Awe and Adolescents' Healthy Eating: Mechanistic Differences and Effect Optimization*

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2026-05-22

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Abstract

This study examined the mechanisms by which different types of awe influence adolescents'healthy dietary preferences and strategies for optimizing their effects through five experiments. The results showed that, compared with neutral emotions, positive natural awe promoted healthy eating by enhancing connectedness to nature, whereas non-natural awe exerted a positive effect by increasing construal level. Building on this, the study further found that under positive natural awe, emphasizing the natural attributes of healthy foods or using natural-colored packaging could further enhance its positive effect; under non-natural awe, individuals' healthy dietary preferences could be more effectively improved by emphasizing the long-term health benefits of foods or presenting distant, holistic images to highlight their high-construal-level characteristics. This study indicates that the mechanisms through which different forms of awe guide healthy eating may differ, providing theoretical support and practical implications for developing effective emotion-driven dietary intervention strategies.

Full Text

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Abstract This study examined, through five experiments, the mechanisms by which different types of awe influence adolescents' healthy eating preferences, as well as strategies for optimizing these effects. The results showed that, compared with neutral emotions, positive nature-based awe promoted healthy eating by enhancing nature connectedness, whereas non-nature-based awe exerted a positive effect by elevating construal level. On this basis, the present study further found that, under positive nature-based awe, emphasizing the natural attributes of healthy foods or using nature-colored packaging could further enhance its positive effect; under non-nature-based awe, emphasizing the long-term health benefits of foods or presenting a distant, holistic image that highlights high-construal-level features could more effectively improve individuals' healthy eating preferences. This study indicates that different forms of awe may differ in their mechanisms of action in guiding healthy eating, providing theoretical support and practical implications for developing effective emotion-driven dietary

intervention strategies.

Keywords awe, healthy eating, adolescents, nature connectedness, construal level

Classification number B842.6

1 Introduction

The healthy development of adolescents is a matter of public concern and also a matter of great national importance. The *Outline of the Plan for Building China into a Leading Country in Education (2024-2035)* states that it is necessary to promote students' healthy growth and all-round development, implement the educational philosophy of prioritizing health, and effectively control the obesity rate among students. Although the policy system is becoming increasingly complete, the effectiveness of dietary interventions for adolescents still faces challenges. In recent years, China has successively introduced multiple policy measures, carrying out systematic arrangements around students' reasonable meals and nutritional health, with an emphasis on the popularization of food-safety knowledge and the establishment of healthy eating concepts. However, traditional interventions mostly rely on supervision by parents and schools or on knowledge transmission, which often triggers adolescents' reactance and cognitive fatigue, resulting in limited intervention effects (Bryan et al., 2016). Studies have found that adolescents' eating behaviors are more likely to be driven by nonrational factors such as emotion and intuition. Compared with traditional cognitive interventions, eliciting positive emotions (such as gratitude, nostalgia, hope, etc.) (Fritz et al., 2019; Lasaleta et al., 2021) and leveraging nonrational forces and the functions of emotions may more effectively promote healthy eating (Cadario & Chandon, 2020; Turnwald et al., 2019).

Received: 2025-08-18
* Supported by the National Social Science Fund of China General Program in Education (BBA230059).
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Awe, as a complex emotion with many positive values, has been shown to guide individuals toward a stronger preference for healthy foods (Cao et al., 2020). However, existing research has largely focused on nature-based awe, while neglecting the effects of awe elicited by non-natural sources, such as architecture and art. According to the prototype theory of awe, although awe from different sources contains the two core components of "perceived vastness" and "need for accommodation," different types of awe differ in their experiential dimensions and psychological consequences (Kaplan et al., 2024; Keltner & Haidt, 2003). In addition, previous studies have mainly examined the positive effects of awe in adult populations (Cao et al., 2020), whereas adolescence is a critical period for the formation of dietary patterns, and dietary habits during this period are

likely to persist into adulthood (Movassagh et al., 2017). Therefore, the present research focuses primarily on adolescents (mainly aged 15–20 years, with Experiment 3b extended to ages 18–24), aiming to examine the mechanisms through which different forms of awe influence adolescents' preferences for healthy eating, and, on this basis, to investigate optimization strategies for different awe effects. This research will enrich emotion-intervention research in the field of health behavior, clarify the differentiated mechanisms of influence of different types of awe, and provide practical implications for society and schools in designing effective nudging strategies for healthy eating among adolescents.

1.1 Awe and Its Classification

Awe is a complex emotional experience involving feelings of shock, wonder, and self-diminishment that arises when individuals encounter things that are vast and exceed their existing cognitive frameworks. According to the prototype theory of awe, its core components include perceived vastness and need for accommodation (Keltner & Haidt, 2003). The former refers to the individual' s perception of a great existence that transcends the self, which may manifest as vastness in physical scale, such as towering mountain peaks or gigantic sculptures, or as sublimity in social meaning, such as authoritative figures or religious rituals. The latter refers to the fact that the experience exceeds existing cognitive structures, requiring individuals to update and reorganize their mental schemas.

From the perspective of eliciting sources, awe can be triggered by natural landscapes, human-made wonders, religious beliefs, or supernatural forces (Keltner & Haidt, 2003). Among these, natural landscapes and human-made wonders are the most typical and common sources of awe (Yaden et al., 2019). Based on the physical attributes of the eliciting source, the present research distinguishes awe into natural awe and non-natural awe. Natural awe refers to awe experiences induced by vast natural landscapes. This type of awe is typically triggered by immense physical scale, mysterious natural phenomena, or powerful forces of nature (Keltner & Haidt, 2003). For example, when facing towering mountains, people feel their own smallness; when facing fierce winds and torrential rain, they feel the irresistible power of nature (Jiang et al., 2024). Non-natural awe refers to awe experiences elicited by non-living entities constructed by humans that possess salient characteristics of vastness and transcendence (Kaplan et al., 2024). This type of awe originates from immense physical scale, unique artistic expression, profound historical and cultural heritage, and the human wisdom and creativity embodied therein. For example, awe toward the Potala Palace or the Eiffel Tower may arise from the smallness elicited by their physical scale, but it may also stem from wonder at the accumulation of human civilization, technology, and culture (Joye & Dewitte, 2016; Keltner & Haidt, 2003).

From the perspective of emotional valence, awe can be further divided into positive awe and negative awe. Although awe is often classified as a positive

emotions (Dong Rui et al., 2013). However, when the eliciting context contains threat, uncertainty, or loss of control—such as natural disasters including earthquakes and storms—it is often accompanied by fear, tension, and sadness, reflecting a typical experience of negative awe (Gordon et al., 2017; Takano & Nomura, 2022). Natural landscapes, in particular, may evoke positive awe, but they may also elicit negative awe because of their unpredictability and potential threat (e.g., lightning, hurricanes). By contrast, human-made wonders are typically characterized by their scale, complexity, and cultural accumulation, and are more likely to evoke positive awe centered on cognitive shock and the experience of meaning (Gordon et al., 2017). Accordingly, this study focuses on two typical awe-eliciting contexts: first, natural awe elicited by natural landscapes, which may be positive or negative in valence, with particular attention to positive natural awe; and second, non-natural awe elicited by human-made objects such as architecture, technology, and culture, which is primarily positive in valence[1]. In doing so, the study systematically examines the effects of different types of awe on adolescents' healthy eating preferences and their underlying psychological mechanisms.

1.2 Psychological and Behavioral Effects of Awe

Awe has many positive psychological effects: it can enhance a sense of meaning in life and self-continuity (Pan & Jiang, 2023; Yuan et al., 2024), increase optimism (Pan & Jiang, 2025), and promote a state of inner peace (Pan et al., 2024). According to the prototypical theory of awe (Keltner & Haidt, 2003), although awe can be induced by different stimuli, its core components—vastness and cognitive accommodation—do not vary by eliciting source. Specifically, experiences of awe, whether in response to positive or negative natural landscapes or to human-made wonders, are generally accompanied by a diminished sense of self and self-transcendence (Zhao et al., 2026), can strengthen individuals' connection with larger wholes (such as society and other people), and promote prosocial tendencies (Guan et al., 2019; Piff et al., 2015). Natural awe, in particular, can also enhance a sense of connectedness with nature (Liu et al., 2023), thereby promoting pro-environmental behavior (Kaplan et al., 2024).

In shaping health behavior, awe can temporarily enable individuals to transcend a self-centered perspective (Chall & Kahn, 2026). Healthy eating decisions involve a trade-off between immediate desires and long-term values, and awe can help individuals move beyond excessive attention to immediate desires and redirect attention toward higher-order value pursuits with long-term significance (Jiang et al., 2018; Zhao et al., 2026). At the same time, awe can also promote self-compassion—that is, understanding and acceptance of one' s own adverse circumstances (Yuan et al., 2025)—and self-compassion has been shown to buffer emotional eating and promote healthy eating (Bicaker et al., 2023). In addition, awe can lead individuals to reorganize their existing psychological schemas and

[1]Because non-natural awe is primarily positive in valence, the main text refers to it simply as "non-natural awe," rather than using the expression "positive non-natural awe."

initiate more cautious analytical processing (Cao et al., 2020), thereby enabling them to weigh immediate taste against long-term health value more rationally when making food choices. However, although negative natural awe likewise contains core features such as vastness and cognitive accommodation (Gordon et al., 2017), it is also accompanied by pronounced feelings of threat, uncertainty, and anxiety (Takano & Nomura, 2022). Existing research has shown that both fear and anxiety are important triggers of unhealthy eating (Cardi et al., 2015). Therefore, compared with positive natural awe and non-natural awe, negative natural awe may have difficulty

produce a considerable positive effect.

Based on the above analysis, this study proposes Hypothesis 1a: Compared with neutral emotions and negative nature-based awe, positive nature-based awe helps promote adolescents' preferences for healthy eating; Hypothesis 1b: Compared with neutral emotions and negative nature-based awe, non-nature-based awe helps promote adolescents' preferences for healthy eating.

1.3 Positive Nature-Based Awe and Healthy Eating: The Mediating Role of Nature Connectedness and Effect Optimization

Nature connectedness refers to people' s identification with nature and their emotional bond with nature (Schultz, 2002). Previous research has shown that awe toward positive natural landscapes can promote nature connectedness (Liu et al., 2023). Nature connectedness can buffer negative emotions, reduce stress responses (Wicks et al., 2022), reduce individuals' cravings for unhealthy foods (Michels et al., 2022), and promote healthy eating (Stott et al., 2024). Accordingly, Hypothesis 2a is proposed: Nature connectedness mediates the effect of positive nature-based awe on preferences for healthy eating.

Based on the emotion–message framing matching hypothesis and related empirical research, when the way information is presented is highly congruent with an individual' s current emotional state, the fluency of information processing will increase (i.e., perceived fluency), thereby strengthening behavioral guidance effects (Han et al., 2016; Saeed et al., 2024). For example, Pounders et al. (2019) found that when the temporal framing of health-persuasion messages (distant vs. near) matched emotional states (shame vs. guilt), individuals experienced higher perceived fluency and, in turn, showed stronger intentions to engage in healthy behavior. Accordingly, when the type of awe matches the way information is presented, healthy eating may be promoted by increasing perceived fluency. Specifically, if Hypothesis 2a holds, then when external cues that are highly related to nature connectedness are strengthened, the facilitating effect of positive nature-based awe will be enhanced accordingly. Nature cues can activate nature-related psychological schemas, increase closeness to nature, and thereby enhance nature connectedness (Martin et al., 2020). Therefore, Hypothesis 2b is proposed: Under the condition of positive nature-based awe,

highlighting the natural (vs. artificial) attributes of healthy foods can enhance individuals' perceived fluency and thereby increase their preference for healthy foods.

In addition, color, as an important visual cue, has an important influence on individuals' emotions, cognition, and behavior (Elliot & Maier, 2014). In the food domain, packaging color not only conveys information about product attributes but may also activate specific emotional associations and value judgments. Natural colors refer to undyed, non-artificial, and unprocessed colors, such as beige and light brown, which can evoke associations with nature, simplicity, authenticity, and the like. Compared with non-natural colors such as red and blue, they can more strongly enhance the perceived naturalness of food (Marozzo et al., 2020). Accordingly, Hypothesis 2c is proposed: Under the condition of positive nature-based awe, natural-colored (vs. non-natural-colored) packaging can more effectively increase individuals' preference for healthy foods.

1.4 Non-Nature-Based Awe and Healthy Eating: The Mediating Role of Construal Level and Effect Optimization

According to construal level theory (Trope & Liberman, 2003), people' s psychological representations of events involve different levels of abstraction, namely construal levels. A high construal level emphasizes abstract, essential aspects that are highly related to goals.

related characteristics, such as interpreting "eating vegetables" as "maintaining health" ; by contrast, low construal levels focus on concrete, superficial features that are more weakly associated with the goal, such as "chewing" or "swallowing." Compared with low construal levels, high construal levels can strengthen individuals' attention to distal goals (Fujita et al., 2006) and improve self-control (Zhang & Zhang, 2022). In addition, individuals with high construal levels attend more to the desirability of things (core value and meaning), whereas those with low construal levels attend more to feasibility (specific steps and convenience) (Trope & Liberman, 2003). In dietary decision-making, nutritional value and long-term health attributes belong to the desirability dimension, whereas taste attributes belong to the feasibility dimension. In sum, high construal levels can lead individuals to prioritize long-term health goals over immediate taste satisfaction, thereby promoting healthy eating (Gardner et al., 2014).

Non-nature awe is elicited by stimuli that are vast and transcend everyday cognition, and it can promote individuals' understanding of things from a macroscopic and abstract perspective (Septianto et al., 2021). For example, when facing grand architecture, people usually experience its magnificence at the holistic level; this process expands the scope of attention, making them aware that they are situated within larger spatial and temporal dimensions (Pan et al., 2024), thereby activating high-construal-level processing. In addition, awe can promote cognitive accommodation—that is, updating existing mental schemas to integrate new stimuli (Rudd et al., 2018). This process involves abstract pro-

cessing of information and deeper thinking, further activating high construal levels (Bullard et al., 2019). Studies have also shown that experiences of non-nature awe—such as imagining looking down over a city from the top of the Eiffel Tower—can enhance individuals' preference for desirability features (vs. feasibility features), and desirability corresponds to a high-construal-level processing mode (Septianto et al., 2021). In sum, non-nature awe may promote healthy eating by increasing construal level. Accordingly, Hypothesis 3a is proposed: construal level mediates the effect of non-nature awe on preferences for healthy eating.

Similarly, based on the matching hypothesis of the emotion–information framework, if Hypothesis 3a holds, it can be inferred that when the high construal level activated by non-nature awe is congruent with the way information is presented, perceived fluency will increase, thereby strengthening the facilitative effect on healthy eating. In addition, according to construal level theory, individuals' construal levels change with temporal distance; emphasizing distal time—such as events that occur in the future or the long-term value of things—will activate representations at a high construal level (Trope & Liberman, 2003). Thus, Hypothesis 3b is proposed: under conditions of non-nature awe, emphasizing the distal (vs. proximal) benefits of healthy foods can enhance individuals' perceived fluency and thereby increase their preference for healthy foods.

Furthermore, existing research has shown that perceived spatial distance can also affect individuals' construal levels (Trope & Liberman, 2003). Compared with close-up images, such as partial close-ups of a product, distant-view images, such as the overall outline of a product, are more likely to elicit greater perceived distance and thereby activate higher construal levels (Kim et al., 2019). Therefore, in contexts of non-nature awe, manipulating the spatial presentation of images may also further strengthen its facilitative effect on preferences for healthy foods. Accordingly, Hypothesis 3c is proposed: under conditions of non-nature awe, presenting food images in distant view (vs. close-up) can more effectively increase individuals' preference for healthy foods.

The present research includes five experiments. Experiment 1 preliminarily examines the effects of different types of awe on dietary decision-making, to test Hypotheses 1a and

1b, while also measuring natural connectedness and construal level, to test their mediating roles in the above process and thereby verify Hypotheses 2a and 3a.

On this basis, subsequent experiments followed the logic of a moderation-of-process design. By manipulating external cues that were highly relevant to natural connectedness or construal level, they further examined the mechanisms through which different types of awe influence healthy eating. Specifically, Experiments 2a and 2b focused on positive natural awe and manipulated nature-related cues through food attributes and packaging colors, respectively, to examine the mechanism by which positive natural awe promotes healthy eating and to identify optimization strategies, thereby testing Hypotheses 2b and 2c. Exper-

iments 3a and 3b focused on non-natural awe and manipulated construal level through temporal and spatial distance, respectively, to examine the mechanism by which non-natural awe promotes healthy eating and to identify optimization strategies, thereby testing Hypotheses 3b and 3c. In addition, Experiments 2a and 3a, based on the matching hypothesis, tested whether the match between awe type and information presentation could influence healthy eating through the mediating role of perceived fluency. Experiments 2b and 3b further extended the semantic nudges used in Experiments 2a and 3a—highlighting the natural attributes of foods or their long-term benefits—to the perceptual/visual level, such as natural-colored food packaging or distant-scenery presentation, in order to develop nudge strategies with low intervention cost and easy integration into real consumption contexts, such as packaging and poster pages. The overall research framework is shown in Figure 1.

Figure 1. Research framework

- **Differentiated mediating mechanisms of different types of awe**
  - **(Experiment 1)**
    - Positive natural awe → Natural connectedness → Healthy eating
    - Non-natural awe → Construal level → Healthy eating
- **Boundary conditions and optimization strategies for the effects of different types of awe**
  - **(Experiment 2a)** Positive natural awe × food natural attributes
  - **(Experiment 3a)** Non-natural awe × long-term benefits of food
  - **(Experiment 2b)** Positive natural awe × natural-colored food packaging
  - **(Experiment 3b)** Non-natural awe × distant-scenery food image
- Based on the matching hypothesis, testing the mediating role of perceived fluency
  ↓ Extending semantic nudges to the perceptual/visual level

- Adding behavioral measurement indicators and expanding optimization strategies

2 Experiment 1: The Mechanism by Which Awe Influences Healthy Food Choices

2.1 Research Method

2.1.1 Experimental Design A single-factor between-subjects experimental design was used, with emotion as the factor: positive natural awe, negative natural awe, non-natural awe, and neutral emotion. The dependent variable was the number of healthy foods selected by participants.

2.1.2 Participants G*Power was used to calculate the analysis of variance for the single-factor between-subjects design employed in this study. Following Cohen' s (1992) recommendation, with the significance level set at $\alpha = 0.05$ and

a medium effect size ($f = 0.25$), a minimum of 180 participants was required to achieve 80% statistical power. A total of 202 participants were recruited from a general high school in Hunan Province. After excluding questionnaires with extensive missing data and those that failed the attention check, 192 valid responses remained, including 93 boys and 99 girls, $M_{age} = 16.03$ years,

$SD = 0.54$ years. There were 51 participants in the positive natural-awe group, 46 in the negative natural-awe group, 47 in the non-natural-awe group, and 48 in the neutral-emotion group. This study was approved by the Ethics Committee of Hunan Normal University (No. 2025049). Before the study began, the students' homeroom teachers and parents were informed of the study content; students participated voluntarily and could withdraw at any time without condition.

2.1.3 Research Materials

(1) Emotion-induction materials: Participants' emotional states were induced by watching videos (e.g., Pan & Jiang, 2025). The video used to induce positive natural awe included continuous mountains, the vast ocean, migrating animals, and other content; the video used to induce negative natural awe included enormous lightning, frightening mudslides, tornadoes, and other content; the video used to induce non-natural awe showed the Egyptian pyramids and a giant lion-headed human figure; and the video for the neutral-emotion group showed ordinary woodworking. Each video lasted approximately 4 minutes.

(2) Emotion manipulation check: A self-report emotion scale was used (Guan et al., 2019). Participants were asked to rate their emotional experiences while watching the materials on a 7-point scale, including six emotions: awe, surprise, happiness, well-being, fear, and anxiety (1 = not at all, 7 = extremely strong). Following the scoring rules of Guan et al. (2019), the average score for awe and surprise indicated the level of awe ($\alpha = 0.76$); the average score for happiness and well-being indicated the level of positive emotion ($\alpha = 0.92$); and the average score for fear and anxiety indicated the level of negative emotion ($\alpha = 0.85$). If the awe group (relative to the neutral-emotion group) elicited a higher sense of awe, and the positive (negative) awe group also elicited higher positive (negative) emotions, this indicated that positive or negative awe had been effectively manipulated (Guan et al., 2019). Because the present study further distinguished between natural awe and non-natural awe, participants also needed to report the content of the video they had watched (A. beautiful natural scenery, B. frightening natural disasters, C. majestic pyramids, D. woodworking) to verify the type of awe.

(3) Nature connectedness scale: The Inclusion of Nature in the Self scale was used (Schultz, 2002). Participants were presented with 7 pairs of circles, each pair representing the self and nature; from the first to the seventh

pair, the degree of overlap gradually increased (i.e., the level of nature connectedness became higher). Participants needed to select the figure that best represented their relationship with nature.

(4) Measurement of construal level: A category inclusiveness task was used (Slepian et al., 2015). Participants were asked to evaluate the extent to which 6 examples (including two typical examples, two moderately typical examples, and two atypical examples) belonged to a given category (1 = does not belong at all, 7 = belongs completely). There were 3 categories in total (transportation, furniture, and clothing). Higher scores indicated that the individual was more inclined to classify the examples into broader and more abstract categories, reflecting a higher construal level.

(5) Food choice task: Following previous research (Gardner et al., 2014), participants were presented with 3 sets of foods (in random order), each consisting of one healthy food (e.g., an apple) and one unhealthy food (e.g., French fries). Participants needed to choose one item from each pair of foods, and the number of healthy foods chosen was used as the healthy eating index. A pilot experiment recruited 51 participants (17 boys and 34 girls; $M_{age} = 15.84$, $SD = 0.58$) to rate the foods' healthiness, liking, and familiarity on a 7-point scale, where "1 = very unhealthy, 7 = very healthy," "1 = strongly dislike, 7 =

"extremely like," and "1 = very unfamiliar, 7 = very familiar." The results showed that, in each group, the perceived healthiness of the healthy food was significantly higher than that of the unhealthy food, whereas liking and familiarity did not differ significantly (see Table 1). Therefore, the above foods were used as the experimental materials in the formal study.

Table 1 Descriptive statistics and difference comparisons for food-evaluation items ($M \pm SD$)

Measure	First group: Apple	First group: French fries	t	p	Second group: Fruit cucumber	Second group: Spicy strips	t	p	Third group: Yogurt	Third group: Cola	t	p
Healthiness	6.80 ± 0.49	3.29 ± 1.63	13.89	< 0.001	6.61 ± 0.80	2.61 ± 1.39	15.87	< 0.001	6.14 ± 1.17	3.02 ± 1.46	12.55	< 0.001
Liking	5.86 ± 1.36	5.45 ± 1.36	1.64	0.11	5.55 ± 1.50	5.16 ± 1.43	1.48	0.15	6.12 ± 0.86	5.86 ± 1.11	1.16	0.25
Familiarity	6.41 ± 0.73	6.25 ± 0.98	1.00	0.32	6.33 ± 1.14	6.18 ± 1.14	0.77	0.45	6.25 ± 0.98	6.02 ± 1.10	1.21	0.23

Note: $df = 50$.

2.1.4 Research Procedure Participants were told that they would take part in a series of unrelated studies. First, participants viewed the emotion-induction materials and completed the emotion-manipulation check. They then completed the food-choice task and measures of natural association and construal level. Finally, they filled in basic information, including gender, age, height, weight, hunger level (1 = not hungry at all, 7 = very hungry), and restrained-eating tendency (i.e., "Would you restrain your eating in order to control your body shape?" 1 = never, 7 = often). At the end of the study, participants were randomly given one of the selected foods as compensation.

2.2 Results

2.2.1 Manipulation Check There were significant differences in emotional experiences across the experimental conditions (see Table 2). Multiple comparisons (Bonferroni correction) showed that awe experiences did not differ significantly among the positive natural awe group, the negative natural awe group, and the nonnatural awe group, and all were significantly higher than those in the neutral-emotion group; positive emotion in the positive natural awe group was significantly higher than in the other emotion conditions; and negative emotion in the negative natural awe group was significantly higher than in the other emotion conditions. In addition, all participants accurately identified the content of the emotion-induction materials, indicating that the study effectively manipulated awe and distinguished different types of awe.

Table 2 Descriptive statistics and difference comparisons for emotional experience under each experimental condition ($M \pm SD$)

Measure	Positive natural awe	Negative natural awe	Nonnatural awe	Neutral emotion	F	Partial η^2
Awe emotion	5.15 ± 1.39^{d}	5.02 ± 1.17^{d}	5.17 ± 1.58^{d}	$3.56 \pm 1.10^{a,b,c}$	16.55^{***}	0.21
Positive emotion	$5.25 \pm 1.46^{b,c,d}$	$1.68 \pm 0.97^{a,c,d}$	$3.22 \pm 1.63^{a,b}$	$3.30 \pm 1.42^{a,b}$	53.13^{***}	0.46
Negative emotion	1.81 ± 1.23^{b}	$4.61 \pm 1.46^{a,c,d}$	1.96 ± 0.84^{b}	1.54 ± 0.97^{b}	72.19^{***}	0.54

Note: $df = (3, 188)$. ^{a} indicates that the mean differs significantly from the positive natural awe condition ($p < 0.001$); ^{b} indicates that the mean differs significantly from the negative natural awe condition ($p <$ [[unclear: remainder cut off]]

0.001); superscript c indicates that the mean differs significantly from the non-natural awe condition ($p < 0.001$); superscript d indicates that the mean differs significantly from the neutral condition ($p < 0.001$); $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ (same below).

2.2.2 Descriptive Statistics and Correlation Analysis

The descriptive statistics and correlation analysis results for all variables are shown in Table 3. Natural connectedness and construal level were significantly positively correlated with the number of healthy food choices; gender, age, BMI (kg/m^2), hunger level, and restrained eating were not significantly correlated with the core variables and therefore were not included in subsequent statistical analyses.

Table 3 Descriptive statistics and correlation analysis of all variables

Variable	*M*	*SD*	1	2	3	4	5	6	7
1. Gender	–	–	–						
2. Age	16.03	0.54	−0.13	–					
3. BMI	21.10	3.77	−0.06	−0.04	–				
4. Hunger level	3.43	1.65	−0.18*	0.14	−0.15*	–			
5. Restrained eating	2.31	0.80	−0.06	0.08	0.04	0.14	–		
6. Natural connectedness	4.99	1.51	−0.03	0.02	−0.04	0.09	0.06	–	
7. Construal level	5.16	1.24	−0.02	−0.08	0.08	0.06	0.12	0.08	–

Variable	M	SD	1	2	3	4	5	6	7
8. Number of healthy food choices	1.55	0.88	−0.002	−0.08	−0.01	−0.13	0.13	0.18*	0.30***

Note: Gender was a dummy variable, 0 = male, 1 = female.

2.2.3 Difference Test for the Number of Healthy Food Choices

The analysis of variance showed that emotion significantly affected the number of healthy food choices (see Figure 2), $F(3, 188) = 47.52$, $p < 0.001$, partial $\eta^2 = 0.43$. Post hoc comparisons revealed that, compared with the negative natural awe condition ($M = 0.83$, $SD = 0.61$) and the neutral emotion condition ($M = 1.10$, $SD = 0.72$), participants in the positive natural awe condition ($M = 2.14$, $SD = 0.63$) and the non-natural awe condition ($M = 2.06$, $SD = 0.70$) chose more healthy foods ($p_s < 0.001$). There was no significant difference in food choices between the positive natural awe condition and the non-natural awe condition ($p = 1.00$), nor was there a significant difference in food choices between the negative natural awe condition and the neutral emotion condition ($p = 0.27$).

Figure 2 Effect of emotion on the number of healthy food choices

Emotion condition	Number of healthy food choices
Positive natural awe	2.14
Negative natural awe	0.83
Non-natural awe	2.06
Neutral emotion	1.10

Note: Error bars indicate the mean ± 1 standard error; the same applies below.

2.2.4 Difference Tests for Mediating Variables

ANOVA indicated that emotion significantly affected connectedness to nature, $F(3, 188) = 6.77$, $p < 0.001$, partial $\eta^2 = 0.10$.

Specifically, connectedness to nature in the positive nature-awe group ($M = 5.49$, $SD = 1.27$) was higher than in the non-nature-awe group ($M = 4.64$, $SD = 1.67$) ($p = 0.004$) and the neutral-emotion group ($M = 4.42$, $SD = 1.46$) ($p < 0.001$). Connectedness to nature in the negative nature-awe group ($M =$

5.41, $SD = 1.38$) was higher than in the non-nature-awe group ($p = 0.01$) and the neutral-emotion group ($p = 0.001$). There was no significant difference in connectedness to nature between the negative nature-awe group and the positive nature-awe group ($p = 0.79$), nor between the non-nature-awe group and the neutral-emotion group ($p = 0.46$).

Emotion also significantly affected construal level, $F(3, 188) = 3.23$, $p = 0.02$, partial $\eta^2 = 0.05$. Specifically, the construal level of the positive nature-awe group ($M = 5.36$, $SD = 1.25$) was higher than that of the negative nature-awe group ($M = 4.85$, $SD = 1.03$) ($p = 0.04$). The construal level of the non-nature-awe group ($M = 5.49$, $SD = 1.12$) was higher than that of the negative nature-awe group ($p = 0.01$) and the neutral-emotion group ($M = 4.93$, $SD = 1.41$) ($p = 0.02$). There was no significant difference in construal level between the positive nature-awe group and the non-nature-awe group ($p = 0.60$) or the neutral-emotion group ($p = 0.08$), nor between the negative nature-awe group and the neutral-emotion group ($p = 0.76$).

2.2.5 Mediation Analysis

The SPSS macro PROCESS (Model 4, bootstrapping 5,000 times; Hayes, 2013) was used to test the mediating role of connectedness to nature between positive nature awe (vs. neutral emotion) and healthy food choices. The results showed (see Figure 3) that the direct effect of positive nature awe in predicting healthy food choices was significant (direct effect = 0.53, $SE = 0.08$, 95% CI = [0.36, 0.70], $p < 0.001$), and the indirect effect of the pathway with connectedness to nature as the mediating variable was significant (indirect effect = 0.08, $SE = 0.04$, 95% CI = [0.01, 0.17]).

Figure 3 diagram text: Positive nature awe (1 = positive nature awe, 0 = neutral emotion) → Connectedness to nature, $\beta = 0.37^{***}$; Connectedness to nature → Number of healthy food choices, $\beta = 0.21^{*}$; Positive nature awe → Number of healthy food choices, direct effect $\beta = 0.53^{***}$, total effect $\beta = 0.61^{***}$.

Figure 3. The mediating effect of connectedness to nature

The mediating role of construal level between non-nature awe (vs. neutral emotion) and healthy food choices was tested. The results showed (see Figure 4) that the direct effect of non-nature awe in predicting healthy food choices was significant (direct effect = 0.49, $SE = 0.08$, 95% CI = [0.33, 0.66], $p < 0.001$), and the indirect effect of the pathway with construal level as the mediating variable was significant (indirect effect = 0.07, $SE = 0.03$, 95% CI = [0.01, 0.14]).

[Path diagram]

Non-natural awe
1 = non-natural awe, 0 = neutral emotion
→ Construal level, $\beta = 0.22^{*}$
→ Number of healthy food choices, $\beta = 0.31^{***}$

Non-natural awe
→ Number of healthy food choices
Direct effect $\beta = 0.49^{***}$
Total effect $\beta = 0.56^{***}$

Figure 4. The mediating role of construal level

To further test the hypotheses, this study additionally examined alternative mediating pathways involving nature connectedness and construal level. The results showed that the mediating effect of nature connectedness between non-natural awe (vs. neutral emotion) and healthy food choice was not significant (95% CI = [−0.03, 0.06]); the mediating effect of construal level between positive natural awe (vs. neutral emotion) and healthy dietary choice was likewise not significant (95%CI = [−0.01, 0.07]). These results indicate that the alternative pathways were not supported.

2.3 Summary

Experiment 1 found that, compared with the negative natural awe group and the neutral emotion group, both positive natural awe and non-natural awe promoted individuals' healthy dietary choices (supporting Hypotheses 1a and 1b), but the two differed in their mediating pathways. Specifically, positive natural awe promoted healthy eating by increasing nature connectedness (supporting Hypothesis 2a); non-natural awe, by contrast, promoted healthy eating by activating a high construal level (supporting Hypothesis 3a).

Using a measurement-based approach, Experiment 1 preliminarily examined the mediating pathways through which different types of awe influence healthy eating. On this basis, subsequent experiments will incorporate process-by-moderation designs to provide causal evidence for the underlying mechanisms. Specifically, Experiments 2a and 2b will focus on positive natural awe and, by objectively manipulating external cues related to nature connectedness (food naturalness and packaging color), further test the mechanism by which positive natural awe promotes healthy eating as well as strategies for optimizing this effect. More specifically, Experiment 2a manipulates food attributes (natural vs. artificial). Based on the matching hypothesis, if nature connectedness is the psychological mechanism through which positive natural awe promotes healthy eating, then the match of "positive natural awe + natural food attributes"should enhance perceived fluency, thereby amplifying its nudging advantage. In addition, whereas Study 1 used high school students as the research participants, Experiment 2a extends the sample to first-year university students, who have greater autonomy in dietary choices, in order to test the replicability of the influence mechanism.

3 Experiment 2a: The Joint Nudging Advantage of "Positive Natural Awe + Natural Food Attributes"

3.1 Research Method

3.1.1 Experimental Design

A 2 (awe type: positive natural awe, non-natural awe) × 2 (food attribute: natural, artificial) between-subjects experimental design was adopted. The dependent variable was participants' preference index for a healthy food (yogurt).

3.1.2 Participants

Using G*Power, we calculated the sample size required for the ANOVA in the two-factor between-subjects design used in this study. With a significance level of $\alpha = 0.05$ and a medium effect size ($f = 0.25$), a minimum of 128 participants was needed to achieve 80% statistical power. Considering that some participants might be excluded for careless responding, 210 first-year students were recruited from a university in Hunan. After questionnaires that failed the attention check were removed, 202 valid responses remained, including 74 male students and 128 female students, $M_{\text{age}} = 18.06$ years, $SD = 0.70$ years. Among them, 49 were in the positive natural awe–natural attribute group, 54 in the positive natural awe–artificial attribute group, 53 in the non-natural awe–natural attribute group, and 46 in the non-natural awe–artificial attribute group.

3.1.3 Study Procedure

Participants were told that they were taking part in a survey about travel experiences. First, they were asked to imagine that they were traveling in Tibet and were shown images of either snow-capped mountains (positive natural awe) or the Potala Palace (non-natural awe).[2] They then completed emotion

[2]The key test examined whether the two awe-induction materials could effectively elicit awe compared with neutral materials. An additional 77 participants were recruited (28 males and 49 females, $M_{\text{age}} = 20.40$, $SD = 2.32$) and were randomly assigned to the positive natural awe condition (snow-capped mountains) ($n = 26$), the non-natural awe condition (Potala Palace) ($n = 26$), or the neutral emotion condition (everyday scenes) ($n = 25$). The emotion self-rating scale (as in Experiment 1) was used to evaluate the images. The internal-consistency coefficients for the items assessing awe, positive emotion, and negative emotion were 0.87, 0.86, and 0.77, respectively. The results showed that emotion condition significantly affected awe, $F(2, 74) = 76.82$, $p < 0.001$, partial $\eta^2 = 0.68$. Multiple comparisons indicated that awe in the positive natural awe condition ($M = 5.71$, $SD = 0.70$) did not differ significantly from that in the non-natural awe condition ($M = 5.85$, $SD = 0.72$) ($p = 0.87$), and both were significantly higher than in the control group ($M = 3.24$, $SD = 1.07$), $p_s < 0.001$. The effect of emotion condition on positive emotion was not significant, $F(2, 74) = 0.24$, $p = 0.79$, $M_{\text{positive natural awe}} = 5.33$, $SD_{\text{positive natural awe}} = 1.09$, $M_{\text{non-natural awe}} = 5.50$, $SD_{\text{non-natural awe}} = 0.79$, $M_{\text{neutral emotion}} = 5.46$, $SD_{\text{neutral emotion}} = 0.90$. The effect of emotion condition on negative emotion was not significant, $F(2, 74) = 0.37$, $p = 0.69$, $M_{\text{positive natural awe}} = 2.17$, $SD_{\text{positive natural awe}} = 1.06$, $M_{\text{non-natural awe}} = 1.94$,

manipulation-check items, reporting the content of the image (A. majestic architecture; B. natural landscape), and completed the emotion self-rating scale (as in Study 1). In the present study, the internal-consistency coefficients for the items assessing awe, positive emotion, and negative emotion were 0.76, 0.92, and 0.67, respectively.

Participants were then told that, during the trip, the tour guide would provide them with a type of yogurt. Food attributes were manipulated through yogurt advertisements: in the natural-attribute group, the advertisement showed a cow eating grass on a prairie, accompanied by the text "A gift from nature, pure and natural" ; in the artificial-attribute group, the advertisement image depicted a scene of handmade yogurt production, accompanied by the text "Handmade, with an authentic local flavor." Participants then reported their liking, perceived attractiveness, and purchase intention for the yogurt (1 = not at all, 7 = very strong). The mean of the three items was used as the healthy-food preference index, with an internal-consistency coefficient of 0.92. Participants also reported their perceived fluency of the food advertisement ("This advertisement looks very comfortable," 1 = strongly disagree, 7 = strongly agree). Finally, they rated the perceived naturalness of the yogurt (1 = more artificial, 7 = more natural) and provided basic demographic information (gender, age).

3.2 Results

3.2.1 Manipulation Check

We examined the effectiveness of the manipulation of awe type. First, all participants were able to accurately identify the image content, indicating that the study successfully distinguished different types of awe. Second, there were no significant differences in awe or negative emotions induced under the different awe conditions, and posi-

The positive natural awe group reported significantly higher positive emotion than the non-natural awe group (see Table 4); therefore, positive emotion was included as a control variable in subsequent analyses.

Table 4 Descriptive statistics of emotional experiences under different experimental conditions ($M \pm SD$) and comparisons of differences

Measured variable	Positive natural awe	Non-natural awe	t	p	Cohen' s d
Awe emotion	5.68 ± 1.11	5.43 ± 1.17	1.53	0.13	0.22
Positive emotion	5.51 ± 1.28	5.06 ± 1.52	2.30	0.02	0.32

$SD_{\text{non-natural awe}} = 1.06$, $M_{\text{neutral emotion}} = 1.96$, $SD_{\text{neutral emotion}} = 1.08$. These results indicate that the images selected for the study could effectively induce awe.

Measured variable	Positive natural awe	Non-natural awe	t	p	Cohen' s d
Negative emotion	2.49 ± 1.21	2.33 ± 1.09	0.94	0.35	0.13

Note: $df = 200$.

To test the effectiveness of the manipulation of food attributes, an independent-samples t test showed that the perceived naturalness of foods in the natural-attribute condition ($M = 5.87$, $SD = 1.03$) was higher than that in the artificial-attribute condition ($M = 4.41$, $SD = 1.30$), $t(200) = 8.85$, $p < 0.001$, Cohen' s $d = 1.25$. These results indicate that the manipulation of food attributes was effective.

3.2.2 Descriptive statistics

The descriptive statistics for each measured variable under different experimental conditions are shown in Table 5.

Table 5 Descriptive statistics for Experiment 2a ($M \pm SD$)

Measured variable	Food attribute	Positive natural awe	Non-natural awe
Food preference	Natural	5.02 ± 1.11	4.47 ± 1.36
	Artificial	4.12 ± 1.13	4.54 ± 1.09
Fluency perception	Natural	4.76 ± 1.11	4.32 ± 1.36
	Artificial	4.09 ± 1.14	4.54 ± 1.17

3.2.3 Difference test for food preference

Using the healthy food preference index as the dependent variable, a 2 (awe type: positive natural awe, non-natural awe) $\times$ 2 (food attribute: natural, artificial) between-subjects ANOVA was conducted. The results showed that the main effect of awe type was not significant: the food preference of the positive natural awe group ($M = 4.55$, $SD = 1.20$) did not differ significantly from that of the non-natural awe group ($M = 4.50$, $SD = 1.23$), $F(1, 198) = 0.16$, $p = 0.69$; the main effect of food attribute was significant: participants' preference for natural-attribute foods ($M = 4.73$, $SD = 1.27$) was higher than their preference for artificial-attribute foods ($M = 4.31$, $SD = 1.13$), $F(1, 198) = 6.32$, $p = 0.01$, partial $\eta^2 = 0.03$; the interaction between awe type and food attribute was significant, $F(1, 198) = 8.44$, $p = 0.004$, partial $\eta^2 = 0.04$. Simple-effects analyses indicated that under the positive natural awe condition, participants

preferred natural-attribute foods more, $F(1, 198) = 15.00$, $p < 0.001$, partial $\eta^2 = 0.07$; under the non-natural awe condition, participants' preferences for foods with different attributes did not differ significantly, $F(1, 198) = 0.08$, $p = 0.79$ (see Figure 5). When the positive emotion score was entered as a covariate, the two-factor between-subjects ANCOVA showed that, after controlling for positive emotion scores, the original main-effect and interaction-effect results

remained unchanged: the main effect of awe type was not significant, $F(1, 197) = 0.16$, $p = 0.69$; the main effect of food attribute was significant, $F(1, 197) = 6.06$, $p = 0.02$, partial $\eta^2 = 0.03$; and the interaction between awe type and food attribute was significant, $F(1, 197) = 8.79$, $p = 0.003$, partial $\eta^2 = 0.04$.

Figure 5. Effect of awe type and food attribute on the healthy-food preference index

- Y-axis: Healthy-food preference index
- Legend: Natural attribute; Artificial attribute
- X-axis categories: Positive natural awe; Non-natural awe
- Values: Positive natural awe—natural attribute 5.02, artificial attribute 4.12 ($***$); Non-natural awe—natural attribute 4.47, artificial attribute 4.54

3.2.3 Mediation Test of Perceived Fluency

Using perceived fluency as the dependent variable, a two-factor between-subjects ANOVA showed that the main effects of awe type and food attribute were both nonsignificant, $F_{\text{awe type}}(1, 198) = 0.002$, $p = 0.96$; $F_{\text{food attribute}}(1, 198) = 1.69$, $p = 0.20$. However, the interaction term between awe type and food attribute significantly affected perceived fluency, $F(1, 198) = 6.86$, $p = 0.01$, partial $\eta^2 = 0.03$. Specifically, under the condition of positive natural awe, individuals reported higher perceived fluency for foods with salient natural attributes, $F(1, 198) = 7.85$, $p = 0.006$, partial $\eta^2 = 0.04$; under the condition of non-natural awe, individuals' perceived fluency did not differ significantly across foods with different attributes, $F(1, 198) = 0.85$, $p = 0.36$. Subsequently, the SPSS macro PROCESS (Bootstrapping $N = 5000$, Model 4) was used to conduct a mediation test, with the interaction term between awe type and food attribute as the independent variable, perceived fluency as the mediator, and healthy-food preference as the dependent variable. The results indicated (see Figure 6) that the interaction between awe type and food attribute significantly influenced healthy-food preference through the mediating role of perceived fluency (indirect effect = 0.23, $SE = 0.10$, 95% CI = [0.04, 0.44]).

Figure 6. Mediating role of perceived fluency

- Awe type × food attribute → Perceived fluency: $\beta = 0.37^{*}$
- Perceived fluency → Food preference: $\beta = 0.62^{***}$
- Awe type × food attribute → Food preference: direct effect $\beta = 0.31^{*}$; total effect $\beta = 0.54^{***}$

3.3 Summary

Experiment 2a found that the match between positive natural awe and the natural attributes of food can enhance perceived fluency, thereby promoting healthy-food preference (supporting Hypothesis 2b). Based on this, Experiment 2b will manipulate the natural attributes of food through natural-color food packaging and set up a control group, while also adding a behavioral measurement indicator (maximum willingness to pay for healthy food), to further examine the effect of positive natural awe on heal[[unclear: text continues on next page]].

mechanisms through which healthy eating is promoted, and further expand the nudging optimization strategies that help advance it. In addition, previous research has primarily focused on general high school students and college students, while relatively neglecting secondary vocational students—a risk group characterized by poorer health literacy and a high incidence of unhealthy eating behaviors (Luo Huijuan et al., 2024). Therefore, Experiment 2b used secondary vocational students as the research participants.

4 Experiment 2b: The Joint Nudging Advantage of "Positive Nature Awe + Natural Packaging Color"

4.1 Research Methods

4.1.1 Experimental Design

A 2 (emotion: positive nature awe, control group) × 2 (packaging color: natural color, non-natural color) between-subjects experimental design was adopted. The dependent variables were participants' preference index for the healthy food and their maximum willingness to pay.

4.1.2 Participants

A total of 170 questionnaires were distributed at a vocational high school. After excluding questionnaires that failed the attention check, 162 valid responses remained. All participants had normal vision and no color blindness or color weakness. Among them, 76 were male and 86 were female, with $M_{age} = 17.20$ years and $SD = 1.50$ years. Specifically, there were 41 participants in the positive nature awe–natural color group, 44 in the positive nature awe–non-natural color group, 39 in the control–natural color group, and 38 in the control–non-natural color group.

4.1.3 Research Procedure

Participants were informed that they were taking part in a study on food consumption. First, participants viewed a series of natural landscape images showing snow mountains and grasslands (positive nature awe condition) or images of a milk production line (control group). They then completed an emotion self-report scale (the same as in Study 1), measuring awe, positive emotion, and negative emotion; the internal consistency coefficients for the three dimensions were 0.81, 0.89, and 0.92, respectively.

Next, all participants viewed a milk advertisement. In the positive nature awe condition, the advertisement background was a grand natural landscape (the Tianshan Mountains), whereas in the control group it was an ordinary desktop. At the same time, the color of the milk packaging was manipulated to influence perceived naturalness. Referring to the study by Marozzo et al. (2020), the natural-color condition used light brown (RGB: 205, 149, 90), whereas the non-natural-color condition used light red (RGB: 245, 95, 70).

After the advertisement was presented, participants reported their degree of preference for the milk (the same as in Experiment 2a, $\alpha = 0.91$), and used a slider to select the maximum price they were willing to pay, ranging from 1 to 30 yuan (item: "At most, how many yuan would you be willing to spend to buy a carton of this milk?"). Finally, participants completed a color manipulation check, reporting whether the milk packaging they saw was light red or light brown, and evaluated the perceived naturalness of the milk (item: "This milk is completely natural" ; 1 = strongly disagree, 7 = strongly agree).

4.2 Results

4.2.1 Manipulation Check

The results of the emotion manipulation check showed (see Table 6) that the awe emotion score in the positive natural awe group was significantly higher than that in the control group, indicating that the awe manipulation was effective. In addition, participants' negative emotion scores did not differ significantly across emotion conditions, whereas the positive emotion score in the positive natural awe group was significantly higher than that in the control group. Therefore, positive emotion was included as a control variable in subsequent analyses.

Table 6 Descriptive statistics ($M \pm SD$) and between-condition comparisons of emotional experiences under each experimental condition

Measurement variable	Positive natural awe	Control group	t	p	Cohen' s d
Awe emotion	5.19 ± 0.89	4.12 ± 0.83	7.85	< 0.001	1.23

Measurement variable	Positive natural awe	Control group	t	p	Cohen' s d
Positive emotion	4.80 ± 1.10	4.08 ± 0.98	4.36	< 0.001	0.69
Negative emotion	2.15 ± 1.22	2.32 ± 1.50	0.80	0.43	0.13

Note: $df = 160$.

The results of the color manipulation check showed that all participants could accurately identify the package color. An independent-samples t test further indicated that, compared with the red package ($M = 4.30$, $SD = 1.12$), the light-brown package was perceived as more natural ($M = 5.15$, $SD = 1.48$), $t(160) = 4.18$, $p < 0.001$, Cohen' s $d = 0.66$. These results indicate that the manipulation of package color was effective and significantly influenced the perceived naturalness of the food.

4.2.2 Descriptive Statistics

The descriptive statistics for each measurement variable under the different experimental conditions are shown in Table 7.

Table 7 Descriptive statistics for Experiment 2b ($M \pm SD$)

Measurement variable	Package color	Positive natural awe	Control group
Food preference index	Natural color	5.39 ± 1.13	4.26 ± 1.10
	Non-natural color	4.40 ± 1.16	4.05 ± 0.96
Maximum willingness to pay	Natural color	8.88 ± 3.23	6.15 ± 3.01
	Non-natural color	6.68 ± 2.66	6.21 ± 2.92

4.2.3 Difference Test for Food Preference

Using the healthy food preference index as the dependent variable, a 2 (emotion: positive natural awe group, control group) × 2 (package color: natural color, non-natural color) between-subjects ANOVA was conducted. The results showed a significant main effect of emotion: food preference under the positive natural awe condition ($M = 4.88$, $SD = 1.24$) was significantly higher than

that in the control group ($M = 4.16$, $SD = 1.03$), $F(1, 158) = 18.35$, $p < 0.001$, partial $\eta^2 = 0.10$; the main effect of package color was significant: individuals' preference for foods in natural-color packaging ($M = 4.84$, $SD = 1.25$) was significantly higher than for those in non-natural colors ($M = 4.24$, $SD = 1.08$), $F(1, 158) = 12.20$, $p < 0.001$, partial $\eta^2 = 0.07$; the interaction between emotion and package color was significant, $F(1, 158) = 5.12$,

$p = 0.03$, partial $\eta^2 = 0.03$. Specifically, for the positive natural-awe group, individuals showed a stronger preference for foods in natural-color packaging, $F(1, 158) = 17.42$, $p < 0.001$, partial $\eta^2 = 0.10$; for the control group, there was no significant difference in individuals' preferences for foods with different packaging colors, $F(1, 158) = 0.72$, $p = 0.40$ (see Figure 7). Taking positive-emotion scores as a covariate, the results of the two-factor between-participants ANCOVA showed that, after controlling for positive-emotion scores, the original main effects and interaction effect remained unchanged: the main effect of emotion was significant, $F(1, 157) = 14.91$, $p < 0.001$, partial $\eta^2 = 0.09$; the main effect of packaging color was significant, $F(1, 157) = 11.81$, $p = 0.001$, partial $\eta^2 = 0.07$; and the interaction between awe type and food attribute was significant, $F(1, 157) = 5.24$, $p = 0.02$, partial $\eta^2 = 0.03$.

Figure 7. Effects of emotion and packaging color on the healthy-food preference index

Y-axis: Healthy-food preference index. Legend: natural-color; non-natural-color. Groups: positive natural awe; control group. Values shown: positive natural awe −5.39 vs. 4.40; control group−4.26 vs. 4.05. ***

4.2.4 Difference Test for Maximum Payment Amount

Using maximum payment amount as the dependent variable, the two-factor between-participants ANOVA indicated that the main effect of emotion was significant: compared with the control group ($M = 6.18$, $SD = 2.95$), the positive natural-awe group was willing to pay a higher amount for healthy foods ($M = 7.74$, $SD = 3.13$), $F(1, 158) = 11.81$, $p < 0.001$, partial $\eta^2 = 0.07$. The main effect of packaging color was significant: the maximum payment amount under natural-color packaging ($M = 7.55$, $SD = 3.39$) was significantly higher than that under non-natural-color packaging ($M = 6.46$, $SD = 2.77$), $F(1, 158) = 5.29$, $p = 0.02$, partial $\eta^2 = 0.03$. The interaction between awe type and food attribute was significant, $F(1, 158) = 5.87$, $p = 0.02$, partial $\eta^2 = 0.04$. Specifically, for the positive natural-awe group, individuals were willing to pay more for foods in natural-color packaging, $F(1, 158) = 16.99$, $p < 0.001$, partial $\eta^2 = 0.10$; for the control group, there was no significant difference in the maximum payment amount for foods with different packaging colors, $F(1, 158) = 0.52$, $p = 0.47$ (see Figure 8). Taking positive-emotion scores as a covariate, the results of the two-factor between-participants ANCOVA showed that, after controlling for positive-emotion scores, the original main effects and interaction effect remained unchanged: the main effect of emotion was signifi-

cant, $F(1, 157) = 6.44$, $p = 0.01$, partial $\eta^2 = 0.04$; the main effect of packaging color was significant, $F(1, 157) = 4.65$, $p = 0.03$, partial $\eta^2 = 0.03$; and the interaction between awe type and food attribute was significant, $F(1, 157) = 6.80$, $p = 0.01$, partial $\eta^2 = 0.04$.

Figure content: Bar chart. Y-axis: "Maximum payment amount" (0–10). X-axis groups: "Positive natural awe" and "Control group." Legend: dark bars = "natural color" ; light bars = "non-natural color." Values: under positive natural awe, natural color = 8.88 and non-natural color = 6.68, with a significance marker $***$; under the control group, natural color = 6.15 and non-natural color = 6.21.

Figure 8. Effects of emotion and packaging color on maximum payment amount

4.3 Summary

Experiment 2b found that positive natural awe can promote healthy eating (increasing the preference index for healthy foods and willingness to pay), and that natural-colored (vs. non-natural-colored) packaging can amplify this facilitating effect (supporting Hypothesis 2c), thereby further extending the nudge-optimization strategy for positive natural awe. In sum, based on a process-moderation design, Experiments 2a and 2b verified that natural cues for healthy foods (emphasizing the natural attributes of foods or using natural packaging colors) can strengthen the nudging effect of positive natural awe, and also indirectly supported the key role of connectedness to nature in the promotion of healthy eating by positive natural awe.

Experiments 3a and 3b focus on non-natural awe and further examine its mechanism for promoting healthy eating and its optimization strategies. Specifically, Experiment 3a manipulates the perceived temporal distance of food benefits (distant vs. near). Based on the matching hypothesis, if construal level is the psychological mechanism by which non-natural awe nudges healthy eating, then the match of "non-natural awe + long-term food benefits" should increase perceived fluency, thereby amplifying its nudging advantage.

5 Experiment 3a: The Joint Nudging Advantage of "Non-Natural Awe + Long-Term Food Benefits"

5.1 Research Method

5.1.1 Experimental Design A 2 (type of awe: positive natural awe, non-natural awe) × 2 (perceived temporal distance of food benefits: distant, near) between-subjects experimental design was adopted. The dependent variable was participants' preference index for healthy foods.

5.1.2 Participants A total of 180 participants were recruited from the freshman class of a university in Hunan. After excluding questionnaires with exten-

sive missing responses, failures on the attention check, and careless responding, 173 valid responses remained, including 29 male students and 144 female students, M_{age} = 18.05 years, SD = 0.56 years. Among them, 43 participants were in the positive natural awe–near temporal distance group, 44 in the positive natural awe–distant temporal distance group, 42 in the non-natural awe–near temporal distance group, and 44 in the non-natural awe–distant temporal distance group.

5.1.3 Research Procedure The research procedure was the same as in Experiment 2a. After completing the emotion induction and manipulation check, participants continued to complete the evaluation of their food preferences.

Unlike Experiment 2a, the present study manipulated perceived temporal distance through advertising slogans. Specifically, in the distant-temporal-distance condition, the slogan "Benefit life, enjoy the future; long-term support for healthy vitality" was used, emphasizing the long-term benefits of the healthy food (yogurt). In the near-temporal-distance condition, the slogan "Benefit life, enjoy this moment; enjoy healthy vitality anytime" was used, emphasizing the short-term attributes of the healthy food. To test the manipulation of perceived temporal distance, the following item was included: "Does this food advertisement highlight the long-term benefits or the short-term benefits of the food?" (1 = greater emphasis on short-term benefits, 7 = greater emphasis on long-term benefits).

Emotion was measured using the same self-report emotion scale as in Experiment 2a. The internal consistency coefficients for the dimensions of awe, positive emotion, and negative emotion were 0.83, 0.86, and 0.81, respectively. Food preference was measured as in Experiment 2a ($\alpha = 0.93$).

5.2 Results

5.2.1 Manipulation Check

The effectiveness of the manipulation of awe type was tested. First, all participants were able to accurately identify the picture content, indicating that the study effectively distinguished between different types of awe. Second, there were no significant differences in the awe, positive emotion, or negative emotion induced under the different awe conditions (see Table 8).

Table 8 Descriptive statistics of emotional experience under each experimental condition ($M \pm SD$) and comparisons of differences

Measured variable

Awe type

t

p

Positive natural awe

Non-natural awe

Awe emotion

5.58 ± 1.04

5.64 ± 1.10

0.36

0.72

Positive emotion

5.32 ± 1.05

5.17 ± 1.06

0.92

0.36

Negative emotion

2.42 ± 1.18

2.42 ± 1.24

0.03

0.98

Note: $df = 171$.

The effectiveness of the manipulation of perceived temporal distance was tested. The independent-samples t test showed that, compared with the near-temporal-distance condition ($M = 3.61$, $SD = 1.97$), participants in the distant-temporal-distance condition ($M = 5.52$, $SD = 1.55$) perceived greater long-term benefits of the food, $t(171) = 7.12$, $p < 0.001$, Cohen's $d == 1.08$. These results indicate that the manipulation of perceived temporal distance was effective.

5.2.2 Descriptive Statistics

The descriptive statistics for each measured variable under the different experimental conditions are shown in Table 9.

Table 9 Descriptive statistics for Experiment 3a ($M \pm SD$)

Measured variable	Temporal distance	Positive natural awe	Non-natural awe
Food preference	Near	4.60 ± 1.41	4.13 ± 1.16
	Far	4.45 ± 1.28	4.97 ± 1.09

Figure 9. The effect of awe type and temporal distance on the healthy food preference index. Legend: far temporal distance; near temporal distance. Y-axis: healthy food preference index. X-axis: positive natural awe; non-natural awe. Values shown: positive natural awe—far 4.45, near 4.60; non-natural awe—far 4.97, near 4.13; ** indicates a significant difference.

Figure 1: Figure 9. The effect of awe type and temporal distance on the healthy food preference index. Legend: far temporal distance; near temporal distance. Y-axis: healthy food preference index. X-axis: positive natural awe; non-natural awe. Values shown: positive natural awe—far 4.45, near 4.60; non-natural awe—far 4.97, near 4.13; ** indicates a significant difference.

Measured variable	Temporal distance	Positive natural awe	Non-natural awe
Perceived fluency	Near	4.26 ± 1.36	3.79 ± 1.28
	Far	4.07 ± 1.35	4.50 ± 1.21

5.2.3 Difference Test for Food Preference

Using the healthy food preference index as the dependent variable, a 2 (awe type: positive natural awe, non-natural awe) $\times 2$ (temporal distance: far, near) between-subjects analysis of variance was conducted. The results showed that the main effect of awe type was not significant; there was no significant difference in food preference between the natural-awe group ($M = 4.52,\ SD = 1.34$) and the non-natural-awe group ($M = 4.56,\ SD = 1.20$), $F(1, 169) = 0.02,\ p = 0.90$. The main effect of temporal distance was not significant; there was no significant difference in food preference between the far temporal-distance group ($M = 4.71,\ SD = 1.21$) and the near temporal-distance group ($M = 4.36,\ SD = 1.31$), $F(1, 169) = 3.43,\ p = 0.07$. The interaction between awe type and temporal distance was significant, $F(1, 169) = 6.79,\ p = 0.01$, partial $\eta^2 = 0.04$. Specifically, under the positive natural-awe condition, temporal distance had no significant effect on healthy food preference, $F(1, 169) = 0.29,\ p = 0.59$. Under the non-natural-awe condition, far temporal distance significantly increased individuals' healthy food preference, $F(1, 169) = 9.88,\ p = 0.002$, partial $\eta^2 = 0.06$ (see Figure 9).

Figure 9 The effect of awe type and temporal distance on the healthy food preference index

5.2.4 Mediation Test of Perceived Fluency

Using perceived fluency as the dependent variable, a two-factor between-subjects analysis of variance indicated that the main effects of awe type and temporal distance were both not significant, $F_{\text{awe type}}(1, 169) = 0.009,\ p = 0.92$;

$F_{\text{temporal distance}}(1, 169) = 1.77,\ p = 0.19$. However, the interaction term between awe type and temporal distance significantly affected perceived fluency, $F(1, 169) = 5.18,\ p = 0.02$, partial $\eta^2 = 0.03$. Specifically, under the positive natural-awe condition, temporal distance had no significant effect on healthy food preference, $F(1, 169) = 0.45,\ p = 0.50$. Under the non-natural-awe condition, far temporal distance significantly increased individuals' perceived fluency, $F(1, 169) = 6.46,\ p = 0.01$, partial $\eta^2 = 0.04$. Subsequently, the SPSS macro PROCESS was used (Bootstrapping $N = 5000$, Model 4), with the interaction term between awe type and temporal distance as the independent variable, perceived fluency as the mediating variable, and healthy food

food preference as the dependent variable. The results indicated (see Figure 10) that the interaction between awe type and temporal distance significantly influenced healthy food preference through the mediating role of perceived fluency (indirect effect $= 0.22,\ SE = 0.11,\ 95\%\text{CI} = [0.02,\ 0.44]$).

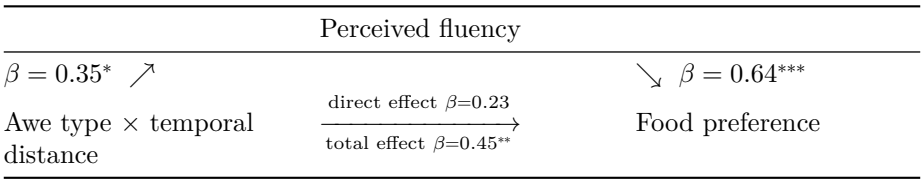

Figure 10. Mediating role of perceived fluency

5.3 Summary

Experiment 3a found that matching non-natural awe with a distant temporal distance (i.e., emphasizing the long-term benefits of foods) can enhance perceived fluency, thereby promoting preference for healthy foods (supporting Hypothesis 3b). Experiment 3b will manipulate construal level through the perceived spatial distance of food images, include a control group, and add a behavioral assessment indicator—the maximum amount participants are willing to pay for healthy foods—to further examine the mechanism by which non-natural awe promotes healthy eating and to extend its nudge-optimization strategy. In addition, prior research has shown that dietary patterns from adolescence to early adulthood exhibit continuity (Movassagh et al., 2017). Therefore, Experiment 3b appropriately broadens the age range (18–24 years) to test the replicability of the influence mechanism.

6 Experiment 3b: The Joint Nudge Advantage of "Non-Natural Awe + Distant-View Food Images"

6.1 Research Method

6.1.1 Experimental Design A 2 (emotion: non-natural awe, control group) × 2 (perceived spatial distance of food images: far, near) between-subjects

experimental design was adopted. The dependent variables were participants' preference index for healthy foods and their maximum willingness to pay.

6.1.2 Participants Participants were recruited on the online questionnaire platform Credamo, with the sample age restricted to the lowest range that could be set in the system (18–24 years). A total of 216 questionnaires were collected. After excluding questionnaires that failed the attention check, 208 valid responses remained. Among them, 76 participants were male and 132 were female; $M_{age} = 20.83$ years, $SD = 1.82$ years. Specifically, there were 53 participants in the non-natural awe–far spatial distance group, 51 in the non-natural awe–near spatial distance group, 53 in the control–far spatial distance group, and 51 in the control–near spatial distance group.

6.1.3 Research Procedure Participants were informed that they were taking part in a survey on healthy food consumption. First, the non-natural awe group viewed a series of images depicting magnificent French architecture (e.g., the Eiffel Tower and the Arc de Triomphe), whereas the control group viewed images of ordinary urban streets in France. Subsequently, all participants completed an emotion self-rating scale (the same as in Study 1), measuring awe, positive emotion, and negative emotion,

The internal consistency coefficients for the dimensions were 0.69, 0.85, and 0.76, respectively.

Next, an advertisement image featuring a bag of whole-wheat bread was presented. In the non-natural awe condition, the background of the advertisement was the towering Eiffel Tower; in the control group, the background was an ordinary building. At the same time, the presentation mode of the manipulated bread image was used to influence construal level (Kim et al., 2019). Specifically, in the near spatial distance condition, a close-up image of the local features of the bread was presented, highlighting details (low construal level); in the far spatial distance condition, a distant image of the entire bread package was presented, emphasizing overall features (high construal level).

After the advertisement was displayed, participants reported their degree of preference for the product (consistent with Experiment 2a, 3 items, $\alpha = 0.93$) and the maximum amount they were willing to pay. Finally, they completed a manipulation-check item for sense of spatial distance: "Does this advertisement reflect the local details or the overall features of the bread?" (1 = more reflective of local details, 7 = more reflective of overall features), to assess their subjective perception of the advertisement' s presentation mode.

6.2 Results

6.2.1 Manipulation check

The results of the emotion manipulation check showed (see Table 10) that awe emotion scores in the non-natural awe group were significantly higher than those in the control group, indicating that the manipulation of awe was effective. In addition, participants' positive emotion and negative emotion scores did not differ significantly across the emotion conditions.

Table 10
Descriptive statistics ($M \pm SD$) and difference comparisons of emotional experience under each experimental condition

Measured variable	Non-natural awe	Control group	t	p	Cohen' s d
Awe emotion	5.42 ± 1.14	4.49 ± 1.30	5.50^{***}	< 0.001	0.76
Positive emotion	4.98 ± 1.16	4.95 ± 1.03	0.19	0.85	0.03
Negative emotion	2.01 ± 0.96	2.22 ± 1.14	1.38	0.17	0.19

Note: $df = 206$.

The results of the independent-samples t test indicated that, compared with the near spatial distance condition ($M = 3.19$, $SD = 2.01$), participants in the far spatial distance condition ($M = 5.70$, $SD = 1.35$) were more inclined to believe that the advertisement highlighted the overall (rather than local) features of the bread, $t(206) = 10.60$, $p < 0.001$, Cohen' s $d = 1.47$. These results indicate that the manipulation of sense of spatial distance was effective.

6.2.2 Descriptive statistics

The descriptive statistics for each measured variable under different experimental conditions are shown in Table 11.

Table 11 Descriptive Statistics for Experiment 3b ($M \pm SD$)

Measure	Spatial distance	Non-nature awe	Control group
Food preference index	Near	5.15 ± 1.11	5.05 ± 1.30

Measure	Spatial distance	Non-nature awe	Control group
Food preference index	Far	5.68 ± 1.09	4.85 ± 1.61
Maximum willingness to pay	Near	11.73 ± 4.34	11.18 ± 4.55
Maximum willingness to pay	Far	13.83 ± 4.51	10.60 ± 4.33

6.2.3 Difference Test for Food Preferences

Using the healthy food preference index as the dependent variable, a 2 (emotion: non-nature awe group, control group) × 2 (spatial distance: far, near) between-subjects ANOVA was conducted. The results showed that the main effect of emotion was significant: food preference in the non-nature awe group ($M = 5.42,\ SD = 1.09$) was significantly higher than that in the control group ($M = 4.95,\ SD = 1.46$), $F(1, 204) = 6.78,\ p = 0.01$, partial $\eta^2 = 0.03$. The main effect of spatial distance was not significant: food preference in the near spatial-distance group ($M = 5.10,\ SD = 1.20$) did not differ significantly from that in the far spatial-distance group ($M = 5.26,\ SD = 1.43$), $F(1, 204) = 0.86,\ p = 0.36$. The interaction between emotion and spatial distance was significant, $F(1, 204) = 4.10,\ p = 0.04$, partial $\eta^2 = 0.02$. Specifically, for the non-nature awe group, food preference in the far spatial-distance group was significantly higher than that in the near spatial-distance group, $F(1, 204) = 4.36,\ p = 0.04$, partial $\eta^2 = 0.02$. For the control group, spatial distance had no significant effect on food preference, $F(1, 204) = 0.60,\ p = 0.44$ (see Figure 11).

Figure content: Legend: near spatial distance; far spatial distance. Y-axis: healthy food preference index. X-axis groups: non-nature awe; control group. Values: non-nature awe—near 5.15, far 5.68 (*); control group—near 5.05, far 4.85.

Figure 11 Effects of Emotion and Spatial Distance on the Healthy Food Preference Index

6.2.4 Difference Test for Maximum Willingness to Pay

Using maximum willingness to pay as the dependent variable, a two-factor between-subjects ANOVA was conducted. The results indicated that the main effect of emotion was significant: maximum willingness to pay in the non-nature awe group ($M = 12.80,\ SD = 4.53$) was significantly higher than that in the control group ($M = 10.88,\ SD = 4.33$), $F(1, 204) = 9.43,\ p = 0.002$, partial $\eta^2 = 0.04$. The main effect of spatial distance was not significant: maximum

willingness to pay in the near spatial-distance group ($M = 11.45,\ SD = 4.43$) did not differ significantly from that in the far spatial-distance group ($M = 12.22,\ SD = 4.69$), $F(1, 204) = 1.55,\ p = 0.21$. The interaction between emotion and spatial distance was significant, $F(1, 204) = 4.74,\ p = 0.03$, partial $\eta^2 = 0.02$. Specifically, for the non-nature awe group, maximum willingness to pay in the far spatial-distance group was significantly higher than in the near spatial-distance condition, $F(1, 204) = 5.86,\ p = 0.02,$ partial $\eta^2 = 0.03$; for the control group, there was no significant difference between the different spatial-distance conditions, $F(1, 204) = 0.43,\ p = 0.51$ (see Figure 12)[3].

Group	Near spatial distance	Far spatial distance
Non-natural awe	11.73	13.83
Control group	11.18	10.60

Y-axis: Maximum payment amount

Figure 12. Effects of emotion and spatial distance on maximum payment amount

6.3 Summary

Experiment 3b found that non-natural awe can promote healthy eating (manifested as higher healthy-food preference indices and maximum payment amounts), and that panoramic distant images of healthy foods (vs. close-up partial images) can enhance this promoting effect (supporting Hypothesis 3c). It should be noted that, in this study, the effect size of the interaction between emotion and sense of spatial distance was relatively small (partial $\eta^2 = 0.02$), suggesting that caution is still needed in generalizing this result. Previous research has shown that small effects are relatively common in the domain of health behavior. For example, a meta-analysis by Cadario and Chandon (2020) found that the average overall effect size of healthy-eating nudge strategies was

[3]We tested whether age group could moderate the effects of emotion and sense of spatial distance. With healthy-food preference and maximum payment amount as dependent variables, respectively, a 2 (emotion: non-natural awe group, control group) × 2 (sense of spatial distance: far, near) × 3 (age: 18-19 years, 20-21 years, 22-24 years) between-subjects ANOVA was conducted. The results showed that the main effect of emotion remained significant [$F_{\text{preference}}(1, 196) = 7.02,\ p = 0.009,$ partial $\eta^2 = 0.04$; $F_{\text{payment}}(1, 196) = 8.68,\ p = 0.004,$ partial $\eta^2 = 0.04$]; the interaction between emotion and sense of spatial distance also remained significant [$F_{\text{preference}}(1, 196) = 4.06,\ p = 0.045,$ partial $\eta^2 = 0.02$; $F_{\text{payment}}(1, 196) = 4.06,\ p = 0.045,$ partial $\eta^2 = 0.02$]. However, the two-way interactions between age and emotion [$F_{\text{preference}}(2, 196) = 0.24,\ p = 0.79$; $F_{\text{payment}}(2, 196) = 0.51,\ p = 0.60$] or between age and sense of spatial distance [$F_{\text{preference}}(2, 196) = 0.05,\ p = 0.95$; $F_{\text{payment}}(2, 196) = 0.27,\ p = 0.76$] were not significant; the three-way interaction among the three factors was also not significant [$F_{\text{preference}}(2, 196) = 0.16,\ p = 0.86$; $F_{\text{payment}}(2, 196) = 0.43,\ p = 0.65$]. These results indicate that, across different age groups, the nudging effect of "non-natural awe + far spatial distance" did not differ significantly.

small, but they may still produce cumulative impacts at the population level. Therefore, although the effect size of this interaction was relatively small, as an initial attempt to match non-natural awe with spatial-distance cues to nudge healthy eating, the present finding still has certain heuristic significance.

In sum, Experiments 3a and 3b, based on process-moderation designs, found that information with a high construal level (such as highlighting long-term benefits or presenting panoramic distant images) can strengthen the nudging effect of non-natural awe, further supporting the idea that construal level is an internal psychological mechanism through which non-natural awe promotes healthy eating.

7 Discussion

Through five experiments, this study adopted multiple ways of inducing awe (background factors unrelated to the eating task, eating situations, or food advertisements), and, based on multidimensional dependent-variable measures (number of healthy foods chosen, degree of preference, and maximum payment amount), combined a measurement-based mediation design (Experiment 1) and process-moderation designs (Experiments 2–3) to systematically examine

the mechanisms by which different types of awe influence adolescents' healthy eating preferences, as well as strategies for optimizing information presentation. The results show that both positive natural awe and non-natural awe can significantly promote adolescents' healthy dietary choices. Specifically, positive natural awe operates mainly by strengthening nature connectedness, whereas non-natural awe exerts its influence by increasing construal level. Further research found that, in contexts of positive natural awe, highlighting the natural attributes of foods can enhance its effect in promoting healthy eating; in contexts of non-natural awe, emphasizing foods' high-construal-level features can further amplify its nudging effect. Overall, this study reveals the differentiated mechanisms through which different types of awe influence healthy eating, verifies the mediating roles of nature connectedness and construal level, and shows that modes of information presentation matched to the type of emotion can improve intervention effectiveness. These findings enrich the theoretical framework linking awe to health behavior, and also provide differentiated visual and informational design strategies for school health education, food marketing, and public health communication.

Previous studies have shown that positive natural awe can increase the proportion of healthy food choices made by individuals (Cao et al., 2020). Building on this foundation, the present study further reveals that different types of awe have differentiated mechanisms of action when influencing adolescents' healthy eating preferences. Based on these mechanistic differences, semantic and visual information-delivery strategies can be used to highlight different attributes of foods, thereby further optimizing the positive effects of different types of awe on healthy eating preferences. On the one hand, positive natural awe indirectly

promotes healthy eating by strengthening individuals' sense of nature connectedness, and this facilitating effect is further enhanced when foods possess stronger natural attributes, such as salient natural origins or packaging in natural colors. This indicates that awe elicited by natural landscapes can evoke an emotional bond between people and nature, making individuals prefer healthy foods with a stronger sense of naturalness. This finding is consistent with the biophilia hypothesis, which holds that humans have an innate tendency to affiliate with nature (Wilson, 1984). Previous research has found that nature connectedness is an important mechanism through which awe promotes pro-environmental behavior and well-being (Liu et al., 2023; Yan et al., 2025). The present study further finds that nature connectedness induced by positive natural awe can also promote healthy eating among adolescents, extending the positive role of nature connectedness in health behavior (Wicks et al., 2022). On the other hand, non-natural awe promotes healthy eating by increasing individuals' construal level, with stronger effects especially when high-construal features are activated in the context, such as emphasizing long-term benefits or distant-view imagery. This suggests that awe experiences elicited by man-made wonders such as magnificent architecture may prompt individuals to consider dietary choices from a more abstract and longer-term perspective, thereby strengthening their preference for healthy foods. Construal level theory proposes that increases in spatial and temporal distance can elevate the level of abstract processing (Trope & Liberman, 2003), and non-natural awe may enhance this psychological distance by activating a spatial sense of self-smallness and a temporal sense of historical depth, thereby increasing construal level (Pan et al., 2024). In sum, although both types of awe can promote healthy dietary choices, their mechanisms of action and optimal matching contexts may differ. This finding not only deepens theoretical understanding of how different types of awe influence health behavior, but also provides more targeted evidence for the design of visual and semantic information in healthy eating interventions.

This study explored the mechanisms through which different forms of awe influence adolescents' healthy eating preferences, and, on this basis, examined strategies for optimizing the effects of different forms of awe; it therefore has important theoretical significance for multiple research fields. First, this study found that positive natural awe and

Both non-natural awe and positive natural awe can effectively promote adolescents' healthy eating preferences, whereas negative natural awe has only a limited effect, indicating that the valence characteristics of awe have an important influence on its behavioral consequences. As previous research has shown, positive awe (compared with negative awe) has unique advantages in enhancing well-being and inhibiting aggressive impulses (Li Xiaoming et al., 2025; Liu et al., 2023). The present study further extends this effect to the domain of healthy eating, revealing the differential influence of awe with different valences in guiding behavior.

Second, this study found that both positive natural awe and non-natural awe can

promote healthy eating, but their mechanisms of action depend respectively on connectedness to nature and construal level. This demonstrates the type-specific and multi-pathway characteristics of awe in shaping attitudes and behaviors, and provides new evidence for the prototype theory of awe in the domain of healthy eating. Finally, this study found that pairing positive natural awe with food presentations high in natural attributes, and pairing non-natural awe with informational cues at a high construal level, can both significantly optimize their promoting effects on healthy eating. This indicates that the intervention effects of different types of awe are context-dependent and are influenced by the fit between individuals' psychological perceptions and external information. Starting from the specific sources of awe, this study provides empirical support for understanding the interaction between emotion and context, as well as for the "emotion–information framing matching hypothesis"(Han et al., 2016; Saeed et al., 2024).

Against the backdrop of national strategies such as "Healthy China" and the "Student Nutrition Improvement Program," this study offers practical implications for school-based health behavior interventions and the design of healthy food advertisements. First, the cultivation of awe should be integrated into school education to strengthen adolescents' emotional resonance with healthy eating and their dietary cognition. Positive natural awe can be elicited through nature education, ecological experiences, and watching documentaries, thereby strengthening students' sense of connectedness to nature and increasing their preference for natural and healthy foods. Non-natural awe, by contrast, can be evoked through humanistic activities such as lectures on history and culture and science-and-technology exhibitions, guiding students to make more rational dietary choices based on long-term health goals. Second, the design of food advertisements should match content and visual elements according to the type of awe. In natural-awe contexts, the natural attributes of food should be highlighted—for example, by using natural packaging and displaying the growth process of ingredients—in order to enhance consumers' emotional resonance with healthy foods and their product preferences. In non-natural-awe contexts, cues expressed at a high construal level should be incorporated, such as emphasizing the product' s long-term health benefits and pairing it with distant-view imagery, so as to further facilitate deeper thinking and forward-looking choices among consumers. Overall, promoting the embedded application of awe in school education and food communication may help construct a support system that combines emotional elicitation with cognitive guidance, thereby providing psychological insights for nudging adolescents toward healthy eating.

This study still has some limitations. First, in terms of research design, all studies were cross-sectional, making it difficult to reveal the long-term impact of awe on healthy eating behavior. Future research should introduce longitudinal methods, such as ecological momentary assessment (EMA), to dynamically capture individuals' emotional states and eating behaviors at multiple time points, thereby depicting the temporal trajectory of behavioral change (Ashurst et al., 2018). Second, in terms of dependent-variable indicators, this

study used healthy food choice, preference, and willingness to pay as indicators for assessing healthy eating, but it has not yet examined purchasing behavior in real-world settings or long-term dietary habits. Future research should also include indicators such as actual purchasing behavior and food intake to enhance the ecological validity of the research.

extent. Third, in terms of mechanisms of influence, although the existing results support the possibility that positive natural awe and non-natural awe may involve differentiated psychological pathways in promoting healthy dietary decision-making, the relevant mechanisms have not yet been verified in a fully mutually exclusive manner. Future research could further examine other alternative explanations and, in combination with techniques such as brain imaging, investigate the neural mechanisms by which different types of awe influence healthy dietary decisions. In addition, future work could develop long-term, effective awe-based intervention strategies. For example, the "awe walk" intervention proposed by Sturm et al. (2022)—which elicits individuals' experiences of natural awe through 15-minute outdoor walks each week over an 8-week period—has already provided preliminary evidence for the feasibility of emotion-based interventions. In the future, this intervention could be introduced into adolescent populations, with the aim of providing a more empirically supported intervention pathway for guiding healthy eating. Finally, although the present study verified the positive influence of positive natural awe on healthy dietary decision-making through multiple emotion-induction methods, it cannot completely rule out the influence of natural landscapes themselves. Future studies could include neutral natural scenes as a more rigorous control condition to further examine the robustness of the results (Chirico et al., 2023).

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Awe and healthy eating among adolescents: Differential mechanisms and intervention strategies

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Abstract

Awe is an emotion of wonder and perceived vastness that arises when people encounter stimuli that exceed their existing mental frames. Prior studies suggest that awe can encourage healthier choices, but it remains unclear whether adolescents respond in the same way to awe elicited by nature and awe elicited by non-nature-based stimuli. Drawing on nature connectedness and construal-level perspectives, this study examined how different forms of awe shaped adolescents' healthy eating preferences and identified presentation strategies that could strengthen these effects.

Five experiments were conducted with adolescent participants (N = 937). In Study 1, video materials were used to induce positive nature-based awe, negative nature-based awe, non-nature-based awe, or a neutral emotional state. Participants then completed a healthy snack-choice task. Nature connectedness and construal level were measured as potential mediators. Studies 2a and 2b tested whether cues related to food naturalness would enhance the effect of positive nature-based awe. Study 2a presented yogurt advertisements that emphasized natural or artificial attributes, whereas Study 2b manipulated packaging color as an indirect cue of naturalness. Healthy eating was assessed using self-reported healthy food preferences and willingness to pay (WTP). Studies 3a and 3b examined whether activating high-level construal would strengthen the effect of non-nature-based awe. Study 3a varied advertising appeals by emphasizing long-term versus immediate health benefits, and Study 3b varied spatial framing by presenting healthy foods in distant versus close-up views. Across experiments, participants completed emotion manipulation checks, food evaluation tasks, and demographic measures.

Consistent with our hypotheses, the results showed that both positive nature-based awe and non-nature-based awe promoted healthier eating, as reflected in healthier snack choices, stronger preferences for healthy foods, and higher WTP.

Crucially, the two forms of awe operated through different psychological pathways. Positive nature-based awe increased healthy eating mainly by strengthening adolescents' connectedness with nature, whereas non-nature-based awe increased healthy eating mainly by promoting a higher construal level. The follow-up experiments further

supported these mechanism-specific enhancement strategies. When adolescents experienced positive nature-based awe, emphasizing a food' s natural attributes, rather than artificial attributes, and using natural packaging colors, rather than non-natural colors, increased healthy food evaluations and WTP. When adolescents experienced non-nature-based awe, highlighting long-term health benefits rather than immediate benefits, or presenting healthy foods in distant rather than close-up views, participants reported stronger healthy eating preferences and higher WTP. These patterns indicated that different forms of awe operate through source-specific psychological mechanisms and that matching food cues to the relevant mechanism produces stronger effects than mismatched or neutral presentations.

Overall, these findings suggest that awe is not a uniform emotional driver of healthy eating. Instead, the health-promoting effect of awe depends on its source and on whether food messages fit the psychological process it activates. The study extends research on emotion and dietary decision-making by distinguishing nature connectedness from construal level as two mechanisms linking awe to adolescents' food choices. It also offers practical implications for nutrition education, school-based health promotion, and public health communication. Awe-based interventions may be more effective when emotional induction is paired with naturalness cues or with higher-level construal framing that matches the type of awe being elicited.

Keywords awe, healthy eating, adolescents, nature connectedness, construal level.

Appendix

Food Advertising Images (Experiment 2b)

Positive natural awe–unnatural-color packaging

Positive natural awe–natural-color packaging

Control group–unnatural-color packaging

Control group–natural-color packaging

Food Advertising Images (Experiment 3b)

Unnatural awe–near spatial distance

Unnatural awe–far spatial distance

Figure 1

Figure 2: Figure 1

Figure 2

Figure 3: Figure 2

Control group–near spatial distance

Control group–far spatial distance

Figures

Figure 3

Figure 4: Figure 3

Figure 4

Figure 5: Figure 4