ISSN: 3029-0708

Review Articles

Journal of Clinical Psychology and Neurology

Epistemic Emotions Research: A Narrative Review

Tiffany Field

University of Miami/Miller School of Medicine and Fielding Graduate University, USA

***Corresponding author**
Tiffany Field, University of Miami/Miller School of Medicine and Fielding Graduate University, USA.

Received: June 03, 2025; **Accepted:** June 17, 2025; **Published:** June 25, 2025

ABSTRACT

Epistemic (knowledge-related) emotions include awe, surprise, curiosity, interest, confusion and boredom. In this review of the 2024-2025 literature on epistemic emotions, most of the emotions were studied either for their elicitors or their effects. Awe and boredom were the most frequently studied. Awe was more reliably elicited to vast landscape images than to -well known faces. Young children showed similar awe responses to vast stimuli. Awe led to increases in self-compassion and concern for others. Boredom was most frequently reported as job boredom and was the only emotion that was related to anxiety, depression, and suicidality. Curiosity was coupled with creativity and suggested to have novelty-seeking as their basis. Surprise and confusion may have been less frequently studied because they are relatively evanescent and more difficult to measure. Methodological limitations of this literature were that most of the studies involved laboratory elicitation of the emotions rather than using diary and Fitbit data collection methods in natural environments.

Universal basic emotions including happiness, surprise, sadness, fear, anger and disgust have been widely researched for many years [1]. Epistemic emotions (knowledge-related) including awe, surprise, curiosity, interest, confusion and boredom have received less attention until recently [2]. In this narrative review, research on epistemic emotions that was published in 2024-2025 is briefly summarized. This research was found on PubMed, PsycINFO and Google Scholar by entering the terms for each of the epistemic emotions and the years 2024-2025. Exclusion criteria included non-English papers, pilot studies and proposed protocols. This literature search yielded 47 papers including 11 papers on awe, 2 papers on surprise, 8 papers on curiosity, 1 paper on interest, 3 papers on confusion and 22 papers on boredom. Interestingly, almost half the papers were on boredom which might reflect the people's most felt emotion which could occur, especially if they had exhausted the other emotions. Awe could lead to surprise, in turn curiosity and interest and then, if those emotions were short-lived, confusion and boredom might happen. Boredom may be the most negative, problematic emotion, so it is not surprising that it has received more research attention

Epistemic emotions are "responsible for people's seeking new knowledge" according to an earlier review [2]. Epistemic emotions in this earlier review included awe, surprise, curiosity, interest, confusion, and boredom which is why they were selected for this review of the more recent 2024-2025 literature. Awe, surprise, curiosity, and interest have been categorized as positive epistemic emotions, and negative epistemic emotions include confusion and boredom [2]. Interestingly, while only 2 out of the 6 universal emotions are considered positive (happiness and surprise), twice as many (4 of the 6) epistemic emotions are considered positive.

According to the recent research review already mentioned, epistemic emotions have different "elicitors, subjective experiences, and action tendencies" [2]. According to that research group, the elicitors have included novelty, complexity, amount of information, and disconfirmed as well as exceeded "expectancies". The subjective experiences have included valence, arousal, coping potential, interruption, absorption, and feeling small. The action tendencies have included exploration and avoidance – approach behavior.

Citation: Tiffany Field. Epistemic Emotions Research: A Narrative Review. J Clin Psychol Neurol. 2025. 3(2): 1-8.
DOI: doi.org/10.61440/JCPN.2025.v3.50

Also, according to that recent review on epistemic emotions, awe Is an emotion that arises in response to vast stimuli that exceed expectancies [2]. Surprise is a response to stimuli that are different than expected whether they're positive or negative. Curiosity results from an information gap. Interest is the motivation to engage with new information. Confusion arises in response to an ongoing mismatch between new information and prior knowledge. And boredom is a lack of stimulation. A stimulus is said to lack stimulation because it is mundane, meaningless, or highly repetitive.

Awe

Awe has been defined as an emotion that arises in response to vast stimuli that exceed expectancies [2]. The research on awe in this current literature addresses the different kinds of stimuli that elicit awe including images of vast panoramic landscapes and natural disasters as well as faces of well-known and admired people. This current literature also addresses positive qualities that result from the experience of awe including self-compassion, empathy, forgiveness and "cohesive collectives" (attention to others' needs). Further, the current literature on awe addresses the reduction of negative qualities following the experience of awe including existential isolation, fear, reactive aggression and psychosomatic symptoms.

In a study that explored responses to images of panoramic landscapes and faces of well- known and admired people, the participants rated several variables [3]. They rated the landscape images and faces according to the participants' admiration for them and for their beauty, awe, emotional valence, and arousal. Consistent with many studies, the experience of awe was stronger for landscapes than for faces. "Temporal lengthening" also occurred as if the participants wanted to prolong their viewing of the landscape scenes. This may relate to the vastness versus smallness preference noted in this literature suggesting that awe is more frequently experienced for vastness like vast landscapes.

Children have been noted to have similar experiences of awe. In a study entitled "Seeing awe: how children perceive awe – inspiring visual experiences", children from the U.S. (N=444 children four-to 9-years-old) viewed expansive nature scenes, natural disaster scenes and slow-motion objects [4]. The children had responses that were like those of adults. The expansive nature stimuli elicited more awe than the other images. All the scenes versus everyday scenes elicited awe and led to greater learning motivation for the children.

Awe has been noted to increase positive qualities in adults including self-compassion, empathy, interpersonal forgiveness and "cohesive collectives" (attention to others' needs). In a paper entitled "Be kinder to yourself: awe promotes self-compassion by self-transcendence", the results are given in the title [5]. Awe was related to self-compassion via the mediator of self-transcendence. This experience was not dependent on exposure to nature.

Awe has also led to empathy based on different empathetic behaviors in seven different studies [6]. In these studies, awe was correlated with trait measures of empathy. Evidence for this relationship was increased perspective-taking, empathic accuracy, and compassion following the awe experience. Relatedly, awe has also stimulated interpersonal forgiveness [7]. This result derived from responses to the Trait Awe Scale.

Another positive change was noted following awe in a study entitled "Bridging me to we: awe is a conduit to cohesive collectives" [8]. In this study, awe was elicited by images of the natural world, art, music and human virtue. Awe was noted to expand adults' perspectives from narrow self – interest to others' needs and collective concerns. Interestingly, this research group uniquely included art, music and human virtue as awe stimuli.

Awe has also contributed to a reduction in negative qualities in adults. These include existential isolation, fear, reactive aggression, and psychosomatic symptoms. In three studies on the impact of awe on existential isolation, awe was associated with existential isolation via an increased sense of feeling small which led to less connectedness [9]. Conversely, awe was also associated with less existential isolation via an increased sense of vastness which led to greater connectedness. The sense of "feeling small" versus the sense of "feeling vastness" needs further research for their unique relationships to connectedness. These may relate to other personality variables such as "feeling vastness" more frequently if you have greater self-esteem/self-confidence.

In a paper entitled "Culture and awe: understanding awe is a mixed emotion", Chinese adults were compared to U.S. adults on their responses to awe stimuli [10]. The Chinese reported feeling fear in response to awe stimuli. In contrast, adults from the U.S. experienced less fear and more positive emotions as well as lower heart rate. This study was unique for its cross - cultural comparison and was one of the few studies that included a physiological measure. Less fear would be associated with lower heart rate, but the cross-cultural differences are difficult to interpret. They could relate to the Chinese sample being more urban than the U.S. sample and having less exposure than the U.S. sample to vast landscapes.

In a study entitled "The relationship between dispositional awe and reactive aggression: the serial mediation role of trait anger and self-control", college students (N=611) were the participants [11]. Dispositional awe was related to reactive aggression when anger was high and self-control was low. In contrast, dispositional awe was not related to reactive aggression when trait anger was low and self-control was high. It's not clear why awe would be expected to lead to aggression, but it's not surprising that anger and self-control were mediating variables as they have been frequently associated with aggression.

Dispositional awe has also contributed to mental health in a longitudinal study in China [12]. In this sample (N= 368 males), dispositional awe led to more positive interpretations, which led to decreased psychosomatic symptoms. The relationship between awe and mental health could relate to all of the above variables. However, most researchers focus on the variables that interest them, like the almost exclusive focus on the vastness of landscape scenes as opposed to many other awe-inspiring stimuli like art and music, highlighting the biased nature of this research, not unlike research on other phenomena.

Surprise

Surprisingly, the surprise emotion has received very little attention in both the universal emotion and epistemic emotion literature. Surprise is considered a positive emotion and has been linked with awe and interest as well as curiosity in the epistemic emotion literature. In the review paper already mentioned, these four emotions were associated with arousal, high coping potential and approach behavior [2]. Surprise was also associated with both "exceeded and disconfirmed expectancies", suggesting that something surprising can go beyond your beliefs or be associated with beliefs you have already rejected.

In a study entitled "The interactive effects of surprise and plausibility on memory", a memory test was given and 24-28 hours later a recall test was given [13]. The unsurprising and plausible stimuli were remembered more than the surprising and implausible stimuli. Only surprise that was plausible led to greater recall. Surprise that was implausible was likely cognitively discounted. Surprise may have received less attention in this literature because it's a fleeting emotion that is often inconsequential except perhaps when it leads to curiosity.

Curiosity

Again, surprisingly, curiosity as another positive epistemic emotion has also rarely appeared in this current literature on epistemic emotions. A few studies have focused on curiosity during childhood or during adulthood, suggesting developmental changes in curiosity, although curiosity across development was rarely studied. Others have addressed predictors of curiosity including personality traits such as openness or associated behaviors such as leisure activity. Most of the literature has focused on the theoretical association between curiosity and creativity and the reputed novelty-seeking basis for both those emotions.

One of the developmental studies involved a validation of different types of curiosity [14]. Data were collected from 389 Chinese parents and 129 teachers of young children. The researchers designated two types of curiosity. One type was labeled an "I type" for interest and joyous exploration and the other a "type D" for deprivation sensitivity which suggests that curiosity might result from just feeling deprived of stimulation.

In another study on children entitled "Does childhood curiosity influence depression in adulthood?", the China Family Panel Study database was analyzed (N = 17,162) [15]. Childhood curiosity was noted to have a protective effect against depression in adulthood. Childhood state curiosity may have developed into trait curiosity that was then sustained into adulthood to be contemporaneously protective against depression rather than childhood curiosity itself protecting against adult depression.

In a study on curiosity across the adult lifespan, age-related differences were noted in state and trait curiosity [16]. In this sample of different age adults (N= 193), state curiosity was noted to increase, and trait curiosity was noted to decrease across age. This result may have derived from older adults experiencing fewer surprising situations that could sustain their trait curiosity. It would seem that state curiosity would need to continually occur to sustain trait curiosity.

Two studies have focused on predictors of curiosity including one on personality traits and one on activities. In a study entitled "Unraveling the intricacies of curiosity", personality traits were explored including impulsive sensation-seeking, intolerance of uncertainty and openness [17]. These three personality traits were jointly noted to predict trait curiosity. A regression analysis on these data would have yielded the relative contributions of these personality traits to trait curiosity. Likely they would have different contributions to the variance in trait curiosity

Leisure activities have also been associated with curiosity [18]. In this study on a Japanese sample (N =1,311 adults 20 to 79 years-old), both men's and women's curiosity were related to leisure activities and work. Presumably both the leisure activities and work were interesting given that they stimulated curiosity in this sample. And this curiosity would likely be labeled the I-Type (stimulated by interest and joyous exploration) [14].

Two studies have addressed the effects of curiosity on the brain. In one of these, curiosity was positively correlated with brain health [19]. More brain regions were activated by curiosity versus fatigue. These results were not surprising inasmuch as curiosity as a very arousing, active state would be expected to stimulate more alpha and beta activity in the brain while fatigue would likely involve slower theta and delta activity.

In another study involving the brain, the results are reflected in the title: "Curiosity satisfaction increases event- related potentials sensitive to reward" [20]. The protocol for this study involved the recording of evoked potentials during and following a surprise memory task. Following that task, satisfaction of curiosity resembled reward processing indicated by the event-related potential data. That surprise and curiosity would involve the reward centers of the brain is not surprising given that both surprise and curiosity are positive, pleasurable emotions.

Most of the papers in this current literature on curiosity are the 29 commentaries that were inspired by a paper entitled "A shared novelty-seeking basis for creativity and curiosity" [21]. In this theoretical paper, the authors claimed that novelty-seeking was the underlying mechanism for both creativity and curiosity. They also noted that expansive nature stimuli elicited more awe than expansive social stimuli. It would not be surprising that the same regions of the brain were involved in both curiosity and creativity including the default mode network, the salience network and the executive control network, although it wasn't clear from the data presented which network was most involved in either curiosity or creativity or both.

Examples of the commentaries that followed this theoretical paper included a paper that suggested that learnability was the driving force behind creativity, curiosity and artistic endeavors [22]. A second research group suggested that mood regulation was the shared basis for curiosity and creativity [23]. In their model, the goals of both curiosity and creativity were to enhance positive mood and reduce negative mood. A third group of researchers challenged the brain regions being the same for curiosity and creativity in a paper entitled "Dissecting the neuroanatomy of creativity and curiosity: the subdivisions within networks matter" [24]. It was surprising that the authors

of the original paper did not attempt to accommodate all these possible interpretations of their data.

Commentaries were found throughout the current literature on curiosity suggesting many different underlying mechanisms for curiosity and the creativity that the researchers have linked to curiosity. While they generally suggest different mechanisms, they also noted the reciprocal nature of curiosity and creativity with the epistemic curiosity emotion stimulating creativity and creativity, in turn, leading to curiosity. It is likely that all these mechanisms have been contributing to curiosity and creativity. However, none of the commentaries addressed the possibility that unresolved curiosity or thwarted creativity could lead to confusion and ultimately boredom, but that would be suggested by a potential continuum of experiencing epistemic emotions from awe to surprise to curiosity to interest to confusion and ultimately boredom.

Confusion

Most of the literature on confusion includes research on confusion that is related to senility rather than confusion as an epistemic emotion. Only a few studies focused on confusion as an epistemic emotion.

In a study entitled "Confused or not: decoding brain activity and recognizing confusion in reasoning learning using electroencephalography", those who were confused versus non- confused had lower EEG power of delta, theta, alpha and beta as well as lower gamma activity [25]. Those who were confused had higher attentional and cognitive load and likely were more frustrated and stressed. These negative emotions, not surprisingly, led to lower EEG power.

In a systematic review of EEG-based emotion recognition of confusion using artificial intelligence, confusion was said to motivate the learning process [26]. The authors also suggested that confusion could hinder the learning process. In a similar review entitled "Seeking optimal confusion: a review of epistemic emotion management in interactive digital learning environments", confusion was also said to be a productive aspect of the learning process [27]. However, the authors similarly concluded that confusion could hinder learning if it persisted. Persistent confusion could then lead to frustration or boredom. Frustration was not discussed in this literature, although it has been considered a difficult emotion. Boredom, on the other hand, has been the focus of many studies in the current literature.

Boredom

Boredom has been defined as a lack of stimulation and boring stimulation as being mundane, meaningless or highly repetitive [2]. Boredom was the most frequently studied emotion in this current literature, possibly because of its problematic negativity. The boredom research can be categorized as elicitors of boredom, boredom effects and underlying mechanisms.

The elicitors can be classified as lack of interest, redundancy, and negative feelings. Lack of interest has been studied in the context of job boredom based on a survey in Japan (N=1019) [28]. Following structural equation modeling on several variables, job boredom was negatively associated with the quantity of job demands and job resources and it was positively associated with psychological distress and turnover intentions. Interestingly, the quality of job demands (sustained cognitive load and use of higher skills), which would seemingly be more important than quantity of job demands, was not related to job boredom. In a longitudinal study on job boredom, adults were observed across 10 days (N= 120) [29]. In this sample, job boredom was reciprocally related to counterproductive work, suggesting a lack of coping with job boredom.

An illustration of redundancy as an elicitor of boredom is a study on switching short videos [30]. In this study entitled "Fast – forward to boredom" (N= 1223), switching between short videos (YouTube or TikTok), called digital switching, led to increased boredom.

Negative states that could be elicitors and/or effects of boredom include loneliness, emotional dysregulation, and impulsivity. In a longitudinal study on Chinese university students (N=699), loneliness led to boredom which led to excessive video use [31]. Boredom and excessive video use were said to be reciprocal.

Emotional dysregulation has also led to boredom in a study on Italian adolescents (N=721) [32]. In a path analysis, emotional dysregulation led to boredom which in turn led to internalizing and externalizing behaviors.

Emotional dysregulation has also led to boredom in even younger children (N= 130 four to 6-year-old children) [33]. The children's strategies for reducing boredom included asking the parents to play with them or playing with toys.

Trait impulsivity has also led to boredom [34]. In this study, impulsive individuals became bored following boring tasks. It's not clear whether it was the impulsivity trait or the boring tasks or both that contributed to boredom in this study.

The papers on the effects of boredom can be classified as negative activities, dysregulated rhythms and negative emotions. The negative activities included impulsivity and excessive smart-phone use. The dysregulated rhythms included changes in the pace of life and sleep rhythms. The negative emotions included anxiety, depression, and suicide risk.

In a laboratory experiment to induce boredom, impulsive choices were increased [24]. A peg-turning task versus a self-selected video increased boredom, which in turn led to impulsive choices.

Excessive smartphone use has resulted from boredom in two papers in this current literature. In a study on university students (N= 112), high state boredom led to craving for smartphone use [35].

In a systematic review and meta-analysis of 54 studies (N= 36,245), the relationship between boredom and smartphone addiction was explored before and after the outbreak of the COVID-19 pandemic [36]. The authors reported a significant correlation between boredom and smartphone addiction. Not surprisingly, COVID-19 was noted to exacerbate that relationship.

Table 1: Epistemic emotions elicitors and effects (and first authors).

Emotion elicitors and effects	First Authors
Awe	
Awe was greater for landscapes than for faces	Droit-Violet
The awe experience of young children is similar to that of adults	O'bri
Awe leads to >self-compassion and empathy	Yuan
Awe decreases existential isolation	Edwards
Awe decreases reactive aggression	Qu
Awe increases mental health	Wang
Surprise	
Linked with awe	Noordewier
>recall for surprises that are plausible	deBruine
Curiosity	
I type (interest & Joyous exploration) and D type (deprivation sensitivity)	Tang
In children it has >protective effect against adult depression	Zheng
State curiosity increases and trait curiosity decreases across age	Whatley
>impulsive sensation-seeking, intolerance of uncertainty & openness	Tian
>leisure activities	Morita
>brain health and >brain regions activated (>alpha & beta activity)	Ni
Shared novelty-seeking basis for curiosity and creativity	Ivancovsky
Learnability driving force for curiosity and creativity	Omigi
Mood regulation shared basis for curiosity and creativity	Zeitlin
Confusion	
<delta, theta, alpha and beta EEG power and <gamma activity	Xu
Motivates and hinders the learning process	Ganepola
Persistent confusion could lead to frustration or boredom	Arguel
Boredom	
Job boredom results from< job demands and resources	Kawada
Job boredom reciprocally related to counterproductive work	Kim
Redundancy of switching short videos leads to boredom	Tam
Loneliness, emotional dysregulation and impulsivity lead to boredom	Yan
Emotional dysregulation leads to boredom in young children	Anderson
Trait impulsivity leads to boredom	Clay
Boredom leads to >impulsive choices	Chao
Boredom leads to >smartphone use	Xiamen, Hu
Boredom leads to faster pace of life	Martarelli
Boredom leads to insomnia	Shiri
Job boredom leads to anxiety, depression and suicidal risk & lower functioning	Li
Boredom proneness leads to anxiety	Zhao
Boredom leads to suicidal behavior	Lissak
>Job boredom leads to <heart rate variability during sleep	Seppola
Boring tasks lead to >cortisol levels	Clay
>boredom in adolescents leads to >frontal asymmetry & theta/beta ratios	Nettiinga

In a paper entitled "Pace of life is faster for a bored person", this phenomenon was reported for individuals as well as for 15 countries [37]. When the sense of time was explored in a virtual waiting room, a slow versus fast ticking clock did not affect boredom [38]. However, greater boredom was associated with time passing more rapidly. Greater boredom was also associated with exhaustion, restlessness, amotivation and frustration as well as later mind-wandering.

Insomnia has also been noted to result from boredom. In a study on work-related boredom among Korean wage workers (N= 30,992), work-related boredom led to burnout which in turn led to insomnia [39].

Negative emotions have also resulted from boredom including anxiety, depression, and suicidal risk. In a study entitled job boredom as an antecedent of four states, workers in Finland (N= 513) were surveyed [6]. Greater anxiety and depression were noted in those who were experiencing job boredom. Also. lower functioning and life satisfaction were noted in those with Job boredom.

Boredom proneness has also been related to anxiety. The Boredom Proneness Questionnaire was given to university students (N=1102) [40]. In this sample, scores on the Boredom Proneness Questionnaire were correlated with scores on the State Anxiety Inventory. Those with high Boredom Proneness Questionnaire scores also had low inhibition scores on the Behavioral Inhibition System Scale.

In a paper entitled "Bored to death: artificial intelligence research reveals the role of boredom in suicide behavior", Facebook postings by 1006 users who had completed the Columbia Suicide Severity Rating Scale were analyzed (N =228,052 postings) [41]. Scores on the boredom scale were predictive of suicide behavior. The relationship between boredom and suicide behavior was mediated by high scores on the depression scale.

A few studies that included physiological measures are suggestive of underlying mechanisms. These include studies on heart rate variability, HPA activity and frontal asymmetry.

In a paper entitled "Is boredom at work bad for your health? Examining the links between job boredom and autonomic nervous system dysfunction" Finnish workers (N= 125), those

with greater job boredom also had lower heart rate variability during sleep [39].

HPA activity was measured by cortisol levels in a study that involved boring tasks (N= 100) [34]. Impulsive individuals had greater boredom following the boring tasks. Impulsivity contributed to elevated cortisol levels which, in turn, predicted boredom.

In research on boredom proneness in preadolescents and adolescents (N= 185 eight to 15 years-old) [42]. Greater boredom was related to greater frontal asymmetry. Greater boredom was also related to greater theta/beta ratios. In this sample, boredom was noted to increase with age.

In one of the only studies that compared emotions, boredom and curiosity were compared [43]. The authors suggested that boredom like hunger arises from lack of information and drives individuals to avoid contexts with low information. Curiosity is similar to appetite, which pulls individuals towards specific sources of information.

In a study entitled "I am easily bored: analysis of a single item measure of boredom", the state and trait boredom scale was compared to the simple item "I am easily bored" [42]. The single item measure was as reliable as the scale, although the measure seemed to tap trait boredom more than state boredom.

In a study entitled "An android can show the facial expressions of complex emotions", Japanese and German adults (N= 240) judged 22 complex emotions expressed by a robot [44]. Thirteen of 22 of them were accurately guessed including the facial expressions of awe and boredom.

Other Epistemic Emotions

Other epistemic emotions appear on the Epistemically – Related Emotions Scale [45]. These include interest, enjoyment, frustration and anxiety. Literature searches for these emotions for the years 2024-2025 suggested that they were not researched as emotions but as situations and as a disorder in the case of anxiety.

Methodological Limitations of this Literature

Several methodological limitations can be noted for this literature on epistemic emotions. The research has been disproportionately focused on awe and boredom emotions. This may relate to their being longer-lived emotions than others like surprise or confusion and, thereby, more easily studied. Diary or Fitbit data could be collected for the more transient emotions. And Fitbit data could have also been collected in more natural environments for awe and boredom as well rather than using images of the natural environment to elicit these emotions or relying on participants' memory of them.

The longer-lived emotions like awe and boredom may also be easier for research participants to recall in the memory retrieval studies. They may be also more readily elicited by virtual presentation of images in the case of awe and boring laboratory tasks like the repetitive peg-turning used in a study on boredom. Unfortunately most of the awe studies were focused on vast landscape scenes rather than multiple other kinds of stimuli that could elicit awe including music and art.

Boredom is a more negative problematic emotion than the others, being the only one that was related to anxiety, depression, and suicidality in this literature. And awe images have served as therapeutic stimulation. They may have been considered more humanly relevant to more researchers and potentially more fundable research topics.

Surprisingly, multiple epistemic emotions have rarely been compared In the same study. A theoretical argument was presented for curiosity and creativity having the same basis in stimulation-seeking, although some 29 commentaries suggested other underlying mechanisms like emotion regulation and mood alteration.

Interestingly, the possibility of these emotions being experienced simultaneously was not considered, for example, curiosity and confusion. They could also be experienced sequentially as in awe leading to curiosity or curiosity leading to interest or confusion leading to boredom. Several other emotions could be considered epistemic like loneliness, envy and frustration. As one scientist suggested we experience countless emotions.

Most of this literature was focused on elicitors or behavioral effects of the different emotions. Although many of the studies were conducted in laboratory situations where physiological data could have been readily collected, potential underlying biological mechanisms were rarely studied except for heart rate variability, elevated cortisol and frontal asymmetry.

Despite these methodological limitations, the 2024-2025 literature on epistemic emotions may help inform the treatment of learning difficulties or the job boredom problem and the mood uplifting effects of awe. This literature on epistemic emotions is complementary to the literature on universal emotions and enhances our understanding of experiences in learning situations like the classroom and the workplace where we spend significant time in our lives.

References

1. Tiffany Field. Universal Emotions Research 2024-2025: A Narrative Review. J Clin Psychol Neurol. 2025. 3: 1-5.
2. Noordewier MK, Gocłowska MA. Shared and unique features of epistemic emotions: Awe, surprise, curiosity, interest, confusion, and boredom. Emotion. 2024. 24: 1029.
3. Droit-Volet S, Dambrun M, Monier F. Awe and time perception. Acta Psychol (Amst). 2024. 245: 104232.
4. O'bi A, Yang F. Seeing awe: How children perceive awe-inspiring visual experiences. Child Dev. 2024. 95: 1271-1286.
5. Yuan W, Chang J, Jiang F, Jiang T. Be kinder to yourself: Awe promotes self-compassion via self-transcendence. Emotion. 2025.
6. Li J, Kaltiainen J, Hakanen JJ. Job boredom as an antecedent of four states of mental health: life satisfaction, positive functioning, anxiety, and depression symptoms among young employees - a latent change score approach. BMC Public Health. 2024. 24: 907.

7. Liao S, Liu Y, Yuan B. The effects of awe on interpersonal forgiveness: the mediating role of small-self. Frontiers in Psychology. 2024. 15: 1336068.
8. Piff PK, Singhal I, Bai Y. Bridging me to we: Awe is a conduit to cohesive collectives. Curr Opin Psychol. 2025. 62: 101979.
9. Edwards ME, Helm PJ, Pratscher S, Bettencourt BA, Arndt J. The impact of awe on existential isolation: Evidence for contrasting pathways. Personality and Social Psychology Bulletin. 2024. 50: 715-732.
10. Stellar JE, Bai Y, Anderson CL, Gordon A, McNeil GD, et al. Culture and Awe: Understanding Awe as a Mixed Emotion. Affect Sci. 2024. 5: 160-170.
11. Qu Y. The Relationship Between Dispositional Awe and Reactive Aggression: The Serial Mediation Role of Trait Anger and Self-Control. Psychol Rep. 2025. 128: 1024-1041.
12. Zhao M, Wang R, Zhao Z, Li L, Luo H, et al. The relationship between boredom proneness, the behavioral inhibition system, and anxiety in college students: variable-centered and person-centered analytic approaches. Front Psychol. 2024. 15: 1414736.
13. de Bruïne A, Vel Tromp M, Koornneef A, Brod G, Jolles D. The interactive effects of surprise and plausibility on memory. J Exp Psychol Learn Mem Cogn. 2025. 51: 954-967.
14. Tang S, Xu T, Jin L, Ji L, Chen Q, et al. Validation of the I- and D-type epistemic curiosity scale among young Chinese children and implications on early curiosity nurture. BMC Psychol. 2024. 12: 795.
15. Zheng C, Liang L, Yuan T, Fei J, Zhao X, et al. Does childhood curiosity influence depression in adulthood? J Psychiatr Res. 2025. 183: 79-85.
16. Whatley MC, Murayama K, Sakaki M, Castel AD. Curiosity across the adult lifespan: Age-related differences in state and trait curiosity. PLoS One. 2025. 20: e0320600.
17. Tian Y, Huang Q, Liu X, Zhang J, Ye Y, et al. Unraveling the Intricacies of Curiosity: A Comprehensive Study of Its Measures in the Chinese Context. Psych J. 2025. 14: 219-234.
18. Morita S, Sueyasu T, Tokuda H, Kaneda Y, Izumo T, et al. Diets and leisure activities are associated with curiosity. PLoS One. 2024. 19: e0314384.
19. Ni Y, Kokubun K, Nemoto K, Yamakawa Y. Examination of the impact of curiosity and fatigue on brain condition. Sci Rep. 2025. 15: 13005.
20. Rüterbories T, Mecklinger A, Eschmann KCJ, Crivelli-Decker J, Ranganath C, et al. Curiosity Satisfaction Increases Event-related Potentials Sensitive to Reward. J Cogn
21. Ivancovsky T, Baror S, Bar M. A shared novelty-seeking basis for creativity and curiosity. Behav Brain Sci. 2023. 47: e89.
22. Omigie D, Bhattacharya J. Beyond novelty: Learnability in the interplay between creativity, curiosity and artistic endeavours. Behavioral & Brain Sciences. 2024. 47.
23. Zeitlen DC, Gasper K, Beaty RE. Mood regulation as a shared basis for creativity and curiosity. Behavioral & Brain Sciences. 2024. 47.
24. Chao T, Todman M, Foltin RW, Evans SM, Bedi G. Laboratory method to induce state boredom increases impulsive choice in people who use cocaine and controls. Am J Drug Alcohol Abuse. 2024. 50: 42-53.
25. Xu T, Wang J, Zhang G, Zhang L, Zhou Y. Confused or not: decoding brain activity and recognizing confusion in reasoning learning using EEG. J Neural Eng. 2023. 20.
26. Ganepola D, Maduranga MW, Tilwari V, Karunaratne I. A Systematic Review of Electroencephalography-Based Emotion Recognition of Confusion Using Artificial Intelligence. Signals. 2024. 5: 244-263.
27. Arguel A, Lockyer L, Chai K, Pachman M, Lipp OV. Puzzle-solving activity as an indicator of epistemic confusion. Frontiers in psychology. 2019. 10: 163.
28. Kawada M, Shimazu A, Miyanaka D, Tokita M, Sakakibara K, et al. Boredom and engagement at work: do they have different antecedents and consequences? Ind Health. 2024. 62: 110-122.
29. Kim J, Kaplan SA, Aitken JA, Ponce LP. Within-Person Dynamics of Job Boredom and Counterproductive Work Behavior: A Latent Change Score Modeling Approach. Affect Sci. 2024. 5: 273-279.
30. Tam KYY, Inzlicht M. Fast-forward to boredom: How switching behavior on digital media makes people more bored. J Exp Psychol Gen. 2024. 153: 2409-2426.
31. Yan Z, Yang Z, Xu X, Zhou C, Sang Q. Problematic Online Video Watching, Boredom Proneness and Loneliness Among First-Year Chinese Undergraduates: A Two-Wave Longitudinal Study. Psychol Res Behav Manag. 2025. 18: 241-253.
32. Iannattone S, Mezzalira S, Bottesi G, Gatta M, Miscioscia M. Emotion dysregulation and psychopathological symptoms in non-clinical adolescents: The mediating role of boredom and social media use. Child Adolesc Psychiatry Ment Health. 2024. 18: 5.
33. Anderson AJ, Perone S. The kids are bored: Trait boredom in early childhood and links to self-regulation, coping strategies, and parent-child interactions. J Exp Child Psychol. 2024. 243: 105919.
34. Clay JM, Badariotti JI, Kozhushko N, Parker MO. HPA activity mediates the link between trait impulsivity and boredom. Physiol Behav. 2024. 284: 114637.
35. Shi X, Xu Y, Liu Z, Niu G, Sun X, et al. More boring, more craving for smartphone use? The moderating role of fear of missing out. J Behav Addict. 2025. 14: 405-415.
36. Hu J, Zhao C, Yu T. The Relationship Between Boredom and Smartphone Addiction Before and After the Outbreak of the COVID-19 Pandemic: A Systematic Review and Meta-Analysis. Psychol Rep. 2025. 27: 332941251314713.
37. Kim G, Choi E. Pace of Life Is Faster for a Bored Person: Exploring the Relationship Between Trait Boredom and Fast Life History Strategy. Evol Psychol. 2025. 23: 14747049241310772.
38. Martarelli CS, Weibel D, Popic D, Wolff W. Time in suspense: investigating boredom and related states in a virtual waiting room. Cogn Emot. 2024. 38: 1080-1094.
39. Seppälä P, Harju L, Virkkala J, Hakanen JJ. Is boredom at work bad for your health? Examining the links between job boredom and autonomic nervous system dysfunction. Stress Health. 2024. 40: e3326.
40. Zhao M, Wang R, Zhao Z, Li L, Luo H, et al. The relationship between boredom proneness, the behavioral inhibition system, and anxiety in college students: variable-centered and person-centered analytic approaches. Front Psychol. 2024. 15: 1414736.

41. Lissak S, Ophir Y, Tikochinski R, Brunstein Klomek A, Sisso I, et al. Bored to death: Artificial Intelligence research reveals the role of boredom in suicide behavior. Front Psychiatry. 2024. 15: 1328122.
42. Drody A, Nettinga J, Dadzie B, Lee J, Trudel C, et al. "I Am Easily Bored." Analysis of a Single Item Measure of Boredom. J Psychol. 2024 Nov. 4: 1-15.
43. Seiler JP, Dan O. Boredom and curiosity: the hunger and the appetite for information. Front Psychol. 2024. 15: 1514348.
44. Diel A, Sato W, Hsu CT, Bäuerle A, Teufel M, et al. An android can show the facial expressions of complex emotions. Sci Rep. 2025. 15: 2433.
45. Pekrun R, Vogl E, Muis KR, Sinatra GM. Measuring emotions during epistemic activities: the Epistemically-Related Emotion Scales. Cognition and Emotion. 2017. 31: 1268-1276.
46. Bondi E, Carbone F, Pizzolante M, Schiena G, Ferro A, et al. Integrating virtual reality, electroencephalography, and transcranial magnetic stimulation to study the neural correlates of awe experiences: The SUBRAIN protocol. PLoS One. 2025. 20: e0302762.
47. Nettinga J, Naseem S, Yakobi O, Willoughby T, Danckert J. Exploring EEG resting state as a function of boredom proneness in pre-adolescents and adolescents. Exp Brain Res. 2024. 242: 123-135.
48. Neurosci. 2024. 36: 888-900.
49. Sinvani RT, Fogel-Grinvald H, Sapir S. Self-Rated Confidence in Vocal Emotion Recognition Ability: The Role of Gender. J Speech Lang Hear Res. 2024. 67: 1413-1423.
50. Wang X, Luo L, Yuan J. Dispositional Awe Predicts Mental Health Through Interpretation Bias During COVID-19 Transmission: A Longitudinal Study. Psych J. 2025.
51. Zhang Y, Bu R, Li X. Social Exclusion and Short Video Addiction: The Mediating Role of Boredom and Self-Control. Psychol Res Behav Manag. 2024. 17: 2195-2203.
52. Zhao M, Wang R, Zhao Z, Li L, Luo H, et al. The relationship between boredom proneness, the behavioral inhibition system, and anxiety in college students: variable-centered and person-centered analytic approaches. Front Psychol. 2024. 15: 1414736.