



The Potential Role of Awe for Depression: Reassembling the Puzzle

Alice Chirico^{1*} and Andrea Gaggioli^{1,2*}

¹ Catholic University of the Sacred Heart of Milan, Milan, Italy, ² Applied Technology for Neuro-Psychology Lab, Istituto Auxologico Italiano, Milan, Italy

OPEN ACCESS

Edited by:

Timothy J. Strauman,
Duke University, United States

Reviewed by:

Eleni Petkari,
Universidad Internacional De La
Rioja, Spain
Lisbeth Carolina Bethelmy Rincón,
Simón Bolívar University, Venezuela

*Correspondence:

Alice Chirico
alice.chirico@unicatt.it
Andrea Gaggioli
andrea.gaggioli@unicatt.it

Specialty section:

This article was submitted to
Emotion Science,
a section of the journal
Frontiers in Psychology

Received: 15 October 2020

Accepted: 17 March 2021

Published: 26 April 2021

Citation:

Chirico A and Gaggioli A (2021) The
Potential Role of Awe for Depression:
Reassembling the Puzzle.
Front. Psychol. 12:617715.
doi: 10.3389/fpsyg.2021.617715

Recently, interest in the unique pathways linking discrete positive emotions to specific health outcomes has gained increasing attention, but the role of awe is yet to be elucidated. Awe is a complex and transformative emotion that can restructure individuals' mental frames so deeply that it could be considered a therapeutic asset for major mental health major issues, including depression. Despite sparse evidence showing a potential connection between depression and awe, this link has not been combined into a proposal resulting in specific intervention guidelines. The aim of this perspective was three-fold: (i) to provide a new unifying model of awe's functioning—the Matryoshka model; (ii) to show systematic and explicit connections between this emotion and depression; and (iii) to suggest specific guidelines of intervention utilizing the potential therapeutic role of awe for mental health, specifically for depression. This theoretical endeavor in its entirety has been framed within the health domain.

Keywords: awe, mental health, depression, Matryoshka model, complex emotions

INTRODUCTION

Recently, within the framework of positive psychology (Ryff and Singer, 2000; Seligman and Csikszentmihalyi, 2000), interest in the unique pathways linking discrete positive emotions to wellbeing promotion has emerged increasingly (e.g., Barrett-Cheetham et al., 2016). Although awe—a complex emotion characterized by an appraisal of vastness and a need for accommodation—has attracted the interest of many researchers in the last 20 years (Sundararajan, 2002; Keltner and Haidt, 2003; Shiota et al., 2007; Chirico et al., 2016; Nelson-Coffey et al., 2019; Chirico, 2020), this phenomenon is still “*in need of research attention in the realm of well-being*” (Barrett-Cheetham et al., 2016, p. 603). This is especially true in the mental health domain.

Pathways between several negative emotions and poor health have been widely investigated (Coifman et al., 2016; Kunzmann et al., 2019), yet the role of specific discrete positive emotions in fostering mental health has only recently become an object of interest (Tugade et al., 2004; Cohen and Pressman, 2006; Anderson et al., 2018; Chirico et al., 2021), especially within the positive psychology framework (Shiota et al., 2017). However, the contribution of discrete complex emotions, such as awe, is practically unexplored. Awe could be considered as an exemplar of this category due to its multi-componential nature stemming from the interaction of simpler emotional aspects, both positive and negative (Grossmann and Ellsworth, 2017). Just its unusual nature would deserve special attention when mental health is involved.

Here, we focused on a specific mental issue whose potential connection to awe has progressively emerged but is still only implicitly discussed and whose relevance has increased and will likely

increase in the near future (Frankham et al., 2020; Gunnell et al., 2020): Major Depression Disorder (MDD). We aimed to outline the potential therapeutic role of awe for depression by considering the potential connections between these two phenomena across multiple levels—namely, the psychological, hormonal, neurophysiological, and existential levels. To this end, we provided a preliminary unifying proposal on awe's functioning based on empirical studies addressing the neuro-psycho-physiologic, metabolic, psychological, and existential dimensions of awe. We then drew connections between awe and depression, relying on the same levels. Finally, we combined this evidence into a proposal resulting in specific intervention guidelines for solutions exploiting the therapeutic potential of awe for the depression domain, where scientifically valid accessible and feasible solutions are always needed (e.g., Biddle and Asare, 2011; Bourne et al., 2018).

A UNIFYING PROPOSAL ON AWE'S FUNCTIONING: THE "MATRYOSHKA" MODEL

The role of several functionally distinct positive emotions for mental health has been increasingly investigated in the last 20 years (e.g., Tugade et al., 2004; Ong et al., 2018; Chirico et al., 2021), including the depression domain (e.g., Gruber et al., 2009). Awe has acted as a special case. After the seminal theoretical work of Keltner and Haidt (2003), which reported the dimension of *vastness* and *need for accommodation* as the core components of this emotion, several empirical efforts have been devoted to unveiling the potential of awe for human flourishing [for a review, see Chirico (2020)], but the mental health domain has remained nearly unexplored. At the same time, the empirical effort around awe has not been accompanied by an up-to-date unifying proposal on its functioning that is also able to elucidate its unique pathway to health outcomes. Here, using empirical data on awe collected so far, we provided an up-to-date unifying proposal on its functioning in the short, medium, and long term in order to elucidate the link between this emotion and Major Depression Disorder as one of the most severe mental issues nowadays.

The potential of this emotion has been deemed to be so vast that it has been considered in relation to a wider process of *transformation* (Pearsall, 2007; Chirico et al., 2018a; Chirico, 2020), or a sudden change after which the person is no longer him-/herself (Skalski, 2009; Paul, 2014; Gaggioli, 2016; Riva et al., 2016); it requires a catalyst, which might be awe (Schneider, 2009; Valdesolo and Graham, 2014; Gaggioli, 2016). This emotion emerged as having a differential impact on individuals as featured by two dimensions: *complexity* of awe-related changes and *time* (i.e., duration or frequency of occurrence). Specifically, empirical studies on this emotion evidenced that awe can affect people by unfolding from a physiological or neurophysiological level, through a psychological one, to an existential one (Schneider, 2009, 2017; Stellar et al., 2015, 2018; Gordon et al., 2016; Hoeldtke, 2016; Bai et al., 2017; Hu et al., 2017). Awe can then act as both a contingent moderately intense phenomenon (Silvia

et al., 2015) and a really intense punctual emotion (Chirico et al., 2018a,b) or as a frequent emotional state occurring several times (Shiota et al., 2006; Bonner, 2015; Zhao et al., 2019; Chirico et al., 2021). *The more awe involves increasingly sophisticated changes, the more it evolves toward more complex forms.* To unify all these dimensions of awe, we proposed a synthetic model organizing all of these changes, which we called the "Matryoshka" model, where the most basic levels of awe unfold toward a more sophisticated experience over time (Figure 1).

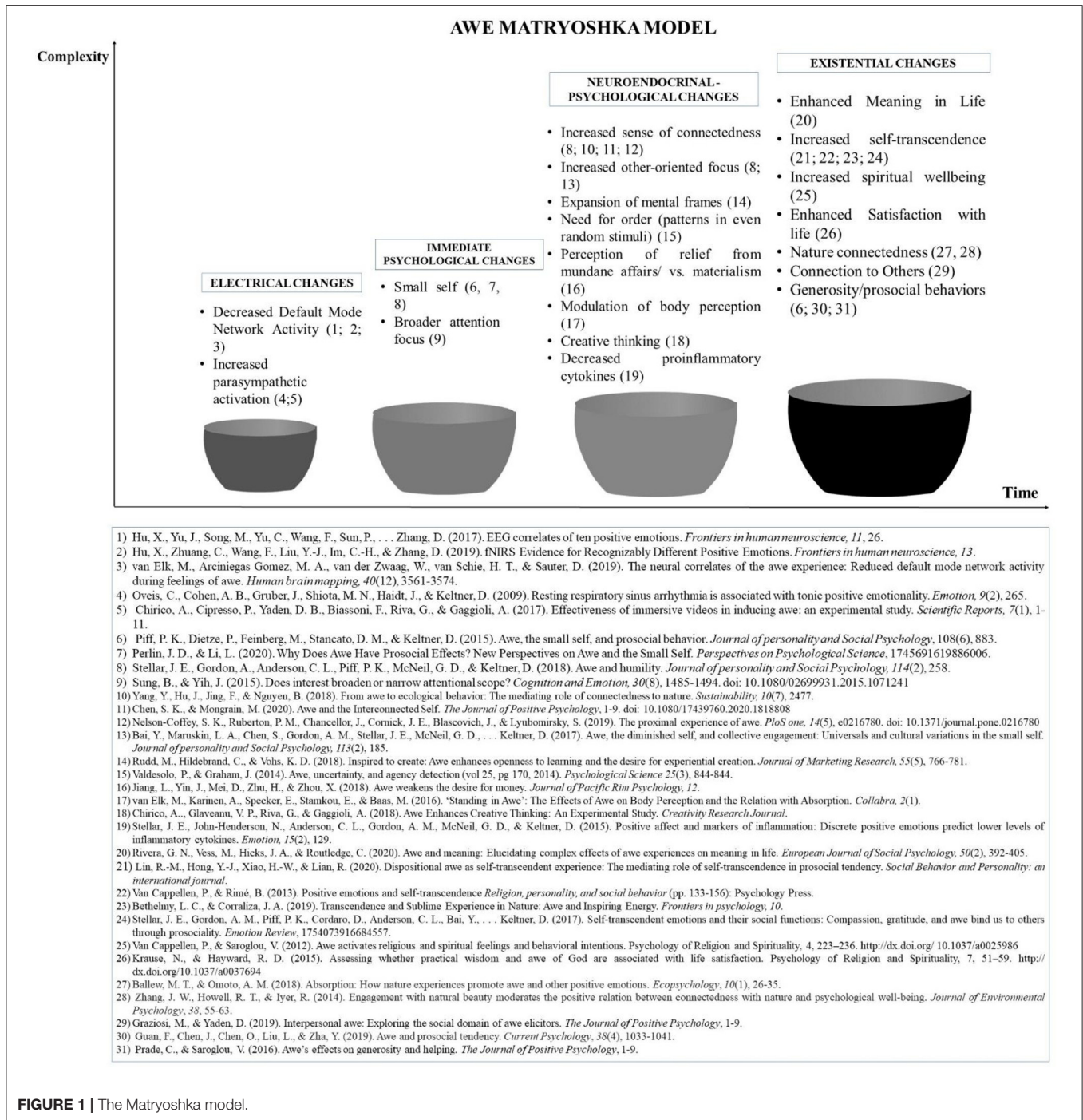
Awe's *electrical* changes (i.e., DMN activity, parasympathetic, sympathetic activity) would act as mediators between a single awe exposure and its *psychological* (i.e., small self, connectedness, expansion of mental frames, seeking for order, relief from contingencies, meaning in life, broader attention), perceptual (i.e., body perception), and behavioral consequences (i.e., generosity behaviors, helping behaviors, ecological purchase, creative ideas), all tapping into superordinate *existential* processes related to well-being and general health (e.g., satisfaction with life, spiritual well-being, nature connectedness, connection with Others, self-transcendence). Repeated exposure to awe entails the reduction of proinflammatory cytokines—the *neuroendocrinal level*—and this aspect encompasses the whole process of awe, but it becomes evident later.

To show the potential therapeutic role of awe for depression, we showed potential *connections* between this emotion and Major Depression Disorder (MDD), relying on the four previously presented levels of awe's functioning: (i) the electrical level; (ii) the immediate basic psychological level, (iii) the more sophisticated psychological level, which also includes hormonal chemical changes; and (iv) the existential level. We then further clustered the four levels according to their *time occurrence*. First, the neurological and physiological changes associated with awe were reported in the very short term. We then deepened the medium-term changes involving a basic and more sophisticated psychological level as well as hormonal effects. Finally, we introduced and discussed the most complex changes expected in the long run at the existential level.

AWE AND DEPRESSION: A FIL ROUGE?

Depression is a major health problem, with a prevalence of between 8 and 12% worldwide, and it is considered as the second biggest disease burden (Ferrari et al., 2013). Its incidence is assumed to increase in the coming months given the past and actual conditions due to the Covid-19 pandemic (Gunnell et al., 2020), and this needs to be managed in advance (Gunnell et al., 2020).

According to the DSM-5, to be diagnosed as MDD, a person must be experiencing five or more core symptoms (e.g., mood decay most of the day; diminished pleasure; significant weight loss; loss of energy; concentration difficulties; suicidal ideation or thinking of death frequently; feelings of worthlessness; reduced physical movement and slowing down) over a 2-week period, and at least one of the symptoms should be either depressed mood or the loss of interest or pleasure.



The link between awe and depression was elaborated from some core symptoms of MDD. We considered that not all individuals fully meet MDD criteria, thus falling under the threshold of MDD, but they still present difficulties associated with this disease, such as a persistent and relevant decay of moods or a sense of hopelessness (Uher et al., 2014), which, according to our hypothesis, could be ameliorated by awe anyway [see Anderson et al. (2018), Leavell et al. (2019)]. The rationale of this work concerns the potential therapeutic role of awe in contrasting

both the symptoms of MDD and some neurophysiological and psychological mechanisms characterizing this pathology.

An Electrical Connection: The Short-Term Level Neurological Changes

A few studies have begun to shed light on the neurophysiological correlates of awe. Hu et al. (2017) investigated the EEG correlates of ten positive emotions (including awe), which were clustered

in three superordinate factors. Awe clustered along with pride, inspiration, hope, and gratitude and was classified as belonging to an “encouragement” factor. Gamma and alpha activity suggested including awe in this cluster as it was positively related to both the central alpha and the beta band and showed negative correlations with the gamma band. The authors explained these findings in terms of an association between these emotions and enhanced cognitive processing. Actually, awe is known to come along with a need to restructure mental schemas—a “need for accommodation,” in the words of Keltner and Haidt (2003)—also associated with a deep uncertainty (Valdesolo and Graham, 2014). Other authors have furthered this research by analyzing the activity of a specific brain network, such as the Default Mode Network (DMN) (van Elk et al., 2019), whose increased activity is usually related to increased self-processing and mind-wandering (Qin and Northoff, 2011; Whitfield-Gabrieli and Ford, 2012) and is attenuated during goal-oriented activities (Bressler and Menon, 2010; Menon, 2011). DMN activity decreased during awe-inspiring videos, especially when participants were required to get absorbed passively (van Elk et al., 2019).

The decreased activity of the DMN is a key neural counterpart of MDD, as shown in several works (e.g., Whitfield-Gabrieli and Ford, 2012). Abnormal activity of DMN is associated with more persistent MDD (Li et al., 2013) while increased DMN connectivity (Greicius et al., 2007) is linked to a higher familiar risk for depression (Posner et al., 2016) and generally increases in depressive individuals (Zeng et al., 2012), especially in the anterior portions (Coutinho et al., 2016). Indeed, functional MRI studies have often showed hyperactivity in the amygdala and the ventral components of the anterior cingulate cortex in MDD, which would also play a key role in treatment response (Arnone, 2019).

Moreover, recently, awe has also been proposed as a potential psychological mechanism mediating the effect of psychedelic-occasioned mystical experiences—especially due to psilocybin—on depression (Hendricks, 2018). This link with the psychedelics domain is not new, as Keltner and Haidt described awe as a “psychotic break or a psychedelic experience” (p. 298) when discussing awe in religion. Specifically, at the neural level, psychedelics generate an augmented global functional connectivity and a reduced activity of the DMN, much like the experimentally induced awe. In other terms, psychedelics originate an experience of ego dissolution having a clear overlap with the “small self” experience induced by awe (Hendricks, 2018). Awe may act as a vicarious mechanism modulating the activity of DMN, akin to psychedelics.

Psychophysiological Changes

Regarding the peripheral physiological system, preliminary evidence has shown that a single experience of awe was associated with both the withdrawal of a sympathetic system (Oveis et al., 2009) and a parasympathetic activation (Chirico et al., 2017b), as well as with goose bumps (Quesnel and Riecke, 2018). In other words, awe’s physiological response resembled a sort of freezing, which resulted in being consistent with evolutionary explanations of this emotion (Keltner and Haidt, 2003; Shiota et al., 2017; Chirico and Yaden, 2018) and its behavioral

consequences concerning the perception of the “small self” (e.g., Piff et al., 2015; Stellar et al., 2018; Perlin and Li, 2020).

The ability of awe to modulate cardiac activity can be a key asset for consideration in relation to depression. Indeed, MDD is associated with reduced activity of the vagus nerve (Chang et al., 2012), which affects the overall self-regulation of the organism (Laborde et al., 2018).

A Psychological and Chemical Connection: The Medium-Term Levels Psychological Changes

At the immediate basic psychological level, awe generates a deep sense of self-diminishment, different from annihilation, where the self is set apart and the attentional focus is oriented “outside” (Sung and Yih, 2015) and above (Yaden et al., 2017). In addition, grief associated with a significant loss by art and nature can be softened if a person experiences awe (Koh et al., 2019). Conversely, patients with MDD reported an increased focus on the self and a decreased one on others, which dons the guise of an uninterrupted negative self-referential thinking associated with dysfunctional regulatory strategies, such as rumination and hopelessness (Nejad et al., 2013).

In this regard, preliminary evidence concerning the potential role of awe in reducing ruminative self-referential tendencies and sense of hopelessness was provided by Tarani (2017), who exposed healthy participants to awe-inspiring vs. amusement-inducing 4-min-long videos. They found that this emotion could decrease two key MDD symptoms: brooding ruminative tendencies (i.e., constant negative self-reflection associated with self-blame) and sense of hopelessness (i.e., expectancy of negative outcomes and helplessness).

Moreover, experimentally induced awe can orient people to interpreting even random events as the result of intentional and purpose-driven agents (Valdesolo and Graham, 2014). For instance, awe prompts us to deal with uncertainty and overcome it by also finding a completely novel explanation (i.e., accommodation). Moreover, awe enables us to broaden our attention focus (Sung and Yih, 2015), thereby facilitating the creation of unprecedented connections among ideas (Chirico et al., 2018b). Awe can even shape people’s tendency to support either a scientific or a supernatural explanation of events, depending on their existing levels of theism (i.e., to what extent they believe in God). This cognitive pattern is opposite to the one showed by patients with MDD, who tend to perceive a lack of meaning, order, and purpose in the world (i.e., sense of hopelessness; Abramson et al., 1989). It should be noted that awe and hope fell within the same cluster in Hu et al. (2017).

Neuroendocrinal Changes

At the hormonal level, psychoneuroimmunology has drawn upon a different perspective on emotions, which are now considered more than ephemeral phenomena and closer to drivers of our well-being and health. Preliminary evidence suggests that awe is associated with a reduction of proinflammatory cytokines, specifically levels of interleukin-6 (IL-6) (Stellar et al., 2015).

From this perspective, living in awe on a daily basis would—alone—be able to shape individuals' physical health at the endocrine level.

On the other hand, peripheral inflammatory states have been found to be associated with central nervous system changes in depression (Peruga et al., 2011; Haji et al., 2012; Lee and Giuliani, 2019). Specifically, an acute increase in pro-inflammatory cytokines produced a sickness syndrome with symptoms overlapping with depression (Capuron et al., 2002). If inflammation contributes to depression (Raison and Miller, 2011), then, interventions targeted at reducing inflammation may act as a preventative measure toward this mental disorder.

An Existential Connection: The Long-Term Level

At the existential level, both empirical and theoretical evidence supports the self-transcendent nature of this emotion (Van Cappellen et al., 2013; Yaden et al., 2016, 2017, 2019; Li et al., 2019; Kitson et al., 2020). As also reported by the recent work of Chen and Mongrain (2020), awe is a “self-expansive emotion” making us transcend our self. Awe expands our sense of connection with the world (Yang et al., 2018) and other human beings, (Quesnel and Riecke, 2018) thereby making us overcome the sense of loneliness and meaninglessness at the core of MDD (Fried et al., 2015).

Preliminary evidence has already shown a link between self-transcendence and depression (Haugan and Innstrand, 2012). Awe, alternatively conceived as an emotional component of the transcendent experience of the sublime (Bethelmy and Corraliza, 2019; Clewis et al., 2021), as a disposition able to foster self-transcendence meaning in life (i.e., spiritual self-transcendence (Lin et al., 2020), or as a mediator between nature and reduced rumination (Lopes et al., 2020), can always elevate us beyond the limit of our mundane affairs toward something bigger than our self and our concerns (Saroglou et al., 2008; Van Cappellen et al., 2013; Krause and Hayward, 2015). This also provides relief from the constant decay of mood characterizing MDD, and it emerged especially in the field of study related to awe-inspiring natural scenarios (e.g., Anderson et al., 2018).

Finally, the ability of awe to deconstruct existing expectations of the world and others—the “transformative potential” of awe (Chirico et al., 2016)—can act as a counterpart to the major issue of cognitive fixedness in MDD (Kube et al., 2017), as also supported within a recent framework on depression provided by the free-energy theory (Fabry, 2019). Therefore, we speculate that awe's transformative potential may be key in unlocking fixed-expectation processes typical of MDD at different ages (Benzi et al., 2018, 2020, 2021).

Awe and Depression: Reassembling the Puzzle

All the components of awe outlined in **Figure 1** can act as counterparts to specific dimensions of depression (see **Figure 2** for a graphical synthesis). First, awe can decrease the activity of DMN, which is hyperactivated in MDD. In addition, this

modulation may also have beneficial effects on the amygdala's activity, which would be involved in the self-dysregulation of the organisms along with reduced vagal control. With regard to this aspect, awe can stimulate the activation of the parasympathetic system and promote the withdrawal of the sympathetic one, thereby modulating the activity of the vagal nerve on the heart. Moreover, awe's self-transcendence nature would act as a counterpart to the incessant self-referential process at the base of rumination and sense of hopelessness. Awe acts as a trigger of accommodation, thereby fostering a process of positive change ranging from basic beliefs to more specific expectations of events. This potential of awe could be beneficial for overcoming cognitive fixedness and updating existing *prior* hypotheses used by people to predict and react to world circumstances.

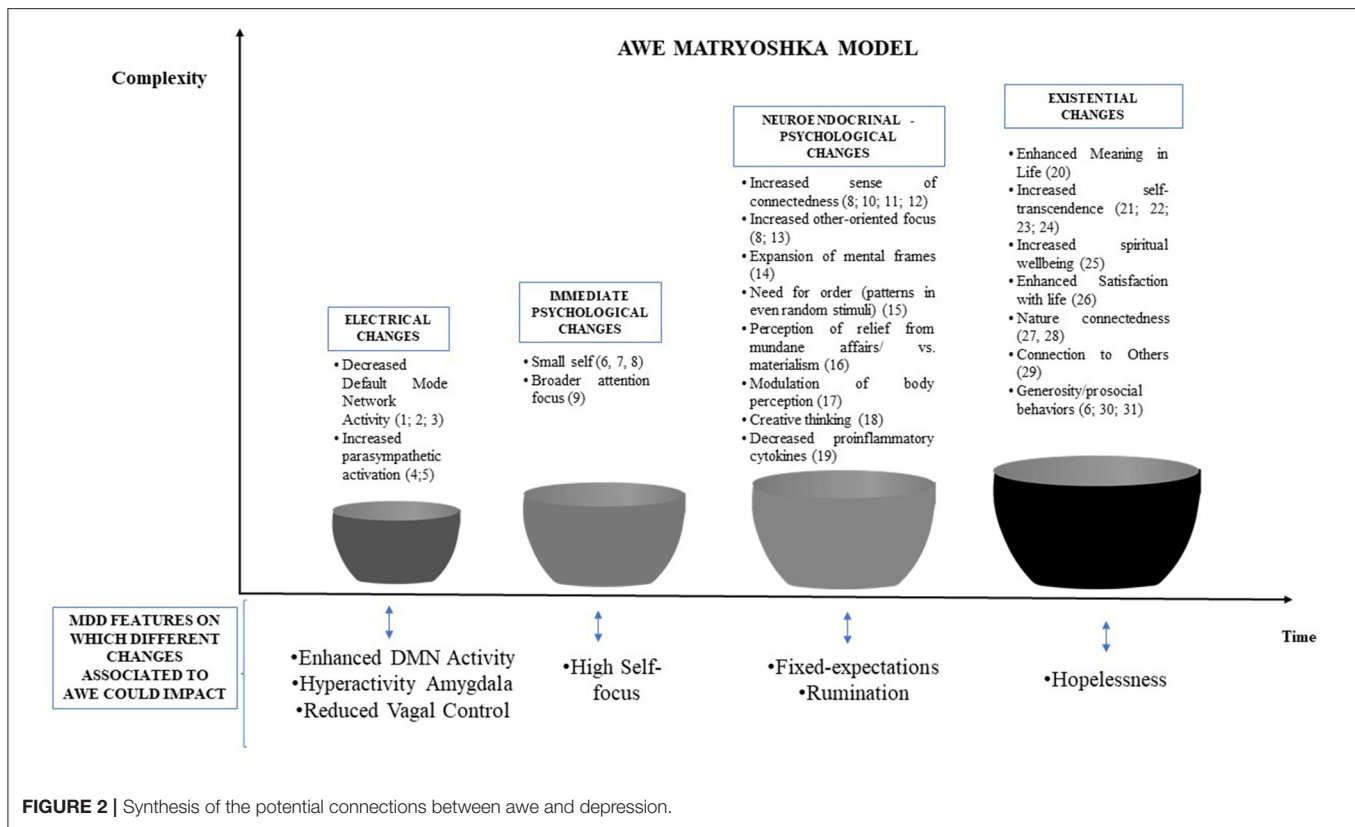
CONCLUSIONS: POTENTIAL FOR AWE-BASED INTERVENTIONS IN MDD

Positive psychology's recent endeavors to understand the potential of specific discrete positive emotions for health promotion (e.g., Barrett-Cheetham et al., 2016) have partially involved awe. However, this complex emotion has shown great potential at several levels in the last 20 years. First, from this perspective, we proposed an up-to-date unifying proposal of awe's functioning, which allowed for a revision of all the empirical evidence supporting the potential therapeutic role of awe for contrasting specifically MDD. The core message of this work concerns the elicitation of awe as a potential therapeutic integrative intervention for contrasting depression.

Although awe induction has not been explicitly considered as a clinical intervention for depression, we reported evidence showing that even an experimental induction of awe had several beneficial effects for mental health, with some also overlapping specific depression components. **Figure 2** shows all connections between awe and depression.

Recent research has demonstrated that the combination of format and content of a given awe-inspiring technique influenced the intensity of awe experience by participants (Chirico et al., 2017b), in order to enhance the ecological validity of the resulting experience. Therefore, it would be useful to focus not just on the most suitable “instrument” to elicit awe, but also on the content used to induce this emotion.

At the level of emotion-induction techniques, recent evidence has outlined different effective awe-eliciting techniques ranging from videos to virtual reality (VR) (Chirico et al., 2016). However, the long-term potential of videos, music, images, and VR for inducing awe has not been tested yet. Although their momentary benefits can be promising for administering doses of awe to people suffering from MDD and subthreshold conditions, a research protocol based on awe for MDD should assess the long-term effects associated to an awe experience as well as the durability of its benefits. Moreover, studies on dispositional awe have shown that a repeated exposure to this emotion brought forth benefits, especially at the hormonal level, which are just assumed to be durable (Stellar et al., 2015).



Moreover, given the social distancing measures adopted worldwide during the Covid-19 pandemic, another caveat would concern the possibility of delivering this intervention remotely as well. For instance, videos can be an effective, though less immersive and involving, solution to implement at distance. On the other hand, a VR setup, which provides an affordable and engaging tool, could be applied in a lab context following specific hygiene standards.

Another key aspect concerns the nature of the awe-inspiring *content* featured in images, videos, VR, and music. Given the multifaceted nature of this emotion, effective awe-inducing stimuli should provide an appropriate balance in terms of valence, thereby resulting into an emotionally mixed experience, which should be validated in advance to allow for the control over other potentially intervenient emotions (Chirico et al., 2017a) and could rely on individuals' preferences for specific elicitors. Combining more awe-eliciting techniques could be a potential solution able to enhance the effectiveness of awe-based interventions. For instance, customized self-selected awe-inspiring music (i.e., reflecting participants' preferences and personality) (Silvia et al., 2015) could be used in combination with visual techniques, such as images and VR, to enhance the personal relevance associated with an awe-inspiring intervention while always using standardized materials. A growing body of evidence concerns the potential of naturalistic scenarios able to release the self-transcendent nature of awe (Bethelmy and Corraliza, 2019) and nature itself, as one of

awe's key elicitors (Ballew and Omoto, 2018; Graziosi and Yaden, 2019; Yaden et al., 2019), resulting in a powerful way to contrast depressive symptoms (e.g., Reklaitiene et al., 2014; Lopes et al., 2020) in both real and digital formats (Browning et al., 2020).

At this stage, we have outlined the key points to define the links between awe and MDD as well as guidelines for designing effective awe-based interventions for MDD. Extant evidence has depicted awe as an encounter with something greater and infinite that could don the guise of an explosion in terms of perceived possibilities, thereby acting as a new "big bang" (or new start) in our lives. This new overarching level would encompass all those that we have introduced so far (i.e., hormonal, neurophysiological, and psychological), acting as a spiral of change. Maybe this is also why awe has often been considered a core moment of transformation (Schneider, 2009). In this regard, the potential of awe for depression might also reside in this renewed sense of perceived *possibilities* (Chirico, 2020), which is at the basis of life and the need to trust the future. This sense would stem from neural processes and hormonal ones, reinforced by other persons and nature itself, while bridging our life, our world view, and suffering, considering the complexity of life and the universe. All this complexity can be encapsulated in even a constrained space, such as a lab or room, if the specifics of this emotion are considered carefully and interventions are built upon them.

AUTHOR CONTRIBUTIONS

AC wrote the first draft and the final version. AC conceived the rationale while AG revised and supervised the entire work.

REFERENCES

- Abramson, L. Y., Metalsky, G. I., and Alloy, L. B. (1989). Hopelessness depression: a theory-based subtype of depression. *Psychol. Rev.* 96, 358–372. doi: 10.1037/0033-295X.96.2.358
- Anderson, C. L., Monroy, M., and Keltner, D. (2018). Awe in nature heals: evidence from military veterans, at-risk youth, and college students. *Emotion* 18, 1195–1202. doi: 10.1037/emo0000442
- Arnone, D. (2019). Functional MRI findings, pharmacological treatment in major depression and clinical response. *Prog. Neuro Psychopharmacol. Biol. Psychiatry* 91, 28–37. doi: 10.1016/j.pnpbp.2018.08.004
- Bai, Y., Maruskin, L. A., Chen, S., Gordon, A. M., Stellar, J. E., McNeil, G. D., et al. (2017). Awe, the diminished self, and collective engagement: universals and cultural variations in the small self. *J. Pers. Soc. Psychol.* 113, 185–209. doi: 10.1037/pspa0000087
- Ballew, M. T., and Omoto, A. M. (2018). Absorption: how nature experiences promote awe and other positive emotions. *Ecopsychology* 10, 26–35. doi: 10.1089/eco.2017.0044
- Barrett-Cheatham, E., Williams, L. A., and Bednall, T. C. (2016). A differentiated approach to the link between positive emotion, motivation, and eudaimonic well-being. *J. Posit. Psychol.* 11, 595–608. doi: 10.1080/17439760.2016.1152502
- Benzi, I., Sarno, I., and Di Pierro, R. (2018). Maladaptive personality functioning and non-suicidal self injury in adolescence. *Clin. Neuropsychiatry* 15, 215–221.
- Benzi, I. M. A., Di Pierro, R., De Carli, P., Cristea, I. A., and Cipresso, P. (2020). All the faces of research on borderline personality pathology: drawing future trajectories through a network and cluster analysis of the literature. *J. Evid. Based Psychother.* 20, 3–30. doi: 10.24193/jebp.2020.2.9
- Benzi, I. M. A., Fontana, A., Di Pierro, R., Perugini, M., Cipresso, P., Madeddu, F., et al. (2021). Assessment of personality functioning in adolescence: development of the adolescent personality structure questionnaire. *Assessment*. doi: 10.1177/1073191120988157
- Bethelmy, L. C., and Corraliza, J. A. (2019). Transcendence and sublime experience in nature: awe and inspiring energy. *Front. Psychol.* 10:509. doi: 10.3389/fpsyg.2019.00509
- Biddle, S. J., and Asare, M. (2011). Physical activity and mental health in children and adolescents: a review of reviews. *Br. J. Sports Med.* 45, 886–895. doi: 10.1136/bjsports-2011-090185
- Bonner, E. (2015). *Exploring Dispositional Awe and Its Relationship With Spiritual Intelligence: Measuring Dispositional Awe as a Multidimensional Construct*. Northcentral University.
- Bourne, J., Andersen-Warren, M., and Hackett, S. (2018). A systematic review to investigate dramatherapy group work with working age adults who have a mental health problem. *Arts Psychother.* 61, 1–9. doi: 10.1016/j.aip.2018.08.001
- Bressler, S. L., and Menon, V. (2010). Large-scale brain networks in cognition: emerging methods and principles. *Trends Cogn. Sci.* 14, 277–290. doi: 10.1016/j.tics.2010.04.004
- Browning, M. H., Mimnaugh, K. J., van Riper, C. J., Laurent, H. K., and LaValle, S. M. (2020). Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. *Front. Psychol.* 10:2667. doi: 10.3389/fpsyg.2019.02667
- Capuron, L., Gunnick, J. F., Musselman, D. L., Lawson, D. H., Reemsnyder, A., Nemeroff, C. B., et al. (2002). Neurobehavioral effects of interferon- α in cancer patients: phenomenology and paroxetine responsiveness of symptom dimensions. *Neuropsychopharmacology* 26, 643–652. doi: 10.1016/S0893-133X(01)00407-9
- Chang, H.-A., Chang, C.-C., Chen, C.-L., Kuo, T. B., Lu, R.-B., and Huang, S.-Y. (2012). Major depression is associated with cardiac autonomic dysregulation. *Acta Neuropsychiatr.* 24, 318–327. doi: 10.1111/j.1601-5215.2011.00647.x
- Chen, S. K., and Mongrain, M. (2020). Awe and the interconnected self. *J. Posit. Psychol.* 1–9. doi: 10.1080/17439760.2020.1818808
- Chirico, A. (2020). *Awe The Palgrave Encyclopedia of the Possible*. Cham: Springer International Publishing, 1–9. doi: 10.1007/978-3-319-98390-5_30-1
- Chirico, A., Cipresso, P., and Gaggioli, A. (2017a). “A process for selecting and validating awe-inducing audio-visual stimuli,” in *The 6th EAI International Symposium on Pervasive Computing Paradigms for Mental Health* (Barcelona). doi: 10.1007/978-3-319-74935-8_3
- Chirico, A., Cipresso, P., Yaden, D. B., Biassoni, F., Riva, G., and Gaggioli, A. (2017b). Effectiveness of immersive videos in inducing awe: an experimental study. *Sci. Rep.* 7:1218. doi: 10.1038/s41598-017-01242-0
- Chirico, A., Ferrise, F., Cordella, L., and Gaggioli, A. (2018a). Designing awe in virtual reality: an experimental study. *Front. Psychol.* 8:2351. doi: 10.3389/fpsyg.2017.02351
- Chirico, A., Glaveanu, V. P., Riva, G., and Gaggioli, A. (2018b). Awe enhances creative thinking: an experimental study. *Creat. Res. J.* 30, 123–131. doi: 10.1080/10400419.2018.1446491
- Chirico, A., Shiota, M. N., and Gaggioli, A. (2021). Positive emotion dispositions and emotion regulation in the Italian population. *PLoS ONE* 16:e0245545. doi: 10.1371/journal.pone.0245545
- Chirico, A., and Yaden, D. B. (2018). “Awe: a self-transcendent and sometimes transformative emotion,” in *The Function of Emotions*, ed H. Lench (Cham: Springer). doi: 10.1007/978-3-319-77619-4_11
- Chirico, A., Yaden, D. B., Riva, G., and Gaggioli, A. (2016). The potential of virtual reality for the investigation of awe. *Front. Psychol.* 7:1766. doi: 10.3389/fpsyg.2016.01766
- Clewis, R. R., Yaden, D. B., and Chirico, A. (2021). Intersections between awe and the sublime: a preliminary empirical study. *Empir. Stud. Arts*, 1–31. doi: 10.1177/0276237421994694
- Cohen, S., and Pressman, S. D. (2006). Positive affect and health. *Curr. Dir. Psychol. Sci.* 15, 122–125. doi: 10.1111/j.0963-7214.2006.00420.x
- Coifman, K. G., Flynn, J. J., and Pinto, L. A. (2016). When context matters: negative emotions predict psychological health and adjustment. *Motiv. Emot.* 40, 602–624. doi: 10.1007/s11031-016-9553-y
- Coutinho, J. F., Fernandes, S. V., Soares, J. M., Maia, L., Gonçalves, Ó. F., and Sampaio, A. (2016). Default mode network dissociation in depressive and anxiety states. *Brain Imaging Behav.* 10, 147–157. doi: 10.1007/s11682-015-9375-7
- Fabry, R. E. (2019). Into the dark room: a predictive processing account of major depressive disorder. *Phenomenol. Cogn. Sci.* 19, 685–704. doi: 10.1007/s11097-019-09635-4
- Ferrari, A., Somerville, A., Baxter, A., Norman, R., Patten, S., Vos, T., et al. (2013). Global variation in the prevalence and incidence of major depressive disorder: a systematic review of the epidemiological literature. *Psychol. Med.* 43, 471–481. doi: 10.1017/S0033291712001511
- Frankham, C., Richardson, T., and Maguire, N. (2020). Psychological factors associated with financial hardship and mental health: a systematic review. *Clin. Psychol. Rev.* 77:101832. doi: 10.1016/j.cpr.2020.101832
- Fried, E. L., Bockting, C., Arjadi, R., Borsboom, D., Amshoff, M., Cramer, A. O., et al. (2015). From loss to loneliness: the relationship between bereavement and depressive symptoms. *J. Abnorm. Psychol.* 124, 256–265. doi: 10.1037/abn0000028
- Gaggioli, A. (2016). “Transformative experience design,” in *Human Computer Confluence. Transforming Human Experience Through Symbiotic Technologies*,

FUNDING

This work was supported by Fondazione Cariplo, grant: Promoting Education of Scientific and Technological Societal Issues Through Sublime (PROMETHEUS) no: 2019-3536.

- eds A. Gaggioli, A. Ferscha, G. Riva, S. Dunne, I. Viaud (Berlin: De Gruyter Open), 96–121. doi: 10.1515/9783110471137
- Gordon, A. M., Stellar, J. E., Anderson, C. L., McNeil, G. D., Loew, D., and Keltner, D. (2016). The dark side of the sublime: distinguishing a threat-based variant of awe. *J. Pers. Soc. Psychol.* 113, 310–328. doi: 10.1037/pspp0000120
- Graziosi, M., and Yaden, D. (2019). Interpersonal awe: exploring the social domain of awe elicitors. *J. Posit. Psychol.* 16, 263–271. doi: 10.1080/17439760.2019.1689422
- Greicius, M. D., Flores, B. H., Menon, V., Glover, G. H., Solvason, H. B., Kenna, H., et al. (2007). Resting-state functional connectivity in major depression: abnormally increased contributions from subgenual cingulate cortex and thalamus. *Biol. Psychiatry* 62, 429–437. doi: 10.1016/j.biopsych.2006.09.020
- Grossmann, I., and Ellsworth, P. C. (2017). What are mixed emotions and what conditions foster them? Life-span experiences, culture and social awareness. *Curr. Opin. Behav. Sci.* 15, 1–5. doi: 10.1016/j.cobeha.2017.05.001
- Gruber, J., Culver, J. L., Johnson, S. L., Nam, J. Y., Keller, K. L., and Ketter, T. A. (2009). Do positive emotions predict symptomatic change in bipolar disorder? *Bipolar Disord.* 11, 330–336. doi: 10.1111/j.1399-5618.2009.00679.x
- Gunnell, D., Appleby, L., Arensman, E., Hawton, K., John, A., Kapur, N., et al. (2020). Suicide risk and prevention during the COVID-19 pandemic. *Lancet Psychiatry* 7, 468–471. doi: 10.1016/S2215-0366(20)30171-1
- Haji, N., Mandolesi, G., Gentile, A., Sacchetti, L., Fresegha, D., Rossi, S., et al. (2012). TNF- α -mediated anxiety in a mouse model of multiple sclerosis. *Exp. Neurol.* 237, 296–303. doi: 10.1016/j.expneurol.2012.07.010
- Haugan, G., and Innstrand, S. T. (2012). The effect of self-transcendence on depression in cognitively intact nursing home patients. *ISRN Psychiatry* 2012:301325. doi: 10.5402/2012/301325
- Hendricks, P. S. (2018). Awe: a putative mechanism underlying the effects of classic psychedelic-assisted psychotherapy. *Int. Rev. Psychiatry* 30, 331–342. doi: 10.1080/09540261.2018.1474185
- Hoeldtke, R. T. (2016). *Awesome Implications: Enhancing Meaning in Life Through Awe Experiences*. Montana State University-Bozeman, College of Psychology.
- Hu, X., Yu, J., Song, M., Yu, C., Wang, F., Sun, P., et al. (2017). EEG correlates of ten positive emotions. *Front. Hum. Neurosci.* 11:26. doi: 10.3389/fnhum.2017.00026
- Keltner, D., and Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cogn. Emot.* 17, 297–314. doi: 10.1080/026999303022297
- Kitson, A., Chirico, A., Gaggioli, A., and Riecke, B. E. (2020). A review on research and evaluation methods for investigating self-transcendence. *Front. Psychol.* 11:547687. doi: 10.3389/fpsyg.2020.547687
- Koh, A. H., Tong, E. M., and Yuen, A. Y. (2019). The buffering effect of awe on negative affect towards lost possessions. *J. Posit. Psychol.* 14, 156–165. doi: 10.1080/17439760.2017.1388431
- Krause, N., and Hayward, R. D. (2015). Assessing whether practical wisdom and awe of God are associated with life satisfaction. *Psycholog. Relig. Spirit.* 7, 51–59. doi: 10.1037/a0037694
- Kube, T., Rief, W., and Glombiewski, J. A. (2017). On the maintenance of expectations in major depression—investigating a neglected phenomenon. *Front. Psychol.* 8:9. doi: 10.3389/fpsyg.2017.00009
- Kunzmann, U., Schilling, O., Wrosch, C., Siebert, J. S., Katzorreck, M., Wahl, H.-W., et al. (2019). Negative emotions and chronic physical illness: a lifespan developmental perspective. *Health Psychol.* 38, 949–959. doi: 10.1037/hea0000767
- Laborde, S., Mosley, E., and Mertgen, A. (2018). A unifying conceptual framework of factors associated to cardiac vagal control. *Heliyon* 4:e01002. doi: 10.1016/j.heliyon.2018.e01002
- Leavell, M., Leiferman, J., Gascon, M., Braddick, F., Gonzalez, J., and Litt, J. (2019). Nature-based social prescribing in urban settings to improve social connectedness and mental well-being: a review. *Curr. Environ. Health Rep.* 6, 297–308. doi: 10.1007/s40572-019-00251-7
- Lee, C.-H., and Giuliani, F. (2019). The role of inflammation in depression and fatigue. *Front. Immunol.* 10:1696. doi: 10.3389/fimmu.2019.01696
- Li, B., Liu, L., Friston, K. J., Shen, H., Wang, L., Zeng, L.-L., et al. (2013). A treatment-resistant default mode subnetwork in major depression. *Biol. Psychiatry* 74, 48–54. doi: 10.1016/j.biopsych.2012.11.007
- Li, J.-J., Dou, K., Wang, Y.-J., and Nie, Y.-G. (2019). Why awe promotes prosocial behaviors? The mediating effects of future time perspective and self-transcendence meaning of life. *Front. Psychol.* 10:1140. doi: 10.3389/fpsyg.2019.01140
- Lin, R. M., Hong, Y. J., Xiao, H. W., and Lian, R. (2020). Dispositional awe and prosocial tendency: the mediating roles of selftranscendent meaning in life and spiritual self-transcendence. *Soc. Behav. Personal. Int. J.* 48:e9665. doi: 10.2224/sbp.9665
- Lopes, S., Lima, M., and Silva, K. (2020). Nature can get it out of your mind: the rumination reducing effects of contact with nature and the mediating role of awe and mood. *J. Environ. Psychol.* 71:101489. doi: 10.1016/j.jenvp.2020.101489
- Menon, V. (2011). Large-scale brain networks and psychopathology: a unifying triple network model. *Trends Cogn. Sci.* 15, 483–506. doi: 10.1016/j.tics.2011.08.003
- Nejad, A. B., Fossati, P., and Lemogne, C. (2013). Self-referential processing, rumination, and cortical midline structures in major depression. *Front. Hum. Neurosci.* 7:666. doi: 10.3389/fnhum.2013.00666
- Nelson-Coffey, S. K., Ruberton, P. M., Chancellor, J., Cornick, J. E., Blascovich, J., and Lyubomirsky, S. (2019). The proximal experience of awe. *PLoS ONE* 14:e0216780. doi: 10.1371/journal.pone.0216780
- Ong, A. D., Benson, L., Zautra, A. J., and Ram, N. (2018). Emodiversity and biomarkers of inflammation. *Emotion* 18, 3. doi: 10.1037/emo0000343
- Oveis, C., Cohen, A. B., Gruber, J., Shiota, M. N., Haidt, J., and Keltner, D. (2009). Resting respiratory sinus arrhythmia is associated with tonic positive emotionality. *Emotion* 9, 265–270. doi: 10.1037/a0015383
- Paul, L. A. (2014). *Transformative Experience*. Oxford: Oxford University Press. doi: 10.1093/acprof:oso/9780198717959.001.0001
- Pearsall, P. (2007). *Awe: The Delights and Dangers of Our Eleventh Emotion*. Health Communications, Inc.
- Perlin, J. D., and Li, L. (2020). Why does awe have prosocial effects? New perspectives on awe and the small self. *Perspect. Psychol. Sci.* 15, 291–308. doi: 10.1177/1745691619886006
- Peruga, I., Hartwig, S., Thöne, J., Hovemann, B., Gold, R., Juckel, G., et al. (2011). Inflammation modulates anxiety in an animal model of multiple sclerosis. *Behav. Brain Res.* 220, 20–29. doi: 10.1016/j.bbr.2011.01.018
- Piff, P. K., Dietze, P., Feinberg, M., Stancato, D. M., and Keltner, D. (2015). Awe, the small self, and prosocial behavior. *J. Pers. Soc. Psychol.* 108, 883–899. doi: 10.1037/pspi0000018
- Posner, J., Cha, J., Wang, Z., Talati, A., Warner, V., Gerber, A., et al. (2016). Increased default mode network connectivity in individuals at high familial risk for depression. *Neuropsychopharmacology* 41, 1759–1767. doi: 10.1038/npp.2015.342
- Qin, P., and Northoff, G. (2011). How is our self related to midline regions and the default-mode network? *Neuroimage* 57, 1221–1233. doi: 10.1016/j.neuroimage.2011.05.028
- Quesnel, D., and Riecke, B. E. (2018). Are you awed yet? How virtual reality gives us awe and goose bumps. *Front. Psychol.* 9:2158. doi: 10.3389/fpsyg.2018.02158
- Raison, C. L., and Miller, A. H. (2011). Is depression an inflammatory disorder? *Curr. Psychiatry Rep.* 13, 467–475. doi: 10.1007/s11920-011-0232-0
- Reklaitiene, R., Grazuleviciene, R., Dedele, A., Virviciute, D., Vensloviene, J., Tamosiunas, A., et al. (2014). The relationship of green space, depressive symptoms and perceived general health in urban population. *Scand. J. Public Health* 42, 669–676. doi: 10.1177/1403494814544494
- Riva, G., Villani, D., Cipresso, P., Repetto, C., Triberti, S., Di Lernia, D., et al. (2016). Positive and transformative technologies for active ageing. *Stud. Health Technol. Inform.* 220, 308–315. doi: 10.3233/978-1-61499-625-5-308
- Ryff, C. D., and Singer, B. (2000). Interpersonal flourishing: a positive health agenda for the new millennium. *Person. Soc. Psychol. Rev.* 4, 30–44. doi: 10.1207/S15327957PSPR0401_4
- Saroglou, V., Buxant, C., and Tilquin, J. (2008). Positive emotions as leading to religion and spirituality. *J. Posit. Psychol.* 3, 165–173. doi: 10.1080/17439760801998737
- Schneider, K. (2009). *Awakening to Awe: Personal Stories of Profound Transformation*. Lanham, MD: Jason Aronson.
- Schneider, K. (2017). The resurgence of awe in psychology: promise, hope, and perils. *Humanist. Psychol.* 45, 103–108. doi: 10.1037/hum0000060
- Seligman, M. E., and Csikszentmihalyi, M. (2000). *Positive Psychology: An Introduction*, Vol. 55. American Psychological Association. doi: 10.1037/0003-066X.55.1.5

- Shiota, M. N., Campos, B., Oveis, C., Hertenstein, M. J., Simon-Thomas, E., and Keltner, D. (2017). Beyond happiness: Building a science of discrete positive emotions. *Am. Psychol.* 72, 617–643. doi: 10.1037/a0040456
- Shiota, M. N., Keltner, D., and John, O. P. (2006). Positive emotion dispositions differentially associated with big five personality and attachment style. *J. Posit. Psychol.* 1, 61–71. doi: 10.1080/17439760500510833
- Shiota, M. N., Keltner, D., and Mossman, A. (2007). The nature of awe: elicitors, appraisals, and effects on self-concept. *Cogn. Emot.* 21, 944–963. doi: 10.1080/02699930600923668
- Silvia, P. J., Fayn, K., Nusbaum, E. C., and Beaty, R. E. (2015). Openness to experience and awe in response to nature and music: personality and profound aesthetic experiences. *Psychol. Aesthet. Creat. Arts* 9, 376–384. doi: 10.1037/aca0000028
- Skalski, J. E. (2009). *The Epistemic Qualities of Quantum Transformation*.
- Stellar, J. E., Gordon, A., Anderson, C. L., Piff, P. K., McNeil, G. D., and Keltner, D. (2018). Awe and humility. *J. Pers. Soc. Psychol.* 114, 258–269. doi: 10.1037/pspi0000109
- Stellar, J. E., John-Henderson, N., Anderson, C. L., Gordon, A. M., McNeil, G. D., and Keltner, D. (2015). Positive affect and markers of inflammation: discrete positive emotions predict lower levels of inflammatory cytokines. *Emotion* 15, 129–133. doi: 10.1037/emo0000033
- Sundararajan, L. (2002). Religious awe: potential contributions of negative theology to psychology, “positive” or otherwise. *J. Theor. Philosoph. Psychol.* 22, 174–197. doi: 10.1037/h0091221
- Sung, B., and Yih, J. (2015). Does interest broaden or narrow attentional scope? *Cogn. Emotion* 30, 1485–1494. doi: 10.1080/02699931.2015.1071241
- Tarani, E. (2017). *Affective and Cognitive Effects of Awe in Predicting Hopelessness and Brooding Rumination*.
- Tugade, M. M., Fredrickson, B. L., and Feldman Barrett, L. (2004). Psychological resilience and positive emotional granularity: examining the benefits of positive emotions on coping and health. *J. Pers.* 72, 1161–1190. doi: 10.1111/j.1467-6494.2004.00294.x
- Uher, R., Payne, J. L., Pavlova, B., and Perlis, R. H. (2014). Major depressive disorder in DSM-5: Implications for clinical practice and research of changes from DSM-IV. *Depress Anxiety* 31, 459–471. doi: 10.1002/da.22217
- Valdesolo, P., and Graham, J. (2014). Awe, uncertainty, and agency detection (vol 25, pg 170, 2014). *Psychol. Sci* 25:844. doi: 10.1177/0956797614525573
- Van Cappellen, P., Saroglou, V., Iweins, C., Piovesana, M., and Fredrickson, B. L. (2013). Self-transcendent positive emotions increase spirituality through basic world assumptions. *Cogn. Emotion* 27, 1378–1394. doi: 10.1080/02699931.2013.787395
- van Elk, M., Arciniegas Gomez, M. A., van der Zwaag, W., van Schie, H. T., and Sauter, D. (2019). The neural correlates of the awe experience: reduced default mode network activity during feelings of awe. *Hum. Brain Mapp.* 40, 3561–3574. doi: 10.1002/hbm.24616
- Whitfield-Gabrieli, S., and Ford, J. M. (2012). Default mode network activity and connectivity in psychopathology. *Annu. Rev. Clin. Psychol.* 8, 49–76. doi: 10.1146/annurev-clinpsy-032511-143049
- Yaden, D. B., Haidt, J., Wood, R. W. Jr., Vago, D. R., Newberg, A. B. (2017). The varieties of Self-transcendent experience. *Rev. Gen. Psychol.* 21, 143–160. doi: 10.1037/gpr0000102
- Yaden, D. B., Iwry, J., Slack, K. J., Eiechstaedt, J. C., Zhao, Y., Vaillant, G. E., et al. (2016). The overview effect: awe and self-transcendent experience in space flight. *Psychol. Conscious. Theo. Res. Pract.* 3, 1–11. doi: 10.1037/cns0000086
- Yaden, D. B., Kaufman, S. B., Hyde, E., Chirico, A., Gaggioli, A., Zhang, J. W., et al. (2019). The development of the awe experience scale (AWE-S): a multifactorial measure for a complex emotion. *J. Posit. Psychol.* 14, 474–488. doi: 10.1080/17439760.2018.1484940
- Yang, Y., Hu, J., Jing, F., and Nguyen, B. (2018). From awe to ecological behavior: the mediating role of connectedness to nature. *Sustainability* 10:2477. doi: 10.3390/su10072477
- Zeng, L.-L., Shen, H., Liu, L., Wang, L., Li, B., Fang, P., et al. (2012). Identifying major depression using whole-brain functional connectivity: a multivariate pattern analysis. *Brain* 135, 1498–1507. doi: 10.1093/brain/aws059
- Zhao, H., Zhang, H., Xu, Y., He, W., and Lu, J. (2019). Why are people high in dispositional awe happier? The roles of meaning in life and materialism. *Front. Psychol.* 10:1208. doi: 10.3389/fpsyg.2019.01208

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2021 Chirico and Gaggioli. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.