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When eco-anger (but not eco-anxiety nor eco-sadness) makes you change! A temporal network approach to the emotional experience of climate change

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ABSTRACT

Research on the emotional experience of climate change has become a hot topic. Yet uncertainties remain regarding the interplay between climate change-related emotions (i.e., eco-anxiety, eco-anger, eco-sadness), general emotions (i.e., regardless of climate change), and pro-environmental behaviors. Most previous research has focused on cross-sectional studies, and eco-emotions in everyday life have seldom been considered. In this preregistered study, 102 participants from the general population rated their eco-emotions (i.e., eco-anxiety, eco-anger, eco-sadness), general emotions (i.e., anxiety, anger, sadness), and pro-environmental intentions and behaviors daily over a 60-day period. Using a multilevel vector autoregressive approach, we computed three network models representing temporal (i.e., from one time-point to the next), contemporaneous (i.e., during the same time-frame), and between-subject (i.e., similar to cross-sectional approach) associations between variables. Results show that eco-anger was the only predictor of pro-environmental intentions and behaviors over time. At the contemporaneous level, the momentary experience of each eco-emotion was associated with the momentary emotional experience of the corresponding general emotion, indicating the distinctiveness of each eco-emotion and the correspondence between its experience and that of its general, non-climate-related emotion. Overall, our findings 1) emphasize the driving role of eco-anger in prompting pro-environmental behaviors over time, 2) suggest a functional and experiential distinction between eco-emotions, and 3) provide data-driven clues for the field's larger quest to establish the scientific foundations of eco-emotions.

Climate change poses a significant threat to the habitats, livelihoods, and health of the many species and people living on Earth (Intergovernmental Panel on Climate Change, 2022). And, as people become increasingly aware of the current and future hazards associated with climate change, alarming rates of anxiety feelings about climate change have been reported worldwide, highlighting it as a potential threat to mental health.

For instance, in a study of 10,000 adolescents and young adults from 10 different countries, 59 % of the participants reported being "very or extremely" concerned about climate change (Hickman et al., 2021). In addition, more than 45 % revealed that climate change concerns were debilitating their daily lives (e.g., had a negative impact on their ability to work or concentrate in school), primarily due to their perception that their future is doomed and that governments are failing young people (Hickman et al., 2021).

Similar alarming rates of high anxiety regarding climate change have

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been reported among adults worldwide (e.g., Clayton & Karazsia, 2020; Gibson et al., 2020; Heeren et al., 2022). For example, in two general population samples from the U.S., about a quarter of the respondents reported levels of anxiety about climate change that resulted in functional impairments in their daily lives (Clayton and Karazsia, 2020). Likewise, in a recent international study in European and African countries (Heeren et al., 2022), one in five participants reported that anxiety vis-à-vis climate change significantly impaired their ability to function in daily life (e.g., their ability to socialize, focus on family, and work effectively). This phenomenon is known as *eco-anxiety* (also known as climate anxiety), and it refers to the experience of anxiety and worry about the potential magnitude of climate change impacts and the uncertainty of their specific nature, timing, and exact location, even among people who have not personally been exposed to the direct impacts (Clayton, 2020; Clayton & Karazsia, 2020).[5] And preliminary evidence has revealed that eco-anxiety can yield detrimental consequences on mental health (for systematic reviews, see Boluda-Verdú et al., 2022; Charlson et al., 2021).

However, much remains to be learned about eco-anxiety (Heeren & Asmundson, 2023). Amidst the many challenges associated with *eco-anxiety*, a key question is whether it can be viewed, by analogy with general anxiety (i.e., regardless of climate change), as an adaptive response to a real threat that, here, could promote *pro-environmental behaviors* and, in turn, help lessen our ecological footprint (Heeren et al., 2023). Indeed, for decades, basic research has viewed anxiety as a potentially adaptive response vis-a-vis future-oriented uncertainty-related situations, notably in terms of adaptive anticipations of possible threats that are not immediately present as well as readiness for dealing with such threats should they occur (e.g., American Psychological Association, 2015; Heeren, 2020; Öhman, 2008). With respect to eco-anxiety, some studies have accordingly shown moderate to strong associations between eco-anxiety and pro-environmental behaviors (e.g., Heeren et al., 2022; Sangervo et al., 2022; Verplanken et al., 2020), particularly when eco-anxiety is not too severe or associated with debilitating functional impairments (Heeren et al., 2022). Yet, despite their merits, most of these studies relied upon cross-sectional data, thus precluding any strong inference regarding the temporal dynamics between this association (Heeren & Asmundson, 2023).

In addition to eco-anxiety, there is evidence of other emotions that people may feel in the face of climate change, a phenomenon known as eco-emotions (for reviews, see Cianconi et al., 2023; Pihkala, 2022; Zaremba et al., 2022). However, although the construct of eco-emotions has gained traction, it has seldom been empirically studied and many key questions remain unanswered. First, some scholars have suggested that the experience of eco-anxiety might actually encompass a larger gamut of emotions than merely anxiety vis-à-vis climate change and the ecological crisis, with a few scholars even suggesting that eco-anxiety may include despair, anger, and sadness (e.g., Dodds, 2021; Kurth, & Pihkala, 2022; for a review, see Coffey et al., 2021). As such, questions arise whether one can experience eco-anxiety without contemporaneously (i.e., at the same time-point) experiencing other emotions vis-à-vis climate change and the ecological crisis.

Second, the plethora of new neologisms—i.e., newly coined words—developed to capture these emotional responses to climate change (e.g., solastalgia; Albrecht et al., 2007) has prompted a dismissive appraisal of the prospect that eco-emotions are a viable psychological construct, notably because the theoretical foundations behind most of the conceptual and empirical works on eco-emotions are not always directly entrenched in the psychological sciences of emotion, nor in the broader domain of affective (neuro)sciences. As a result, this lack of theoretical basis has cast doubt on the relevance and distinction (and potential overlap) between these eco-emotions. The authoritative Intergovernmental Panel on Climate Change (2022) has even expressed, in its most recent report, serious concerns about the lack of serious empirical research regarding this emerging field (Cissé et al., 2022).

Aside from the many theoretical speculations about eco-emotions, a few empirical studies have been published (Clayton & Karazsia, 2020; Doherty & Clayton, 2011), however, and point to three key climate change-related emotions, namely: *Eco-anger* (or feelings of anger about climate change); *Eco-anxiety* (as defined above); and *Eco-sadness* (or feelings of sadness about climate change). Interestingly, in a recent large study that aimed to inductively explore the emotional landscape associated with the perception of climate change, these three eco-emotions were the most frequently reported, as well as the most frequently co-occurring emotional experiences related to climate change (Marczak et al., 2023). Moreover, Stanley et al. (2021) recently found that these three eco-emotions were all positively associated with collective pro-environmental behaviors, such as taking part in a protest. But, when controlling for all other eco-emotions (that is, when examining the unique contribution of each variable in the model), only eco-anger remained significantly associated with both personal (i.e., at the individual level) and collective pro-environmental behaviors, suggesting that eco-anger might be the only emotional response that can really prompt ecological-friendly behaviors and, therefore, be considered as adaptive in the fight against climate change.

However, much is still unknown about the distinction between eco-emotions and their general, non-climate-related emotional counterparts. A first clue arises from the literature on the associations between eco-emotions and other negative general emotions such as fear, sadness/depression, or anger. But despite numerous studies showing small-to-moderate associations between eco-anxiety with either depression or anxiety (e.g., Clayton & Karazsia, 2020; Mouguiama-Daouda et al., 2022; Wullenkord et al., 2021), only Stanley et al. (2021) examined the relationships between the three distinct eco-emotions (i.e., eco-anxiety, eco-sadness, and eco-anger) with depression, anxiety, and stress. They found that higher levels of eco-anxiety and eco-sadness were associated with higher symptoms of depression, anxiety, and stress, but eco-anger was the only eco-emotion that was not negatively associated with general emotions. This observation was interpreted by the author as eco-anger being potentially protective and a uniquely adaptive emotional response to the climate crisis (Stanley et al., 2021). Yet this study was based solely on cross-sectional data. Moreover, given that prior research focused on the mental health impact of eco-emotions, this research has mostly relied upon measures of depression or anxiety symptoms. But, none of these studies examined whether the momentary experience of each of the three eco-emotions (i.e., eco-anger, eco-anxiety, and eco-sadness) actually relate to the momentary experience of their non-climate-related specific emotional counterpart (i.e., anger, anxiety, sadness).

Yet, one might ask whether experiencing eco-anger would also activate the feeling of anger? Or can one feel eco-anxiety without also simultaneously feeling anxiety? Although this point may seem trivial, it is crucial for the scientific foundation of eco-emotions to ensure that the momentary emotional experience of each eco-emotion shares the same momentary subjective experience of the corresponding general emotion. Should the momentary experience of each eco-emotion not be related to the momentary experience of the corresponding general emotion, this

[5] Although the notion of climate anxiety (and eco-anxiety) has gained traction, there is a striking lack of consensus among authors regarding its very definition. In a recent scoping review, Coffey et al. (2021) identified more than 10 operationalizations in the existing literature. As argued elsewhere (e.g., Heeren & Asmundson, 2023), in addition to stressing the lack of integrative theoretical formulations regarding climate anxiety, such a lack of consensus regarding its hallmark features severely hinders scientific progress. On the other hand, most recent empirical research has aligned with Clayton (2020) 's operationalization whereby climate anxiety refers to the experience of anxious feelings and worries associated with the perception of the potential scope of the anticipated impacts of climate change and the uncertainty over their nature, timing, and location, even among people who have not personally experienced any direct effect. Here, in line with recent empirical development, we followed Clayton (2020).

would require stopping the attachment of terms such as anxiety, anger, or sadness to the prefix "eco-", and instead urgently require clarifying the very emotional nature of these so-called eco-emotions. However, should each eco-emotion shares the momentary experience of its corresponding emotion, it would empirically allow the relevance of distinguishing each eco-emotion, and help ensure that future research in this emerging field can be grounded on decades of emotion research.

Finally, since this entire area of research is based almost exclusively on cross-sectional data, it focuses only on between-subject differences. This is unfortunate, given that within-person changes reflect how a person's emotional experience is inherently dynamic and constantly changing (Kuppens & Verduyn, 2017). Moreover, between-subject differences from cross-sectional data thwart any inference one can make regarding the momentary (i.e., during a specific time-frame) or temporal (from one time-point to the next) dependencies between variables. Therefore, to clarify whether a person's emotional experience of climate change can elicit an adaptive response or whether the momentary experience of eco-emotions relates to the momentary experience of their corresponding general emotion, one must also consider the covariance between these variables at the within-subject level (Heeren & Asmundson, 2023). This point is crucial for theoretical and interventionist inferences, as between-subject inferences cannot be generalized to within-subject ones (e.g., Fisher et al., 2018).

Thus, in the current study, we assessed the dynamic within-subject interplay between eco-emotions (eco-anger, eco-sadness, eco-anxiety), possible associations with their non-climate-related emotional counterparts (i.e., anger, sadness, anxiety), and their possible relationships with adaptive responses (i.e., intentions to behave in an environmentally friendly manner, as well as actual environmentally-friendly behaviors). Because we assumed that, in a temporal framework, emotions might trigger intentions before they affect behavior, we decided to assess intentions as well, rather than behaviors only, as it was the case in previous studies. To best capture the ever-changing nature of these processes, we instructed participants to report their experiences once per day over a two-month period (i.e., 60 days). To characterize the dynamic associations between variables, we used a multilevel vector autoregressive network model, which is particularly useful for visualizing multivariate temporal relationships (for a scoping review, see Blanchard et al., 2023). Specifically, we estimated three types of networks of these intensively surveyed variables (Epskamp, Waldorp et al., 2018): 1) *a temporal network*, a within-subject model to examine how variables are related from one time-point to the next; 2) *a contemporaneous network*, a within-subject model to examine how variables are related within the same time-frame (i.e., momentary associations between variables) and 3) *a between-subjects network* model to observe the mean-level relationships between variables collapsed across time (i.e., similar to a cross-sectional approach). This threefold framework is a typical practice in temporal network analysis to disentangle the dynamic interplay between all variables of interest at once by considering different perspectives (for a review, see Blanchard et al., 2023). Given that this study is the first of its kind and we did not know how participants would experience daily fluctuations in our variables of interest, we did not formulate any specific a priori hypothesis. This study is therefore exploratory, without confirmatory hypotheses about the network structure or the temporal relationships between the variables of interest.

1. Methods

1.1. Transparency and openness

The study design and analysis plan for this study were preregistered on the Open Science Framework (https://osf.io/q2yks). We provide the study materials, R code, and de-identified data at https://osf.io/mrb4w/.

1.2. Participants[6]

We recruited 104 French-speaking Belgian adult participants from the general community via social media, flyers, and local news. Of these, two participants did not complete at least 1/3 of the entire survey (i.e., at least 20 days of surveys; Blanchard et al., 2023), and were not considered for further analysis. Our final sample, therefore, included 102 participants (aged 18–69 years, $M = 31.81$, $SD = 10.91$, 72.5 % female).

Table 1
Sample characteristics.

	Participants (N = 102)
Sociodemographic characteristics	
Gender, n (% female)	*74 (72.5)*
Age, mean (SD, range)	*31.81 (10.91, 18 - 69)*
Civil Status, n (%)	59 (57.8)
Single	19 (18.6)
Married	22 (21.6)
Couple of fact	2 (2.0)
Divorced	
Educational level, mean of years studied from primary (SD)	*17.04 (2.44)*
Occupation, n (%)	*48 (47.1)*
Full-time worker	*11 (10.8)*
Part-time worker	*2 (2.0)*
On sick leave but still employed	*4 (3.9)*
Unemployed	*33 (32.4)*
Student	*3 (2.9)*
Retired	*1 (1.0)*
Receiving/pending on disability pension	
Net income, n (%)	23 (22.5)
From 1 to 1.500 €/year	23 (22.5)
From 1.500 to 2.500 €/year	10 (9.8)
From 2.500 to 3.500 €/year	17 (16.7)
From 3.500 to 4.500 €/year	11 (10.8)
From 4.500 to 5.500 €/year	4 (3.9)
More than 5.500 €/year	14 (13.7)
I prefer not to say it	
Baseline measures	
DASS-21, Mean (SD)	8.80 (4.83)
Stress subscale (range 0 - 21)	5.34 (4.60)
Anxiety subscale (range 0 - 21)	7.18 (5.20)
Depression subscale (range 0 - 21)	21.33 (12.33)
Total (range 0 - 63)	
CCAS, Mean (SD)	
Cognitive-Emotional Impairment subscale (range 1 - 5)	1.92 (0.65)
Functional Impairment subscale (range 1 - 5)	2.06 (0.86)
Total (range 1 - 5)	1.97 (0.69)
Environmental Identity Scale (range 0 - 7)	5.76 (0.81)
Climate Change Scepticism (range 1-5), Mean (SD)	1.95 (0.46)

Note. SD = Standard Deviations; DASS-21 = Depression Anxiety and Stress Scale – 21; CCAS = Climate Change Anxiety Scale.

[6] Since there is no possibility to estimate a priori power analyses for temporal networks, our sample size decision was based upon previous research combining ESM and temporal network analysis with similar number of nodes and time-points; e.g., Aalbers et al. (2019); Contreras et al. (2020); Greene et al. (2020); as suggested in Blanchard et al. (2023)). For more information, see our preregistration available at https://osf.io/mrb4w/registrations.

Participants' characteristics are depicted in Table 1. Participants received 50€ for participating in the entire study (and 10€ if they dropped out before completing at least 1/3 of the surveys). Each participant provided written informed consent before completing the survey. The study was approved by the Institutional Review Board of the Psychological Sciences Research Institute of UCLouvain (Reference: Project IPSY 2021–12) and conducted according to the Declaration of Helsinki.

1.3. Baseline measures

Before beginning the daily surveys, participants were asked to provide information about their sociodemographic characteristics (i.e., age, gender, civil status, education, and net income). Then, we assessed depression, anxiety, stress, and climate anxiety using, respectively, the French version of the Depression Anxiety and Stress Scale (DASS-21; Ramasawmy, 2015) and the French version of the Climate Change Anxiety Scale (CCAS; Mouguiama-Daouda et al., 2022). Their scores on all these scales are available in Table 1.

The *Depression Anxiety and Stress Scale – 21* (DASS-21; Lovibond & Lovibond, 1995) is a 21-item self-report instrument assessing depression, anxiety and stress over the previous week. The scale is composed of three subscales with 7 items each, assessing respectively: Depression (e.g., " I couldn't seem to experience any positive feeling at all "), Anxiety (e.g., " I felt scared without any good reason"), and Stress (e.g., " I was intolerant of anything that kept me from getting on with what I was doing"). Participants reported mild to moderate scores for depression and anxiety and mild scores for the stress subscale (see Table 1). Internal reliability for the three subscales was good in our sample, with Cronbach alphas of 0.90 for depression, 0.85 for anxiety, and 0.88 for stress.

The *Climate Change Anxiety Scale* (CCAS; Clayton & Karazsia, 2020) is a 13-item self-report questionnaire that measures climate change anxiety. We relied on the CCAS since it has become the most used instrument to assess climate change anxiety worldwide (e.g., Hickman et al., 2021; Innocenti et al., 2021; Wullenkord et al., 2021). The CCAS includes two subscales[7] with: a) eight items measuring the cognitive and emotional impairments of climate anxiety (e.g., "Thinking about climate change makes it difficult for me to concentrate"); and (b) five items measuring the functional impairments (e.g., "My concerns about climate change interfere with my ability to get work or school assignments done"). In the present study, the internal reliability of CCAS was good, with a Cronbach's alpha of 0.90 for the global scale score (0.82 for the cognitive-emotional impairments subscale and 0.84 for the functional impairment one).

To best characterize our sample, we also assessed their perception of, identification with, and emotional connection to nature using the *Environmental Identity Scale* (EIS; Clayton et al., 2021). It is an 11-item scale (e.g., "Acting responsibly for the planet - with a sustainable lifestyle - is part of my moral values") with a 7-point Likert scale. A total score can be calculated by averaging all items. In this study Cronbach's alpha was good ($\alpha = 0.82$).[8]

1.4. Daily assessment

Participants answered the daily survey at approximately 7 P.M. each evening. They had three hours to respond after receiving the notifications. Thus, they received a total of 60 notifications (one per day for 60 days). The notifications were sent to the participants using m-path software (Mestdagh et al., 2022). The daily diary survey included eight items presented in random order and presented with a response-slider ranging from 0 (not at all) to 100 (absolutely). Five items related to climate change and began with the heading "In relation to climate change, today I've felt...". Items focused specifically on eco-anxiety ("... anxious"), eco-anger ("...angry"), eco-sadness ("...sad"), eco-friendly intentions ("I have felt motivated to behave more environmentally friendly"), and eco-friendly behaviors ("I have actively behaved in an environmentally friendly way"). Three questions related to general emotional experiences, independent of climate change. They began with the heading "In general today I have felt..."- and thus independent of climate change) and specifically assessed anxiety ("... anxious"), anger ("... angry"), and sadness ("…sad"). More details can be found in the Supplementary Materials (Table S1; Section 1).

These items were designed, created, and pretested in line with the ESM literature, in which questions are asked one to several times a day over an extended period of time (Palmier-Claus et al., 2019; Myin-Germeys & Kuppens, 2022). The exact items in French (and their English translations) can be found in Table S1 in the Supplementary Material. We also examined the psychometric properties of these items by ensuring that each item had sufficient within-subject variability and that none of the items were redundant (see Section 1 in the Supplementary Materials). Following Experience Sampling Methodology (ESM) guidelines (e.g., Myin-Germeys & Kuppens, 2022), the order of the items was randomized (at every time-point) to prevent systematic sequence effects from introducing bias to the data.

1.5. Data analysis

We used a multilevel vector autoregressive model (*mlVAR*; Epskamp, Waldorp et al., 2018) for time-series data to account for temporality and within-person dependency of the time-points. From this model, we built three different network models.

First, the *mlVAR* model regresses each variable at time *t* on itself and on all other variables at time *t-1*, thus estimating how each variable predicts all other variables at the next time-point (Epskamp, Waldorp et al., 2018). This would correspond to the *temporal network* model that visualizes the associations between variables from one time-point to the next via arrows, while accounting for all other associations. Second, a *contemporaneous network* model illustrates contemporaneous (i.e., within the same time-point) associations between variables by regressing the residuals of one variable from the mlVAR model on all other residuals from the same time-point. This network displays how variables are simultaneously (i.e., within the same time frame) associated, after controlling for all other contemporaneous and temporal associations. Epskamp, Waldorp et al. (2018) suggest that the contemporaneous network might capture processes that occur faster than the lag interval (e.g., daily in this study). Finally, participant mean responses were used to build a *between-subjects network model* that depicts the associations between variables on average between participants, collapsing across time (and controlling for all other variables). Thus, the *mlVAR* model includes fixed (i.e., group-level) and random (i.e., individually estimated) effects.

Data were analyzed using *R*, via the *mlVAR* (Epskamp et al., 2021) and *qgraph* (Epskamp et al., 2022) packages. For the contemporaneous and between-subject networks, we used the conservative "AND" rule to retain a significant edge, i.e., both coefficients (from node A to node B and vice-versa) had to be significant ($\alpha = 0.05$) for that edge to be kept in the final model. We also assessed the two main assumptions of *mlVAR* models: normality and stationarity (see Section 2 in the Supplementary Materials).

[7] Following recent studies on the CCAS (e.g., Mouguiama-Daouda et al., 2022), we focused only on the two subscales related to climate anxiety (i.e., the first 13 items).

[8] Originally, we had also planned to assess climate change denial using the 6-item scale developed by Brügger et al. (2015), which asks participants to indicate their skepticism about climate change. However, we decided not to use this scale in the present study because the psychometric properties of the French version of the scale were too poor (e.g., Cronbach alpha of 0.62).

2. Results

2.1. Descriptive statistics

The mean number of surveys answered per person was 55.12 observations (out of 60), with a compliance rate of 92 %. Descriptive information regarding demographics and baseline questionnaires are available in Table 1, while descriptive information regarding the ESM measures (e.g., intraindividual means, SDs, intraclass correlations) can be seen in the Supplementary Materials (Table S2).

2.2. Contemporaneous network

The contemporaneous network model (Fig. 1a) shows the associations between variables within the same time-frame (i.e., same day), after controlling for all other temporal and contemporaneous relationships. A few observations stand out. First, the three non-climate-related emotions are strongly related, suggesting that the experience of one emotion is associated with also experiencing the two other emotions during the same day. In the same vein, the three eco-emotions are strongly related: thus, experiencing one eco-emotion is associated with also experiencing the other two eco-emotions that same day. Moreover, each eco-emotion is positively associated to the *intention* to behave in an environmentally friendly way, but not to the behavior per se. Finally, the most striking observation was that each eco-emotion appears uniquely associated with its corresponding, non-climate-related, emotion. In other words, the momentary experience of eco-anger is uniquely associated with the emotional experience of anger (and has no association with anxiety nor with sadness), the momentary experience of eco-anxiety is uniquely associated with the emotional experience of anxiety (and has no association with anger nor with sadness), and the momentary experience of eco-sadness is uniquely associated with the emotional experience of sadness (and has no association with anxiety nor with anger).

2.3. Temporal network model

The temporal network model (see Fig. 1b) illustrates how each variable predicts other variables and itself (self-loops) at the next time-point (e.g., the next day). First, all variables have positive autoregressive (i.e., self-predictive) loops, suggesting a potential temporal stability of eco-anger, eco-sadness and eco-anxiety. In other words, if someone experienced any of the eco-emotions, they were likely to keep experiencing it the next day. Second, unlike the contemporaneous network, the three eco-emotions are no longer connected to their corresponding, non-climate-related, emotion, with those latter now emerging as functionally independent from the climate-related variables when considering their temporal dynamics. In other words, they do not trigger one another over time. Third, each eco-emotion positively predicts the two other eco-emotions: eco-anxiety positively predicts eco-anger and eco-sadness over time, eco-anger positively predicts eco-anxiety and eco-sadness over time, and eco-sadness positively predicts eco-anxiety and eco-anger. Finally, eco-anger is the only eco-emotion that positively triggers (from one day to the next) not only the intention to engage in pro-environmental behaviors but also the execution of pro-environmental behaviors per se. Unexpectedly, pro-environmental behaviors, but not intention to behave in an eco-friendly manner, also positively predicts eco-anger over time.

2.4. Between-subject network

The between-subjects network (Fig. 1c) shows the correlations between the intra-individual mean levels of the variables over the entire testing period (i.e., 60 days). First, this model shows that participants with higher average of pro-environmental intentions also have higher average of pro-environmental behaviors. Second, participants with higher tendency (in average) of experiencing a given eco-emotion also have a higher tendency of experiencing the corresponding non-climate-related emotion.

3. Discussion

Research on the emotional responses to climate change has gained traction over the last few years. Yet uncertainties remain regarding the interplay between climate change-related emotions (i.e., eco-anxiety, eco-anger, eco-sadness), their corresponding non-climate-related emotions, and pro-environmental intentions and behaviors. In addition, most research has remained at the cross-sectional level, which precludes any inference about the temporal dependencies between these variables (Maurage et al., 2013). In this preregistered study, we therefore

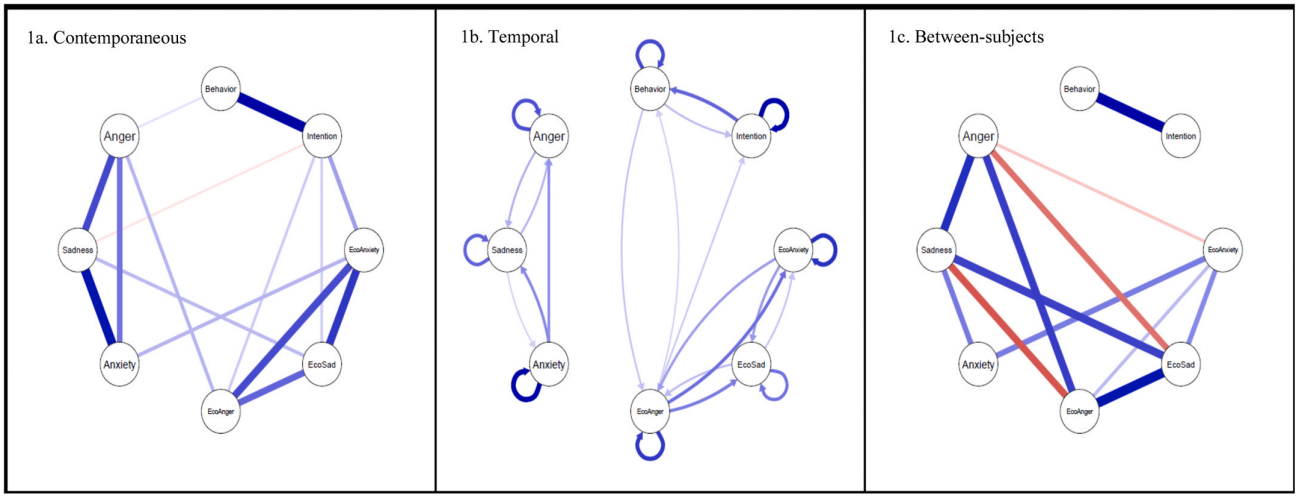

Fig. 1. ***Results from multilevel vector autoregressive (mlvar): contemporary, temporal and between-subject network models.*** *Note.* Blue lines depict positive relations while red lines depict negative relation between variables. *1.a. Contemporaneous:* Edges depict associations between the variables within the same time-frame after controlling for temporal associations. 1.b. *Temporal:* Edges depict prediction between nodes from one measurement point to the next time-point, after controlling for all other variables at the previous time point. *1.c. Between-subject:* Edges depict correlations between intra-individual mean levels after considering the remaining variables in the network. Behavior = Pro-environmental behaviors; Intentions = Pro-environmental Intentions.

examined the temporal associations between these variables (assessed daily), through the lens of temporal network analysis.

The most striking result was the observation of eco-anger as the only eco-emotion temporally driving both pro-environmental intentions and behaviors. In other words, from our findings, if people experience eco-anger on a given day, they are more likely to behave in an environmentally-friendly fashion the subsequent day. And that observation should not come as a surprise. It echoes previous cross-sectional studies reporting that only eco-anger remained significantly associated with pro-environmental behavior when controlling for other eco-emotions (Stanley et al., 2021). Here, we replicate this observation and extend it to the temporal realm. Since one key question of today's research agendas on eco-emotions is whether climate-related emotions can play an adaptive role in the adaptation to climate change, our results echo a small but growing empirical literature suggesting that eco-anger might play a unique and highly determinant role in prompting adaptive behaviors vis-à-vis climate change.

But could the experience of anger about climate change really be considered an adaptive response to a climate–related threat? In prominent psychological literature, emotions are often described as a space consisting of two independent dimensions: (un)pleasure and (de)activation (e.g., Barrett & Russell, 1999). While the first dimension refers to the hedonic tone of the emotional experience (i.e., a pleasant or unpleasant emotion), the degree of activation refers to a sense of mobilization or the degree to which an emotion promotes or inhibits action (Barrett et al., 2016; Barrett & Russell, 1999). From this perspective, not only fear and anxiety but also anger are considered "activating" because they predict behavioral attempts to reduce the threat, whereas other negatively-valenced emotions such as sadness are considered less activating and may lead to disengagement from a perceived threat. As such, our observation of eco-anger as the sole predictor of pro-environmental behavior is not surprising and aligns with decades of research on the potentially adaptive nature of anger, especially in a context when negative feelings should be expressed to elicit people's motivation to find solutions to problems (e.g., Celik et al., 2016; Ransan-Cooper et al., 2018). Here, we extended this finding to the context of climate change. At the societal level, this is consistent with decades of research in political science showing the successful impact of collective and nonviolent expressions of anger (e.g., via nonviolent boycott, protest, civil disobedience) in creating broad-based social changes across history, cultures, and political regimes (for a review, see Chenoweth & Stephan, 2012).

On the other hand, the elicitation of anger regarding climate change to prompt pro-environmental behaviors might not be the ultimate panacea. Indeed, the experience of excessive anger can cause problems, such as increased risks for emotional disorders (for a discussion, see Cassiello-Robbins & Barlow, 2016). As such, one might even wonder whether the daily experience of excessive eco-anger might not have harmful consequences. Therefore, a crucial next step will be to assess the long-term adaptive and maladaptive impacts of eco-anger. Moreover, in the temporal network model, our unexpected observation that pro-environmental behaviors also predict eco-anger raises concerns about the potentially harmful consequences of excessive engagement in pro-environmental behavior over time. This is consistent with a small but growing empirical literature that points to the potential side effects of over-commitment in causes wherein the expected changes do not readily occur (e.g., Dwyer et al., 2019). Although recent research suggests that promoting pro-environmental behaviors may be a potential strategy to help people combat feelings of hopelessness and promote community attachment and social support (Schwartz et al., 2022), practitioners should therefore carefully consider whether engaging in pro-environmental behaviors has restorative or harmful consequences for their clients before prescribing it (for a discussion, see Heeren & Asmundson, 2023).

Another striking finding in our study is the observation, in the contemporaneous network, that the momentary experience of a given eco-emotion is associated with the momentary activation of its corresponding non-climate-related emotion, and not with the activation of other emotions. In other words, one likely cannot experience a given eco-emotion without experiencing the corresponding non-climate-related emotion. For instance, the emotional experience of eco-anger in one specific time-frame is associated with the emotional experience of anger (and not sadness or anxiety) during the same time-frame. And the same goes for the experience of eco-anger and eco-sadness, respectively. This observation has strong implications. First, this finding is at odds with the emerging views of scholars who question the relevance of examining eco-anxiety through the lens of anxiety research and who instead suggest that the emotional experience of eco-anxiety encompasses a larger gamut of emotional experiences than anxiety (e.g., Dodds, 2021; Kurth, & Pihkala, 2022). In contrast, our results suggest that the momentary experience of each of the three key eco-emotions assessed in this study is specifically associated with momentary experience of their corresponding, non-climate-related, emotion. In this way, our results thus clearly emphasize the importance of functionally and experientially distinguishing between eco-emotions. A critical next step would thus be to investigate whether each eco-emotion shares the same behavioral, cognitive, and physiological characteristics as its corresponding, non-climate-related, emotion. Given that the Intergovernmental Panel on Climate Change (Cissé et al., 2022) has expressed serious concerns about the lack of conceptual and empirical foundations regarding eco-emotions, anchoring future research on eco-emotions in an already well-established scientific approach to emotions could help invigorate this emerging field.

This study has several limitations that need to be further explored in future research. First, our sample was unselected and included only French speakers from Belgium. Given that the current and long-term consequences of climate change are more severe for people in Asian and African countries than in European countries, particularly in terms of human health and safety and food and water security (World Meteorological Organization, 2020), a key step would be to investigate whether the present results can be generalized to more geographically and culturally diverse samples. Likewise, since the beneficial impact of eco-anxiety on pro-environmental behaviors may depend upon the level of eco-anxiety (Heeren et al., 2022), one might wonder whether individuals with low versus high eco-anxiety would exhibit different patterns of daily associations between eco-emotions and pro-environmental behaviors. Second, we did not distinguish between individual (e.g., recycling) and collective (e.g., political voting, environmental activism) pro-environmental behaviors. This is unfortunate, as previous research has linked eco-emotions to individual and collective pro-environmental actions (e.g., Stanley et al., 2021). On the other hand, it may be challenging to assess the variations in collective actions on a daily basis. Similarly, future iterations may benefit from more objective measures of pro-environmental behavior (e.g., Lange, 2022). Finally, consistent with previous research, we focused on negatively-valenced emotions related to climate change. However, one might also consider the role that positively-valenced ones—with and without regard to climate change—may play in the daily emotional experience of climate change (e.g., Harth, 2021). Recent research, for example, has highlighted the potentially protecting role of hope in the mental health consequences of climate change (e.g., Ojala, 2012). A critical step in future iterations would thus be to examine whether hope can temporally drive pro-environmental behaviors, and buffer the impact of negatively-valenced emotions.

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Ethical statement

The research described in this article was approved by the Institutional Review Board of the Psychological Sciences Research Institute of UCLouvain (Reference: Project IPSY 2021–12), and conducted according to the Declaration of Helsinki.

CRediT authorship contribution statement

AC: Conceptualization, Methodology, Software, Investigation, Project Administration, Data Curation, Formal Analysis, Writing – Original Draft; **MAB:** Validation, Methodology, Writing – Review & Editing. **CM:** Project Administration, Validation, Writing – Review & Editing. **AH:** Conceptualization, Methodology, Validation, Supervision, Project Administration, Funding Acquisition, Writing – Original Draft, Writing – Review & Editing.

Declaration of Competing Interest

Dr. Heeren is an Associate Editor of the Journal of Anxiety Disorders. He receives financial support through payments for his editorial work on the journal mentioned above and royalties from various book publishers. The authors have no other known conflict of interest to disclose.

Data availability

The de-identified data and R code of this study have been made publicly available via the Open Science Framework at https://osf.io/mrb4w/. The study design and analysis plan for this study was preregistered on the Open Science Framework at https://osf.io/sbwn9.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.janxdis.2023.102822.

References

Aalbers, G., McNally, R. J., Heeren, A., De Wit, S., & Fried, E. I. (2019). Social media and depression symptoms: A network perspective. *Journal of Experimental Psychology: General, 148*(8), 1454.

Albrecht, G., Sartore, G. M., Connor, L., Higginbotham, N., Freeman, S., Kelly, B., Stain, H., Tonna, A., & Pollard, G. (2007). Solastalgia: The distress caused by environmental change. *Australasian Psychiatry, 15*(1). https://doi.org/10.1080/10398560701701288

American Psychological Association. (2015). Fear. *APA dictionary of psychology* (2nd ed.,). Washington, DC: American Psychological Association.

Barrett, L. F., & Russell, J. A. (1999). The structure of current affect: Controversies and emerging consensus. *Current Directions in Psychological Science, 8*(1), 10–14. https://doi.org/10.1111/1467-8721.00003

Barrett, L. F., Lewis, M., & Haviland-Jones, J. M. (Eds.). (2016). *Handbook of emotions*. Guilford Publications.

Blanchard, M. A., Contreras, A., Kalkan, R. B., & Heeren, A. (2023). Auditing the research practices and statistical analyses of the group-level temporal network approach to psychological constructs: A systematic scoping review. *Behavior Research Methods, 55*(2), 767–787. https://doi.org/10.3758/s13428-022-01839-y

Boluda-Verdú, I., Senent-Valero, M., Casas-Escolano, M., Matijasevich, A., & Pastor-Valero, M. (2022). Fear for the future: Eco-anxiety and health implications, a systematic review. *Journal of Environmental Psychology, 84*. https://doi.org/10.1016/j.jenvp.2022.101904

Brügger, A., Morton, T. A., & Dessai, S. (2015). Hand in Hand: Public endorsement of climate change mitigation and adaptation. *PLOS ONE, 10*(4), Article e0124843. https://doi.org/10.1371/JOURNAL.PONE.0124843

Cassiello-Robbins, C., & Barlow, D. H. (2016). Anger: The unrecognized emotion in emotional disorders. *Clinical Psychology: Science and Practice, 23*(1), 66–85. https://doi.org/10.1111/cpsp.12139

Celik, P., Storme, M., & Myszkowski, N. (2016). Anger and sadness as adaptive emotion expression strategies in response to negative competence and warmth evaluations. *The British Journal of Social Psychology, 55*(4), 792–810. https://doi.org/10.1111/bjso.12149

Charlson, F., Ali, S., Benmarhnia, T., Pearl, M., Massazza, A., Augustinavicius, J., & Scott, J. G. (2021). Climate Change and Mental Health: A Scoping Review. *International Journal of Environmental Research and Public Health, 18*, 4486.

Chenoweth, E., & Stephan, M. J. (2012). *Why civil resistance works: The strategic logic of nonviolent conflict.* Columbia University Press,.

Cianconi, P., Hanife, B., Grillo, F., Betro', S., Lesmana, C. B. J., & Janiri, L. (2023). Eco-emotions and psychoterratic syndromes: Reshaping mental health assessment under climate change. *The Yale Journal of Biology and Medicine, 96*(2), 211–226. https://doi.org/10.59249/EARX2427

Cissé, G., McLeman, R., Adams, H., Aldunce, P., Bowen, K., Campbell-Lendrum, D., Clayton, S., Ebi, K. L., Hess, J., Huang, C., Liu, Q., McGregor, G., Semenza, J., & Tirado, M. C. (2022). Health, Wellbeing, and the Changing Structure of Communities. In H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1041–1170). Cambridge, UK and New York, NY, USA: Cambridge University Press. ⟨10.1017/9781009325844.009⟩.

Clayton, S. (2020). Climate anxiety: Psychological responses to climate change. *Journal of Anxiety Disorders, 74*, Article 102263. https://doi.org/10.1016/j.janxdis.2020.102263

Clayton, S., & Karazsia, B. T. (2020). Development and validation of a measure of climate change anxiety. *Journal of Environmental Psychology, 69*. https://doi.org/10.1016/j.jenvp.2020.101434

Clayton, S., Czellar, S., Nartova-Bochaver, S., Skibins, J. C., Salazar, G., Tseng, Y. C., Irkhin, B., & Monge-Rodriguez, F. S. (2021). Cross-cultural validation of a revised environmental identity scale. *Sustainability (Switzerland), 13*(4), 1–12. https://doi.org/10.3390/su13042387

Coffey, Y., Bhullar, N., Durkin, J., Islam, M. S., & Usher, K. (2021). Understanding Eco-anxiety: A Systematic Scoping Review of Current Literature and Identified Knowledge Gaps. *The Journal of Climate Change and Health, 3*, Article 100047. https://doi.org/10.1016/j.joclim.2021.100047

Contreras, A., Valiente, C., Heeren, A., & Bentall, R. (2020). A temporal network approach to paranoia: A pilot study. *Frontiers in Psychology, 11*, Article 544565.

Dodds, J. (2021). The psychology of climate anxiety. *BJPsych Bulletin, 45*(4), 222–226. https://doi.org/10.1192/bjb.2021.18

Doherty, T. J., & Clayton, S. (2011). The Psychological Impacts of Global Climate Change. *American Psychologist, 66*(4), 265–276. https://doi.org/10.1037/a0023141

Dwyer, P. C., Chang, Y. P., Hannay, J., & Algoe, S. B. (2019). When does activism benefit well-being? Evidence from a longitudinal study of Clinton voters in the 2016 U.S. Presidential election. *PLoS ONE, 14*(9). https://doi.org/10.1371/journal.pone.0221754

Epskamp, S., Waldorp, L. J., Mõttus, R., & Borsboom, D. (2018). The Gaussian Graphical Model in Cross-Sectional and Time-Series Data. *Multivariate Behavioral Research, 53*(4), 453–480. https://doi.org/10.1080/00273171.2018.1454823

Epskamp, S., Deserno, M.K., Bringmann L.F. & Veenman, M. (2021). Multi-Level Vector Autoregression R package version 0.5. ⟨https://CRAN.R-project.org/package=mlVAR⟩.

Epskamp, S., Costantini, G., Haslbeck J., Isvoranu, A., Cramer, A.O.J., Waldorp, L.J., Schmittmann, V.D. & Borsboom, D. (2022). qgraph: Graph Plotting Methods, Psychometric Data Visualization and Graphical Model Estimation. R package version 1.9. ⟨https://CRAN.R-project.org/package=qgraph⟩.

Fisher, A. J., Medaglia, J. D., & Jeronimus, B. F. (2018). Lack of group-to-individual generalizability is a threat to human subjects research. *Proceedings of the National Academy of Sciences, 115*(27), E6106–E6115.

Gibson, K. E., Barnett, J., Haslam, N., & Kaplan, I. (2020). The mental health impacts of climate change: Findings from a Pacific Island atoll nation. *Journal of Anxiety Disorders, 73*. https://doi.org/10.1016/j.janxdis.2020.102237

Greene, T., Gelkopf, M., Fried, E. I., Robinaugh, D. J., & Lapid Pickman, L. (2020). Dynamic network analysis of negative emotions and DSM-5 posttraumatic stress disorder symptom clusters during conflict. *Journal of Traumatic Stress, 33*(1), 72–83.

Harth, N. S. (2021). Affect, (group-based) emotions, and climate change action. *Current Opinion in Psychology, 42*, 140–144. https://doi.org/10.1016/j.copsyc.2021.07.018

Heeren, A. (2020). On the Distinction Between Fear and Anxiety in a (Post)Pandemic World: A Commentary on Schimmenti et al. (2020). *Clinical Neuropsychiatry, 17*(3), 189–191. https://doi.org/10.36131/cnfioritieditore20200307

Heeren, A., & Asmundson, G. J. G. (2023). Understanding climate anxiety: What decision-makers, health care providers, and the mental health community need to know to promote adaptative coping. *Journal of Anxiety Disorders, 93*, Article 102654. https://doi.org/10.1016/j.janxdis.2022.102654

Heeren, A., Mouguiama-Daouda, C., & Contreras, A. (2022). On climate anxiety and the threat it may pose to daily life functioning and adaptation: a study among European and African French-speaking participants. *Climatic Change, 173*(1-2), Article 15. https://doi.org/10.1007/s10584-022-03402-2

Heeren, A., Mouguiama-Daouda, C., & McNally, R. J. (2023). A network approach to climate change anxiety and its key related features. *Journal of Anxiety Disorders, 93*, Article 102625. https://doi.org/10.1016/j.janxdis.2022.102625

Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R. E., Mayall, E. E., Wray, B., Mellor, C., & van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *The Lancet Planetary Health, 5*(12), e863–e873. https://doi.org/10.1016/S2542-5196(21)00278-3

Innocenti, M., Santarelli, G., Faggi, V., Castellini, G., Manelli, I., Magrini, G., Galassi, F., & Ricca, V. (2021). Psychometric properties of the Italian version of the Climate Change Anxiety Scale. *The Journal of Climate Change and Health, 3*, Article 100080. https://doi.org/10.1016/j.joclim.2021.100080

Intergovernmental Panel on Climate Change. (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York, NY, USA: Cambridge University Press. https://doi.org/10.1017/9781009325844

Kuppens, P., & Verduyn, P. (2017). Emotion dynamics. *In Current Opinion in Psychology* (Vol. 17,, 22–26. https://doi.org/10.1016/j.copsyc.2017.06.004

Kurth, C., & Pihkala, P. (2022). Eco-anxiety: What it is and why it matters. *Frontiers in Psychology, 13*, Article 981814. https://doi.org/10.3389/fpsyg.2022.981814

Lange, F. (2022). Behavioral paradigms for studying pro-environmental behavior: A systematic review. *Behavior Research Methods*. https://doi.org/10.3758/s13428-022-01825-4

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy, 33*(3), 335–343. https://doi.org/10.1016/0005-7967(94)00075-U

Marczak, M., Winkowska, M., Chaton-Østlie, K., Morote Rios, R., & Klöckner, C. A. (2023). "When I say I'm depressed, it's like anger." An exploration of the emotional landscape of climate change concern in Norway and its psychological, social and political implications. *Emotion, Space and Society, 46*. https://doi.org/10.1016/j.emospa.2023.100939

Maurage, P., Heeren, A., & Pesenti, M. (2013). Does chocolate consumption really boost Nobel award chances? The peril of over-interpreting correlations in health studies. *The Journal of Nutrition, 143*(6), 931–933. https://doi.org/10.3945/jn.113.17481

Mestdagh, M., Verdonck, S., Piot, M., Niemeijer, K., Kuppens, P., & Dejonckheere, E. (2022). m-Path: An easy-to-use and flexible platform for ecological momentary assessment and intervention in behavioral research and clinical practice. ⟨https://doi.org/10.31234/OSF.IO/UQDFS⟩.

Mouguiama-Daouda, C., Blanchard, M. A., Coussement, C., & Heeren, A. (2022). On the Measurement of Climate Change Anxiety: French Validation of the Climate Anxiety Scale. *In Psychologica Belgica, 62*(1). https://doi.org/10.5334/pb.1137

Myin-Germeys, I., & Kuppens, P. (2022). *The open handbook of experience sampling methodology: A step-by-step guide to designing, conducting, and analyzing ESM studies (2nd ed..,). Leuven*: Center for Research on Experience Sampling and Ambulatory Methods Leuven. x,.

Öhman, A. (2008). Fear and anxiety: Overlaps and dissociations. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 709–728). The Guilford Press.

Ojala, M. (2012). Hope and climate change: The importance of hope for environmental engagement among young people. *Environmental Education Research, 18*(5), 625–642. https://doi.org/10.1080/13504622.2011.637157

Palmier-Claus, J., Haddock, G., & Varese, F. (2019). Experience sampling in mental health research. *Routledge*. https://doi.org/10.4324/9781315398341.

Pihkala, P. (2022). Toward a Taxonomy of Climate Emotions. *Frontiers in Climate, 3*, Article 738154. https://doi.org/10.3389/fclim.2021.738154

Ramasawmy, S. (2015). Validation of the French Depression Anxiety Stress Scales (DASS-21) and predictors of depression in an adolescent Mauritian population. (Doctoral dissertation, Aix-Marseille). ⟨https://www.theses.fr/2015AIXM3001⟩.

Ransan-Cooper, H., A. Ercan, S., & Duus, S. (2018). When anger meets joy: How emotions mobilise and sustain the anti-coal seam gas movement in regional Australia. *Social Movement Studies, 17*(6), 635–657. https://doi.org/10.1080/14742837.2018.1515624

Sangervo, J., Jylhä, K. M., & Pihkala, P. (2022). Climate anxiety: Conceptual considerations, and connections with climate hope and action. *Global Environmental Change, 76*. https://doi.org/10.1016/j.gloenvcha.2022.102569

Schwartz, S. E. O., Benoit, L., Clayton, S., Parnes, M. F., Swenson, L., & Lowe, S. R. (2022). Climate change anxiety and mental health: Environmental activism as buffer. *Current Psychology*. https://doi.org/10.1007/s12144-022-02735-6

Stanley, S. K., Hogg, T. L., Leviston, Z., & Walker, I. (2021). From anger to action: Differential impacts of eco-anxiety, eco-depression, and eco-anger on climate action and wellbeing. *The Journal of Climate Change and Health, 1*, Article 100003. https://doi.org/10.1016/j.joclim.2021.100003

Verplanken, B., Marks, E., & Dobromir, A. I. (2020). On the nature of eco-anxiety: How constructive or unconstructive is habitual worry about global warming? *Journal of Environmental Psychology, 72*. https://doi.org/10.1016/j.jenvp.2020.101528

World Meteorological Organization (2020). *State of the global climate 2020*. WMO-No. 1264 ⟨https://library.wmo.int/index.php?lvl=notice_display&id=21880#.YWwkRy2FDRY⟩.

Wullenkord, M. C., Tröger, J., Hamann, K. R. S., Loy, L. S., & Reese, G. (2021). Anxiety and climate change: a validation of the Climate Anxiety Scale in a German-speaking quota sample and an investigation of psychological correlates. *Climatic Change, 168*(3–4). https://doi.org/10.1007/s10584-021-03234-6

Zaremba, D., Kulesza, M., Herman, A. M., Marczak, M., Kossowski, B., Budziszewska, M., Michałowski, J. M., Klöckner, C. A., Marchewka, A., & Wierzba, M. (2022). A wise person plants a tree a day before the end of the world: coping with the emotional experience of climate change in Poland. *Current Psychology*. https://doi.org/10.1007/s12144-022-03807-3