] Griffiths, R. R., Johnson, M. W., Richards, W. A., Richards, B. D., McCann, U., Jesse, R. Psilocybin occasioned mystical-type experiences: Immediate and persisting dose-related effects. *Psychopharmacology*, **2011**, 218(4): 649–665.

[77] Ross, S., Bossis, A., Guss, J., Agin-Liebes, G., Malone, T., Cohen, B., Mennenga, S. E., Belser, A., Kalliontzi, K., Babb, J. et al. Rapid and sustained symptom reduction following psilocybin treatment for anxiety and depression in patients with life-threatening cancer: A randomized controlled trial. *Journal of Psychopharmacology*, **2016**, 30(12): 1165–1180.

[78] Hendricks, P. S. Awe: a putative mechanism underlying the effects of classic psychedelic-assisted psychotherapy. *International Review of Psychiatry*, **2018**, 30(4): 331–342.

[79] Studerus, E., Gamma, A., Kometer, M., Vollenweider, F. X. Prediction of psilocybin response in healthy volunteers. *PLoS One*, **2012**, 7(2): e30800, DOI:10.1371/journal.pone.0030800.

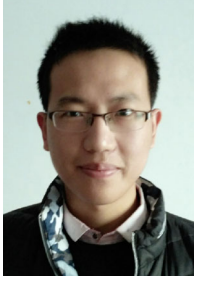
[80] Stellar, J. E., Gordon, A., Anderson, C. L., Piff, P. K., McNeil, G. D., Keltner, D. Awe and humility. *Journal of Personality and Social Psychology*, **2018**, 114(2): 258–269.

[81] Gruber, J., Mauss, I. B., Tamir, M. A dark side of happiness? how, when, and why happiness is not always good. *Perspectives on Psychological Science*, **2011**, 6(3): 222–233.

[82] Buston, K., Parry-Jones, W., Livingston, M., Wood, S., Bogan, A. Qualitative research. *British Journal of Psychiatry*, **1998**, 172(3): 197–199.

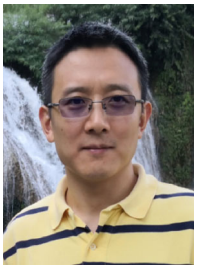
Li Luo is a Ph.D. student in psychology in Southwest University. Her current research interests are focused on the emotion of awe and its influence on individual behaviors. E-mail: luoliv9@aliyun.com.

Jixuan Mao is a postgraduate student at the Faculty of Psychology in Southwest University. Her research interests focus on emotion regulation in social context and anhedonia in depression. E-mail: sxhjmjx@163.com.



Shengdong Chen is now studying for his doctor's degree at the Faculty of Psychology in Southwest University. His research interests mainly focus on the cognitive and neutral mechanisms of automatic emotion regulation, and its application in the treatment of emotional disorders (e.g., depression). He is now using multimodal functional magnetic resonance imaging (fMRI) and event-related potentials (ERP)-electroencefalograpy (EEG) approaches to explore these relevant questions. E-mail: csddyx@outlook.com

Gao Wei is a Ph.D. student in psychology in Southwest University. His current research interests are focused on the interrelationship and neural mechanism between cognitive flexibility and emotion regulation flexibility. E-mail: Gavin2234@126.com.



Jiajin Yuan received his Ph.D. degree from Southwest University, China (2009), and then received his postdoctoral training in the University of Chicago (2011–2012). Now, he is a full professor and doctoral supervisor in Sichuan Normal University. He was selected as the Young Top Talent of the High-level Talent Special Support Program in Chongqing (2017) and the first Hanhong Youth Talent Support Project of Southwest University (2017). He won the second Hanxiang Young Scientist Award (2019). He has published more than 70 papers on journals including *Neuroscience & Biobehavioral Reviews*, *JAMA Network Open*, *Social Cognitive & Affective Neuroscience*, *Human Brain Mapping*, *Cognitive, Affective & Behavioral Neuroscience*, *Neuropsychologia*, *Psychophysiology and Biological Psychology*, etc. His current research interests are focused on psychological and cognitive neuroscience research in the fields of emotional susceptibility and mental health, emotional regulation and behavioral control. E-mail: yuanjiajin168@126.com.