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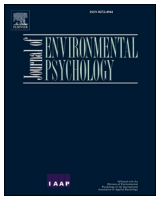

Testing an integrated model of climate change anxiety

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ABSTRACT

Emerging studies have reported that people may experience anxiety when thinking about climate change. Although such an anxiety experience can be a rational response to climate change threats, it can still be a psychological burden to people's daily lives. In this research, we proposed an integrated model of climate change anxiety as a guiding framework to identify relevant psychological factors that predict climate change anxiety. According to this model, anxiety about climate change is related to experience, perception, and appraisal of climate change, processes that are underpinned by experiential, cognitive, and sociocultural factors. Furthermore, previous studies have operationalized climate change anxiety either by affect-based responses (i.e., anxiety-related feelings) or symptom-based responses (i.e., anxiety-related impairments), but it is unclear whether the two types of responses are conceptually and empirically similar or distinct. We thus examined how the three sets of factors relate to these responses and how they relate to outcome correlates simultaneously. We tested our framework in two pre-registered studies conducted in the US (Study 1) and China (Study 2). Both studies involved representative samples of US and Chinese adults regarding gender and age. Results of the partial least square-structural equation modeling revealed supporting evidence for the role of experiential, cognitive, and sociocultural factors, although some patterns were inconsistent with our pre-registered hypotheses. Importantly, we observed that the two types of climate change anxiety showed both similar and different correlation patterns with the predictors (e.g., efficacy beliefs, values) and outcome variables (e.g., pro-environmental behavior, life satisfaction). Our findings provide initial evidence for the usefulness of the integrated model as a guiding framework for understanding climate change anxiety and the need to differentiate different types of climate change anxiety responses.

1. Introduction

Climate change poses significant threats to our lives. Exposure to acute climate events is known to harm physical and mental health (Manning & Clayton, 2018; Obradovich et al., 2018). Recent research has reported that the negative impact of climate change on mental health can extend to people who do not directly experience climate-related hazards (e.g., Clayton & Karazsia, 2020; Hickman et al., 2021; Stanley et al., 2021). In particular, mere awareness of climate change or its associated uncertainty and catastrophe is sufficient to trigger anxiety responses that significantly hamper people's daily functioning. Some refer to such experiences as climate change anxiety (Clayton & Karazsia, 2020). Despite its negative impact on well-being, climate change anxiety could be a rational response to climate change threats (Clayton, 2020; Ogunbode et al., 2021). With the impact of climate change becoming more proximal, tangible, and severe, researchers and mental health professionals have expressed concern about whether climate change anxiety would become more prevalent, especially among the younger generations (Hickman et al., 2021). There is thus a pressing need to understand what psychological factors underlie climate change anxiety. Yet, to date, although emerging research has attempted to understand the consequences of climate change anxiety (e.g., Schwartz et al., 2022; Reyes, Carmen, Luminarias, Mangulabnan, & Ogunbode, 2021) and the measures of climate change anxiety (e.g., Cruz & High, 2022; Wullenkord et al., 2021), only a handful of studies have systematically identified predictors of climate change anxiety (e.g., Asgrizadeh et al., 2023; Whitmarsh et al., 2022; for a review, see Tam et al., 2023). To fill this gap, the present research tests an integrated model of climate change anxiety that simultaneously considers the influences of experiential, cognitive, and sociocultural factors.

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1.1. Climate change anxiety

Climate change anxiety refers to "anxiety which is significantly related to anthropogenic climate change" (Pikhala, 2020, p.3) and "a more clinically significant anxious response to climate change" (Clayton & Karazsia, 2020, p. 9). Some researchers have also broadly defined it as the distress experience of climate change-related negative emotions, including worry, fear, hopelessness, and despair (e.g., Hickman et al., 2021; Ojala et al., 2021). In general, climate change anxiety is not inherently pathological, although it has been found to correlate with poorer mental well-being (e.g., Ogunbode et al., 2022; Reyes et al., 2021). Because of its potential negative implications for mental health, there is an emerging scientific interest in understanding who is more likely to experience climate change anxiety.

Several studies have explored the associations between various factors and climate change anxiety (e.g., Clayton, Sangalang, & Anderson, 2023b, 2023a; Hickman et al., 2021; for a review, see Tam et al., 2023). For example, some studies examined such demographic factors as gender and age. While a few studies reported that being younger and female was related to higher levels of climate change anxiety (e.g., Clayton & Karazsia, 2020; Heeren et al., 2022; Hickman et al., 2021), other studies reported no correlation between age and climate change anxiety (e.g., Schwartz et al., 2022; Wullenkord et al., 2021) or between gender and climate change anxiety (e.g., Schwartz et al., 2022; Whitmarsh et al., 2022). Also, studies have commonly suggested that direct experience of climate change-related weather hazards and exposure to climate change-related risk information are potential mechanisms behind the experience of climate change anxiety (e.g., Tam et al., 2023; Whitmarsh et al., 2022). However, overall, research into the factors behind climate change anxiety is still in its infancy. We argue that it is crucial to extend the previous endeavors in this regard and thereby more systematically identify which sectors in the population are more vulnerable to experiencing climate change anxiety.

1.2. The integrated model of climate change anxiety

In this research, we propose an integrated model of climate change anxiety based on general anxiety theories (e.g., Barlow, 2004; Clark & Beck, 2010; Grupe & Nitschke, 2013) and theoretical models explaining climate change risk perception (e.g., climate change risk perception model; Van der Linden, 2015). General anxiety theories conceptualize anxiety as a future-oriented emotion triggered by anticipated dangers with uncertainty, unpredictability, and uncontrollability. Accordingly, we posit that climate change anxiety results from people's perception and appraisal of climate change as threatening, uncertain, unpredictable, and uncontrollable. Experiential, cognitive, and sociocultural factors capture such perception and appraisal of climate change. For example, the direct experience of extreme weather events could remind people of the dangerousness of climate change. Cognitive processes also determine whether an individual sees climate change as severe, certain, and manageable. Lastly, people may construe the risk of climate change and environmental issues based on their sociocultural experiences such as values, beliefs, social norms, and political ideologies (e.g., Chan & Tam, 2021; Crandon et al., 2022; Van der Linden, 2015). Our proposition is consistent with van der Linden's (2015) climate change risk perception model, which suggests that climate change risk perception originates from people's experiences of climate change-related weather events, knowledge of climate change risk, and sociocultural factors. Overall, we attempt to integrate insights from experiential, cognitive, and socio-cultural processes in order to comprehensively understand what factors underlie climate change anxiety. Fig. 1 illustrates our conceptual model.

In the following, we discuss how the variables in each factor domain would relate to climate change anxiety. It should be noted that we identified these variables based on theories and previous studies, and we did not aim to offer an exhaustive list of factors in our model. Instead, our goal is to demonstrate the viability of using the proposed overarching framework for predicting and understanding climate change anxiety; positive results supporting this framework would open up new avenues for future studies on the topic.

1.2.1. Experiential factors

Experiential factors capture individuals' experiences of climate change. The experience of extreme weather events may directly trigger people's anxiety responses to climate change, as these events can remind them of the dangers of climate change. Previous studies have examined the role of direct experience in the impacts of climate change (e.g., Clayton & Karazsia, 2020; Heeren et al., 2023; Kumar et al., 2021; Schwartz et al., 2022). For example, Bratu et al. (2022) found that the experience of the 2021 Western North American heat dome increased people's climate change anxiety. Yet, some studies did not find supporting evidence for the role of direct experience. For example, a couple of studies showed that past flooding experiences were unrelated to climate change anxiety (Ogunbode et al., 2022; Whitmarsh et al., 2022).

The mixed findings may suggest that what people experience objectively does not always give rise to anxiety, plausibly because people do not necessarily attribute the happening of extreme weather events to climate change (Ogunbode et al., 2019; for a discussion, see

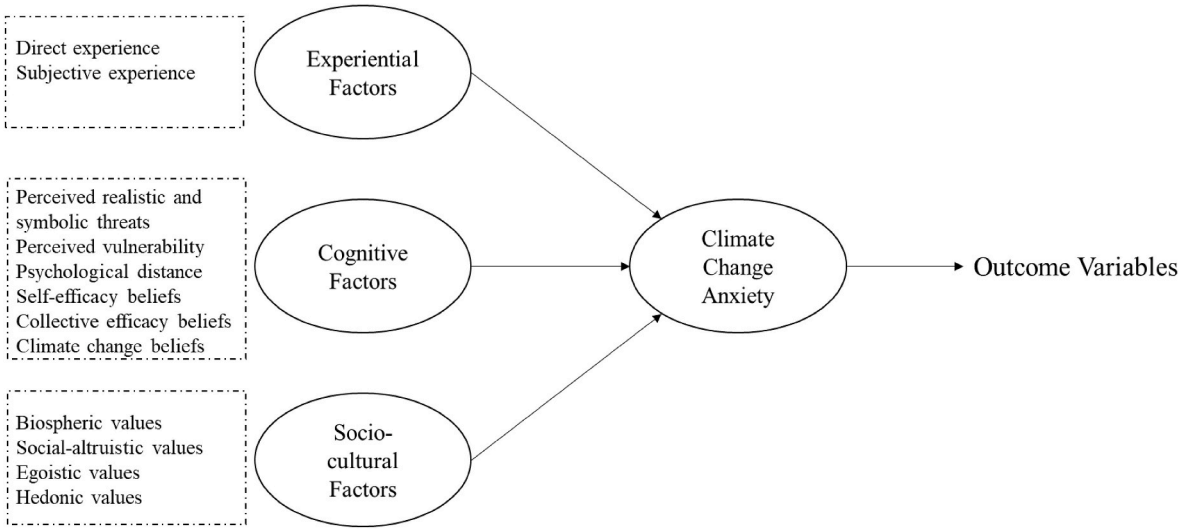

Fig. 1. Illustration of the integrated model of climate change anxiety.

Whitmarsh et al., 2022). Indeed, Ogunbode et al. (2019) found that the experience of extreme weather was related to greater climate change risk perception among individuals who attributed such experience to climate change. We thus propose to also consider the subjective experience of climate change impact – perception of whether one has experienced climate change impact – in understanding what predicts climate change anxiety. We expect that direct experience (objective and subjective) would have a positive association with climate change anxiety (Hypothesis 1).

1.2.2. Cognitive factors

Cognitive factors capture people's cognitive appraisal of climate change threats. Based on the cognitive model of anxiety (Beck et al., 1985; Clark & Beck, 2010), a stressor (in this case, climate change) would trigger heightened anxiety when people appraise its harmful effects to be severe, certain, and unmanageable. In general, cognitive appraisal involves a threat appraisal process and a coping appraisal process (Reser et al., 2011). Accordingly, we identify the cognitive factors based on these two processes. In the threat appraisal process, individuals evaluate the possible adverse impacts of the stressor on the self, significant others, and even society. Recent studies have demonstrated that people are aware of the physical and existential threat of climate change and its impacts on the economy, society, and culture (i.e., symbolic threat; e.g., Cunsolo & Ellis, 2018; Tam et al., 2022). Incorporating the social and cultural impacts contributes to explaining why people feel anxious, even without a direct experience of climate events. The anticipated changes in social structures and cultural traditions could be sufficient to trigger climate change anxiety. Consistent with this notion, the integrated threat theory (Stephan & Stephan, 2000) and its extension to non-intergroup threats (e.g., COVID-19; Kachanoff et al., 2021) suggest that the perception of both realistic (physical and economic) and symbolic (social and cultural) threats could give rise to the feeling of anxiety toward the sources of threat (e.g., outgroup migrants, COVID-19, and in our case, climate change). Indeed, climate change challenges not only the survival of the human race but also the cultural values and practices that one uses to defend against the thought of death (Smith et al., 2022). We thus expect that perceived realistic threat and perceived symbolic threat would have a positive association with climate change anxiety (Hypotheses 2a and 2b).

Individuals would also evaluate their levels of risk based on how vulnerable they, or the regions they live in, are to the impact of climate change (Leiserowitz, 2006). People who perceive themselves to be more vulnerable to such an impact should perceive the threat as more severe and of high certainty. Tam et al. (2023) also reported a positive correlation between climate change anxiety and the perceived harm of climate change to the self and the country. Individuals may also base their threat appraisal on their perceived psychological distance of climate change (Spence et al., 2012). If they perceive climate change as a geographically, socially, and temporally distant threat, they may consider climate change threat to be less severe and of low certainty. We thus expect that perceived vulnerability and perceived proximity of climate change threat have a positive association with climate change anxiety (Hypotheses 2c and 2d).

In the coping appraisal process, individuals evaluate whether they are able to manage the stressor (Higginbotham et al., 2014). In general, when individuals believe that the stressor is manageable and controllable, they feel less anxious (Grupe & Nitschke, 2013). This evaluation can include their beliefs about whether they can tackle climate change personally (i.e., self-efficacy belief) or collectively as a group (i.e., collective efficacy belief). In general, individuals should feel less anxious and stressed if they believe that they are capable of handling climate change through personal and collective efforts (Clayton, 2020). We thus expect efficacy beliefs to be negatively related to climate change anxiety (Hypothesis 2e). Lastly, we include climate change beliefs as an additional cognitive factor. Such beliefs reflect whether people acknowledge the happening, human causes, and scientific consensus of climate change. People with stronger climate change beliefs may experience higher levels of climate change anxiety, as they believe the threat is certainly happening and caused by human activity. In a recent study, Tam et al. (2023) reported a positive correlation between climate change beliefs and climate change anxiety, although the evidence was not consistent between countries. We expect a positive association between climate change beliefs and climate change anxiety (Hypothesis 2f).

1.2.3. Socio-cultural factors

Socio-cultural factors also shape how people appraise and evaluate climate change (Chan & Tam, 2021; Crandon et al., 2022; Reser et al., 2011; Van der Linden, 2015). Some examples of these factors include values (e.g., Chan & Tam, 2021; Van der Linden, 2015), social norms (e.g., Van der Linden, 2015), political ideologies and orientations (e.g., Chan & Tam, 2023; Cruz, 2017), and social worldviews (e.g., Chan & Tam, 2021). People do not always base their understanding of climate change and related issues on objective, scientific information. Their mental construal of climate change is sometimes guided by their social and cultural values and beliefs instead (Chan & Tam, 2021). For example, the value-belief-norm model suggests that egoistic, biospheric, and social-altruistic values shape how people construe the severity and responsibility of tackling environmental problems (Stern, 2000). In a similar way, political orientation and political party affiliation could trigger the rejection of climate change and its solutions, particularly when the issue of climate change conflicts with the core values underlying the political ideology and political narratives that are prevalent in a political camp (Chan & Tam, 2023; Cruz, 2017). Also, Ogunbode et al. (2022) recently found that perceived descriptive norms of climate change-related negative emotions were related to higher climate change anxiety, possibly because of the process of social amplification of risk.

In this research, we follow previous studies (e.g., van Valkengoed et al., 2023) and use broad value orientations to capture the influence of sociocultural factors. As noted earlier, it is not our intention to include all possible sociocultural factors in testing our proposed model. We focus on values, as they are essential elements comprising the influence of culture and serve as the fundamental guiding principles in people's life (Schwartz, 1992), and because they are robustly related to people's environmental attitudes, climate change opinions, and mitigation behaviors (e.g., Chan & Tam, 2021; Steg et al., 2014; Van der Linden, 2015), and bear implications for mental well-being (e.g., Sortheix & Schwartz, 2017; Yasuma et al., 2019). These value orientations include biospheric (caring for nature and biosphere), social-altruistic (caring for the wellness of others), egoistic (caring for the self and personal interests), and hedonic values (maximizing pleasure) (Steg et al., 2014).

As few studies have examined the role of values on climate change anxiety, we derive our hypotheses from the general understanding of values. Values influence what people prioritize and how they evaluate different entities and events. People who care more about the biosphere tend to experience greater emotional disturbance when they think about the harmful impacts of climate change on the natural environment. The same argument applies to people who care about the wellness of others. In line with this notion, previous studies found that individuals with a stronger connection to or greater concern for nature reported higher levels of climate change anxiety (e.g., Clayton & Karazsia, 2020; Helm et al., 2018; Whitmarsh et al., 2022). Yet, it is noteworthy that Whitmarsh et al. (2022) reported a negative correlation between environmental values (measured by the new ecological paradigm) and climate change anxiety, suggesting an opposite pattern of correlation. In brief, we expect biospheric and social-altruistic values to relate positively to climate change anxiety (Hypotheses 3a and 3b). We explore the role of egoistic and hedonic values without making any prior hypotheses.

1.3. The operationalization of climate change anxiety

Existing studies have measured climate change anxiety in terms of

either affect-based or symptom-based responses. Some studies have measured it by asking people how much climate change makes them anxious, worried, and afraid (e.g., Hickman et al., 2021; Stanley et al., 2021). Relatedly, other researchers adapted existing state anxiety inventories and asked participants to report their momentary anxiety responses to climate change (e.g., Ogunbode et al., 2021, 2022). These measures capture the affect-based responses of climate change anxiety without assuming that the anxiety responses would translate into psychological or functional impairment (Ogunbode et al., 2022).

Clayton and Karazsia (2020) developed the climate change anxiety scale (CCAS) by operationalizing climate change anxiety in terms of anxiety-related clinical symptoms. The CCAS measures climate change anxiety based on people's experience of cognitive-emotional impairment (e.g., rumination) and functional impairment (e.g., impacts on the ability to work or study) resulting from their thoughts about climate change. Since its publication, studies have demonstrated the validity of the CCAS in multiple countries (e.g., Cruz & High, 2022; Tam et al., 2023; for critiques of the scale, see Innocenti et al., 2021; Wullenkord et al., 2021). Unlike the affect-based responses, the CCAS assumes that climate change anxiety is reflected in people's impairment.

This distinction between a measure that assesses state emotions and a measure that assesses clinically oriented symptoms in response to climate change is important to note and worth clarification. To our best knowledge, no studies have empirically compared these two measures previously. It is uncertain to what extent they are conceptually and empirically similar to or different from each other, and it is also unknown whether they show similar or different patterns of relationships with other variables. The present research fills this gap by measuring both types of climate change anxiety responses.

1.4. The present research

We conducted a survey study in the US (Study 1) and mainland China (Study 2) to test our proposed model. To establish the generality of the model in different cultural contexts, which has been recognized as an important endeavor (Jylhä et al., 2021; Tam et al., 2021; Tam & Milfont, 2020), we used participants recruited from the US in Study 1 and mainland China in Study 2, respectively. As such, this research can provide insights for understanding the predictors of climate change anxiety for both Western industrialized countries (i.e., the US) and non-western developing countries (i.e., China). Furthermore, as the US and mainland China are among the largest carbon emitters, it would be crucial to understand how Americans and mainland Chinese respond to climate change.

We aim to additionally address the question of whether affect-based and symptom-based anxiety responses are similar or distinct. We thus operationalize climate change anxiety in both ways in both studies. Although the present research focuses on understanding the predictors of climate change anxiety, we also explore how the two types of anxiety responses are correlated with adaptive and maladaptive outcome variables, including pro-environmental behaviors, support for mitigation and adaptation policies, climate change avoidance, and mental health-related outcomes (i.e., generalized anxiety, depression, and life satisfaction). Previous studies revealed that climate change anxiety could relate to both adaptive (i.e., pro-environmental behavior and policy support; e.g., Tam et al., 2023; Whitmarsh et al., 2022), maladaptive responses to climate change mitigation (e.g., climate change avoidance; Wullenkord et al., 2021), and poorer mental well-being (e.g., Clayton & Karazsia, 2020; Whitmarsh et al., 2022). Accordingly, we expect climate change anxiety to be positively related to pro-environmental behaviors and policy support (Hypotheses 4 and 5), climate change avoidance (Hypothesis 6), and generalized anxiety and depression (Hypothesis 7a and 7b), and negatively related to life satisfaction (Hypothesis 7c). All our hypotheses are pre-registered: https://osf.io/rwzj7/?view_only=44e203403ef34d3287ad57672efca53b.[1]

2. Study 1 (The United States)

2.1. Method

2.1.1. Participants

One thousand and four US adults participated in this study. We commissioned Ipsos, a market research company, for the data collection. The sample was nationally representative of US adults in terms of gender and age distributions, with diverse income and education levels. Supplementary Table S1 shows the distributions of the participants' demographic information. Regarding the recruitment of participants, the market research company invited participants from their participant pool to join the study. In total, 92,882 qualified individuals from their pool were invited. 8358 individuals initiated the survey. Among them, 1004 participants completed the whole survey and also passed all data quality checks.

To ensure data quality, we adopted two types of checks: instructional manipulation checks (Oppenheimer et al., 2009) and response speed (Wood et al., 2017). Regarding the first type, we included two questions that explicitly asked participants to choose a specific response option ("For quality purpose, please select … "). Participants who answered either question incorrectly were excluded from the final sample. As for the second type of check, participants' responses were timed for two question pages in the survey package. Participants who completed either page in 10 s or less were excluded from the sample replaced. Overall, all participants included in the final samples had passed both types of data quality checks (four questions in total).

2.1.2. Measures and procedures

Participants completed an online survey administered by the market research company. The data collection and research procedure were approved by the research ethics committee of the university the corresponding author affiliating with (masked for the sake of double-blinded review). Table 1 shows the mean and standard deviation of the measures. We reported the reliability indexes of the measures in Supplementary Table S2. See Supplementary Information for the full items of the measures.[3]

Symptom-based climate change anxiety. We measured the symptom-based anxiety responses with the 13-item climate change anxiety scale (CCAS; Clayton & Karazasia, 2020). The CCAS measured two dimensions of symptom-based responses – cognitive-emotional impairment (8 items; e.g., "Thinking about climate change makes it difficult for me to concentrate") and functional impairment (five items; e.g., "My concern about climate change makes it hard for me to have fun with my family or my friends"). Participants reported on a five-point scale to indicate their responses (1 = never to 5 = almost always). Although several studies have confirmed the two-factor structure of the measure (e.g., Clayton & Karazsia, 2020; Tam et al., 2023), other studies did not find similar evidence (e.g., Wullenkord et al., 2021). Cruz and High (2022) found a good model fit for either a first-order or second-order unidimensional model but not for a two-factor model. We thus conducted a confirmatory factor analysis to test the scale's factor structure in our data. We found that both a one-factor solution (χ^2 = 347.76, df = 65, $p < 0.001$; CFI = 0.975, TLI = 0.970; RMSEA = 0.066, SRMR = 0.021) and a two-factor solution (χ^2 = 343.97, df = 65, $p <$ 0.001; CFI = 0.975, TLI = 0.970; RMSEA = 0.066, SRMR = 0.020) fit equally well to the data ($\Delta\chi^2 = 3.79$, $\Delta df = 1$, $p = 0.051$). For the sake of parsimony, we opted to present the results of the regression analyses based on an average score of CCAS.

Affect-based climate change anxiety. We measured the affect-based anxiety responses with seven items based on the state-trait anxiety inventory (Ogunbode et al., 2022; Spielberger, 1983). Participants reported on a five-point scale (1 = not at all to 5 = extremely) to indicate the extent to which they felt calm, tense, relaxed, anxious, peaceful, worried, or terrified when they thought about climate change at the moment. The scores of the three positive affect items (i.e., calm, relaxed,

Table 1
Summary of means and standard deviations of the key constructs.

	Study 1 (US sample)		Study 2 (mainland Chinese sample)	
	Mean (SD)	Range	Mean (SD)	Range
Predictor variables				
Direct experience of climate change-related weather events	2.44 (1.59)	0–6	2.88 (1.63)	0–6
Subjective experience of climate change impact	3.19 (1.21)	1–5	3.74 (0.78)	1–5
Perceived realistic threats	1.77 (1.03)	0–4	1.84 (0.95)	0–4
Perceived symbolic threats	1.46 (1.06)	0–4	1.31 (1.01)	0–4
Perceived vulnerability	2.96 (1.03)	1–5	2.43 (0.90)	1–5
Perceived climate change to be a proximal threat	4.94 (1.51)	1–7	5.40 (0.86)	1–7
Perceived climate change to be a distant threat	3.31 (1.50)	1–7	3.82 (1.45)	1–7
Self-efficacy beliefs	4.70 (1.43)	1–7	5.47 (0.89)	1–7
Collective efficacy beliefs	4.76 (1.46)	1–7	5.84 (0.88)	1–7
Climate change beliefs	4.65 (1.34)	1–7	4.80 (0.73)	1–7
Certainty of the happening of climate change	3.57 (1.33)	1–5	3.65 (0.95)	1–5
Egoistic values	1.81 (0.87)	0–4	2.21 (0.76)	0–4
Social-altruistic values	2.86 (0.85)	0–4	2.95 (0.68)	0–4
Biospheric values	2.80 (0.92)	0–4	3.06 (0.75)	0–4
Hedonic values	2.51 (0.84)	0–4	2.65 (0.78)	0–4
Climate change anxiety				
Climate change anxiety scale (CCAS)	1.61 (0.82)	1–5	2.06 (0.76)	1–5
State-climate change anxiety	2.70 (0.97)	1–5	2.71 (0.79)	1–5
Outcome variables				
Sustainable consumption	3.51 (0.86)	1–5	3.49 (0.77)	1–5
Sustainable diet	2.53 (1.14)	1–5	2.75 (0.97)	1–5
Public-sphere pro-environmental behaviors	1.15 (1.61)	0–6	1.78 (1.57)	0–6
Support for mitigation policies	4.96 (1.40)	1–7	5.54 (0.79)	1–7
Support for adaptation policies	4.74 (1.35)	1–7	5.50 (0.81)	1–7
Climate change avoidance	3.62 (1.22)	1–7	3.83 (1.10)	1–7
Generalized anxiety	0.72 (0.73)	0–3	0.71 (0.58)	0–3
Depression	0.66 (0.67)	0–3	0.69 (0.56)	0–3
Life satisfaction	4.43 (1.39)	1–7	4.34 (1.29)	1–7

and peaceful) were reversed when computing the average score of the measure.[2] CCAS and the state climate change anxiety were weakly correlated ($r = 0.23$), suggesting that the two measures capture different aspects of climate change anxiety.

Experience of climate change-related weather events. We measured participants' direct experience by measuring whether or not they had experienced flooding (in their own home, in the local area, and travel disruption or disruption to the ability to work as a result of flooding), heat wave (experienced discomfort and illness due to a heat wave), and an extreme precipitation event (e.g., winter snowstorms). We computed a sum score to reflect an overall level of direct experience. Additionally, participants also reported on a five-point scale to indicate their subjective experience of the effects of climate change (i.e., I have personally experienced the effects of climate change; 1 = strongly disagree to 5 = strongly agree).

Perceived realistic and symbolic threats of climate change. We adopted the integrated COVID-19 threat scale from Kachanoff et al. (2021) and changed the wording to "climate change." More specifically, participants were instructed to think about to what extent climate change is a threat to a list of issues, including cultural values, social systems, economy, and personal safety. Five items measured the perceived realistic threats (e.g., your personal health and safety, your personal financial safety), and five items measured the perceived symbolic threats (e.g., what it means to be American, American values and traditions). Participants reported on a five-point scale to indicate the extent to which they perceived climate change as a threat to each issue (0 = not a threat to 4 = a major threat). A confirmatory factor analysis supported the two-factor structure of the measure (versus one-factor structure; $\Delta\chi^2 = 451.13$, $\Delta df = 1$, $p < 0.001$; $|\Delta CFI| = 0.067$, $|\Delta RMSEA| = 0.054$). See Supplementary Information for the full items of the measure and the model fit indices.

Perceived vulnerability of climate change threat. We measured perceived vulnerability with two items. Participants reported on a five-point scale the extent to which they considered their region vulnerable to natural disasters and the impacts of climate change (1 = not at all vulnerable to 5 = very vulnerable).

Perceived psychological distance of climate change. We created a six-item measure of psychological distance based on past studies (e.g., Chu & Yang, 2020; Spence et al., 2012), covering the geographical, social, and temporal distances. Specifically, perceived proximity of climate change threat would be reflected by the perception that climate change will affect my local area (geographically proximal), people like me (socially proximal), and that people are already feeling its effect (temporally proximal). By contrast, perceived climate change to be a distant threat would be reflected by the perception that climate change would affect areas far away, people in other countries, and people in future generations. Participants reported on a seven-point scale (1 = strongly disagree to 7 = strongly agree). Our confirmatory factor analysis suggested that a two-factor solution fitted better than a one-factor solution ($\Delta\chi^2 = 897.62$, $\Delta df = 1$, $p < 0.001$; $|\Delta CFI| = 0.323$, $|\Delta RMSEA| = 0.258$). See Supplementary Information for the full items of the measure and the model fit indices. Thus, we opted for using two scores to capture the perceived climate change as a proximal and distant threat separately.

Self-efficacy beliefs. We identified a three-item measure for self-efficacy beliefs from past studies (e.g., "I can change my daily routines to combat climate change"; Chan & Tam, 2021). Participants reported on a seven-point scale (1 = strongly disagree to 7 = strongly agree).

Collective efficacy beliefs. We identified a three-item measure for collective efficacy beliefs from past studies (e.g., "Through joint actions, Americans could effectively contribute to combating climate change; Chan & Tam, 2021). Participants reported on a seven-point scale (1 = strongly disagree to 7 = strongly agree).

Climate change beliefs. We identified an eight-item measure for climate change beliefs from past studies (e.g., "climate change is happening" and "climate change is mostly caused by human activities"; Whitmarsh, 2011). Participants reported on a seven-point scale (1 = strongly disagree to 7 = strongly agree). We also included a single-item measure to capture people's perceived certainty of the happening of climate change (i.e., how sure are you that climate change is happening?). Participants reported on a five-point scale (1 = not at all sure to 5 = extremely sure).

Personal values. We adopted a 16-item measure of personal values from past studies (e.g., Steg et al., 2014). Participants indicated the extent to which they considered a list of 16 values to be an important guiding principle of their life on a five-point scale (0 = not at all important to 5 = extremely important). These items captured the four environment-relevant value domains (i.e., egoistic, biospheric,

social-altruistic, and hedonic values).

Outcome variables. We measured a list of outcome variables that possibly correlate with climate change anxiety. We presented the full items of all the measures in the Supplementary Information. We considered outcome variables contributing to mitigating or adapting to climate change as adaptive outcomes and outcome variables not contributing to such mitigation and mental health as maladaptive outcomes. As for adaptive outcomes, we measured private-sphere pro-environmental behavior by asking participants to report how frequently they engaged in six daily consumption and diet-related behaviors in the past months (e.g., eating less meat) (Tam et al., 2023). They reported on a five-point scale (1 = never to 5 = almost always). We measured public-sphere pro-environmental behavior by asking participants to indicate whether they had engaged in six behaviors in the past 12 months (e.g., signing a petition about climate change). Participants also reported the extent to which they support or oppose a list of mitigation policies (7 items; e.g., "Providing public funding to make residential buildings in low-income communities more energy efficient") and adaptation policies (four items; e.g., "Allocating public resources to build infrastructures for reducing the impact of climate change") (1 = completely against to 5 = completely favor).

As for maladaptive outcomes, we measured climate change avoidance by using the avoidance of climate change subscale of the climate self-protection scale (eight items; Wullenkord & Reese, 2021). Participants reported on a seven-point scale (1 = strongly disagree to 7 = strongly agree). We measured generalized anxiety, depression, and life satisfaction by using the seven-item generalized anxiety disorder scale (GAD-7; Spitzer et al., 2006, p. 0 = not at all to 3 = nearly every day), the eight-item personal health questionnaire depression scale (PHQ-8; Kroenke et al., 2009, p. 0 = not at all to 3 = nearly every day), and the five-item life satisfaction scale (Diener et al., 1985, p. 1 = strongly disagree to 7 = strongly agree), respectively.

2.2. Results

2.2.1. Data analysis plan

We pre-registered to analyze each set of factors separately using multiple regression analyses and an overall model using structural equation modeling (SEM). As we believe that the overall model provides more insights into how these factors are related to the two types of climate change anxiety, we opted for presenting the results of the SEM in the main text and the separate regression models in the Supplementary Information (see Supplementary Analysis and Supplementary Tables S8 and S9). We also presented the zero-order correlation among the variables in Supplementary Information (see Fig. S1). We conducted a partial least square-structural equation modeling (PLS-SEM) to test the integrated model of climate change anxiety. PLS-SEM is suitable for handling complex structural models that involve many constructs and indicators. PLS-SEM imposes a less restrictive assumption of the normality of the data, which is suitable for handling the non-normally distributed CCAS. Importantly, PLS-SEM is appropriate for testing prediction and theory development (Dash & Paul, 2021; Hair Jr, Matthews, Matthews, & Sarstedt, 2017). We consider PLS-SEM to be suitable for the purpose of the present study, as we are developing rather than confirming a theoretical model for predicting climate change anxiety. We conducted PLS-SEM using the "seminr" package of R (Hair Jr et al., 2021). The PLS-SEM involved the measurement model and the structural model. A typical procedure is first to evaluate the reliability and validity of the measurement model, followed by testing the hypothesized links in the structural model. In the following, we first present the results of the measurement model and then the structural model.

2.2.2. Evaluation of the measurement model

We first evaluated the reliability of the measurement model based on Cronbach's α coefficients and composite reliability (CR) coefficients and convergent validity based on the average variance explained (AVE) coefficients and indicator loadings of the constructs. We treated the two binary measures (i.e., direct experience of climate change-related weather events and public-sphere behaviors) as formative measures and all other measures as reflective measures (for a discussion about formative and reflective measures, see Diamantopoulos et al., 2008; Coltman et al., 2008). We conceptualized the two variables as formative measures as people who experienced one climate change-related weather event or engaged in one public-sphere behavior may not necessarily experience another such event or have opportunities to engage in another behavior. Supplementary Table S2 shows the results. All Cronbach's α coefficients and composite reliability (CR) coefficients of the reflective measures were higher than 0.70, indicating high internal consistency. For convergent validity, the AVE coefficients of all constructs were above 0.50, and most of the indicator loadings were above the recommended cut-off of 0.70. The remaining indicator loadings were between 0.40 and 0.70, which was still acceptable as the AVE and CR coefficients of the construct were above 0.50 and 0.70 respectively (Hair Jr, Matthews, Matthews, & Sarstedt, 2017). Overall, our findings support the reliability and convergent validity of the measurement model. Next, we evaluated the discriminant validity of the measurement model with the Heterotrait-Monotrait ratio (HTMT) (Henseler et al., 2015). Supplementary Table S3 shows the HTMT values. All HTMT values were less than 0.85 for conceptually distinct constructs and less than 0.90 for conceptually similar constructs (i.e., self-efficacy beliefs and collective efficacy beliefs; support for mitigation and adaptation policies; depression and anxiety), reflecting sufficient discriminant validity. Lastly, to evaluate the two formative measures, we obtained the variance inflation factor (VIF) values for the indicator variables and investigated the significance levels of the weight. All VIF values were lower than 5. Yet, the weight of one item of direct experience and two items of public-sphere behaviors were non-significant, and their loadings were lower than 0.50. We thus removed these items from the model. Our results remained consistent with or without including these items. Additionally, the variance inflation factor (VIF) coefficients of the latent variables were less than 5, suggesting no multicollinearity problem in the model.

2.2.3. Testing the structural model (hypothesized links)

For the structural model, we bootstrapped the model with 10,000 subsamples to estimate the standard errors of the path coefficients. Table 2 shows the results. As expected, both objective and subjective experiences of climate change were positive and significant predictors of CCAS, with small effect sizes ($f^2 = 0.029$ and 0.045, respectively). These findings were consistent with Hypothesis 1. Among the cognitive factors, perceived symbolic and realistic threats were positive and significant predictors of CCAS, although the effect sizes were very small ($f^2 = 0.007$ and 0.016, respectively). These findings support Hypotheses 2a and 2b. Unexpectedly, perceived climate change as a distant rather than proximal threat was positively related to CCAS, with a small to medium effect size ($f^2 = 0.093$). Although perceived proximity and vulnerability also had positive zero-order correlations with CCAS, they were non-significant in predicting CCAS in the model. Climate change beliefs were negatively related to CCAS, although the strength of the association is very weak ($f^2 = 0.008$). Thus, we did not find supporting evidence for Hypotheses 2c to 2f. Lastly, the socio-cultural factors also demonstrated patterns that were inconsistent with the hypotheses. Social-altruistic values were a negative and significant predictor of CCAS, while biospheric values were negative and non-significant. The effect sizes of both associations were very small ($f^2 = 0.005$ and 0.002, respectively). These findings were inconsistent with Hypotheses 3a and 3b. We also observed that egoistic values were a positive and significant predictor of CCAS, and hedonic values were a negative and significant predictor of it. The effect size of the association between egoistic values and CCAS was small to medium ($f^2 = 0.076$), while that of the hedonic values and CCAS was very small ($f^2 = 0.006$). Altogether, these factors explained 45.2% of the variance in CCAS.

Table 2
Estimated coefficients of the effects of predictor variables on climate change anxiety (Study 1).

	CCAS			State-Climate Change Anxiety		
	b (SE)	95% CI	f^2	*b* (SE)	95% CI	f^2
Direct experience	0.15 (0.04)	[0.08, 0.23]	0.031	0.12 (0.03)	[0.06, 0.17]	0.019
Subjective experience	0.24 (0.04)	[0.17, 0.32]	0.043	0.08 (0.04)	[0.00, 0.16]	0.005
Perceived symbolic threat	0.10 (0.04)	[0.02, 0.17]	0.007	0.02 (0.04)	[-0.06, 0.09]	0.000
Perceived realistic threat	0.17 (0.04)	[0.09, 0.26]	0.016	0.20 (0.04)	[0.12, 0.29]	0.023
Vulnerability	0.00 (0.03)	[-0.06, 0.07]	0.000	0.09 (0.03)	[0.03, 0.16]	0.009
Perceived climate change to be a proximal threat	−0.08 (0.05)	[-0.18, 0.01]	0.003	0.01 (0.05)	[-0.08, 0.11]	0.000
Perceived climate change to be a distant threat	0.26 (0.03)	[0.21, 0.32]	0.092	0.04 (0.03)	[-0.02, 0.10]	0.002
Self-efficacy beliefs	0.07 (0.04)	[0.00, 0.14]	0.003	0.03 (0.04)	[-0.06, 0.10]	0.000
Collective efficacy beliefs	0.06 (0.03)	[-0.01, 0.13]	0.003	−0.08 (0.04)	[-0.15, 0.00]	0.004
Climate change beliefs	−0.14 (0.05)	[-0.24, −0.05]	0.009	0.33 (0.05)	[0.24, 0.43]	0.050
Certainty of the happening of climate change	0.02 (0.04)	[-0.07, 0.11]	0.000	0.05 (0.04)	[-0.02, 0.13]	0.002
Egoistic values	0.27 (0.03)	[0.20, 0.34]	0.076	−0.04 (0.03)	[-0.10, 0.03]	0.001
Social-altruistic values	−0.08 (0.03)	[-0.14, −0.01]	0.005	−0.01 (0.04)	[-0.08, 0.06]	0.000
Biospheric values	−0.05 (0.03)	[-0.11, 0.01]	0.002	0.06 (0.03)	[-0.01, 0.12]	0.003
Hedonic values	−0.07 (0.03)	[-0.13, −0.02]	0.007	−0.02 (0.03)	[-0.07, 0.04]	0.000
R-squared	0.452			0.482		
Adjusted *R-squared*	0.443			0.474		

Note. CCAS = climate change anxiety scale.

As for state-climate change anxiety, the two experiential factors were positive and significant, with very small effect sizes (f^2 = 0.018 for objective and 0.005 for subjective experience, respectively). These findings support Hypothesis 1. Among the cognitive factors, perceived realistic threat, perceived vulnerability, and climate change beliefs were positive and significant predictors of state-climate change anxiety, while all other cognitive factors were non-significant. The effect sizes ranged from very small (f^2 = 0.009) to small (f^2 = 0.048). These findings were consistent with Hypotheses 2a,2c, 2f but not 2b, 2d, and 2e. Lastly, none of the sociocultural factors were significant in predicting state-climate change anxiety, suggesting that personal values may not be crucial for predicting affect-based climate change anxiety. These findings were inconsistent with Hypotheses 3a and 3b. Altogether, these factors explained 47.3% of the variance in state-climate change anxiety.

We also examined the relationship between CCAS, state-climate change anxiety, and the outcome variables. We also included all experiential, cognitive, and socio-cultural factors as the predictor variables, as these factors were conceptually related to pro-environmental behaviors, policy support, and mental health outcomes. Table 3 shows the results. As for the adaptive outcomes, CCAS was positively related to engagement in sustainable diet (but not sustainable consumption) and public-sphere behaviors. State-climate change anxiety was unrelated to private-sphere and public-sphere behaviors. These findings only partially support Hypothesis 4. Inconsistent with Hypothesis 5, both CCAS and state-climate change anxiety were unrelated to support for mitigation and adaptation policies. For the maladaptive outcomes, both

Table 3
Estimated coefficients of the effects of climate change anxiety variables on the outcome variables (Study 1).

	CCAS			State-Climate Change Anxiety		
	b (SE)	95% *CI*	f^2	*b* (SE)	95% *CI*	f^2
Outcome variables						
Sustainable consumption	0.04 (0.04)	[-0.03, 0.11]	0.003	−0.01 (0.04)	[-0.09, 0.07]	0.000
Sustainable diet	0.27 (0.04)	[0.20, 0.34]	0.057	0.04 (0.04)	[-0.04, 0.12]	0.001
Public-sphere pro-environmental behaviors	0.50 (0.04)	[0.43, 0.57]	0.244	−0.05 (0.04)	[-0.12, 0.02]	0.002
Support for mitigation policies	−0.02 (0.03)	[-0.07, 0.03]	0.001	0.02 (0.03)	[-0.03, 0.07]	0.001
Support for adaptation policies	0.06 (0.03)	[-0.01, 0.12]	0.005	0.01 (0.03)	[-0.06, 0.07]	0.000
Climate change avoidance	0.17 (0.04)	[0.09, 0.25]	0.021	0.09 (0.04)	[0.00, 0.17]	0.006
Generalized anxiety	0.21 (0.04)	[0.13, 0.29]	0.031	0.35 (0.04)	[0.27, 0.42]	0.078
Depression	0.26 (0.05)	[0.17, 0.35]	0.053	0.28 (0.04)	[0.20, 0.36]	0.046
Life satisfaction	0.11 (0.04)	[0.04, 0.19]	0.007	−0.20 (0.05)	[-0.29, −0.11]	0.022

Note. CCAS = climate change anxiety scale. In predicting each outcome variable, we have included the effects of all predictor variables in Table 2.

CCAS and state-climate change anxiety were positively related to climate change avoidance, generalized anxiety, and depression. Unexpectedly, while state-climate change anxiety was negatively related to life satisfaction, CCAS was positively related to it. These findings support Hypotheses 6, 7a, and 7b but only partially support Hypothesis 7c.

2.2.4. *Brief discussion of the main findings*

Overall, we found consistent evidence of the role of experiential factors. There were mixed results regarding cognitive and sociocultural factors. While experiential factors appear to show more consistent predictions for the two types of climate change anxiety, the hypothesized effects of cognitive factors were more aligned with state-climate change anxiety. We also did not observe the expected associations between sociocultural factors and the two types of climate change anxiety. Regarding the outcome variables, we found consistent associations between the two types of climate change anxiety and some of the outcome variables (i.e., climate change avoidance, generalized anxiety, and depression). Only CCAS predicted pro-environmental behaviors, while neither CCAS nor state-climate change anxiety was related to policy support. In sum, our findings suggest both convergent and divergent associations between the two types of climate change anxiety, predictor variables, and outcome variables.

2.2.5. *Supplementary analyses*

To provide insights into the potential similarities and differences between the two operationalizations of climate change anxiety, we conducted a series of latent profile analyses (LPA) to explore the differences between CCAS and state-climate change anxiety. While the above variable-centered analyses contribute to examining the similarities and differences in the correlates of the two types of climate change anxiety, the supplementary person-centered analyses (i.e., LPAs) can provide additional insights into identifying the distinct profiles of climate change anxiety responses. These supplementary analyses were not pre-registered. We determined the optimal number of profiles based on the Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) values, the Vuong-Lo-Mendell-Rubin Likelihood Ratio test, and the theoretical interpretation of the profiles (Spurk et al.,

2020). Additionally, we also evaluated the model based on entropy, which reflects the accuracy of the model classification of latent profiles (Wang et al., 2017). Supplementary Table S12 presents the fit indices of the models, and Fig. 2 illustrates the latent profiles. A four-profile model showed the best fit for the data. We identified latent profiles that varied in terms of the levels of affect-based and symptom-based responses. Importantly, we identified a profile (profile 3: 16.63%) that showed moderate to high levels of state-climate change anxiety (mean = 3.18) but low levels of CCAS (mean = 1.99 and 1.98 for cognitive-emotional impairment and functional impairment, respectively). Profile 2 (5.08%) showed similar levels of state-climate change anxiety (mean = 3.01) but high levels of CCAS (mean = 3.84 for cognitive-emotional impairment and functional impairment, respectively). These findings revealed that state-climate change anxiety and CCAS were distinct forms of climate change anxiety in which individuals might experience affect-based anxiety responses without significant disturbance in daily functioning.

3. Study 2 (China)

3.1. Method

3.1.1. Participants, measures, and procedures

One thousand and nine mainland Chinese adults participated in this study. As in Study 1, we commissioned Ipsos for the data collection. The sample was nationally representative of mainland Chinese adults in terms of gender and age, with diverse income and education levels. Supplementary Table S1 shows the distributions of the demographic information of the participants. As in Study 1, the market research company recruited participants from their participant pool. In total, 42,966 qualified individuals from their pool were invited and 4790 individuals initiated the survey. Among them, 1009 individuals completed the whole survey and also passed all data quality checks. The data quality check questions were the same as Study 1.

Participants completed the same set of measures as in Study 1. As all measures were originally in English, a translation and back translation procedure was implemented to translate the items into simplified Chinese by native speakers of Chinese language. We also conducted a series of confirmatory factor analyses to validate a two-factor solution for perceived realistic and symbolic threats, and the psychological distance of climate change. See Supplementary Information for the details. Findings from the CFA models support a two-factor solution for these constructs, respectively. Additionally, we examined the factor structure of CCAS with the confirmatory factor analysis (see also supplementary analysis in the Supplementary Information). We found that both a one-factor model and a two-factor model showed a good fit to the data. To maintain consistency with Study 1, we opted for using a one-factor model. Table 1 shows the mean and standard deviation of the key constructs. Supplementary Table S4 shows the reliability coefficients of the measures.

3.2. Results

We adopted the PLS-SEM to test the integrated model of climate change anxiety (see Supplementary Information and Supplementary Tables S10 and S11 for the results of the multiple regression analyses). Supplementary Fig. S2 shows the zero-order correlations among the key constructs. As in Study 1, we conceptualized direct experience of climate change-related weather events and public-sphere behaviors as formative measures and the others as reflective measures.

3.2.1. Evaluation of the measurement model

We first evaluated the reliability and validity of the measurement model. Supplementary Tables S4 and S5 show the full results. The Cronbach's α and composite reliability (CR) coefficients were above 0.70 for all constructs (except climate change beliefs), suggesting good reliability of the measure. A further investigation revealed that the indicator loadings of two items were below 0.40 and, therefore, were removed from the construct. Both Cronbach's α and CR coefficients were above 0.70 after removing the two items. For convergent validity, the average variance explained (AVE) coefficients were above 0.50 for all constructs except for state-climate change anxiety and climate change

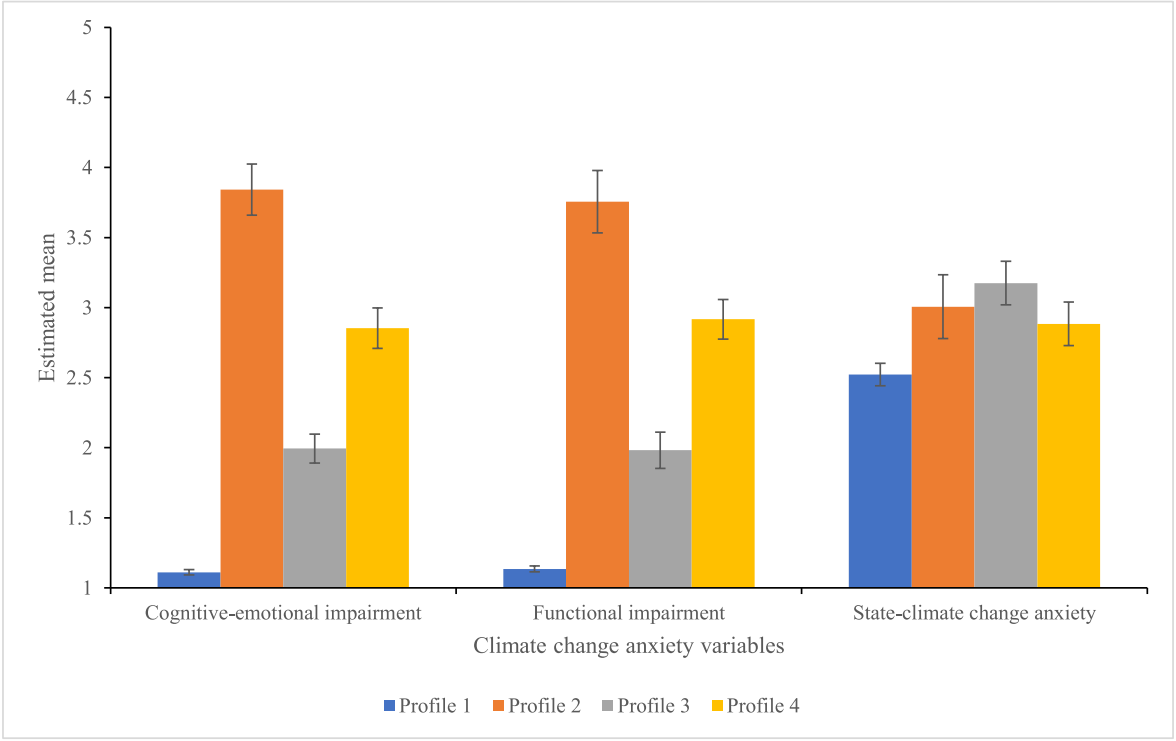

Fig. 2. Illustration of the latent profiles of climate change anxiety among the US participants.

beliefs. As the AVE coefficients of the two constructs were above 0.40 and their CR coefficients were above 0.70, we can still conclude sufficient convergent validity for the two constructs. Lastly, the Heterotrait-Monotrait ratios (HTMT) values were below 0.85 for conceptually distinct constructs and below 0.90 for conceptually similar constructs, except three pairs of constructs (i.e., biospheric and social-altruistic values, support for mitigation policies and support for adaptation policies, and anxiety and depression). Yet, the bootstrapped 90% confidence intervals of all constructs with 10,000 subsamples were below 1.0, indicating that the discriminant validity was still acceptable. Lastly, for the formative measures, the VIF values of indicators were below 5.0. The bootstrapped weight of two indicators of direct experience was non-significant (i.e., items 2 and 4), while all other indicators significantly differed from zero. We thus removed the two items. Our results remained consistent with or without including the two items.

3.2.2. *Testing the structural model (hypothesized links)*

We bootstrapped the model with 10,000 subsamples to obtain the standard errors and 95% confidence intervals of the path coefficients. Table 4 shows the results. Direct experience but not personal subjective experience of climate change was positively related to CCAS, with a small effect size ($f^2 = 0.041$). This finding only partially supports Hypothesis 1. Among the cognitive factors, both perceived realistic and symbolic threats were positively related to CCAS, with very small effect sizes (f2 = 0.007) and small effect sizes (f2 = 0.050), respectively. Furthermore, perceived climate change as a distant threat, self-efficacy beliefs, and perceived certainty of climate change threat were positively related to CCAS, whereas collective efficacy beliefs and climate change beliefs were negatively related to it. Again, the effects of psychological distance, self-efficacy beliefs, and climate change beliefs were inconsistent with our hypotheses. Perceived vulnerability and perceived climate change to be a proximal threat were unrelated to CCAS, although these two factors had positive zero-order correlations with CCAS. As such, the current findings only supported Hypotheses 2a and 2b but not 2c to 2f. Lastly, consistent with Study 1, egoistic values were a positive and significant predictor of CCAS. Both hedonic values and social-altruistic values were negatively related to CCAS. The effect sizes were very small (f^2 ranged from 0.004 to 0.016). Biospheric values were positive but non-significant. Again, these findings did not support Hypotheses 3a and 3b. Overall, these factors explained 39.5% of the variance in CCAS.

Consistent with Study 1, all experiential factors were positively related to state-climate change anxiety, with very small effect sizes for both direct experience ($f^2 = 0.016$) and subjective experience ($f^2 = 0.005$). Among the cognitive factors, perceived realistic threat, climate change beliefs, and self-efficacy beliefs were positively related to state-climate change anxiety, whereas collective efficacy beliefs were negatively related to it. The effect sizes were very small ($f^2 = 0.004$) to small ($f^2 = 0.031$). All other cognitive factors were non-significant. These findings only supported Hypothesis 2a and Hypothesis 2f. Lastly, hedonic values were a negative and significant predictor of state-climate change anxiety, with a very small effect size ($f^2 = 0.005$). All other values were non-significant. These findings thus did not support Hypotheses 3a and 3b. Overall, these factors explained 22.4% of the variance in state-climate change anxiety.

We also examined the relationship between CCAS, state-climate change anxiety, and the outcome variables. Similar to Study 1, we included all experiential, cognitive, and socio-cultural factors as predictors of the outcome variables. Table 5 shows the results. For the adaptive outcome variables, CCAS was positively related to private-

Table 4
Estimated coefficients of the effects of predictor variables on climate change anxiety (Study 2).

	CCAS			State-Climate Change Anxiety		
	b (SE)	95% CI	f^2	*b* (SE)	95% CI	f^2
Direct experience	0.17 (0.03)	[0.12, 0.23]	0.041	0.13 (0.03)	[0.06, 0.19]	0.018
Subjective experience	0.04 (0.03)	[-0.02, 0.09]	0.002	0.07 (0.04)	[0.00, 0.15]	0.005
Perceived symbolic threat	0.29 (0.04)	[0.21, 0.37]	0.050	0.07 (0.05)	[-0.03, 0.18]	0.003
Perceived realistic threat	0.12 (0.04)	[0.04, 0.20]	0.008	0.27 (0.05)	[0.16, 0.38]	0.030
Vulnerability	0.05 (0.03)	[-0.01, 0.11]	0.004	0.05 (0.03)	[-0.02, 0.11]	0.003
Perceived climate change to be a proximal threat	−0.03 (0.04)	[-0.10, 0.04]	0.001	−0.02 (0.04)	[-0.10, 0.06]	0.000
Perceived climate change to be a distant threat	0.12 (0.03)	[0.06, 0.18]	0.017	−0.01 (0.04)	[-0.08, 0.06]	0.000
Self-efficacy beliefs	0.11 (0.04	[0.04, 0.18]	0.010	0.08 (0.04)	[0.00, 0.15]	0.004
Collective efficacy beliefs	−0.11 (0.04)	[-0.18, −0.04]	0.011	−0.09 (0.04)	[-0.16, −0.02]	0.005
Climate change beliefs	−0.17 (0.04)	[-0.24, −0.09]	0.021	0.16 (0.05)	[0.07, 0.24]	0.013
Certainty of the happening of climate change	0.10 (0.03)	[0.04, 0.16]	0.009	−0.01 (0.04)	[-0.08, 0.06]	0.000
Egoistic values	0.13 (0.03)	[0.06, 0.19]	0.016	0.02 (0.04)	[-0.06, 0.10]	0.000
Social-altruistic values	−0.10 (0.04)	[-0.18, −0.03]	0.008	−0.07 (0.04)	[-0.14, 0.01]	0.002
Biospheric values	0.02 (0.03)	[-0.05, 0.09]	0.000	0.03 (0.04)	[-0.04, 0.11]	0.001
Hedonic values	−0.07 (0.03)	[-0.13, −0.00]	0.005	−0.08 (0.04)	[-0.15, −0.00]	0.005
R-squared	0.404			0.237		
Adjusted *R-squared*	0.395			0.226		

Note. CCAS = climate change anxiety scale.

Table 5
Estimated coefficients of the effects of climate change anxiety variables on the outcome variables (Study 2).

	CCAS			State-Climate Change Anxiety		
	b (SE)	95% *CI*	f^2	*b* (SE)	95% *CI*	f^2
Outcome variables						
Sustainable consumption	0.18 (0.04).	[0.11, 0.25]	0.023	−0.05 (0.03)	[-0.11, 0.02]	0.002
Sustainable diet	0.35 (0.04).	[0.28, 0.43]	0.086	−0.06 (0.04)	[-0.13, 0.01]	0.004
Public-sphere pro-environmental behaviors	0.36, (0.04).	[0.28, 0.44]	0.095	−0.06 (0.03)	[-0.13, 0.00]	0.004
Support for mitigation policies	−0.07 (0.03)	[-0.13, −0.01]	0.006	−0.04 (0.03)	[-0.09, 0.01]	0.003
Support for adaptation policies	−0.05 (0.03)	[-0.11, 0.02]	0.002	−0.07 (0.03)	[-0.13, −0.02]	0.006
Climate change avoidance	0.22 (0.04)	[0.14, 0.30]	0.034	−0.01 (0.04)	[-0.08, 0.07]	0.000
Generalized anxiety	0.31 (0.04).	[0.23, 0.39]	0.077	0.28 (0.04)	[0.21, 0.35]	0.081
Depression	0.32 (0.04).	[0.23, 0.41]	0.080	0.26 (0.04)	[0.19, 0.34]	0.065
Life satisfaction	0.04 (0.04).	[-0.04, 0.11]	0.001	−0.22 (0.04)	[-0.29, −0.14]	0.037

Note. CCAS = climate change anxiety scale. In predicting each outcome variable, we have included the effects of all predictor variables in Table 4.

sphere behaviors (both sustainable consumption and diet) and public-sphere behaviors. Similar to Study 1, state-climate change anxiety was unrelated to these behaviors. Unexpectedly, CCAS was negatively related to support for mitigation policies, and state-climate change anxiety was negatively related to support for adaptation policies. For the maladaptive outcome variables, CCAS was positively related to climate change avoidance, generalized anxiety, and depression. State-climate change anxiety was positively related to generalized anxiety and depression and negatively associated with life satisfaction, although its association with climate change avoidance was non-significant. Overall, these patterns of findings were more aligned with the hypotheses regarding the maladaptive outcomes (Hypotheses 6, 7a, 7b, and 7c).

3.2.3. Brief discussion of the main findings

Consistent with Study 1 (US sample), we found consistent evidence regarding the role of experiential factors (except for the association between subjective experience and CCAS), while the results regarding cognitive and sociocultural factors were mixed. The hypothesized effects of cognitive factors were more aligned with state-climate change anxiety. We also observed that collective self-efficacy was consistently related to less climate change anxiety. Despite not supporting our hypotheses, a negative association between CCAS and climate change beliefs and a positive association between CCAS and self-efficacy belief in both US (Study 1) and Chinese samples (Study 2) were observed. Similarly, among the sociocultural factors, egoistic values were positively and hedonic values were negatively related to CCAS in both samples. Regarding the outcome variables, we found that only CCAS was related to pro-environmental behaviors. Both CCAS and state-climate change anxiety were related to maladaptive outcome variables (except for the link between state-climate change anxiety and climate change avoidance). We observed an unexpected negative association between CCAS and support for mitigation policies and between state-climate change anxiety and support for adaptation policies. These unexpected negative associations indicate that Chinese participants may disengage from supporting climate change policies when they experience high levels of climate change anxiety. Overall, our findings are largely consistent with the US sample (Study 1), with a few exceptions (e.g., collective self-efficacy, support for mitigation and adaptation policies).

3.2.4. Supplementary analysis

Similar to Study 1, we also conducted exploratory latent profile analyses to identify the profiles of climate change anxiety. Supplementary Table S13 shows the results of the model indexes. A four-profile model fitted the best among the alternative models. Interestingly, we also observed latent profiles that showed similar levels of state-level climate change anxiety but different levels of CCAS (profile 2 versus profile 4; see Fig. 3). We found that members of profile 2 (N = 62; 6.15%) showed high levels of symptom-based climate change anxiety (mean values = 3.69 and 3.71 for cognitive-emotional impairment and functional impairment, respectively) but a moderate level of state-climate change anxiety (mean value = 2.93); member of profile 4 (N = 313; 31.02%) showed some degrees of symptom-based climate change anxiety (mean values = 2.21 and 2.13 for cognitive-emotional impairment and functional impairment, respectively) but moderate levels of state-climate change anxiety (mean value = 2.86). These profiles suggest that state-climate change anxiety and CCAS represented two different aspects of climate change anxiety – that people may experience affect-based climate change anxiety without experiencing severe impairments in daily functioning.

4. General discussion

In the pre-registered studies conducted in the US and mainland China, we examined the relationships among a variety of experiential, cognitive, and sociocultural factors and the two types of climate change anxiety. Results from the PLS-SEM suggest that experiential factors were robust in predicting both types of climate change anxiety. Our findings regarding cognitive factors and sociocultural factors were mixed and inconsistent across the two types of climate change anxiety, except for perceived realistic threats. For example, climate change beliefs were related to less symptom-based anxiety (i.e., CCAS) but more affect-based anxiety (i.e., state-climate change anxiety). Perception of climate

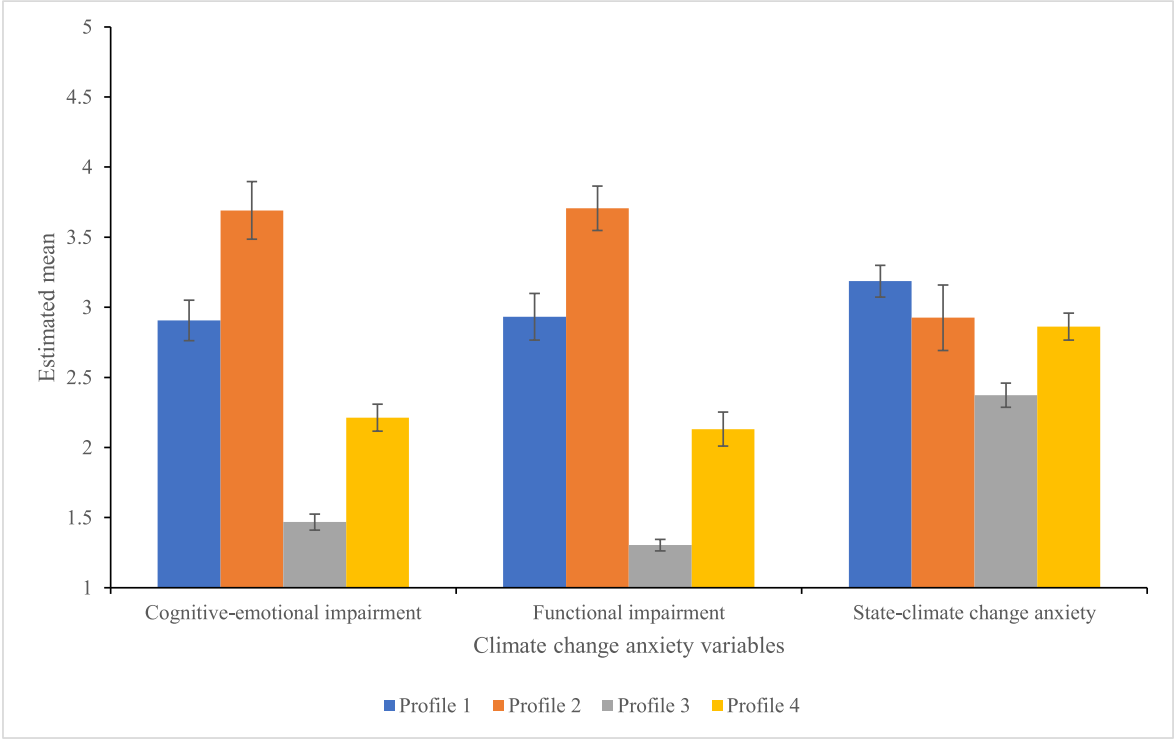

Fig. 3. Illustration of the latent profiles of climate change anxiety among the mainland Chinese participants.

change as a distant threat and egoistic values were positively related to levels of symptom-based anxiety but not affect-based anxiety in both studies. Despite the inconsistencies observed between the two types of climate change anxiety, we still observed some consistent patterns of associations across the US and Chinese samples. These patterns of findings suggest the viability of identifying possible predictors of climate change anxiety via the classification of experiential, cognitive, and sociocultural factors. We thus deem the proposed integrated model a useful framework for predicting and understanding climate change anxiety.

4.1. Distinguishing between affected-based and symptom-based measures of climate change anxiety

One crucial implication of the present study is that state-climate change anxiety and CCAS are distinct measures of climate change anxiety and possibly represent different experiences and responses to climate change (see also Hogg et al., 2023). The correlations between the two were only 0.23 and 0.38 in our US and Chinese samples, respectively, suggesting that the two types of responses were sufficiently distinct. Our supplementary latent profile analyses further revealed the possibility that people experience state-climate change anxiety without having cognitive-emotional and functional impairments (i.e., CCAS) simultaneously. The two measures were also correlated with the outcome variables in different manners. Only CCAS was related to pro-environmental behaviors when considered simultaneously with state-climate change anxiety and other predictor variables. This pattern of results may suggest that feeling anxious about climate change is insufficient to motivate pro-environmental behaviors. Individuals may choose different ways to cope with their affective feelings. When such anxiety is expressed through cognitive-emotional symptoms, climate change issues could be a salient issue in people's minds. As such, people may be more likely to do something aiming at mitigating climate change to relieve the salient anxious feelings (Heeren et al., 2023; Tam et al., 2023). However, CCAS was positively associated with climate change avoidance, while state-climate change anxiety was not. Also, in our Chinese sample, we observed a negative link between CCAS and support for mitigation policies. These findings indicate that problem-focused coping may not be the only consequence of CCAS; climate change anxiety may also lead to avoidance or emotional-focused coping that protects one from the uncomfortable status of cognitive-emotional and functional impairments (Wullenkord et al., 2021). Similarly, in our Chinese sample, we also observed a negative link between state-climate change anxiety and support for adaptation policies, whereas CCAS was unrelated to it. These patterns of findings suggest that the experience of climate change anxiety may not necessarily promote adaptational responses to climate change. Future studies will benefit from identifying under what circumstances climate change anxiety would trigger different coping strategies. Importantly, both forms of climate change anxiety we considered appear to be valid measures of psychological distress responses to climate change, as they were consistently related to anxiety and depression in both studies when considered simultaneously.

All these findings point to the need to develop a better theoretical understanding of different facets of climate change anxiety. We speculate that affect-based anxiety and symptom-based anxiety may represent different levels of anxiety experience or different phases of anxiety disturbance. For example, although it is rational and non-pathological for individuals to feel anxious about climate change, they may experience difficulty in coping with such anxiety and, in turn, develop clinically significant impairment. It is possible that the use of different coping approaches would relate to not only how climate change anxiety relates to different outcomes but also the maintenance and development of anxiety symptoms over time. To scrutinize these possibilities, future studies can use longitudinal research methods to better probe into the onset and development of anxiety about climate change.

We also reckon that neither of the measures has fully captured the experience of climate change anxiety yet. It should be acknowledged that the current measures of climate change anxiety capture only cognitive, emotional, and behavioral responses and exclude physiological responses (Coffey et al., 2021; van Valkengoed et al., 2023). It is possible that people who experience affect-based climate change anxiety may experience physiological complaints (e.g., nausea, heart palpitation, etc.) simultaneously, although they do not necessarily suffer cognitive-emotional or functional impairment. Another crucial endeavor for future studies would be to develop a more comprehensive measure that can capture the various dimensions of anxiety responses.

4.2. Predicting climate change anxiety

Our findings demonstrated that experience of climate change threat (both direct experience of various climate-related hazards and subjective experience) relates to higher levels of affect-based and symptom-based climate change anxiety. These findings are consistent with the notion that groups that are more likely to experience climate-related hazards could be at risk for developing climate change anxiety. It is crucial to note that the current research did not consider the role of vicarious experience. Whitmarsh et al. (2022) found that more frequent exposure to climate change-related information was related to higher levels of symptom-based climate change anxiety (i.e., CCAS). We believe it is crucial for future studies to consider this vicarious aspect of the experience of climate change.

Among the cognitive factors, we observed that people reported higher levels of climate change anxiety if they perceived climate change to be a realistic (physical and economic) and symbolic (cultural and social) threat. These findings imply that people are aware of how climate change would disrupt not only their physical and economic safety but also the continuity of their cultural and social values (Tam et al., 2022), and such awareness may trigger anxiety responses to climate change. Interestingly, we found that perceived symbolic threats were related to only symptom-based climate change anxiety, while perceived realistic threats were related to both. We speculate that the effect of perceived symbolic threats may relate to the coping of stress and death anxiety associated with climate change. According to the terror management theory (Pyszczynski et al., 2015), individuals may defend against death anxiety by turning to their cultural values and practices. When these symbolic immortal entities are challenged by climate change, individuals may feel even more anxious and develop functional impairment. This possibility warrants future studies to validate.

The other cognitive factors were inconsistent in predicting different types of climate change anxiety responses. These cognitive factors either did not have a unique effect on climate change anxiety or showed patterns that were consistent with our hypotheses only for state-climate change anxiety. Unexpectedly, in both studies, we observed that climate change beliefs were negatively related to symptom-based responses (i.e., CCAS) but positively related to affect-based responses (i.e., state-climate change anxiety). This negative association is opposite to our pre-registered hypothesis. These findings suggest that climate change believers may feel anxious about climate change and, yet, not necessarily experience more impairment symptoms in daily life. They may even experience fewer such symptoms. We speculate that how climate change believers (or disbelievers) cope with their thoughts about climate change may play a crucial role in shaping their symptom-based anxiety. For example, there is preliminary evidence that greater knowledge about climate change is associated with reduced anxiety (e.g., Asgarizadeh et al., 2023; Zacher & Rudolph, 2023), perhaps because it provides individuals with a greater sense of cognitive control (Clayton et al., under review); studies have also found that CCAS is negatively correlated with climate change denial (Wullenkord et al., 2021). In addition, individuals who strongly believe in climate change may have stronger trust in scientists and scientific efforts in tackling the climate crisis. Such a strong trust may help them develop healthier coping strategies for handling their anxiety (e.g., meaning-focused coping;

Ojala & Bengtsson, 2019), preventing them from engaging in cognitive rumination or focusing excessively on their anxious feelings. This possibility warrants future investigation.

We also observed unexpected patterns of association between psychological distance and symptom-based climate change anxiety. Our participants who reported higher levels of such anxiety also perceived climate change to be a distant threat. It suggests that individuals may still experience anxiety symptoms in their daily lives even if they consider climate change to be a distant threat. Importantly, we observed only a significant positive zero-order correlation between perceived proximity and climate change anxiety. We speculate that the effect of perceived proximity could be partially explained away by other predictor variables. For example, perceived climate change to be a proximal threat may make people consider it to have severe negative impacts on physical safety, economy, culture, and society, and in turn, experience higher climate change anxiety. As our studies are cross-sectional, we can only provide preliminary evidence for this proposition. Our supplementary analysis showed that the indirect effect of perceived proximity via perceived realistic threat was significant in predicting both types of climate change anxiety (see Supplementary Information). As such, it would be crucial for future studies to adopt a longitudinal design to unpack the causal sequence of these predictors of climate change anxiety.

Regarding the sociocultural factors, we did not find the expected positive associations between biospheric values, social-altruistic values, and climate change anxiety. Instead, social-altruistic values showed a very small but significantly negative association with CCAS. Our findings imply that individuals holding values aligned with environmental protection (in this case, biospheric and social-altruistic values) do not experience more climate change anxiety. Although this pattern of association is inconsistent with our pre-registered hypothesis, it is not completely novel. Whitmarsh et al. (2022) also reported a negative association between another measure of environmental values — the new ecological paradigm – and CCAS. These findings suggest the need to unpack how pro-environment-oriented values are related to people's emotional experiences (including anxiety) associated with climate change. Interestingly, we observed a consistently positive association between egoistic values and CCAS. That is, individuals emphasizing personal achievement and wealth are more likely to experience symptom-based climate change anxiety. It reflects that concerns about personal loss could be a risk factor for developing symptom-based climate change anxiety. This pattern of findings is consistent with research findings showing a negative relationship between extrinsic goal orientations and well-being (e.g., Sagiv et al., 2015; Sortheix & Schwartz, 2017). Considering that well-being is contingent on goal satisfaction and fulfillment, the uncertainty, threat, and possible loss associated with climate change could represent a barrier to people's extrinsic and egoistic pursuits. Consequently, it seems reasonable that people emphasizing personal rather than pro-environmental values experience more climate change anxiety. We also observed a consistent but very small negative association between hedonic values and CCAS (and also state-climate change anxiety in the mainland Chinese sample). As hedonic values focus on pleasure-seeking, it is possible that individuals emphasizing these values are less concerned about climate change and experience less climate change anxiety. Together, our findings suggest that values emphasizing personal and extrinsic achievements could be more relevant to climate change anxiety than values emphasizing wellness of nature and social others.

We reckon that future studies must broaden the scope of sociocultural factors by including factors other than personal values. One interesting candidate to consider is perceived social norm. A panicking social norm may amplify people's risk perception (Reser & Swim, 2011). Indeed, Ogunbode et al. (2022) found that perceived descriptive norms of negative emotions toward climate change were related to higher levels of state-climate change anxiety. Similarly, Van der Linden (2015) found that perceived social norms of climate change actions were associated with higher perceived climate change risk; such social norms possibly signify the importance of climate change as a societal threat. Additionally, it is crucial to move beyond just individual-level factors when conceptualizing the role of sociocultural factors. Emerging studies have demonstrated that people's responses to climate change can be jointly shaped by individual-level factors (e.g., values, perceived social norms, and political orientation) and societal-level or institution-level factors (e.g., societal cultures, economic conditions, and fossil reliance; Chan, 2020; Chan & Tam, 2023; for a review, see Tam & Milfont, 2020). Future research will benefit from examining the interplay of these factors. For example, it is plausible that the influence of hedonic values on climate change anxiety is more pronounced among societies wherein the culture encourages people to make decisions based on personal preference (e.g., individualistic culture) rather than collective good (e.g., collectivistic culture). Put differently, although the present research suggests that the effect of personal values on climate change anxiety seems small, there are good reasons to expect that the strength of this effect varies across different societal conditions.

Furthermore, considering the role of societal-level factors enables researchers to systematically examine how the relationship between predictor or outcome variables and climate change anxiety differs across societies. We have observed some differences in the associations between predictor or outcome variables and climate change anxiety between the US and Chinese samples. For example, collective efficacy beliefs were related to less climate change anxiety only in the Chinese sample. Based on this observation, we call for more attention to the potential dynamics between collective efficacy beliefs and societal-level or institution-level factors.

In all, with the integrated model tested in the present research, we hope researchers would feel encouraged to more systematically and comprehensively examine factors leading to climate change anxiety along the three domains proposed: experiential, cognitive, and sociocultural.

4.3. Limitations

The present research has at least the following three noteworthy limitations. First, our study is cross-sectional. Our findings are only suggestive of what experiential, cognitive, and sociocultural factors are more relevant in predicting symptom-based and affect-based climate change anxiety. As noted earlier, it is possible that some of these factors could be an antecedent of other factors. Future studies would benefit from using a longitudinal design to unpack the dynamic between these factors in shaping climate change anxiety. Furthermore, some outcome variables explored in the present study can also be conceptualized as predictors of climate change anxiety. For example, pro-environmental behaviors and generalized anxiety were conceptualized as predictors of CCAS in previous studies (e.g., Whitmarsh et al., 2022). The directionality of the associations can only be tested with a longitudinal design in future studies.

Second, we only included participants from the US and mainland China in the current study. Although we observed consistent patterns of findings between the two samples, we are aware of the possible influence of the broader socio-ecological contexts in influencing the association between the three sets of predictors and climate change anxiety. For example, experiential factors could have a stronger effect on climate change anxiety in societies with fewer (versus richer) resources for coping with climate-related hazards. Relatedly, although we aimed to recruit representative samples of US and mainland Chinese adult participants in terms of age and gender, there were potential sampling biases owing to the sampling pools offered by the marketing company and the response rates of the participants. For example, it is uncertain to what extent the sampling pools involved participants who were geographically more versus less vulnerable to climate change threats within a country. Such uncertainty can undermine the representativeness of our samples. Notwithstanding this, the distribution of climate

change anxiety scores (i.e., mean and standard deviation) were comparable to those measured in previous studies (e.g., Tam et al., 2023), suggesting that the current samples still capture a meaningful variation of climate change anxiety in the two countries.

Lastly, although we have carefully selected a list of relevant predictors in the three domains based on theories, more than 50% of the variance in climate change anxiety remains unexplained. It is noteworthy that the effect sizes of the predictors were very small to small, suggesting that climate change anxiety is complex and likely to be determined by multiple psychological factors, especially sociocultural factors. Having said that, we believe that our findings are still useful as they provide critical insights into formulating a comprehensive model for predicting and understanding climate change anxiety. Our proposed model can serve as a basic framework for researchers to introduce additional predictors in understanding climate change anxiety.

Endnote:

1. In our pre-registration, we conceptualized perceived realistic and symbolic threats as experiential factors, with the assumption that these threat perceptions represent an anticipated change in society. However, we acknowledge that such a conceptualization may make it difficult to differentiate between experiences and cognitive appraisal of climate change. To provide a clearer conceptual definition, we now define experiential factors as those that reflect an experience of climate change events or impacts, and we consider it more appropriate to conceptualize perceived threats as a cognitive evaluation of climate change risks. Despite these changes in conceptualization, the hypothesized associations remained unchanged. It also did not influence our main analysis using the partial least square-structural equation modeling.
2. We explored the measurement invariance of state-climate change anxiety between our US sample (Study 1) and the mainland Chinese sample (Study 2), as previous studies did not test the measurement invariance of the measure. We presented the findings in the supplementary document. In brief, we found that a two-factor model fitted the data better than a one-factor model in both samples. Importantly, we observed that the configural model, metric-invariance model, and scalar-invariance model showed good fit to the data. We obtained evidence that supported the scalar invariance of the measure between the two samples. Although we found evidence supporting the two-factor model, we opted to follow previous studies in computing the score of the state-climate change anxiety for two reasons. First, it allows us to compare our findings with previous studies that measure climate change anxiety in terms of emotional states (e.g., Ogunbode et al., 2022). Second, the two factors were loaded by the positive items and negative items in the measure, respectively. This pattern suggested the possibility that the second factor was merely the result of a method effect (specifically, item wording effect) and hence conceptually not meaningful. As we do not have any prior hypotheses regarding the factor structure of this measure, we deem it appropriate to reverse the scores of the positive items and then compute an overall index score of state-climate change anxiety.

CRediT authorship contribution statement

Hoi-Wing Chan: Methodology, Investigation, Formal analysis, Conceptualization, Writing – original draft. **Kim-Pong Tam:** Conceptualization, Investigation, Writing – review & editing. **Susan Clayton:** Investigation, Writing – review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2024.102368.

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