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Is Mindfulness a Double-Edged Sword? Associations With Climate Anxiety and Pro-Environmental Behavior

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Abstract

Objectives At a time of growing global concern about climate change, mindfulness has been put forward as a potential tool to alleviate climate anxiety and engage people with environmental issues. However, climate anxiety is not a pathology to treat. Instead, climate anxiety is increasingly understood as reflecting a deep engagement with environmental concerns that motivates pro-environmental action. We question whether some aspects of mindfulness may be related to lower climate anxiety that flows into lower pro-environmental behavior.

Method We surveyed people living in Australia ($n = 287$) about their experiences of dispositional mindfulness, climate anxiety, anticipatory solastalgia (distress about future environmental losses), and their pro-environmental behavior.

Results In a mediation analysis, we identified that mindfulness has a potential anxiolytic effect on climate anxiety, specifically acting with awareness, nonreactive decentering, and accepting nonjudgmental attitude related to lower scores on climate anxiety facets. Conversely, both greater awareness of internal and external experiences were related to greater climate anxiety. In its association with lower climate anxiety, acting with awareness also related indirectly to lower engagement in pro-climate collective action behavior. Awareness of external experiences related to higher anticipatory solastalgia and in turn greater engagement in collective action and personal pro-environmental behaviors.

Conclusions Overall, the current study adds to a growing body of literature that highlights the nuanced relationships between mindfulness, affect, and pro-environmental behavior. It specifically raises the question of whether greater mindful emotion regulation and meta-awareness might reduce individuals' likelihood of pro-environmental action, potentially by removing the negative affective motivator. In contrast, greater awareness of experiences might increase pro-environmental behavior by increasing experienced negative affect.

Preregistration The study was not preregistered.

Keywords Climate anxiety · Eco-anxiety · Solastalgia · Anticipatory emotion · Mindfulness · Pro-environmental behavior · Collective action

Climate change has become a tangible reality for a large majority of the world population (IPCC, 2022) and is unlikely to be fully averted by any feasible measures (Jewell & Cherp, 2023). Nevertheless, mitigation efforts at societal and combined individual levels are still possible and can help humanity to avoid some worst-case scenarios (IPCC, 2022). Unsurprisingly, many people report feeling anxious about climate change, especially among the younger generations (Hickman et al., 2021). This has raised concerns about the impact of climate anxiety in the context of an ongoing mental health crisis (Gago et al., 2024) and led to calls for research to understand the best way to support individuals facing climate anxiety (e.g., Clayton, 2020).

Supporting people to manage their climate anxiety is increasingly important as concerns may rise with further changes to the climate. But it poses an interesting conundrum. While excessive anxiety is clearly nonfunctional and

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associated with a host of detrimental outcomes for individuals, mild to moderate anxiety also serves a preparatory function aimed at averting potential threats (McNaughton & Gray, 2000). This effect has been documented for a wide range of subjects, from participation in cancer screening (Goodwin et al., 2023) to earthquake preparedness (Dooley et al., 1992). In line with this, climate anxiety has been found to be positively related to increased climate activism and pro-environmental behavior (Gao et al., 2021; Hogg et al., 2024a; Mathers-Jones & Todd, 2023).

Research about reducing excess levels of climate anxiety has often focused on mindfulness (Ray, 2020). Indeed, mindfulness is an effective anxiolytic (Hofmann & Gómez, 2017), and consistent with its general anxiolytic effect, limited research indicates that mindfulness is related to lower climate anxiety (Bourban, 2023; Whitmarsh et al., 2022). At the same time, mindfulness has been indicated as a potential approach to heighten individuals' awareness of the need to act on environmental issues, with some researchers calling for it to be considered a core approach at all levels of research on climate change (Wamsler, 2018). The effects of mindfulness on pro-environmental behavior have been attributed to a wide range of factors, ranging from reduced social dominance orientation to increased connectedness with nature (Nicol & De France, 2018; Panno et al., 2018; Sadowski et al., 2022; Schutte & Malouff, 2018; Van Gordon et al., 2018).

The associations between mindfulness, climate anxiety, and pro-environmental behavior likely depend on the exact nature of mindfulness being investigated. While mindfulness can be broadly understood as either a trait or an induced state as part of practice (Krägeloh, 2020), these two components are linked together, with increased mindfulness states resulting in increased trait mindfulness (Kiken et al., 2015). Rather than a singular construct, mindfulness is best understood as a complex structure of interacting components. These facets of mindfulness can have independent and potentially opposing effects (Karl & Fischer, 2020; Lindsay & Creswell, 2017). For example, components of trait mindfulness that are focused on nonjudgmental acceptance help people regulate their emotional and behavioral responses and thus can decrease anxiety and negative affect, while open monitoring components of mindfulness increase focus on one's concerns and can therefore *increase* anxiety and negative affect in response to anxiety-inducing stimuli (Karl & Fischer, 2022).

One of the most comprehensive multi-faceted conceptualizations of trait mindfulness is expressed in the Comprehensive Inventory of Mindfulness Experiences (CHIME; Bergomi et al., 2013; Karl et al., 2024). The CHIME was developed to assess a broad understanding of mindfulness and captures eight facets: awareness of internal experiences, awareness of external experiences, acting with awareness, accepting nonjudgmental attitude, nonreactive decentering, openness to experience, awareness of thoughts' relativity, and insightful understanding. Awareness of internal experiences is defined as individuals' tendencies to be aware of both emotional and physical sensations and their changes. Awareness of external experiences refers to individuals' tendencies to be aware of qualitative features of their environment. Acting with awareness can be defined as individuals' tendencies to be fully focused and absorbed in the present moment. Accepting nonjudgmental attitude is individuals' tendencies to exhibit kindness to themselves, even if they make mistakes. Nonreactive decentering is defined as individuals' tendencies to maintain equanimity and separate between emotion, cognition, and action in the face of negative experiences. Openness to experience can be defined as individuals' tendencies to accept experiences as they come without avoiding negative experiences or thoughts. Awareness of thoughts' relativity refers to individuals' tendencies to regard their own thoughts and beliefs as transient and situational conditional. Last, insightful understanding is defined as individuals' tendencies to take a lighthearted approach to self-monitoring.

This conceptualization of mindfulness expands on existing structures, such as the Five-Facet Model of Mindfulness (Baer et al., 2006; Karl & Fischer, 2020), by incorporating mindfulness components, such as insightful understanding and awareness of thoughts' relativity, which are central to traditional conceptualizations of mindfulness, but have been commonly neglected in trait mindfulness measures (Krägeloh et al., 2019). In a recent study, Jansen et al. (2024) showed that only insightful understanding and awareness of external experiences were related to sustainable behavior directly, but all facets except nonjudgmental acceptance and nonreactive decentering were indirectly related to sustainable behavior via connectedness to nature, disruption of routines, and pro-sociality. It is interesting to note that neither nonjudgmental acceptance nor nonreactive decentering had an indirect effect, potentially because the authors focused on non-emotional factors with a positive valence. Together with acting with awareness, these two facets have shown the most pronounced negative relationship with anxiety in past research (Bergmann et al., 2021).

The conceptualization of climate anxiety has also shifted towards more complex models, with recent definitions highlighting that the experience involves cognitive, affective, and behavioral components (van Valkengoed et al., 2023). The Hogg Climate Anxiety Scale (Hogg et al., 2024b, see also Hogg et al., 2021, for the more general eco-anxiety version of the measure) was developed to capture this complexity, indexing the frequency that participants experience feelings of anxiety and worry about climate change (affective symptoms), disruptions to daily life due to their concerns (behavioral symptoms), an inability to stop thinking about

climate change (rumination), and concern fixated on their role in causing and addressing climate change (personal impact anxiety). Previous research has identified that more symptomatic dimensions of climate anxiety (i.e., affective and behavioral symptoms) are stronger predictors of negative mental health outcomes, while cognitive aspects (personal impact anxiety and rumination) are stronger predictors of engagement in pro-environmental behavior (Hogg et al., 2024a). These latter dimensions may focus people's attention on their effects on the environment and keep these concerns top of mind, respectively, thus shaping their behavioral responses.

The ecological emotions literature also grew recently with the introduction of *anticipatory solastalgia*, a construct that captures distress in the present about expectations of future environmental losses (Stanley, 2023). This construct is thought to capture a related, yet broader emotional response than climate anxiety, as it encompasses worry and sadness about treasured aspects of the environment being lost due to climate change (see also Stanley et al., 2024, for qualitative evidence of the construct). Beyond an anxiety response, anticipatory solastalgia shows associations with other eco-emotions (e.g., feeling angry, depressed, about climate change) but is yet to be tested as a potential correlate of pro-climate action.

Considered together, the previous research raises an interesting question: if greater climate anxiety is related to greater pro-environmental behavior, and mindfulness reduces climate anxiety, is there the possibility that mindfulness could reduce pro-environmental behavior? In our study, we aimed to examine the potential alternative pathways mindfulness has on pro-environmental behavior via climate anxiety and anticipatory solastalgia. Based on previous research that has highlighted the motivational effects of climate anxiety on pro-environmental behavior, we expect that mindfulness facets that reduce anxiety (nonreactive decentering, nonjudging, and acting with awareness, see Bergmann et al., 2021; Nila et al., 2016) might decrease climate anxiety, which in turn decreases pro-environmental behavior. This would represent a mediating relationship of climate anxiety between mindfulness and climate action, which would complement similar mediated relationships for constructs such as connectedness to nature and pro-social orientation (Jansen et al., 2024). These mindfulness traits support people to regulate their emotions and meta-cognitive patterns, thereby reducing anxiety. In contrast, facets such as awareness of internal and external experiences might increase individuals' focus on environmental impacts and their own anxieties, which could have the effect of increasing climate anxiety and in turn pro-environmental behavior. It is also possible that the anxiolytic dimensions of mindfulness uniquely predict reductions in only the symptomatic aspects of climate anxiety (i.e., reducing affective and behavioral symptoms). This

is because affective and behavioral symptoms are uniquely implicated in psychological distress, perhaps because both climate anxiety and distress share aspects of negative affect that could theoretically both respond to anxiety-reducing aspects of mindfulness. Meanwhile, pathways to pro-environmental behavior could remain intact through personal impact anxiety and rumination that may focus and maintain concerns about responding to climate change needed to motivate action. We consider associations with both personal pro-environmental behaviors and collective action, meaning the behaviors people take in their everyday lives to reduce their environmental impacts, and their engagement with climate activism, respectively.

Method

Participants and Procedure

We aimed to recruit at least 250 participants as this is the minimum to identify stable correlations (Schönbrodt & Perugini, 2013). We opened 300 places on Prolific for individuals living in Australia to take part in the study in exchange for the platform's minimum payment (6 GBP/hr). We used the balanced sample feature to ensure an approximate gender balance. In total, 301 participants took part in the study. To screen non-compliance, we used instructional attention checks ("Please select 'Strongly disagree' to show you are paying attention" and "This is an attention check. Please select 'nearly every day'"). Participants who did not select the option as instructed were considered to have failed. We excluded 14 participants who failed either of our two attention checks. The remaining 287 participants included approximately equal numbers of men ($n = 143$) and women ($n = 139$), and five participants who preferred another term to describe their gender identity. Participants reported an average age of 35.05 years ($SD = 12.33$) and self-identified more strongly on the political left compared to the political right ($M = -13.50$, $SD = 22.28$, as measured from -50 [*left wing*] to 50 [*right wing*]).

Measures

Mindfulness We administered the previously validated CHIME (Bergomi et al., 2013), which allows participants to rate themselves on a 6-point Likert scale (1 = *Almost never* to 6 = *Almost always*). The 37 items are distributed across eight facets: awareness of internal experiences ("When my mood changes, I notice it right away."; $\alpha = 0.78$, 95% CI [0.75, 0.82]), awareness of external experiences ("I notice details in nature, such as colors, shapes, and textures."; $\alpha = 0.85$, 95% CI [0.82, 0.88]), acting with awareness ("I break or spill things because I am not paying attention or I am thinking of

something else." [reverse scored]; $\alpha = 0.70$, 95% CI [0.64, 0.75]), accepting nonjudgmental attitude ("In the ups and downs of life, I am kind to myself."; $\alpha = 0.84$, 95% CI [0.81, 0.87]), nonreactive decentering ("When I have distressing thoughts or images, I am able to feel calm soon afterward."; $\alpha = 0.87$, 95% CI [0.85, 0.90]), openness to experience ("I try to stay busy to avoid specific thoughts or feelings from coming to mind." [reverse scored]; $\alpha = 0.66$, 95% CI [0.60, 0.72]), awareness of thoughts' relativity ("It is clear to me that my evaluations of situations and people can change easily."; $\alpha = 0.71$, 95% CI [0.65, 0.76]), and insightful understanding ("In everyday life, I notice when my negative attitudes toward a situation make things worse."; $\alpha = 0.81$, 95% CI [0.77, 0.84]). We found support for the factor structure of the CHIME in our data (Tables S1-2 in the Supplementary Information).

Climate Anxiety We administered the 13-item Hogg Climate Anxiety Scale (HCAS) previously validated in the USA and UK (Hogg et al., 2024b). The HCAS allows participants to rate the extent they have experienced aspects of climate anxiety over the past 2 weeks on a 4-point Likert scale ($0 = $ *Not at all* to $3 = $ *Nearly every day*). The items are distributed across 4 facets: affective symptoms ("Feeling nervous, anxious or on edge"; $\alpha = 0.88$, 95% CI [0.86, 0.91]), rumination ("Unable to stop thinking about future climate change"; $\alpha = 0.88$, 95% CI [0.85, 0.90]), behavioral symptoms ("Difficulty sleeping"; $\alpha = 0.82$, 95% CI [0.78, 0.85]), and anxiety about personal impact ("Feeling anxious about the impact of your personal behaviors on climate change"; $\alpha = 0.86$, 95% CI [0.83, 0.88]). All items were prefaced by the statement: "Over the last 2 weeks, how often have you been bothered by the following problems, when thinking about climate change?".

Anticipatory Solastalgia We also administered the 5-item Anticipatory Solastalgia Scale developed and validated by Stanley (2023) from a revision of the Environmental Distress Scale (Higginbotham et al., 2006), where substantial psychometric evidence is presented in Christensen et al. (2024). Participants rated the extent they experience items such as "I am worried that aspects of this area that I value are being lost" on a Likert scale ($1 = $ *Strongly disagree* to $7 = $ *Strongly agree*). Stanley (2023) noted that the fourth item refers to an expected (rather than actual) increase in solastalgia ("I will be increasingly upset at the way the environment looks"), and thus may capture *anticipated* solastalgia rather than anticipatory solastalgia. We followed the recommendation in their paper to adjust the wording from "will be" to "am" to better capture anticipatory solastalgia. The 5 items capture a uni-dimensional conceptualization of anticipatory solastalgia ($\alpha = 0.91$, 95% CI [0.90, 0.93]). We found support for the factor structure of the Hogg Climate Anxiety Scale and

its differentiation from Anticipatory Solastalgia in our data (Tables S3-6 in the Supplementary Information).

Pro-Environmental Behavior We measured participant's engagement in both personal pro-environmental behaviors and collective action behaviors using two 8-item scales used in Stanley et al. (2021), who reported satisfactory internal consistency of each scale. Participants rated how often they have taken each action in the past year on a sliding scale ranging from 0 (*Never*) to 100 (*At every opportunity*). Before analyzing the scale, we examined responses for potential floor and ceiling effects in reporting behavior. We removed any item with a variance of one standard deviation below the median across all items in the scale: two collective action items showed substantially limited variance ("Joined a protest march," "Written a letter to a member of parliament"; both have median response $= 0$) and one pro-environmental behavior ("Switched lights off around the house whenever possible"; median response $= 90$). With these three items removed, we then standardized all participant scores by centering and *z*-scoring them to avoid scale issues, then created mean scores for engagement in collective action (6-item subscale; $\alpha = 0.87$, 95% CI [0.84, 0.89]) and engagement in pro-environmental behavior (7-item subscale; $\alpha = 0.79$, 95% CI [0.75, 0.83]).

Data Analyses

We first calculated and reported descriptive statistics for, and zero-order correlations between, all scales described above. To test our key research question about the potential mediating effect of climate anxiety between mindfulness and pro-environmental behavior, we initially fitted a mediation model in which mindfulness predicted climate anxiety and anticipatory solastalgia, which in turn predicted pro-environmental behavior. Importantly, although cross-sectional mediation analysis cannot establish causality, it allows for the investigation of theoretically specified paths based on previous experimental and longitudinal findings (Zhao et al., 2010). To ensure robust standard errors and correct for any assumption violations, we bootstrapped the model using 1000 bootstraps. Furthermore, as bootstrapping outcomes rely partially on the initial seed, we re-ran this analysis 100 times using different seeds (Sandve et al., 2013). To increase the robustness of our results and avoid inclusion of spurious effects, we retained all path-coefficients and indirect effects that were significant at $p < 0.05$ in at least 95% of all models. To further increase the robustness of our inference, we re-ran the model with centered (around 50 as the mid-point) and scaled political orientation as control variable. We report the full adjusted results in the supplementary code on the Open Science Framework and indicate substantial changes in text.

Results

We show means, standard deviations, and zero-order Pearson's correlations of all scales in Table 1. The descriptive statistics reflect that, on average, participants rate themselves as enacting mindfulness some of the time, as rarely experiencing the facets of climate anxiety, though slightly agreeing they experience anticipatory solastalgia about climate change. Similarly, the standard deviations indicate that our data captures a wide range of responses, especially for climate anxiety where one standard deviation reflected a movement of more than half a point on the 0–3 response scale from the mean. Participants on average reported enacting pro-environmental behaviors in their personal lives some of the time ($M = 56.06$, $SD = 19.45$), and engaging in climate activism rarely ($M = 29.90$, $SD = 25.38$). Table 1 shows differences in the correlates of climate anxiety and anticipatory solastalgia. For example, where awareness of internal and external experiences were both not significantly related to the dimensions of climate anxiety, they are positively correlated with anticipatory solastalgia. Meanwhile, acting with awareness and accepting nonjudgmental attitude are correlated with climate anxiety and not significantly associated with anticipatory solastalgia.

Results from our mediation model identify that affective and behavioral symptoms were both predicted only by acting with awareness and accepting nonjudgmental attitude. These associations were negative, indicating that endorsing these facets of mindfulness was associated with reporting lower affective and behavioral symptoms of climate anxiety. Indeed, acting with awareness was a significant negative predictor of all four dimensions of climate anxiety. Personal impact anxiety was also predicted by awareness of internal experiences (positive association; indicating that participants reported more concern about their own role in addressing climate change when they reported stronger awareness of internal experiences), and nonreactive decentering (negative association; indicating that being able to feel calm soon after a period of distress is associated with lower anxiety about one's role in causing and responding to climate change; note that this finding was not robust to the inclusion of political orientation and in this model was only significant in 13% of the samples). Awareness of external experiences was positively associated with reporting greater anticipatory solastalgia. Both rumination and anticipatory solastalgia predicted higher engagement in both personal and collective pro-environmental behaviors; personal impact anxiety predicted engaging in collective action behaviors. We also identified direct associations from mindfulness to action, whereby greater awareness of external experiences, acting with awareness, and awareness of thoughts' relativity were associated with higher engagement in personal pro-environmental behavior. Openness to experience predicted taking part in more collective action behavior. We show the significant and robust direct paths in Table 2 and Fig. 1 (all other paths can be found in Table S7 in the Supplementary Information).

Beyond the direct paths, we also identified several indirect paths. Specifically, there was a negative association between acting with awareness and collective action behavior through both rumination ($b = -0.06$, 95% CI [$-0.11, -0.01$], $p = 0.026$) and personal impact anxiety ($b = -0.04$, 95% CI [$-0.08, -0.00$], $p = 0.035$; but note that this finding was not robust to the inclusion of political orientation and was only significant in 71% of the seeds). Anticipatory solastalgia mediated the association between awareness of external experiences and collective action behavior ($b = 0.08$, 95% CI [0.03, 0.12], $p = 0.001$) and between awareness of external experiences and personal pro-environmental behaviors ($b = 0.04$, 95% CI [0.01, 0.08], $p = 0.022$).

Discussion

Climate change is another stressor expected to contribute to a burgeoning mental health crisis. Amid these concerns, mindfulness has been presented as a potential way to ease anxiety (Bamber & Morpeth, 2019; Vøllestad et al., 2012) and climate anxiety specifically (Wamsler, 2018; Whitmarsh et al., 2022). Our research aimed to investigate whether, in its associations with lower climate anxiety, mindfulness may be related to a reduction in pro-environmental behavior. Indeed, our mediation model indicated that the acting with awareness facet of mindfulness was related to lower participation in collective action through reduced anxiety about one's personal impact on climate change and lower rumination about climate change.

We expected that the mindfulness facets known to reduce anxiety (nonreactive decentering, accepting nonjudgmental attitude, and acting with awareness) would be negatively associated with climate anxiety, which comprises the four facets of affective symptoms, behavioral symptoms, rumination, and personal impact anxiety. We found some evidence for this in our model, whereby nonreactive decentering was associated with lower personal impact anxiety, and accepting nonjudgmental attitude was associated with lower affective and behavioral symptoms. We conversely predicted that awareness of internal and external experiences might be related to greater climate anxiety due to the increased focus on personal and environmental concerns these facets may entail. Indeed, awareness of internal experiences related to higher reports of personal impact anxiety, and awareness of external experiences related to higher anticipatory solastalgia. We also identified a direct effect of awareness of external experiences on personal pro-environmental behavior.

Table 1 Means, standard deviation, and zero-order Pearson's correlations of all scales in the study

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Comprehensive Inventory of Mindfulness Experiences															
1. Awareness of internal experiences															
2. Awareness of external experiences	0.62***														
3. Acting with awareness	0.10	0.09													
4. Accepting nonjudgmental attitude	0.25***	0.19**	0.41***												
5. Nonreactive decentering	0.48***	0.35***	0.31***	0.59***											
6. Openness to experience	−0.17**	−0.11	0.30***	0.21***	0.05										
7. Awareness of thoughts' relativity	0.36***	0.33***	−0.04	0.19**	0.40***	−0.22***									
8. Insightful understanding	0.49***	0.36***	0.07	0.46***	0.69***	−0.11	0.53***								
Climate anxiety and solastalgia															
9. Affective symptoms	0.00	−0.07	−0.40***	−0.32***	−0.22***	−0.18**	−0.05	−0.09							
10. Ruminative symptoms	0.06	0.06	−0.27***	−0.20***	−0.09	−0.10	−0.07	−0.07	0.59***						
11. Behavioral symptoms	−0.04	−0.08	−0.33***	−0.26***	−0.08	−0.13*	−0.01	−0.03	0.76***	0.45***					
12. Personal impact anxiety	0.08	0.09	−0.26***	−0.23***	−0.20***	−0.09	−0.04	−0.08	0.54***	0.72***	0.37***				
13. Anticipatory solastalgia	0.13*	0.23***	−0.11	−0.11	−0.04	−0.08	0.12*	0	0.19**	0.35***	0.06	0.44***			
Personal and collective behavior															
14. Personal pro-environmental behavior	0.30***	0.37***	0.09	0.1	0.14*	0.05	0.24***	0.18**	0.13*	0.30***	0.00	0.31***	0.36***		
15. Collective action behavior	0.20***	0.23***	−0.06	−0.02	0.08	0.05	0.12*	0.11	0.21***	0.43***	0.10	0.46***	0.49***	0.50***	
Mean	4.10	4.48	3.58	3.21	3.77	2.96	4.36	3.93	0.57	0.34	0.45	0.57	5.35	56.06	29.90
Standard deviation	0.85	0.99	0.97	1.03	0.92	0.89	0.75	0.91	0.68	0.54	0.67	0.68	1.26	19.45	25.38
Scale range	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	0–3	0–3	0–3	0–3	1–7	0–100	0–100

Note. $*p < 0.05$; $**p < 0.01$; $***p < 0.001$. Personal pro-environmental behavior and collective action behavior are both standardized ($M = 0$, $SD = 1$) in the main analysis. The power to detect the smallest correlation, average, and largest ($r = 0.00$, $r = 0.22$, $r = 0.76$) based on a sample of 287 participants and a significance level of 0.05 was 0.05, 0.97, and 1 respectively

Table 2 Findings from final mediation model

Predictor	Outcome	Average std. coefficient	Average 95% CI lower estimate	Average 95% CI upper estimate	Average p-value
Predictors of climate anxiety and anticipatory solastalgia					
Acting with awareness	Affective symptoms	−0.31	−0.42	−0.20	< 0.001
Accepting nonjudgmental attitude	Affective symptoms	−0.18	−0.32	−0.04	0.013
Acting with awareness	Personal impact anxiety	−0.20	−0.32	−0.08	0.001
Awareness of internal experiences	Personal impact anxiety	0.16	0.02	0.31	0.029
Nonreactive decentering	Personal impact anxiety	−0.19	−0.35	−0.02	0.024
Acting with awareness	Behavioral symptoms	−0.28	−0.39	−0.17	< 0.001
Accepting nonjudgmental attitude	Behavioral symptoms	−0.23	−0.37	−0.09	0.001
Acting with awareness	Rumination	−0.25	−0.37	−0.12	< 0.001
Awareness of external experiences	Anticipatory solastalgia	0.24	0.11	0.37	< 0.001
Predictors of pro-environmental behavior					
Personal impact anxiety	Collective action	0.20	0.07	0.34	0.003
Rumination	Collective action	0.23	0.07	0.39	0.004
Openness to experience	Collective action	0.15	0.03	0.26	0.012
Anticipatory solastalgia	Collective action	0.31	0.22	0.41	< 0.001
Acting with awareness	Personal behavior	0.16	0.04	0.28	0.011
Awareness of thoughts' relativity	Personal behavior	0.17	0.05	0.28	0.004
Rumination	Personal behavior	0.19	0.03	0.36	0.023
Awareness of external experiences	Personal behavior	0.22	0.09	0.35	0.001
Anticipatory solastalgia	Personal behavior	0.18	0.05	0.30	0.005

Our findings of the facet level relationships of mindfulness, climate anxiety, and pro-environmental behavior to some extent reflect the distinction of mindfulness components raised in the monitoring and acceptance theory (Lindsay & Creswell, 2017). Both nonreactive decentering and accepting nonjudgmental attitude represent acceptance skills, which support individuals in modifying their behavioral and affective reactions to internal and external experiences. In contrast, internal and external experiences represent monitoring skills, which increase experiential awareness, also of negative emotions in the absence of appropriate acceptance skills. In line with this, we found that the acceptance skills facets showed overall anxiolytic effects, whereas the monitoring skills facets were associated with increased anxiety and anticipatory solastalgia. Strikingly, acting with awareness, which represents general present moment focus and absorption and sits outside of Lindsay and Creswell's (2017) categorization, showed the most pronounced anxiolytic relationships, which in turn also reduced pro-environmental behavior. While acting with awareness has generally shown anxiolytic effects in past research (Bergmann et al., 2021), its pronounced relationship with climate anxiety is noteworthy and is potentially rooted in the perceived temporal distance of climate change and the episodic rather than consistent perceived impact of climate change in individuals daily lives (McDonald et al., 2015; Većkalov et al., 2021). Individuals who are highly absorbed in the present moment might allocate fewer cognitive resources to perceived distal stressors, reducing anxiety.

This theoretical lens highlights an important implication of our findings for applying mindfulness in an environmental context. While developing mindfulness interventions that primarily focus on the training of acceptance and awareness skills might be effective in reducing climate anxiety, they might also reduce individuals' motivation to engage in pro-environmental behavior. Conversely, interventions which focus on monitoring skills might lead to increased negative affect, but also increase motivation to address environmental issues. This suggests that an effective mindfulness-based intervention requires the incorporation of both aspects of mindfulness, which enables individuals to perceive the urgency of climate change, but also supports them in regulating excess negative affect.

Our findings contribute further evidence that ecological emotions (in this case, climate anxiety and anticipatory solastalgia) can predict greater engagement with climate solutions (e.g., Hogg et al., 2024a). Although the majority of our participants reported very low levels of climate anxiety and thus these findings must be interpreted with caution, our results did not support an eco-paralysis hypothesis, which would predict that greater levels of eco-distress are associated with lower action. Indeed, none of the facets of climate change or anticipatory solastalgia related negatively to pro-environmental behavior. However, some facets were
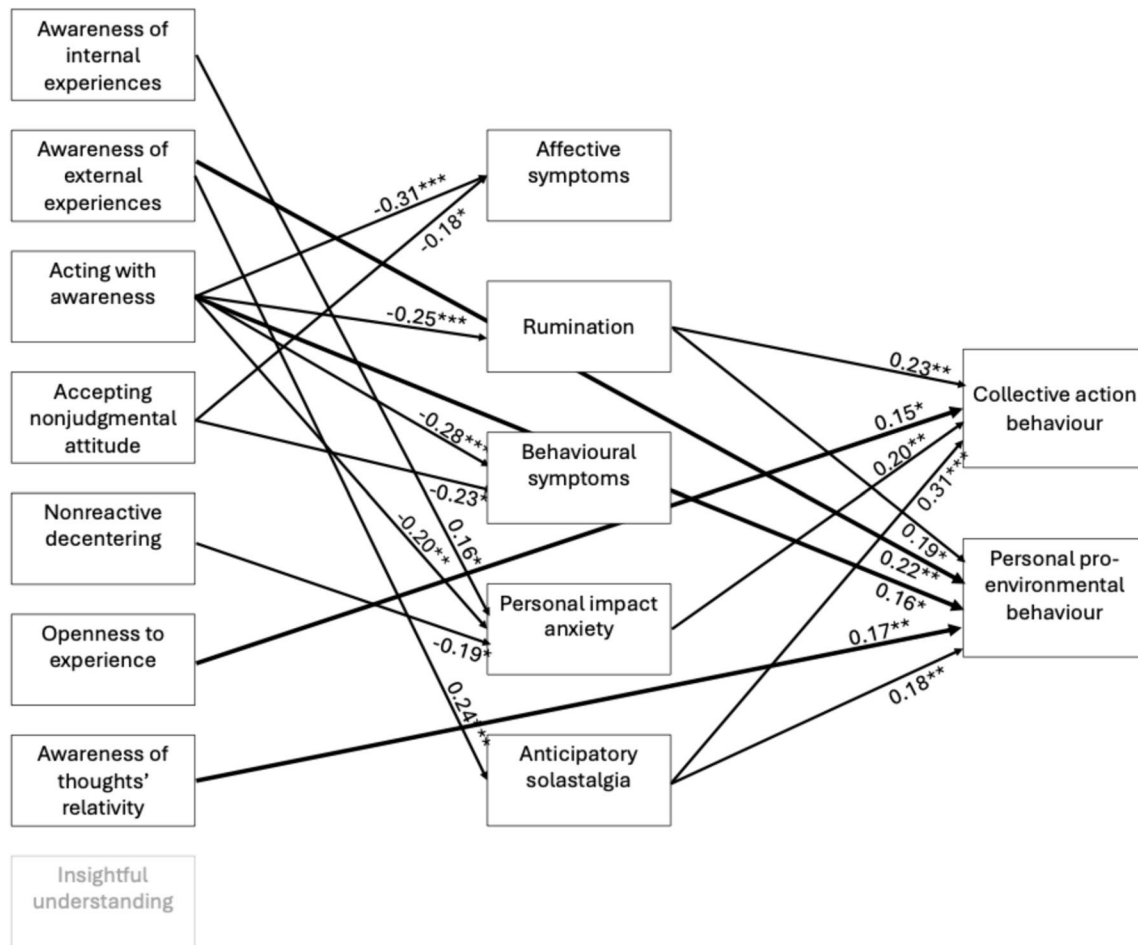
Fig. 1 Path model showing associations between facets of mindfulness, climate anxiety and anticipatory solastalgia, and pro-environmental behavior. *Note*. The "insightful understanding" facet of mindfulness did not robustly predict any variables. Bolder arrows show direct effects from mindfulness facets to pro-environmental behaviors

not significantly related, highlighting the specificity in the domains of affective responses to climate change that are most relevant to behavior. The unique associations we found between dimensions of climate anxiety and pro-environmental behavior mirrored past research on eco-anxiety (Hogg et al., 2024a), identifying rumination and personal impact anxiety as most relevant to climate action, and no significant unique effects of affective and behavioral symptoms on pro-environmental action.

Rumination involves repetitive thinking about the consequences of climate change, which may help keep the issue top of mind and thus increase the likelihood that climate concerns direct pro-environmental behavior. Meanwhile, personal impact anxiety focuses on feelings of anxiety about one's own role in contributing to climate change and its solutions. Personal responsibility is thus highly salient for those reporting increased personal impact anxiety. Therefore, this facet may function in a similar way to guilt (Sampaio et al., 2023), a self-conscious emotion that can

drive pro-environmental behavior (Mallett, 2012). Interestingly, personal impact anxiety was related only to increased engagement in collective action behaviors, and not to making changes in one's personal life to reduce their impact on the environment, suggesting these concerns are more relevant to choosing to engage in impactful behavior only alongside the efforts of others.

Those experiencing greater symptomatic aspects of climate anxiety were no more likely to contribute to environmental solutions. Instead, affective and behavioral symptoms tend to be stronger correlates of negative well-being outcomes and null correlates of pro-environmental behavior (Hogg et al., 2024a). Taken together, our findings could implicate accepting nonjudgmental attitude as the most promising mindfulness facet for addressing climate anxiety; this facet was associated only with a decline in affective and behavioral symptoms. A key caveat is that these symptoms may feed into experiences of the other climate anxiety dimensions that *do* predict environmental action, thus

potentially introducing undesirable flow-on effects (Hogg et al., 2024a). Finally, anticipatory solastalgia was associated with higher engagement in both individual and collective action. This experience reflects distress regarding expected environmental losses, and as such may motivate behavioral efforts to avert such losses.

Limitations and Future Research

One potential limitation of our research is our measurement of mindfulness. While the CHIME represents a comprehensive and holistic measurement of mindfulness, it would be important to probe the relationship with other operationalizations, especially as one of the facets (namely, openness to experience) showed lower reliability (for a previous study that found similarly low reliability in a comparable population, see Karl et al., 2024). A second limitation is that our sample showed overall low climate anxiety, which highlights the necessity to replicate the current study in a sample which reports greater climate anxiety. Additionally, while our study provides a deeper insight into the relationship of mindfulness, climate anxiety, and pro-environmental behavior using a comprehensive measure of mindfulness, our findings are based on cross-sectional data, limiting causal claims. In our analysis, we based our meditation model on a conceptual pathway in which mindfulness underpins emotional experiences (for an alternative perspective on this pathway, see Karl & Fischer, 2022). Similarly, we based our assumption that these experiences motivate pro-environmental behavior on previous research (e.g., Hogg et al., 2024a; Pavani et al., 2023). Nevertheless, longitudinal data are needed to provide a deeper understanding of the causal pathways. Experimental research is needed to test our claims regarding the likely effects of mindfulness interventions on eco-anxiety, anticipatory solastalgia, and pro-environmental behavior. Based on our findings, future research could fruitfully examine the effects (and *side* effects) of interventions based on fostering an accepting nonjudgmental attitude, as well as interventions that combine mindfulness skills. Similarly, the strength of our observed effects might be dependent on the local ecological conditions of individuals. For example, for individuals who reside in communities that face consistent perceivable threats stemming from climate change, such as desertification or coastal loss, some facets might show different effects, especially acting with awareness. Finally, our current study links in with ongoing debates about the interaction between mindfulness, negative emotions such as anger and anxiety (Anālayo, 2018, 2020), and ethical behavior (Schindler et al., 2019; Tan, 2021). While our study has largely focused on self-directed emotions, others have raised the point that mindfulness and negative emotions such as anger are not incompatible when experienced on behalf of others (Yeng, 2020) and might even increase the likelihood of retribution

if others have been harmed (Kay et al., 2023). While our study as well as the study by Jansen et al. (2024) provide insight into the role of self-directed emotions, mindfulness, and climate action, more research is needed to disentangle the differential effects of self and other focused negative emotions, mindfulness, and climate action.

Overall, our study highlights an important and often neglected dynamic in the relationship between mindfulness and pro-environmental behavior: the potential for mindfulness to reduce individuals' pro-environmental behavior by reducing the negative affective motivation to act. Together with studies such as Jansen et al. (2024), our study indicates that mindfulness interventions in the environmental space must carefully balance individuals' affective well-being and capacity to act on planetary well-being.

Declarations

Ethics Approval The Australian National University Human Research Ethics Committee approved the ethical aspects of the study (protocol 2020/429).

Informed Consent Participants read a detailed onscreen participant information sheet and were instructed that continuing on to the survey indicated their consent to participate in the study, thus providing passive informed consent.

Conflict of Interest The authors declare no competing interests.

Use of Artificial Intelligence No artificial intelligence was used in conducting or writing up this research.

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