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Anxiety and climate change: a validation of the Climate Anxiety Scale in a German-speaking quota sample and an investigation of psychological correlates

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Abstract

The climate crisis is an unprecedented existential threat that causes disturbing emotions, such as anxiety. Recently, Clayton and Karazsia measured climate anxiety as "a more clinically significant 'anxious' response to climate change" (2020, p. 9). To gain a more nuanced understanding of the phenomenon from an empirical psychological perspective, we translated the core of the Climate Anxiety Scale into German and assessed potential correlates in a large German-speaking quota sample ($N = 1011$, stratified by age and gender). Overall, people reported low levels of climate anxiety. Climate anxiety correlated positively with general anxiety and depressiveness, avoidance of climate change in everyday life, frustration of basic psychological needs, pro-environmental behavioral intentions, and policy support. It correlated negatively with different forms of climate denial and was unrelated to ideological beliefs. We were not able to replicate the two dimensions found in the original scale. Moreover, we argue that items appear to measure a general climate-related emotional impairment, rather than distinctly and comprehensively capturing climate anxiety. Thus, we encourage researchers to rework the scale and include an emotional factor in future research efforts.

Keywords Climate anxiety · Climate denial · Pro-environmental intentions · Ideology · Psychological needs · Eco-anxiety

1 Introduction

The climate crisis represents an existential threat to human well-being and survival (Masson-Delmotte et al. 2018; Steffen et al. 2015). Its effects on (non)human ecosystems are tremendous and surpass previous predictions substantially (Masson-Delmotte et al. 2018). Given its existential nature, it is not surprising that people experience disturbing emotions in relation to the climate crisis (Albrecht 2012; Böhm 2003; Norgaard 2006a). Nevertheless, empirical psychological research has only recently started

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to investigate climate anxiety as a specific emotional response to the climate crisis, its potential impacts on mental health and well-being, and its consequences for climate action (e.g., Clayton & Karazsia 2020; Stanley et al. 2021; Pikhala 2020). With an expected increase in people reporting climate anxiety, "an urgent response is needed from clinicians, public health practitioners, families, researchers, educators, and policy makers" (Cunsolo et al. 2020, p. e261). To contribute to the discourse and empirical evidence about climate anxiety in our own discipline, we report data from a large German-speaking quota sample, originally collected as part of a larger project on the spectrum of climate denial. Building on empirical psychological research by Clayton and Karazsia (2020; see Pikhala (2020) for a review of research on climate anxiety in other disciplines), our research has three goals: First, we validate a German translation of the two core dimensions of the *Climate Anxiety Scale* (CAS) by Clayton and Karazsia (2020). Second, going beyond previous research, we investigate relations of climate anxiety with climate denial, political ideologies, basic psychological needs, and aspirations. Third, we test whether climate anxiety relates to pro-environmental behavioral intentions and policy support.

2 Theoretical background

2.1 Climate anxiety

Complex emotional responses to the climate crisis such as anxiety, fear, and worry (Böhm 2003; Pikhala 2020), grief (Cunsolo & Ellis, 2018), guilt (Rees et al. 2015), hopelessness (Norgaard, 2006a), or melancholia (Lertzman 2015) can be uncomfortable if not deeply disturbing. They have wide-ranging consequences for the sense of self, personal and place identity, and a sense of continuity and safety (Norgaard 2011). *Climate anxiety* can be defined as "anxiety which is significantly related to anthropogenic climate change" (Pikhala 2020, p. 3). Similarly, the broader term *eco-anxiety* can be defined as the apprehension and stress about anticipated threats to ecosystems (Cunsolo et al. 2020) or "the generalized sense that the ecological foundations of existence are in the process of collapse" (Albrecht 2012, p. 250). Within empirical psychology, Clayton and Karazsia recently defined climate anxiety as "a more clinically significant 'anxious' response to climate change" (2020, p. 9) that may impair human well-being and functioning. However, interpreting climate anxiety as "pathological" would contribute to a deficit-oriented health discourse and potentially cause stereotyping and marginalization (e.g., see Hyett et al. 2019). Rather, it may be an adaptive, reasonable response to an existential threat. Nevertheless, if climate anxiety indeed required clinical attention, it would be necessary to develop means to assess its severity, which "allow for consistency in measurements and understandings" (Clayton & Karazsia 2020, p. 3). To this end, Clayton and Karazsia (2020) developed the CAS to assess climate anxiety and its impacts in everyday life. In our study, we aim to replicate the two core dimensions of the original scale and some of the study's findings in a large German-speaking quota sample. Given that Clayton and Karazsia (2020) conceptualize climate anxiety as potentially "clinically significant," we expect to replicate their finding:

> *Climate anxiety correlates positively with general anxiety and depressiveness (H1).*

2.2 Potential correlates of climate anxiety

Given its psychological significance, it is likely that various psychological factors relate to how much climate anxiety people actually report. In the following, we elaborate on potential correlates that were available in our dataset. These correlates pertain to two aspects of human responses to the climate crisis: First, environmental correlates such as acknowledgment of the climate crisis as a problem, ideological beliefs that are closely related to responses to the climate crisis, and pro-environmental behavioral intentions and policy support, and second, well-being correlates such as basic psychological need satisfaction, aspirations, and general anxiety and depressiveness.

2.2.1 Climate denial

One way to cope with debilitating emotional experiences is to use defensive, self-protective strategies that serve to suppress, deny, or avoid uncomfortable emotions and thereby protect the self from pain and loss (see Jonas et al. 2014; Weintrobe 2013). If these strategies are successful, uncomfortable emotions like anxiety may not be (consciously) felt and/or reported (e.g., in questionnaire studies, Lertzman 2015). Following Cohen's work on the denial of human rights violations (2001), climate-relevant defensive, self-protective strategies can be classified into literal denial (i.e., denial of hard facts), interpretive denial (i.e., distortion of facts or emotional distancing), and implicatory denial (i.e., recognition of facts but denial of their psychological, political, or moral implications). These strategies can be more or less successful in numbing the emotional response. For example, one prerequisite for reporting climate anxiety is the recognition that climate change is a threat with vast consequences for human existence (Weintrobe 2013). Denying the existence of climate change (literal denial) or reinterpreting its implications (interpretive denial) should reduce the reported anxiety more than rationalizing one's own contribution to the climate crisis or merely avoiding information about it in everyday life (implicatory denial). This does not mean that the underlying anxiety disappears. The denial may simply be a repressed manifestation of underlying anxiety, masking it, and breeding more anxiety in the long run (see Weintrobe (2013, p. 39) on the "vicious spiral" of anxiety and denial). In the case of avoidance, feelings of anxiety remain but are pushed away by avoiding its triggers in everyday life (Salander & Windahl, 1999). In a recent study, Kapeller and Jäger (2020) simulated complex interactions of climate anxiety and literal denial and generally found them to be negatively related. Based on the findings reviewed above, we hypothesized:

Climate anxiety correlates negatively with climate denial (H2).

2.2.2 Ideological beliefs

Previous research shows that people with certain ideological beliefs use denial to protect what the climate crisis threatens, such as the safety and privileges the status quo affords them (Feygina et al. 2010; Jylhä et al. 2016). Ideologies are sets of attitudes comprising more or less coherent belief systems that fundamentally shape people's perceptions and interpretations regarding important topics (Jost et al. 2008), such as climate change and environmental degradation (McCright et al. 2016). *System justification*, the tendency to justify and defend the status quo, is one important ideological driver of resistance to climate

change information (Feygina et al. 2010). The dual-process model of ideology (Duckitt 2001) describes *social dominance orientation* (SDO, Pratto et al. 1994) and *right-wing authoritarianism* (RWA, Altemeyer 1981) as key ideological beliefs. People high on SDO typically endorse hierarchical structures and legitimize inequalities, while people high on RWA are typically resistant to change and motivated to maintain the status quo. Both RWA and SDO are strong negative predictors of various socio-political outcomes such as willingness to act against global inequality, appreciating attitudes toward outgroups, or support of human rights measures (McFarland 2010; Reese et al. 2014). They typically correlate negatively with pro-environmental attitudes and intentions (Stanley & Wilson 2019). *Human dominance over nature* captures the belief that humans are superior to nature (Milfont et al. 2013). It is associated with striving to maintain the status quo and climate denial (Jylhä et al. 2020). If people with high scores on system justification, SDO, RWA, and human dominance over nature tend to deny climate change, they may not report climate anxiety because that would in turn mean they would acknowledge the existence of climate change or its emotional consequences on the self. Correspondingly, one could expect similar relations for people with a right-wing rather than left-wing political orientation, given that the former deny climate change more than the latter (e.g., Häkkinen & Akrami 2014). Based on the empirical findings on ideological beliefs and climate denial and the negative proposed relationship between climate anxiety and climate denial, we expected:

> *Climate anxiety correlates negatively with certain ideological beliefs (i.e., system justification, SDO, RWA, human dominance over nature, and right-wing political orientation; H3).*

2.2.3 Needs and aspirations

Further potential correlates of climate anxiety are basic psychological needs, as basic psychological need frustration is often associated with anxiety and various forms of ill-being. Self-determination theory (Deci & R.M. Ryan 2000; R.M. Ryan & Deci 2017) is a humanistic, organismic-dialectical theory of human motivation. It proposes that the universal, innate basic psychological needs for relatedness (belonging), competence (efficacy), and autonomy (self-determination) have to be satisfied to experience mental health and well-being and to cope with stressors and threat proactively. People whose basic psychological needs are satisfied are more likely to act pro-environmentally (see Wullenkord (2020) for an overview). Need frustration is, in contrast, associated with inner conflicts, reduced human functioning, ill-being, and defensiveness (Benita et al. 2019; Heissel et al. 2018; Hodgins et al. 2006; R.M. Ryan & Deci 2017; Vansteenkiste & R.M. Ryan 2013). For example, first findings in the climate context suggest that basic psychological need frustration is associated with climate denial (Wullenkord 2019). Severe and ongoing need frustration can lead to non-optimal human functioning and psychopathology (Deci & R.M. Ryan 2000). For example, need frustration is associated with depressive symptoms (Heissel et al. 2018) and anxiety among adolescents (Kearns 2017), in dental patients (Halvari et al. 2019), and in many other populations (Deci & R.M. Ryan 2000; Vansteenkiste & R.M. Ryan 2013). In particular, *satisfied autonomy* needs predicted lower general anxiety for rheumatoid arthritis patients (S. Ryan & McGuire 2016), while *frustrated autonomy* needs predicted worry and sleep disruption in times of uncertainty (Howell & Sweeny 2019). Furthermore, helplessness and powerlessness are typical anxious experiences that represent diminished efficacy and control beliefs (Grupe & Nitschke 2013), in other words,

thwarted needs for competence. Brenning et al. (2021) found need frustration to partially mediate the relationship between dysfunctional emotion regulation and internalizing problems in a sample of adolescents. Based on these empirical findings and theoretical considerations, we expected:

Climate anxiety correlates positively with need frustration and negatively with need satisfaction (H4).[1]

Closely related to basic psychological needs and indicative of well-being are aspirations, namely, life goals. Goal contents theory (Kasser & R.M. Ryan 1996; R. M. Ryan & Deci 2017), a sub-theory of self-determination theory, classifies people's aspirations into intrinsic aspirations (pursuit of personal growth, meaningful relationships, and contribution) and extrinsic aspirations (financial success, popularity, and image). Extrinsic aspirations are less likely to satisfy basic psychological needs than intrinsic aspirations. R.M. Ryan et al. (1996) showed that extrinsic aspirations were related to anxiety and depressive symptoms. Based on these findings, we expected:

Climate anxiety correlates positively with extrinsic aspirations and negatively with intrinsic aspirations (H5).

2.2.4 Pro-environmentalism

Instead of a self-protective response, people can also acknowledge their emotions in the context of climate change (Reser et al. 2012). A so-called practical anxiety can trigger information-seeking tendencies and coping with the threat (Kurth 2018). Accordingly, the perception of threat and worry about climate change can motivate support of climate action and policies (Leiserowitz 2006; Mayer et al. 2017; Smith & Leiserowitz 2014), through an increase in perceived personal responsibility (Bouman et al. 2020). Furthermore, being a bystander to severe collective climate damage could intensify anger and motivate people to take personal responsibility (Kleres & Wettergren 2017; Stanley et al. 2021).

Nevertheless, Clayton and Karazsia (2020) found climate anxiety and pro-environmental behavior to be unrelated. Kapeller and Jäger (2020) showed that more anxiety is not necessarily associated with more pro-environmental behavior. In fact, relations between reported anxiety and pro-environmental behavior may not be straightforward. Perceiving severe threat and fear can be overwhelming and lead to apathy, especially when one feels incapable to deal with the threat (Kapeller & Jäger 2020; Miller et al. 2009). General emotion management also depends on people's cultural backgrounds and socio-material contexts. For instance, Kleres and Wettergren argue that people in the Global North "embrace" feelings of fear internally but reject them externally because "a general fear culture in the north voids the mobilizing power of fear" (2017, p. 11). This likely influences our study because we analyze individuals living in a northern liberal culture. Furthermore, if people are able to resolve their anxiety by acting pro-environmentally (Kapeller & Jäger 2020), they may as a consequence experience more hope and report less anxiety (Kleres

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[1] This hypothesis differs from our pre-registration. Originally, we assumed an interaction between climate anxiety and basic psychological needs to predict pro-environmental behavior and policy support. However, in this paper, we focus on the basic correlation assumption. We report on the interaction hypothesis in Supplementary Materials S2 and S3.

& Wettergren 2017; Ojala 2012). Given these mixed findings on the relationship between fear, worry, anxiety, and pro-environmentalism, and the finding by Clayton and Karazsia (2020) upon which we built our study, we expected:

> *Climate anxiety is uncorrelated with pro-environmental behavioral intentions and policy support (H6).*

3 Method

The current study was part of a larger project initially designed to study the interrelations of climate denial, basic psychological needs, and ideology (see our pre-registration[2] and Wullenkord (under review)). Here, we use the complete data to contribute to a better understanding of climate anxiety by validating the two core dimensions of the CAS (Clayton & Karazsia 2020) in a German-speaking quota sample and assessing potential correlates of climate anxiety.

3.1 Sample and procedure

We collected 1134 complete datasets of German-speaking participants through the online-access panel provider Respondi AG.[3] The study was hosted on the platform SoSci-Survey (Leiner 2020). Participants gave their informed consent and then answered questions about their climate anxiety and potential correlates. As an incentive, participants received *mingle points*, which they could exchange for money, shopping vouchers, or donations to several organizations. This study was approved by the local ethics committee (293_2020) and was in line with the Declaration of Helsinki. We pre-registered our hypotheses (see footnote 2). After outlier detection,[4] the final sample consisted of $N=1011$ participants. The sample was stratified for age ($M=43.91$, $SD=13.97$, range: 18–69) and gender (51.14% female), based on 2011 census data retrieved from the European Statistical System (2020). We also assessed education (26.31% had university entrance qualification, and 29.48% had a university degree) and monthly income (on average, people earned between 1500 and 2500€).

3.2 Measures

When no validated German translations were available, we used back-translation to translate the measures. If not otherwise indicated, participants responded to all measures on 7-point Likert scales from 1 (*strongly disagree/does not apply at all*) to 7 (*strongly agree/applies completely*). Psychometric properties are summarized in Table 1.

Climate anxiety We used the factors *cognitive-emotional impairment* (e.g., "Thinking about climate change makes it difficult for me to concentrate") and *functional impairment*

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[2] https://aspredicted.org/blind.php?x=js5pc4

[3] Data are available upon request.

[4] We excluded speeders ($RSI \geq 2$, $N=32$, Leiner 2019), straightliners ($N=19$, Kim et al. 2019), those with inconsistent answers on several item pairs ($N=61$), and multivariate outliers ($N=11$, Tabachnick & Fidell 2013). Please find more detailed information in Supplementary Materials S2 and S3.

Table 1 Descriptive statistics of study variables

Variable	Items	M	SD	Min	Max	Skewness	Kurtosis	α [95% CI]
Climate anxiety	13	1.81	.82	1	5.42	1.22	1.16	.89 [.87, .90]
Anxiety and depressiveness	4	1.67	.72	1	4	1.29	1.27	.88 [.87, .89]
Climate denial	30	2.97	1.06	1	6.40	.55	−.17	.95 [.95, .96]
Rationalization	7	3.18	1.46	1	7	.54	−.20	.92 [.92, .93]
Avoidance	8	3.04	1.18	1	6.75	.09	−.57	.89 [.88, .90]
Denial of personal outcome severity	4	2.35	1.21	1	7	.85	.29	.87 [.86, .89]
Denial of global outcome severity	3	2.58	1.59	1	7	1.00	.22	.91 [.90, .92]
Denial of guilt	4	3.92	1.39	1	7	.38	−.46	.83 [.82, .85]
Literal denial	4	2.45	1.55	1	7	1.14	.61	.94 [.93, .95]
Ideological beliefs								
System justification	8	3.94	1.09	1	7	−.25	−.13	.83 [.82, .85]
Social dominance orientation	8	2.93	1.03	1	6.62	.35	.22	.80 [.78, .82]
Human dominance over nature	10	2.51	1.14	1	7	.63	−.03	.89 [.88, .90]
Right-wing authoritarianism	12	3.53	1.03	1	6.50	−.13	−.47	.82 [.82, .84]
Political orientation	1	44.59	18.8	1	101	−.02	.18	
Basic psychological needs								
Relatedness satisfaction	3	5.39	1.17	1	7	−.83	.83	.84 [.82, .85]
Relatedness frustration	3	2.63	1.43	1	7	.69	−.27	.80 [.78, .82]
Competence satisfaction	3	4.37	1.3	1	7	−.25	−.24	.78 [.76, .81]
Competence frustration	3	2.66	1.34	1	7	.56	−.55	.77 [.74, .79]
Autonomy satisfaction	3	5.01	1.1	1	7	−.51	.07	.79 [.77, .81]
Autonomy frustration	3	3.12	1.43	1	7	.29	−.69	.75 [.72, .77]
Aspirations—importance	18	−2.09	1.09	−5.38	1.15	.−07	−.24	.81 [.79, .83]
Aspirations—likelihood	18	−1.26	0.96	−4.10	1.85	−.32	−.04	.87 [.86, .88]
Pro-environmentalism								
Policy support	2	71.35	20.88	1	101	−.86	.83	.67[a][.63, .74]
Intentions	3	3.49	1.26	1	7	.26	−.26	.74 [.71, .77]
Age	1	43.91	13.97	18	69	−.07	−1.10	

Note. [a]Spearman's rho

(e.g., "My friends say I think about climate change too much") of the *CAS* to measure climate anxiety as operationalized by Clayton and Karazsia (2020). According to Clayton and Karazsia, these two factors "constitute the climate anxiety scale" (p. 4). In their original study, Clayton and Karazsia also assessed the factors *experience of climate change* (e.g., "I have been directly affected by climate change") and *behavioral engagement* (e.g., "I recycle"). In line with their interpretation, we regard these factors not as indicative of climate anxiety per se but rather as potential correlates. In our study, two authors independently translated the original English items into German and resolved disagreement in discussion. The German items were then back-translated into English by two other researchers, who

were not aware of the original scale. Afterwards, we determined the final wording of the German item (see Supplementary Material S4, $\alpha = 0.89$).

Anxiety and depressiveness We used the *PHQ-4* (Kroenke et al. 2009, $\alpha = 0.88$) that screens for general anxiety and depressiveness (e.g., "feeling nervous, anxious, or on edge") within the past two weeks on a 4-point Likert scale from 1 (*not at all*) to 4 (*nearly every day*).

Climate denial We used the *Climate Self-Protection Scale* (Wullenkord & Reese 2021), consisting of five subscales for interpretive (3, 4) and implicatory denial (1, 2, 5): (1) rationalization (e.g., "How I behave toward the environment has minimal impact on climate change," $\alpha = 0.92$), (2) avoidance (e.g., "I try to avoid negative thoughts about climate change in my everyday life," $\alpha = 0.89$), (3) denial of personal outcome severity (e.g., "I expect climate change to affect other regions but not to burden me," $\alpha = 0.87$), (4) denial of global outcome severity (e.g., "I believe that climate change won't be as severe as expected in the future," $\alpha = 0.91$), and (5) denial of guilt (e.g., "I don't need to make climate change a matter of conscience," $\alpha = 0.83$). We added four items on (6) literal climate denial (two own items; two taken from Jylhä et al.'s (2016), own translation; $\alpha = 0.94$).

Ideological beliefs We used the *System Justification scale* (Kay and Jost (2003); German adaptation by Ullrich and Cohrs (2007); e.g., "Most political decisions serve the benefit of all people." $\alpha = 0.83$), the *$SDO_{7(8)}$ scale* (Ho et al. 2015; own translation; e.g., "Some groups of people are simply inferior to other groups.," $\alpha = 0.80$), the *RWA^3D scale* (Funke 2003; "The true key for the 'good life' are obedience, discipline, and virtue.," $\alpha = 0.82$), and as a measure of human dominance over nature subscale nine of the *Environmental Attitudes Inventory* (Milfont & Duckitt 2010; German translation by Markey 2013, items 5–8 own translation; e.g., "Humans were meant to rule over the rest of nature.," $\alpha = 0.89$). Additionally, we assessed political orientation using a slider bar ranging from 1 (*left-wing*) to 101 (*right-wing*).

Basic psychological needs We used the *Balanced Measure of Basic Psychological Needs Scale* (Sheldon & Hilpert 2012, German translation by Neubauer & Voss 2016) to assess both satisfaction and frustration of autonomy (e.g., "I was free to do things my own way," $\alpha_{sat} = 0.79$, $\alpha_{frus} = 0.75$), competence (e.g., "I took on and mastered hard challenges," $\alpha_{sat} = 0.78$, $\alpha_{frus} = 0.77$), and relatedness (e.g., "I felt close and connected with other people who are important to me," $\alpha_{sat} = 0.84$, $\alpha_{frus} = 0.80$) during the last month.

Aspirations We assessed importance and likelihood of intrinsic and extrinsic aspirations using a short version of the *Aspiration Index* (Grouzet et al. 2005; German translation by Matthey & Kasser 2013; e.g., "In the future, I will have a job that pays well."). We then calculated a relative intrinsic vs. extrinsic value orientation score for both importance and likelihood (recommendations by Kasser (2019)), with negative scores indicating relative intrinsic value orientation (max −6) and positive scores indicating relative extrinsic value orientation (max 6).

Pro-environmental behavioral intentions We used three items based on Wullenkord et al. (2020) to assess participants' pro-environmental intentions with respect to political and activist engagement ("I plan to become involved in *politics/activism* in the future to
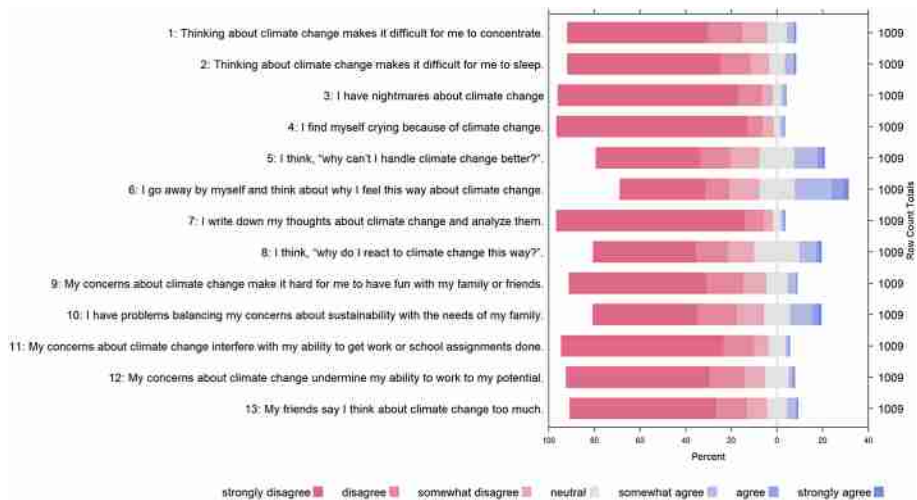
Fig. 1 Diverging stacked bar chart of responses to the Climate Anxiety Scale. This figure shows the distribution of participant responses to the individual items of the Climate Anxiety Scale and the scale as a whole. Red signifies disagreement and blue agreement with the items

limit the consequences of climate change"), and changes in everyday life ("I plan to act in an environmentally protective way in my *everyday life* in the future to limit the consequences of climate change"; $\alpha = 0.74$).

Policy support Inspired by the European Election Studies (Schmitt et al. 2016), participants indicated their personal views on investments in climate protection measures and taxes on slider bars ranging from 1 to 101.

4 Results

We used the statistical environment R, version 4.0.3 (R Core Team 2020). Supplementary Material S1 contains results not outlined here in a clear and concise format. In Supplementary Material S2, we report detailed results of all analyses. In Supplementary Material S3, we explicate exclusion criteria, data analyses using the entire dataset without exclusions, and analyses without covariates.

4.1 Validating the Climate Anxiety Scale

To validate the core of the original CAS, we explored its structure and relations with sociodemographic variables.

4.1.1 Structure of the Climate Anxiety Scale

We first ran a confirmatory factor analysis (CFA) to investigate whether a 2-factorial structure of the CAS inspired by Clayton and Karazsia's work, with the subscales *cognitive-emotional impairment* and *functional impairment*, could be confirmed in our sample, using

the R-package *lavaan*, version 0.6–7 (Rosseel 2012). The dataset contained no missing data. The 13 items of the CAS were not normally distributed but displayed significant floor effects (see Fig. 1) and multivariate non-normality, as revealed by histograms, Q-Q-plots, skewness, kurtosis, and the Doornik-Hansen test ($E[26] = 2144.40$, $p < 0.001$). We used robust maximum likelihood estimation with Satorra-Bentler correction (Finney & DiStefano 2013) to account for multivariate non-normality. We constrained latent factors with a mean of 0 and variance of 1. The dataset was sufficiently large to ensure high statistical power ($N{:}q$ ratio was 37:1). A graphical representation of the model including (un)standardized parameter estimates, standardized residuals, squared multiple correlation coefficients, and empirical and model-implicated variance–covariance-matrices can be found in Supplementary Material S2.

The hypothesized model was identified but did not have satisfactory fit (Hair et al. 2019; Hu & Bentler 1999), Satorra-Bentler χ^2 (64, $N = 1011$) = 321.34, $p < 0.001$, Robust Comparative Fit Index (CFI) = 0.91, Robust Tucker-Lewis Index (TLI) = 0.89, Akaike Information Criterion (AIC) = 38,004.51, Robust Root Mean Square Error of Approximation (RMSEA) = 0.084, 90% CI [0.075, 0.093], and Standardized Root Mean Square Residual (SRMR) = 0.052. While the Robust CFI was acceptable, the Robust TLI was rather low, and the χ^2:df ratio was > 3 indicating bad fit (see Bollen 1989). We interpret this as evidence that the existence of the subscales *cognitive-emotional impairment* and *functional impairment* does not fit our German quota sample. A one-dimensional model had slightly worse fit (Satorra-Bentler χ^2 [65, $N = 1011$] = 325.72, $p < 0.001$; Robust CFI = 0.91; Robust TLI = 0.89; AIC = 38,012.38; Robust RMSEA = 0.084, 90% CI [0.075, 0.093]; SRMR = 0.052; χ_{diff}^2[1, $n = 1011$] = 4.51, $p = 0.034$). However, the difference between models was marginal.

We therefore ran an exploratory main axis analysis with oblique rotation to explore whether individual items clustered into different interpretable subscales in our sample. Items were well-suited for factor analysis (KMO = 0.93). No items needed to be excluded because of high inter-item correlations ($r > 0.80$, recommendations by Tabachnick and Fidell (2013)). According to Horn's (1965) parallel analysis, items distributed over four factors (Eigenvalues = 0.14–5.23, 51% cumulative explained variance). After inspection of the scree plot with an elbow point after two factors and due to difficulty in meaningfully interpreting four factors, we enforced a two factor solution (Eigenvalues = 0.44–5.23). One item ("I go away by myself and think about why I feel this way about climate change.") had both a very low factor loading (< 0.30) and low commonality ($h^2 = 0.21$). Given that it was an outlier when inspecting correlations of single items with study outcomes and did not directly assess anxiety in our interpretation, we re-analyzed the scale without it. The 12-item measure was well-suited for factor analysis (KMO = 0.93). Again, items are distributed over four factors (Eigenvalues = 0.14–5.01, 53% cumulative explained variance), but we enforced a two-factor solution (Eigenvalues = 0.44–5.01) based on inspection of the scree plot (see Supplementary Material S1 for item statistics, factor loadings after oblique rotation, communalities, Eigenvalues, and explained variance of the factors). The two-factor solution explained 47% of sample variance. All items loaded exclusively on their target factor with factor loadings > 0.30, except for one item with factor loadings < 0.30. Communalities were acceptable with $h^2 > 0.30$, except for one item with $h^2 = 0.29$. We interpreted the resulting factors as follows: *behavioral symptoms* (9 items on sleep, concentration, and emotional expression, etc., e.g., "I find myself crying because of climate change.") and *cognitive consequences* of climate anxiety (3 items, e.g., "I think, 'why do I react to climate change this way?'"). The second factor had an Eigenvalue < 1 and a one factor-model without the problematic item (Satorra-Bentler χ^2 [54, $N = 1011$] = 260.35, $p < 0.001$;

Robust CFI = 0.92; Robust TLI = 0.90; AIC = 34,185.63; Robust RMSEA = 0.085, 90% CI [0.074, 0.095]; SRMR = 0.051) had better model fit than the original two factor-model (χ^2 [10, n = 1011] = 69.81, p < 0.001, see Table S1 in Supplementary Material 1 for an overview over all factor analyses). Even though we evaluate neither model to be satisfactory, we decided to use a single score of climate anxiety in the following analyses. Using the simpler model eases interpretability of our results.

4.1.2 Climate anxiety and socio-demographics

On average, participants reported low climate anxiety (M = 1.81). They reported low levels of general anxiety and depressiveness, medium–low levels of climate denial, medium levels of right-wing ideological beliefs, medium–high levels of basic psychological need satisfaction, relatively intrinsic value orientations, high policy support, and medium pro-environmental intentions. An inspection of scatter plots and bivariate correlations revealed climate anxiety not to differ with age. A Welch two sample t-test revealed people identifying as female to report significantly more climate anxiety than people identifying as male, t(1009) = − 2.96, p = 0.003, d = 0.19, 95% CI of group difference (− 0.25, − 0.05), $M(SD)_{female}$ = 1.88(0.83), $M(SD)_{male}$ = 1.73(0.80). A Kruskal–Wallis test indicated no differences in climate anxiety between levels of education, H(7) = 8.93, p = 0.258. Climate anxiety was unrelated to income in our sample.

4.2 Potential correlates of climate anxiety

We display descriptive statistics of the main study variables in Table 1 and Spearman correlations between the main variables in Tables 2 and 3. To ease interpretation, we also report correlation coefficients in writing. Supporting H1, the overall mean score of climate anxiety was related to general anxiety and depressiveness in our sample (r = 0.25). Supporting H2, climate anxiety was negatively correlated with most types of climate denial. People reporting higher climate anxiety reported less literal climate denial, denied global consequences of climate change less, rationalized climate change less, and reported less denial of guilt for climate change ($r's$ = − 0.37 to − 0.13). However, they reported more avoidance of climate change in their everyday lives (r = 0.17). Denial of personal outcome severity was not correlated with climate anxiety. Contrary to H3, climate anxiety was unrelated to the examined ideological beliefs of system justification, SDO, and RWA and correlated slightly positively with human dominance over nature (r = 0.08). In line with H3, we found a weak negative correlation with political orientation (r = − 0.11), such that people reporting a more left-wing political orientation reported more climate anxiety. Mostly supporting H4, climate anxiety correlated negatively with the satisfaction of basic psychological needs for relatedness (r = − 0.10) and autonomy (r = − 0.14) but not competence and positively with frustration of relatedness (r = 0.27), autonomy (r = 0.20), and competence (r = 0.29). Supporting H5, climate anxiety was weakly related with the importance (r = 0.13) and the likelihood (r = 0.09) of aspirations: The more important people rated extrinsic relative to intrinsic aspirations, the more climate anxiety they reported. Contrary to H6, we found a weak positive correlation between climate anxiety and policy support (r = 0.17) and a medium positive correlation between climate anxiety and pro-environmental behavioral intentions (r = 0.44).

Additionally, we examined the relative explanatory value of all potential correlates of climate anxiety in an exploratory regression model. This is important because testing

Table 2 Spearman correlations of climate anxiety with well-being correlates

	1	2	3	4	5	6	7	8	9
1. Climate anxiety	-								
2. General anxiety and depressiveness	.25**	-							
3. Relatedness satisfaction	−.10**	−.30**	-						
4. Relatedness frustration	.27**	.45**	−.41**	-					
5. Competence satisfaction	.01	−.21**	.28**	−.02	-				
6. Competence frustration	.29**	.55**	−.32**	.65**	−.12**	-			
7. Autonomy satisfaction	−.14**	−.35**	.44**	−.34**	.29**	−.38**	-		
8. Autonomy frustration	.20**	.47**	−.28**	.63**	.03	.61**	−.48**	-	
9. Importance of aspirations	.13**	.03	−.15**	.20**	.11**	.15**	−.14**	.14**	-
10. Likelihood of aspirations	.09**	.13**	−.20**	.22**	.02	.20**	−.20**	.22**	.59**

Note. $N = 1011$

† $p < .10$

* $p < .05$

** $p < .01$

Table 3 Spearman correlations of climate anxiety with environmental and ideological correlates

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Climate anxiety	-												
2. Rationalization	-.17**	-											
3. Avoidance	.17**	.44**	-										
4. Denial of global outcome severity	-.05†	.61**	.45**	-									
5. Denial of personal outcome severity	-.15**	.65**	.42**	.72**	-								
6. Denial of guilt	-.37**	.57**	.10	.46**	.57**	-							
7. Literal denial	-.13**	.61**	.37**	.63**	.83**	.53**	-						
8. System justification	.04	-.18**	-.06†	-.02	-.14**	-.20**	-.18**	-					
9. Social-dominance orientation	-.03	.34**	.22**	.34**	.35**	.25**	.34**	.06†	-				
10. Right-wing authoritarianism	.00	.34**	.27**	.31**	.39**	.33**	.40**	-.18**	.45**	-			
11. Human dominance over nature	.08*	.34**	.25**	.38**	.37**	.22**	.34**	.07*	.34**	.31**	-		
12. Political orientation	-.11*	.34**	.14**	.29**	.36**	.32**	.34**	-.04	.41**	.46**	.23**	-	
13. Policy support	.17**	-.42**	-.27**	-.46**	-.56**	-.40**	-.54**	.04	-.33**	-.30**	-.38**	-.36**	-
14. Pro-environmental intentions	.44**	-.49**	-.27**	-.38**	-.44**	-.40**	-.39**	.07	-.27**	-.26**	-.17**	-.33**	.40**

Note. N = 1011, except for correlation with policy support (*n* = 973)

† *p* < .10

* *p* < .05

** *p* < .01

multiple bivariate correlations in a large sample might lead to random significant findings. We controlled for gender, age, and income. Our sample was sufficiently large (required sample size to detect a small effect of $f^2 = 0.03$ with $\alpha = 0.05$ and $1\text{-}\beta = 0.90$ was $N = 965$, G*Power 3, Faul et al. 2007). We found no evidence for multicollinearity and singularity (VIF < 10). Because climate anxiety was not normally distributed, we used log-transformed data where appropriate. The model explained 40% of the variance in climate anxiety ($F[25, 947] = 25.62$, $p < 0.001$, $R^2 = 0.40$, $R^2_{adjusted} = 0.39$). Pro-environmental intentions ($\beta = 0.43$, $p < 0.001$, 95% CI [0.41, 0.45]) emerged as the strongest correlate. Further significant correlates were avoidance ($\beta = 0.21$, $p < 0.001$, 95% CI [0.19, 0.23]), denial of personal outcome severity of climate change ($\beta = 0.08$, p < 0.041, 95% CI [0.02, 0.14]), human dominance over nature ($\beta = 0.11$, $p < 0.001$, 95% CI [0.09, 0.13]), general anxiety and depressiveness ($\beta = 0.10$, $p = 0.004$, 95% CI [0.03, 0.17]), competence frustration ($\beta = 0.09$, $p = 0.026$, 95% CI [0.06, 0.11]), right-wing political orientation ($\beta = 0.06$, $p = 0.049$, 95% CI [0.06, 0.06]), and age ($\beta = 0.15$, $p < 0.001$, 95% CI [0.15, 0.15]). However, given the absence of a bivariate correlation between age and climate anxiety and a correlation of *left*-wing political orientation and climate anxiety, relations with age and political orientation should be interpreted cautiously. Denial of guilt ($\beta = -0.26$, $p < 0.001$, 95% CI [$-0.34, -0.18$]) was negatively related to climate anxiety.

5 Discussion

Understanding people's emotional responses to the climate crisis and its devastating consequences is vital. This is the first study to investigate climate anxiety in a well-powered German-speaking quota sample. Overall, people only reported low levels of climate anxiety. Those who reported higher levels of climate anxiety, however, reported more general anxiety and depressiveness (supporting H1). People with higher climate anxiety also denied climate change to a smaller extent (supporting parts of H2) and experienced lower basic psychological need satisfaction (supporting H4). They expressed stronger pro-environmental intentions and supported climate-relevant policies more than those scoring low on climate anxiety (contradicting H6). Less intuitively, climate anxiety in this sample related positively yet slightly to beliefs in human dominance over nature and was unrelated to system justification, SDO, and RWA (contradicting parts of H3). The more climate anxiety people reported, the more they supported extrinsic values (supporting H5). Furthermore, we found no evidence for the factors *cognitive-emotional* and *functional impairment* as proposed by Clayton and Karazsia in the original study (2020).

In the following, we discuss our initial evidence of correlates of climate anxiety in relation to previous findings. Then, we critically review the CAS as an instrument and reflect on our own learning process while conducting the study. We finish with limitations and recommendations for future research.

5.1 Initial evidence of correlates of climate anxiety

Our results both confirm and contradict existing research. Similar to findings in the USA (Clayton & Karazsia 2020), high levels of climate anxiety were not very common in our German-speaking quota sample. On average, people reported low levels of climate anxiety, and there were significant floor effects. Replicating literature that generally finds women to experience more climate-related anxiety and worry (Clayton & Karazsia 2020; Searle

& Gow 2010), women in our sample reported more climate anxiety. Our results regarding age are inconclusive. While younger people reported more climate anxiety and concern in prior research (Milfont et al., 2021), we found no bivariate correlation with age, and a positive relation in the regression analysis accounting for all assessed variables, indicating that rather older people were more anxious about climate change.

As predicted, the more climate anxiety people experienced, the less climate denial they expressed. This confirms findings by Kapeller and Jäger (2020) who showed climate anxiety and denial to be negatively related in a simulation study. One exception in our study is avoidance: People with climate anxiety tended to avoid engaging with climate change information in their everyday lives. In line with Norgaard (2011), people who avoid information about climate change may acknowledge climate change as a severe problem and may experience uncomfortable emotions when they are confronted with it. An avoidance of the trigger in everyday life may calm this experience. This is in line with findings by Epstein (1972) showing that people who feel anxious often feel overwhelmed and tend to avoid engaging with the subject matter of their anxiety.

Contrary to our predictions, climate anxiety was unrelated to most ideological beliefs in our sample and was slightly positively related to beliefs of human dominance over nature. One explanation could be that the climate change debate is less polarized along political ideology in Germany than in the USA (Hornsey et al. 2018). Moreover, emotional reactions to the climate crisis might not yet be perceived as part of the political climate change debate and may thus not activate people's political identities. Given that risk perception and coping with climate change are also socially constructed (Lamb et al. 2020; Norgaard 2006b), ideological beliefs are only one factor that influences how likely people acknowledge and report climate anxiety (see Lertzman 2015). Regardless of ideological beliefs, one may feel deeply troubled in the face of climate change. This may explain the absence of respective relations in our study.

Supporting H4, the less satisfaction of their basic psychological needs for autonomy, competence, and relatedness people experienced, the more climate anxiety they reported. Our result is in line with the theoretical underpinnings of self-determination theory (Deci & R.M. Ryan 2000) and replicates previous findings on need frustration and anxiety (Halvari et al. 2019; S. Ryan & McGuire 2016), worry (Howell & Sweeny 2019), and depressiveness (Heissel et al. 2018). People who indicated that extrinsic values were relatively more important for them reported higher climate anxiety. They may feel more threatened because climate change impairs the pursuit of extrinsic aspirations such as the pursuit of status.

5.2 Validity and reflections on the Climate Anxiety Scale

We were not able to reproduce the factors *cognitive-emotional impairment* and *functional impairment* of the CAS in our sample. We interpreted the factors emerging from an exploratory factor analysis in our sample as *behavioral symptoms* and *cognitive consequences* of engaging with climate change. However, rather than recommending the use of the scale and interpretation of these factors, we raise a general discussion of the CAS, specifically with regard to the content and the clinical significance of climate anxiety as assessed in this scale.

5.2.1 What does the Climate Anxiety Scale measure?

Studying the scale and its constituent items more closely when analyzing the data, we became skeptical as to whether the scale actually captures the emotional core of climate anxiety that would differentiate it from other emotions. Many of its items are based on a measure of rumination, which is a typical symptom of depression (see Clayton and Karazsia (2020)). It may thus be misleading to talk about climate anxiety in this case. A more accurate term could be climate-related *emotional impairment* as a consequence of climate-related distress. Therefore, our results may be interpreted with care in the sense that we may not be able to talk about correlates of climate anxiety per se. We consider the CAS as a measure that summarizes different possible impairments resulting from the climate crisis. However, it does not capture emotional experiences of climate anxiety. This should be targeted in the future by more complex and multi-faceted assessments. The current CAS could be used to measure climate-related emotional impairment as part of such an instrument but needs further development to capture gradations and degrees of severity of climate anxiety. Based on our findings and interpretation, we suggest to rework the scale by (1) including an emotional factor that assesses a range of anxiety-related feelings, such as worry, fear, and anxiety; (2) including "classic ingredients in anxiety" such as "difficult feelings of uncertainty, unpredictability, and uncontrollability" that climate change produces (Pikhala 2020, p. 2); and (3) extending the cognitive factor to better grasp the definition of climate anxiety as "the generalized sense that the ecological foundations of existence are in the process of collapse" (Albrecht 2012, p. 250).

5.2.2 Is climate anxiety clinically relevant?

While we understand climate anxiety to be an adaptive response to the existential threat of climate change, we see value in discussing whether it may indeed require clinical support. In fact, some authors (Clayton & Karazsia 2020; Cunsolo et al. 2020) argue that this may potentially be the case, especially for people with underlying symptoms of anxiety, depression, or stress (Searle & Gow 2010). In our sample, the correlations of climate anxiety with general anxiety and depressiveness were significant but low. Clayton and Karazsia (2020) report higher correlations, indicating that the reported climate anxiety may be more clinically significant in their US sample than in our German-speaking sample.

Furthermore, our study shows that people reporting higher climate anxiety avoid information about climate change in their everyday lives, perhaps to protect themselves from experiencing even more troubling emotions. This might be a relatively adaptive self-protective response to anxiety, as it avoids stimulating the anxiety in everyday life and thereby avoiding its potentially debilitating effects (Salander & Windahl 1999).

In the case of pathological anxiety, people likely are unable to act (Barlow 2002). "Pathological" refers to human experiences that derive from a manifested disease, not an adaptive response to an existential crisis. Contradicting the findings of the original study (Clayton & Karazsia 2020), people in our study with higher climate anxiety reported more pro-environmentalism. For example, people reporting climate anxiety also reported higher support for climate-mitigation policies. This may indicate a deep understanding in this group of people that climate mitigation also requires structural measures that go beyond individual behaviors. Perceiving government action as insufficient (i.e., absence of effective climate-supportive legislation) and associated feelings of uncontrollability or

hopelessness may perpetuate the anxiety and associated impairments. This is in line with former results, showing *climate change distress* (i.e., anxiety, sorrow, loss) to be a predictor of pro-environmentalism (Kleres & Wettergren 2017; Reser et al. 2012). This may indicate that the reported impairment (and possible underlying climate anxiety) is not pathological but adaptive (Verplanken et al. 2020). It may be a practical anxiety (Kurth 2018)—an activating emotion that moves people to remove the threat and behave pro-environmentally when the anxiety does not become too overwhelming. Thus, we interpret our study in line with Pikhala's (2020) summary of a multitude of disciplines that describe *eco-anxiety* as a non-pathological phenomenon.

Nevertheless, no one in our sample reported high levels of climate-related emotional impairments. It may be possible that an underlying anxiety about the climate crisis—a rational fear—may cause levels of impairment that may require therapeutic support to cope and maintain or regain functioning. However, based on this research, we can only speculate on relations with behavior and the requirement of clinical support. Given that climate anxiety will likely increase in the future (e.g., Cunsolo et al. 2020), future research should recruit "extreme groups" that report higher levels of climate anxiety to understand the genesis, complexity, and functionality of climate anxiety and requirement of therapeutic interventions. Similar to relations of stress or other forms of anxiety with behavior, relations of climate anxiety and different outcomes may be non-linear (see Yerkes & Dodson 1908), such that very low and very high climate anxiety may be related to absence of behavior, whereas medium levels of anxiety may be related to higher levels of behavior. Larger variance in the data would allow to uncover such relations.

5.3 Limitations and future directions

Our study has two strengths that set it apart from other studies in the field. First, it is the first empirical psychological study investigating climate anxiety in a well-powered German-speaking quota sample, stratified for age and gender. Second, it provides a theoretically sound analysis of potential psychological correlates of climate anxiety. Nevertheless, we cannot draw conclusions representative for the German population, as this would have required a random sampling procedure. Moreover, one needs to be cautious in terms of generalizing the current findings to other contexts. Different emotional responses to the climate crisis are normative in and contingent on different cultures (see Kleres & Wettergren 2017; Norgaard 2011). Germany represents a different cultural context than the USA, where the original measure was developed, even though both are industrialized Western nations. Even though we do not expect that it significantly influenced our findings, our measurement of climate anxiety differs from that of the original study (Clayton & Karazsia 2020) because we only included the two core dimensions of the CAS.

Furthermore, we used self-report measures. Besides common difficulties inherent in self-report measures (e.g., Kormos & Gifford 2014), something as complex, sensitive, and deeply contextualized as climate anxiety may simply not be fully captured using a self-report measure (Lertzman 2015). This research is thus inherently limited to the conscious perception and explicit acknowledgment of climate anxiety. Finally, our study is limited by its cross-sectional design. Processes underlying climate anxiety, for instance, different coping strategies people use to reduce their anxiety over time, cannot be uncovered in cross-sectional designs. Future studies should thus employ mixed methods, longitudinal approaches to capture the development, complexity, contradictions, salience, and unconsciousness of climate anxiety. One approach may be to create and investigate protected spaces, in which people can fully

express, acknowledge, and work through their climate-related emotions in a supportive group (perhaps similar to death cafés, e.g., Miles and Corr (2017), or work on grief and active hope, Macy and Johnstone (2012)). Another could be to combine in-depth interviews about the climate crisis with psycho-physiological measurements.

6 Conclusion

This study is the first to systematically investigate correlates of climate anxiety in a German-speaking quota sample. We found that basic psychological need frustration, left-wing political orientation, and absence of climate denial are related to climate anxiety. Given that we could not satisfactorily replicate the original factor structure of the CAS, we recommend to rework the scale by including the emotional core of the anxious experience and use this extended measure in creative, mixed-methods approaches. This would aid not only our understanding of climate anxiety but also contribute to productive ways of working with this anxiety in a world that faces the climate crisis and is in dire need of a socio-ecological transformation to ensure a livable planet.

Availability of data and material The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Code availability Code used to analyze the data presented in this article is available on request.

Declarations

Ethics approval This study was approved by the local ethics committee (293_2020) and was in line with the Declaration of Helsinki.

Consent to participate All participants provided their informed consent before participating in this study.

Consent for publication All participants consented to the results of the study being published in a scientific publication.

Conflict of interest The authors declare no competing interests.

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