



Environmental knowledge is inversely associated with climate change anxiety

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Received: 30 December 2022 / Accepted: 18 March 2023 / Published online: 23 March 2023
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Abstract

This study tests the hypotheses that overall environmental knowledge and climate-specific knowledge are inversely related to climate change anxiety, such that people who know more (less) about the environment in general, and about climate in particular, are less (more) anxious about climate change. Time lagged data were collected from $N=2,066$ individuals in Germany. Results showed that, even after controlling for demographic characteristics, personality characteristics, and environmental attitudes, overall environmental knowledge and climate-specific knowledge were negatively related to climate change anxiety (both $B=-.09$, $p<.001$).

Keywords Anxiety · Climate change · Environment · Knowledge · Pro-environmental behavior

1 Introduction

The British mathematician and philosopher Bertrand Russell (1872–1970) is quoted as saying, “The degree of one’s emotions varies inversely with one’s knowledge of the facts, the less you know the hotter you get.” Consistent with this idea, we report the results of a study that tested the hypotheses that overall environmental knowledge and climate-specific knowledge are negatively related to climate change anxiety. The rationale for investigating these relationships is that climate change anxiety may be reduced through interventions that enhance environmental knowledge. *Environmental knowledge* refers to the body of acquired facts and learned expertise in the environmental domain (including climate; Geiger et al. 2019). *Climate change anxiety* involves people’s self-reported negative emotional responses associated with their awareness of climate change (Clayton 2020). Accordingly, the measure used in this study assesses responses such as worrying and distress, reduced well-being, as well as concentration and sleep difficulties due to people’s thoughts about climate change (Clayton and Karazsia 2020). Compared to more constructive forms of worrying about global warming that result in adaptive responses (e.g., Verplanken et al. 2020), it seems

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desirable to reduce climate change anxiety because it has been shown to have detrimental consequences for people's general health and well-being, including higher levels of depression, anxiety, and distress (Schwartz et al. 2022; Searle and Gow 2010).

Psychological theorizing suggests that a lack of knowledge about a topic leads to greater feelings of uncertainty which, in turn, may result in anxiety associated with the topic, whereas greater available knowledge about a topic is likely to reduce experiences of topic-associated uncertainty and anxiety (Hirsh et al. 2012; Jungermann and Thüring 1993). Indeed, empirical studies conducted on various topics (e.g., aging, interpersonal and intergroup relations, finances, entrepreneurship) suggest that knowledge about a topic is negatively related to uncertainty and anxiety (Nuevo et al. 2009; Stephan et al. 1999; Townsend et al. 2018; Wang et al. 2011). For example, a meta-analysis showed that knowledge about one's own and others' emotions is inversely related to social anxiety (O'Toole et al. 2013).

Several motivational predictors of pro-environmental behavior, such as environmental awareness, attitudes, values, and identity, are positively related to climate change anxiety (e.g., Verplanken et al. 2020). So far, however, no research on the association between environmental knowledge and climate change anxiety exists (Coffey et al. 2021; Whitmarsh et al. 2022). An exception is a qualitative case study on environmental knowledge and various emotions experienced by activists (e.g., fear, hope; Martiskainen et al. 2020). The descriptive evidence presented in this study suggests that both a positive and a negative relationships may be possible: "Frontline protesters were really concerned about climate change... They were often the most knowledgeable about climate change ..." (p. 14). In contrast, the researchers also observed that "In terms of cognitive knowledge, a surprising number of our strikers were not very aware about climate change; with some even stated that they had no knowledge and were merely striking to impress others (such as a romantic partner) or to give a friend company" (p. 16). Another study showed that knowledge about the causes of climate change and its potential health consequences positively predicted cognitive and affective risk judgments (Sundblad et al. 2007). However, the risk judgment measures used in this study differ from the more personal and emotional construct of climate change anxiety, in that participants were asked to estimate the probability of, and their worries about, serious negative consequences of climate change in three specific countries (i.e., Sweden, the Netherlands, Bangladesh) for three different time horizons (i.e., 5, 50, 100 years).

In summary, drawing on psychological theorizing and research on associations among knowledge, uncertainty, and anxiety, we hypothesize that people with greater overall environmental knowledge and climate-specific knowledge experience generally less climate change anxiety. In contrast, people with less overall environmental knowledge and climate-specific knowledge should be more likely to experience higher climate change anxiety.

Hypothesis 1: Overall environmental knowledge is inversely associated with climate change anxiety.

Hypothesis 2: Climate-specific knowledge is inversely related to climate change anxiety.

2 Method

2.1 Participants and procedure

Time lagged data were collected from a large sample in Germany at four time points across three months (i.e., Time [T] 1=August, T2=September, T3=October, and T4=November of 2022). The time lags help reduce the potential problem of common method bias and allow drawing stronger inferences regarding the assumed temporal ordering of variables. Collecting constructs at different time points was also necessary to reduce the length of each survey. Participants were recruited by an ISO 26362 certified professional online panel company. At T1, participants provided information on demographic characteristics and environmental attitudes as control variables. At T3, participants took an environmental knowledge test (n.b., no data collected at Time 2 is used in the current study). Finally, at T4, participants reported their climate change anxiety, as well as the Big Five personality characteristics as control variables.

A sample of 2,066 employed adults in Germany participated in this study. The sample was 50.39% female and on average 47.07 years of age ($SD=12.18$, range 18–85 years). Most participants (43.47%) held a college/university or technical college degree. The sample was not representative of the general population, as it did not include children, retirees, and unemployed people. The sample was also older and more highly educated than the working population in Germany (i.e., average age of 44 years, 24% college/university degree). Further information on the sample (e.g., income, industry) is available in Table S1 in the online supplemental materials (OSM; <https://osf.io/5mqjh>).

The first survey was initiated by 3,566 people. Sample sizes for observed variables varied by time point (T1: 3,256–3,562; T3: 2,350–2,353; T4: 2,336–2,337), suggesting some degree of attrition over time and some degree of missingness within each time point. Our analyses are based on a sample of 2,066 individuals who provided complete data on our substantive and control variables across all time points. Table S1 compares these complete responders to incomplete responders ($n=1,500$). We also ran a logistic regression model showing that T1 demographics predicted less than 2% of the variance in attrition, suggesting that bias due to attrition was not a significant concern. Complete data and R code to reproduce the analyses reported in this paper can be found in the OSM.

2.2 Measures

Reliability information for all measures is reported in Table S2 in the OSM.

Environmental knowledge A 35-item multiple-choice environmental knowledge test, in which answers to the questions can be scored as “correct” or “incorrect,” was collected from participants at T3 (Geiger et al. 2019). An example item is: “Which of the following phenomena has been the main cause of global warming over the last 20 years? (a) Reduction of the ozone layer (the so-called ozone hole), (b) Increased emissions of greenhouse gases (the so-called greenhouse effect), (c) Changes in ocean currents, (e.g., “el Niño”), (d) Changes in the skewness of earth’s axis.” Each participant’s overall environmental knowledge score was represented as the number of correct answers out of 35. Consistent with Geiger et al. (2019), we further computed seven dimension scores based on subsets of the items, including basic ecology (5 items), economy (3 items), consumption behavior (9 items), environmental contamination (5 items), climate (5 items), resources (4 items), and society/politics (4 items).

Climate change anxiety A 13-item measure of climate change anxiety was collected at T4 (Clayton & Karazsia 2020; Wullenkord et al. 2021). Example items are “Thinking about climate change makes it difficult for me to concentrate” and “I find myself crying because of climate change.” Responses were provided on a 7-point scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*. Clayton and Karazsia (2020) suggested that their scale consists of two dimensions, cognitive-emotional and functional impairment, which were strongly correlated in their studies (i.e., $r=0.78$, $r=0.84$). Consistent with Wullenkord et al. (2021), who were unable to replicate this two-dimensional structure using the German version of the scale, we used a single score of climate change anxiety in our focal analyses. As shown in our correlation table (Table S3 in the OSM), the two dimensions were also strongly correlated in our study ($r=0.88$). However, we report results of supplemental analyses for each climate change anxiety dimension. As shown in Table S4 in the OSM, these results were very similar to our focal results.

Demographic characteristics We controlled for age (in years), sex (0 = *male*, 1 = *female*), and education (0 = *lower secondary school*, 1 = *intermediate secondary school*, 2 = *upper secondary school*, 3 = *college/university or technical college*) collected at T1. Younger and female persons are more likely to experience climate change anxiety (Searle and Gow 2010). Moreover, people with higher education may possess greater environmental knowledge.

Personality characteristics We additionally controlled for core personality characteristics classified by the “Big Five” model (i.e., extraversion, agreeableness, conscientiousness, emotional stability, openness). Emotional stability (the opposite of neuroticism) is associated with clinically-relevant indices of anxiety (Kotov et al. 2010) and climate change anxiety (Clayton 2020). Moreover, people with higher conscientiousness and openness may be more motivated to obtain environmental knowledge. We collected the 21-item Big Five Inventory at T4 (Rammstedt and John 2005). Participants provided their responses on a 7-point rating scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*.

Environmental attitudes Finally, we controlled for environmental attitudes using a well-established eight-item scale collected at T1 (Bamberg 2003). Environmental attitudes (and closely related motivational constructs, such as environmental awareness) are positively related to climate change anxiety (e.g., Verplanken et al. 2020). An example item is “For the benefit of the environment we should be ready to restrict our momentary style of living.” Responses were provided on a 5-point scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*.

2.3 Statistical analyses

We used ordinary least squares (OLS) regression for our focal analyses. In a first model, T4 climate change anxiety was regressed onto T1 demographics and environmental attitudes, T4 personality characteristics, and T3 overall environmental knowledge. In a second model, we regressed climate change anxiety on the control variables and the seven environmental knowledge dimensions (instead of overall environmental knowledge).

3 Results

Descriptive statistics and correlations are provided in Tables S1 and S3 in the OSM. The mean of climate change anxiety was 2.10 (on a scale ranging from 1 to 7), and on average there were 21.50 correct responses to the 35 environmental knowledge questions (range: 5–35). The bivariate correlations of overall environmental knowledge and climate-specific knowledge with climate change anxiety were $r = -0.34$ and $r = -0.24$, respectively.

Results of regression analyses (see Table 1) showed that overall environmental knowledge negatively predicted climate change anxiety ($B = -0.09$, $p < 0.001$), above and beyond the effects of demographics, environmental attitudes, and personality characteristics (see Fig. 1). Thus, Hypothesis 1 was supported: people who possess more (less) overall environmental knowledge experience less (more) climate change anxiety. Moreover, scores of six out of the seven content domains were negatively associated with climate change anxiety in a separate analysis, including knowledge about consumption behavior ($B = -0.10$, $p < 0.001$), basic ecology ($B = -0.06$, $p = 0.022$), economy ($B = -0.12$, $p < 0.001$), society/politics ($B = -0.06$, $p = 0.015$), contamination ($B = -0.09$, $p < 0.001$), and climate ($B = -0.09$, $p < 0.001$, see Table 1). The latter finding supports Hypothesis 2: people who possess more (less) climate-specific knowledge experience less (more) climate change anxiety.

The effects of the control variables were largely consistent with expectations and previous research (e.g., Whitmarsh et al. 2022). Specifically, in both models, education, environmental attitudes, and openness positively predicted climate change anxiety, whereas age, conscientiousness, and emotional stability negatively predicted climate change anxiety. In contrast to previous research, sex was not significantly correlated with climate change anxiety at the bivariate level (Table S3), but negatively predicted it in the regression analyses, suggesting that women experience less climate change anxiety when men. A supplemental specification curve analysis suggested that environmental attitudes, emotional stability, and environmental knowledge may be masking this effect in the correlations (see Figure S1 in the OSM).

3.1 Supplemental analyses

Due to a skewed distribution of climate change anxiety, we additionally considered generalized linear models (inverse Gaussian with an identity link) as a robustness check. The results of these models were equivalent to the OLS models in terms of the statistical conclusions drawn from our primary analysis (see Table S5 in the OSM).

In addition, although previous research suggests a linear relationship between knowledge and anxiety, we explored nonlinear associations between environmental knowledge and climate change anxiety. As shown in Table S6 in the OSM, there was evidence for nonlinear effects of overall environmental knowledge and its consumption and climate dimensions on climate change anxiety. However, as shown in Figure S2, these relations had a very similar form as the linear relations (i.e., “L-shaped,” suggesting “diminishing returns” rather than “U-shaped” effects).

Table 1 Results of Ordinary Least Squares Regression Analyses Predicting Climate Change Anxiety

	T4 Climate Change Anxiety	T4 Climate Change Anxiety
	Estimate [SE]	Estimate [SE]
(Intercept)	4.524*** [0.192]	4.515*** [0.199]
T1 Age	-0.004* [0.002]	-0.004* [0.002]
T1 Sex (0 = male, 1 = female)	-0.337*** [0.048]	-0.322*** [0.048]
T1 Education	0.111*** [0.024]	0.109*** [0.024]
T1 Env. Attitudes	0.341*** [0.028]	0.342*** [0.028]
T4 Extraversion	0.029 [0.020]	0.03 [0.020]
T4 Agreeableness	-0.007 [0.022]	-0.01 [0.022]
T4 Conscientiousness	-0.154*** [0.025]	-0.151*** [0.025]
T4 Emotional Stability	-0.254*** [0.020]	-0.254*** [0.020]
T4 Openness	0.067** [0.023]	0.065** [0.023]
T3 Overall Env. Knowledge	-0.085*** [0.004]	
T3 Env. Knowledge – Basic Ecology		-0.059* [0.026]
T3 Env. Knowledge – Economy		-0.116*** [0.028]
T3 Env. Knowledge – Consumption Behavior		-0.101*** [0.016]
T3 Env. Knowledge – Env. Contamination		-0.093*** [0.023]
T3 Env. Knowledge – Climate		-0.092*** [0.026]
T3 Env. Knowledge – Resources		-0.038 [0.024]
T3 Env. Knowledge – Society/Politics		-0.061* [0.025]
N	2,066	2,066
AIC	5944.351	5948.815
BIC	6011.951	6050.215
R-squared	.316	.319
R-squared Adjusted	.313	.313
RMSE	1.014	1.012

Table 1 (continued)

	T4 Climate Change Anxiety Estimate [SE]	T4 Climate Change Anxiety Estimate [SE]
Sigma	1.017	1.016

T = Time; Env. = Environmental. Regression coefficients are unstandardized

* $p < .05$

** $p < .01$

*** $p < .001$

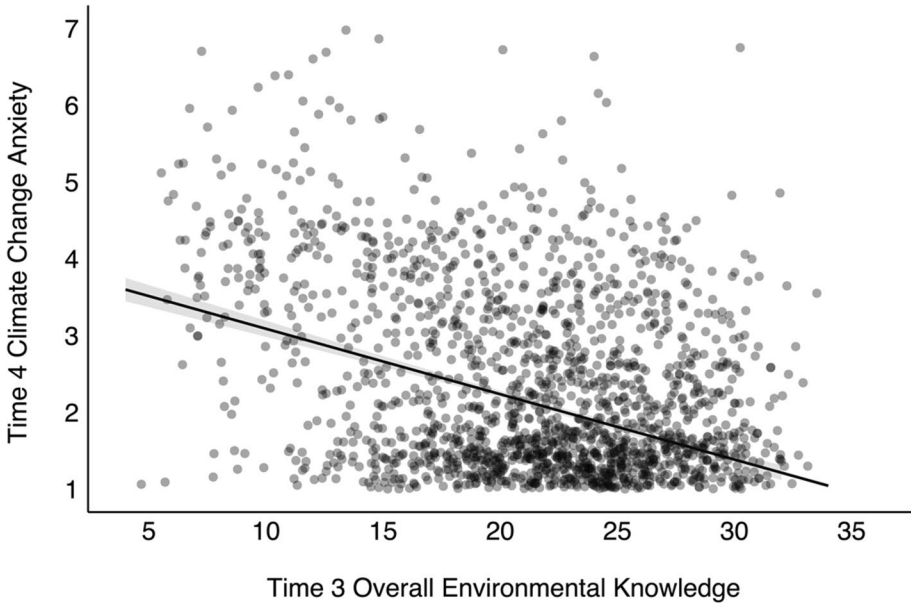


Fig. 1 Inverse Association between Time 3 Overall Environmental Knowledge and Time 4 Climate Change Anxiety. Note. Data points have been “jittered” to avoid overplotting

4 Discussion

The results of this study add to the growing body of evidence that higher domain-specific knowledge is associated with lower domain-associated anxiety. They also contribute to the emerging literature on the construct of climate change anxiety, which so far has focused on demographics, attitudes, and personality characteristics as predictors and neglected the role of environmental knowledge (Clayton 2020). In terms of practical implications, the main finding that environmental knowledge is negatively related to climate change anxiety suggests that efforts to improve environmental knowledge, for instance through educational and training interventions, may help reduce such anxiety. This seems important given demonstrated links between climate change anxiety and more general forms of mental ill-health, including generalized anxiety, depression, and distress (Schwartz et al. 2022; Searle

and Gow 2010). These interventions could be targeted especially at younger people and people with higher environmental awareness and attitudes (e.g., climate scientists), who are at risk of experiencing higher climate change anxiety (Clayton 2020; Crandon et al. 2022; Verplanken et al. 2020).

However, consistent with previous research (Wullenkord et al. 2021), the average level of climate change anxiety in our sample was already quite low and, thus, it may not be possible to decrease it much further through interventions. It could also be questioned whether climate change anxiety has only (and always) negative consequences or, under certain circumstances, may even lead to positive outcomes. For example, recent research has suggested that engaging in collective action to address climate change can buffer the effect of climate change anxiety on depressive symptoms (Schwartz et al. 2022). Moreover, the measure used in our study is based on a definition of climate change anxiety as “a more clinically significant ‘anxious’ response” (Clayton and Karazsia 2020, p. 9). Future research should also focus on the potentially beneficial outcomes of more adaptive forms of climate change anxiety, such as practical anxiety (Pihkala 2020) or rational worrying (Verplanken and Roy 2013). Compared to clinical forms of climate change anxiety, these more adaptive forms may be constructively channeled into productive responses, such as increased information seeking and pro-environmental behavior (Verplanken et al. 2020).

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10584-023-03518-z>.

Author contributions Both authors contributed to the study conception and design. Material preparation and data collection were performed by Hannes Zacher, and analyses were performed by Cort W. Rudolph. The first draft of the manuscript was written by Hannes Zacher and Cort W. Rudolph and both authors commented on previous versions of the manuscript. Both authors read and approved the final manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Data availability The dataset generated and analyzed during the current study are available in the Open Science Framework, <https://osf.io/5mqjh>

Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose.

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References

- Bamberg S (2003) How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. *J Environ Psychol* 23(1):21–32. [https://doi.org/10.1016/S0272-4944\(02\)00078-6](https://doi.org/10.1016/S0272-4944(02)00078-6)
- Clayton S (2020) Climate anxiety: Psychological responses to climate change. *J Anxiety Disord* 74:102263. <https://doi.org/10.1016/j.janxdis.2020.102263>

- Clayton S, Karazsia BT (2020) Development and validation of a measure of climate change anxiety. *J Environ Psychol* 69:101434. <https://doi.org/10.1016/j.jenvp.2020.101434>
- Coffey Y, Bhullar N, Durkin J, Islam MS, Usher K (2021) Understanding eco-anxiety: A systematic scoping review of current literature and identified knowledge gaps. *J Clim Change Health* 3:100047. <https://doi.org/10.1016/j.joclim.2021.100047>
- Crandon TJ, Scott JG, Charlson FJ, Thomas HJ (2022) A social–ecological perspective on climate anxiety in children and adolescents. *Nat Clim Chang* 12(2):123–131. <https://doi.org/10.1038/s41558-021-01251-y>
- Geiger SM, Geiger M, Wilhelm O (2019) Environment-specific vs. general knowledge and their role in pro-environmental behavior. *Front Psychol* 10:718. <https://doi.org/10.3389/fpsyg.2019.00718>
- Hirsh JB, Mar RA, Peterson JB (2012) Psychological entropy: A framework for understanding uncertainty-related anxiety. *Psychol Rev* 119(2):304–320. <https://doi.org/10.1037/a0026767>
- Jungermann H, Thüring M (1993) Causal knowledge and the expression of uncertainty. *Adv Psychol* 101:53–73. [https://doi.org/10.1016/S0166-4115\(08\)62652-7](https://doi.org/10.1016/S0166-4115(08)62652-7)
- Kotov R, Gamez W, Schmidt F, Watson D (2010) Linking “big” personality traits to anxiety, depressive, and substance use disorders: A meta-analysis. *Psychol Bull* 136(5):768–821. <https://doi.org/10.1037/a0020327>
- Martiskainen M, Axon S, Sovacool BK, Sareen S, Del Rio DF, Axon K (2020) Contextualizing climate justice activism: Knowledge, emotions, motivations, and actions among climate strikers in six cities. *Glob Environ Change* 65:102180. <https://doi.org/10.1016/j.gloenvcha.2020.102180>
- Nuevo R, Wetherell JL, Montorio I, Ruiz MA, Cabrera I (2009) Knowledge about aging and worry in older adults: Testing the mediating role of intolerance of uncertainty. *Aging Ment Health* 13(1):135–141. <https://doi.org/10.1080/13607860802591088>
- O’Toole MS, Hougaard E, Mennin DS (2013) Social anxiety and emotion knowledge: A meta-analysis. *J Anxiety Disord* 27(1):98–108. <https://doi.org/10.1016/j.janxdis.2012.09.005>
- Pihkala P (2020) Eco-Anxiety and Environmental Education. *Sustainability* 12(23):10149. <https://doi.org/10.3390/su122310149>
- Rammstedt B, John OP (2005) Kurzversion des Big Five Inventory (BFI-K) [Short version of the Big Five Inventory (BFI-K): Development and validation of an economic inventory for assessment of the five factors of personality]. *Diagnostica* 51(4):195–206. <https://doi.org/10.1026/0012-1924.51.4.195>
- Schwartz SEO, Benoit L, Clayton S, Parnes MF, Swenson L, Lowe SR (2022) Climate change anxiety and mental health: Environmental activism as buffer. *Curr Psychol*. <https://doi.org/10.1007/s12144-022-02735-6>
- Searle K, Gow K (2010) Do concerns about climate change lead to distress? *Int J Clim Change Strateg Manag* 2(4):362–379. <https://doi.org/10.1108/17568691011089891>
- Stephan WG, Stephan CW, Gudykunst WB (1999) Anxiety in intergroup relations: A comparison of anxiety/uncertainty management theory and integrated threat theory. *Int J Intercult Relat* 23(4):613–628. [https://doi.org/10.1016/S0147-1767\(99\)00012-7](https://doi.org/10.1016/S0147-1767(99)00012-7)
- Sundblad E-L, Biel A, Gärling T (2007) Cognitive and affective risk judgements related to climate change. *J Environ Psychol* 27(2):97–106. <https://doi.org/10.1016/j.jenvp.2007.01.003>
- Townsend DM, Hunt RA, McMullen JS, Sarasvathy SD (2018) Uncertainty, knowledge problems, and entrepreneurial action. *Acad Manag Ann* 12(2):659–687. <https://doi.org/10.5465/annals.2016.0109>
- Verplanken B, Roy D (2013) “My worries are rational, climate change is not”: Habitual ecological worrying is an adaptive response. *PLoS ONE* 8(9):e74708. <https://doi.org/10.1371/journal.pone.0074708>
- Verplanken B, Marks E, Dobromir AI (2020) On the nature of eco-anxiety: How constructive or unconstructive is habitual worry about global warming? *J Environ Psychol* 72:101528. <https://doi.org/10.1016/j.jenvp.2020.101528>
- Wang M, Keller C, Siegrist M (2011) The less you know, the more you are afraid of—A survey on risk perceptions of investment products. *J Behav Financ* 12(1):9–19. <https://doi.org/10.1080/15427560.2011.548760>
- Whitmarsh L, Player L, Jiongco A, James M, Williams M, Marks E, Kennedy-Williams P (2022) Climate anxiety: What predicts it and how is it related to climate action? *J Environ Psychol* 83:101866. <https://doi.org/10.1016/j.jenvp.2022.101866>
- Wullenkord MC, Tröger J, Hamann KR, Loy LS, 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. *Clim Change* 168(3):1–23. <https://doi.org/10.1007/s10584-021-03234-6>