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Climate Anxiety Among Undergraduates at an R1 University in the United States

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Abstract

Climate anxiety is an emerging public health concern, particularly among young adults. Using survey data, this study examines the prevalence, emotional dimensions, and predictors of climate anxiety among 547 undergraduate students at a large university in the U.S. Mountain West. Results show that undesirable responses—especially powerlessness, frustration, and worry—are most common, though some students report hope and optimism. We assessed climate anxiety based on responses to ten questions, eight taken from a global survey of adolescents and young adults. We find that climate anxiety in the surveyed population scales nearly isometrically with generalized anxiety and depression (assessed using the GAD-7 scale) and is relatively common. Additional predictors of climate anxiety include whether climate change is a top personal concern, frequency of exposure to climate information—especially online and in classrooms—and political ideology. Academic major was not a significant predictor, contrary to expectations; although, environmental studies students on average had higher climate anxiety than students from other majors. Findings highlight climate anxiety as both a mental health risk and a potential motivator for engagement, underscoring the need for supportive interventions and engagement opportunities for undergraduate populations.

Keywords: climate anxiety; generalized anxiety; affective responses; environmental studies; information sources

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1. Introduction

The emotional toll of environmental degradation, like mental health in general, is not at the forefront of policy or pedagogy discussions [1–3]. Climate anxiety is a specific form of ecological anxiety related to perceived concerns about how climate change will affect oneself, friends and family, cherished habitats or wildlife, and life-supporting ecological systems over short and long time scales [4]. Both ecological anxiety and climate anxiety represent a spectrum [5], ranging from emotions leading to adaptive action and engagement [6–8] to denial and dysfunction in daily life [4,7].

Children and young adults may be more prone to climate anxiety than older adults, given climate change and its effects have been societal concerns throughout their

lives [9–14]. A report from the American Psychological Association in 2020 found that 67% of 18–23 year olds in the U.S. felt somewhat or extremely anxious about the impact of climate change, compared with 63% of 24–39 year olds, 58% of 40–55 year olds, and 42% of 56–74 year olds [9]. On a worldwide scale, ref. [15] found that 59% of 10,000 adolescents and young people, ages 16–25, in 10 countries (Australia, Brazil, Finland, France, India, Nigeria, Philippines, Portugal, the UK, and the USA) were very or extremely worried about climate change, and 84% were at least moderately worried. Climate anxiety within this demographic is thus a worldwide phenomenon. Furthermore, climate anxiety is expected to intensify among youth and young adults as the effects of climate change become increasingly apparent in daily life, and if meaningful mitigation targets are not met [15].

Adolescents and young adults are particularly vulnerable to mental health effects because mature coping capabilities and resilience are nascent or still evolving [12,13]. Consequences related to worry about climate change among children and adolescents (e.g., anxiety, depression, sleep disorders, and substance abuse) can lead to problems with emotional regulation, cognition, learning, and academic performance [10]. These responses are of concern for students matriculated in post-secondary education, a critical time for the development of knowledge and skills needed to be productive and engaged adults in society. Students with high levels of climate anxiety report that climate change is a key factor when making major life decisions, including career choice [16,17]. Classroom pedagogy therefore plays an important role in how difficult topics are delivered to students [18], and whether students can critically evaluate information to which they are exposed [17,19]. Instructors risk exacerbating climate anxiety by neglecting the affective responses of their teaching [20,21]. Despite this evidence pointing to pedagogy as a means to mitigate climate anxiety, it is still unknown the extent to which classroom instruction influences climate anxiety relative to the assimilation of climate news from other information sources.

Research on climate anxiety among undergraduate students shows that it is both widespread and closely tied to levels of mental health and environmental awareness. Studies across diverse contexts—including the United Kingdom, United States, South Africa, Italy, Mexico, and the Philippines—indicate that students with greater exposure to climate change information, whether through formal education or media consumption, tend to report higher levels of climate anxiety [16,22,23]. This pattern is particularly evident among environmentally focused students, who often experience heightened concern alongside stronger identification with nature [16,24]. Yet, it is still unclear if differences in the focus of degree programs are a universal distinction across institutions of higher education, particularly in water-limited regions where the effects of climate change are regularly in mainstream news.

Climate anxiety in undergraduates students has been linked to symptoms of generalized anxiety and depression (GAD; [25,26]). However, existing questionnaires often used to assess climate anxiety potentially conflate climate anxiety with generalized anxiety and depression (GAD). Ref. [27] developed a questionnaire with twenty-two questions divided into two sets: the first thirteen questions constitute a Climate Anxiety Scale (CAS) measuring both cognitive-emotional impairment and functional impairment, while the other nine questions capture an individual's experience with climate change and behavior engagement. The Hogg Eco-Anxiety Scale (HEAS; [28]) includes thirteen questions quantifying affective and ruminative mental states, as well as indicators associated with general behavior (e.g., sleep) and perceived behavioral effect on environmental problems. A correlation between climate anxiety and GAD based upon the CAS or HEAS may be expected because some of the questions in these tools are similar to questions used in the seven question scale (GAD-7; [29]) used by physical and mental health professionals to diagnose

generalized anxiety and depression. It is important to be able to distinguish climate anxiety from GAD, as the two may be independent mental states driven by different factors among undergraduate populations [23]. The development of tools that isolate climate anxiety from GAD is needed to better understand the relationship between these phenomena and test their independence.

Here, we examine the common affective responses and prevalence of climate anxiety experienced by nearly 550 undergraduate students. We quantify the prevalence of climate anxiety using ten questions, including eight questions posed by [15], to gauge beliefs about climate change. We independently quantify the prevalence of generalized anxiety and depression using the GAD-7 scale [29] and assess the relationship between climate anxiety and GAD using an approach that does not assume causality between factors. Finally, we assess the factors contributing to climate anxiety, with the goal of identifying approaches to mitigate mental health effects that may impair student well-being. The present work adds to the growing number of studies assessing climate anxiety in undergraduate populations around the world. It is the only study of undergraduate students to simultaneously assess affective responses and predictors of climate anxiety.

2. Research Questions and Hypotheses

Undergraduate students enrolled in courses focused on climate change commonly experience a range of affective responses [21], including frustration, guilt, anger and sadness. Yet, some students also report feelings of hope and optimism [7,30]. Despite the potential regularity of these responses to education about the climate crisis, emotions are largely ignored in higher education settings [1,21,31]. Emotional responses must be described to fully understand how individuals experience climate anxiety. We thus ask:

RQ1: What are the affective responses to climate change identified by undergraduate students?

Undergraduate students are at a critical juncture in life when factors, such as academic progress, finances, and relationships, are major concerns [32,33] that co-occur with or possibly supersede climate anxiety. Consequently, generalized anxiety and depression are relatively common among undergraduate students [25]. Growing empirical evidence suggests climate anxiety and generalized anxiety are well-correlated [14,34–38], but it is unclear if the relationship between these phenomena may be bidirectional. Given this evidence, we examine the following hypothesis:

H1. *Climate anxiety and general anxiety and depression are positively correlated, but independent, phenomena.*

We also investigated whether students who experience chronic stressors as a result of their identity, such as gender and/or race, may differentially experience climate anxiety. Females tend to exhibit more stress related to climate change than males [23,39]. There are many internal and external forces driving this phenomenon. For example, members of dominant sociodemographic groups, often White males, tend to perceive less risk relative to individuals who belong to other groups [40]. Females are more likely to suffer from anxiety than men [41], due in part to a heightened sensitivity to unpredictable threats [42]. Furthermore, females worldwide are disproportionately affected by climate change, exacerbating the risk of negative mental health impacts [43–45]. We are thus interested in whether undergraduate females experience greater climate anxiety relative to their male counterparts.

Climate change and, more specifically, climate injustice are experienced differently by various groups of people [46,47]. Some argue that climate discourses center whiteness

and need to recognize the different ways in which people of color experience and manage conditions presented by climate change (e.g., [30]). Others have recognized that this may be more appropriately termed a "social inequality effect" [48], because perceptions of risk are typically higher among minority groups in society. However, ref. [49] found that those who are socially privileged are often more engaged in climate science, policy, and advocacy and are therefore more likely to experience climate anxiety than those who are socially disadvantaged, despite being more susceptible to the detrimental effects of climate change. Along these lines, and given the lack of empirical evidence from which we can derive a clear hypothesis, we pose the following research question:

RQ2: Does climate anxiety vary among individuals of different race/ethnicity or gender?

Climate anxiety may be common among undergraduate students majoring in a variety of disciplines, given the growing concern about climate change among youth and young adults [15]. Yet, students whose coursework or degree programs focus on climate change from physical, biological, or sociocultural perspectives may be particularly vulnerable to climate anxiety stemming from consistent exposure to climate challenges uncoupled from pedagogical approaches that acknowledge and validate students' emotional responses [21,50]. Two independent surveys of undergraduate students in the United Kingdom and at a mid-Atlantic state university in the U.S. found that students pursuing an environmental degree reported greater levels of climate anxiety than students majoring in non-environmental degrees [16,24]. Other studies found that students with greater knowledge of climate change feel more stress about it, without specifying differences in major [17,23]. Few studies have quantified the prevalence of climate anxiety among undergraduate students across a variety of majors while also assessing whether exposure to climate information in the classroom influences climate anxiety. We posit that:

H2. *Students who are majoring in environmental degrees have heightened climate anxiety than students whose major is unrelated to the environment due to greater exposure to climate change information in the classroom.*

Many of us experience and learn about climate change through mediated experiences. In the contemporary media environment, mediated experiences consist primarily of online media use. The media coverage of climate change's impacts and responses tends to be saturated with threat information undermining perceived self-efficacy [51]. Ref. [52] reported that young people (aged 18–26 years) have a strong sense of behavioral inefficacy about climate change that is impacted by messages in the media and social media networks. The trend of "doom-scrolling," or consuming negative news online or via social media, promotes negative emotional consequences [53]. Evidence shows that consuming climate information through online and social media, particularly in visual form, is positively associated with climate anxiety [22,23,54,55]. We thus expect frequency of exposure to information about climate change in online media to be related to climate anxiety among undergraduate students and want to assess the influence of online media relative to other sources of information.

Based on agenda setting theory [56,57], media tends to set and shape the public agenda and information consumed through media often form the basis for interpersonal conversations in daily life. Media coverage and subsequent discussions about climate change are no exception [22]. Younger generations (i.e., iGen and Millennials) are more likely to engage in discussions about climate change relative to older generations [58]. Thus, we are interested in whether and to what extent interpersonal discussions about climate change impact one's anxiety about the topic. One study found a positive association

between interpersonal discussion and climate anxiety [54]. However, given the limited scholarship on this relationship, we pose the following research question:

RQ3: How are frequency of exposure to climate information from different sources (classroom, online media, and interpersonal interactions) and climate anxiety related?

We are also interested in the interactive effects of individual factors, including race, gender, major, and political ideology, and climate information sources. Therefore, we investigate the interactions between these variables and their relationships with climate anxiety:

RQ4: Does climate anxiety vary as a function of interactions between individual demographic factors, including frequency of exposure to climate information from various sources?

3. Materials and Methods

Data were collected via convenience sampling, using voluntary surveys, from 1120 undergraduate students enrolled in three Environmental & Sustainability Studies (ENVST) courses and one Communication course over two semesters at the University of Utah, a large R1 institution in the U.S. Mountain West. The three ENVST courses in which the survey was deployed spanned introductory to advanced classes to invite responses from a range of student experiences within a degree program exploring aspects of climate science and policy: Introduction to Environmental Science, Global Climate Change, and an ENVST capstone course. All three ENVST courses are required by the ENVST major. The Communication course, Introduction to Quantitative Communication Research, is a mid-level research methods class that may be selected by students to complete a Communications major. Of the total number of responses, 573 were removed because the respondent did not provide consent, did not complete the survey, or completed the survey on more than one occasion. In total, 547 responses were included in the analyses.

Surveys were distributed to students using learning management system (LMS) technology. Students were offered extra credit in courses for completing the survey. Students were briefed on study objectives, risks of completing the survey, and survey length prior to starting the survey. Students were required to consent to taking the survey after reading the introductory information. To avoid any perception of coercion with respect to personal experiences, students were offered the option 'prefer not to say' for multiple choice responses. The survey was still considered complete if students opted not to respond to open ended questions. This study was approved by the Institutional Review Board of the authors' institution (IRB #00156671).

The environmental setting for this study is a semi-arid biome that historically receives an average of 394 mm of precipitation per year, primarily as snow [59]. However, the region has been experiencing a multi-year 'megadrought' exacerbated by rising, record-setting air temperatures over the last decade [60]. These climate phenomena, combined with patterns of human water consumption, have brought the Great Salt Lake to the brink of ecological collapse [61]—a situation that has been covered extensively in courses at the University of Utah, as well as in print and online media at regional to national scales.

3.1. Affective Responses

Respondents were prompted to rate their affective response to climate change using a 5-point Likert scale (1 = "Never," 5 = "A lot"; Figure 1): "How often in the last two weeks has the topic of climate change made you feel any of the following emotions?" Response options included the following emotions: "Happy", "Hopeful", "Optimistic", "Inspired", "Vulnerable", "Powerless", "Worried/Stressed", "Numb", "Indifferent", "Frustrated", "Fearful", "Depressed", "Ashamed", "Guilty", "Angry/Outraged", "Afraid",

"Anxious", and "Sad/Hurt". This inclusion of related emotions allowed for determination of individual consistency in affective state. Factor analysis using principal component analysis (PCA) and varimax rotation showed that emotional responses clustered into two categories generally considered 'undesirable' (sad, anxious, afraid, angry, guilty, ashamed, depressed, fearful, frustrated, numb, worried, powerless, and vulnerable; Cronbach's $\alpha = 0.95$, McDonald's $\omega = 0.95$) or 'desirable' (optimistic, inspired, hopeful, and happy; Cronbach's $\alpha = 0.82$, McDonald's $\omega = 0.87$), with the exception of "Indifferent" that loaded as an isolated category.

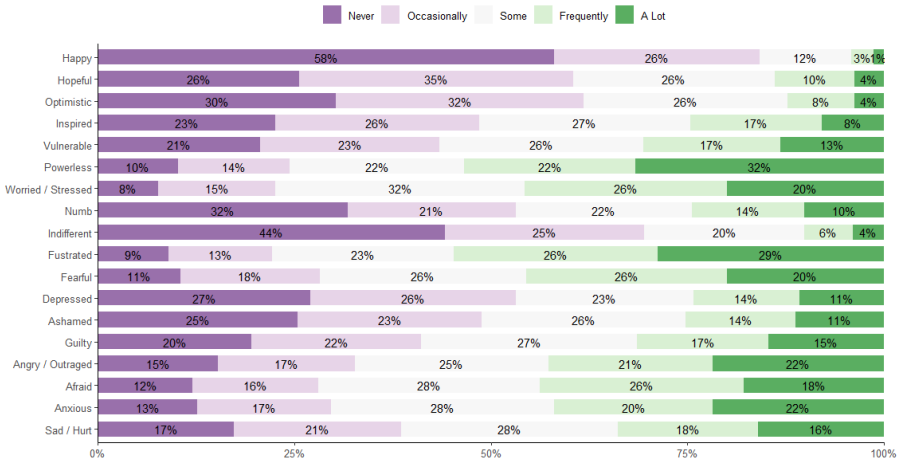

Figure 1. Student responses to varied affective responses regarding the topic of climate change. Rounding of percentages within each response category has resulted in row sums unequal to 100% in some cases.

3.2. Regression Measures

3.2.1. Dependent Variables

Climate anxiety ($M = 3.14$, $SD = 0.86$; Figures 2A and S1A) was assessed using ten questions, eight of which taken from [15]. Respondents were asked to rate their response to the following statements on a 5-point Likert scale (1 = "Never," 5 = "A lot"): "People have failed to take care of the planet," "The things I most value will be destroyed," "My family's security will be threatened," "I will not have access to the same opportunities my parents had," "The future is frightening," "Humanity is doomed," "I am hesitant to have children," "My feelings about climate change negatively affect my daily life," "I am worried about global warming," and "People dismiss me when I talk about climate change." Responses to these ten questions loaded onto a single factor based on PCA and varimax rotation (Cronbach's $\alpha = 0.89$, McDonald's $\omega = 0.90$), justifying the generation of an averaged climate anxiety index (CAI) used in subsequent statistical tests used to address our research questions and hypotheses.

We opted to use the questions posed by [15] because the authors did not include questions related to the GAD-7, although some of the questions can be construed as beliefs about climate change rather than symptoms of anxiety. We also wanted to compare our results to responses from the largest study to date of climate anxiety among youth worldwide. We included two additional questions because "My feelings about climate change negatively affect my daily life" addresses an immediate temporal scale, and "I am worried about global warming" centers the responses on climate change specifically, as compared to eco-anxiety in general.

3.2.2. Independent Variables

Gender (66.0% female) is a self-reported binary variable. Respondents were asked to identify their gender ("female," "male," "non-binary," or "prefer not to say"). Ap-

proximately 3.7% of the sample identified as non-binary or preferred not to provide this information. Given the lack of power to conduct statistical tests using such a small sample size, these responses were coded as missing data and excluded from subsequent analysis.

Race (69.3% White) is a self-reported categorical variable. Respondents were asked to identify their race/ethnicity by selecting from a list; they were allowed to select more than one race. If a respondent selected "White" and another race or ethnicity, they were coded as "non-White" in the resulting binary variable used in analysis. Although our survey included multiple categories of race/ethnicity, sample sizes for individual categories lumped within the "non-White" classification were too small to analyze separately.

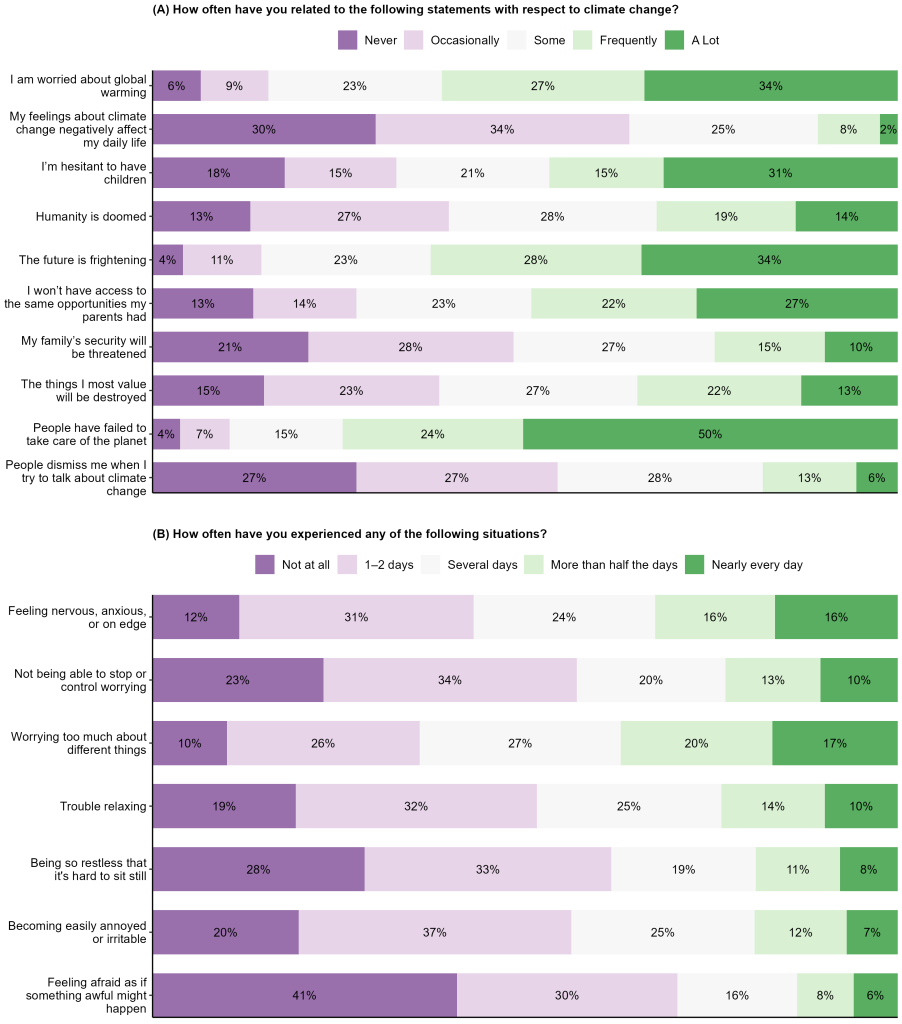

Figure 2. Distribution of responses to items measuring (**A**) climate anxiety (Climate Anxiety Index; CAI) and (**B**) general anxiety (Generalized Anxiety Disorder scale; GAD-7). Rounding of percentages within each response category has resulted in row sums unequal to 100% in some cases.

Political ideology ($M = 2.33$, $SD = 0.87$) is an index created by averaging two items asking respondents whether they are "very liberal" (1), "liberal" (2), "moderate" (3), "conservative" (4), or "very conservative" (5) on social and economic issues.

Major (36.8% ENVST majors) is a binary variable indicating whether the student is majoring in ENVST for their undergraduate degree.

Frequency of exposure to climate information in the classroom ($M = 3.94$, $SD = 1.22$) was a single-item measure asking respondents how often they obtained information about this issue from classes. We also created two other indices of frequency of exposure to climate information *online via social media, web searching, on streaming platforms, and in online news*

($M = 3.17$, $SD = 0.91$, Cronbach's $\alpha = 0.75$, McDonald's $\omega = 0.78$) and *through interpersonal sources* ($M = 2.75$, $SD = 0.99$, Cronbach's $\alpha = 0.74$, McDonald's $\omega = 0.74$). Measures of frequency of exposure to climate information from various media were measured using 5-point Likert scales ranging from "Never" (1) to "A lot" (5) (see Figure 3).

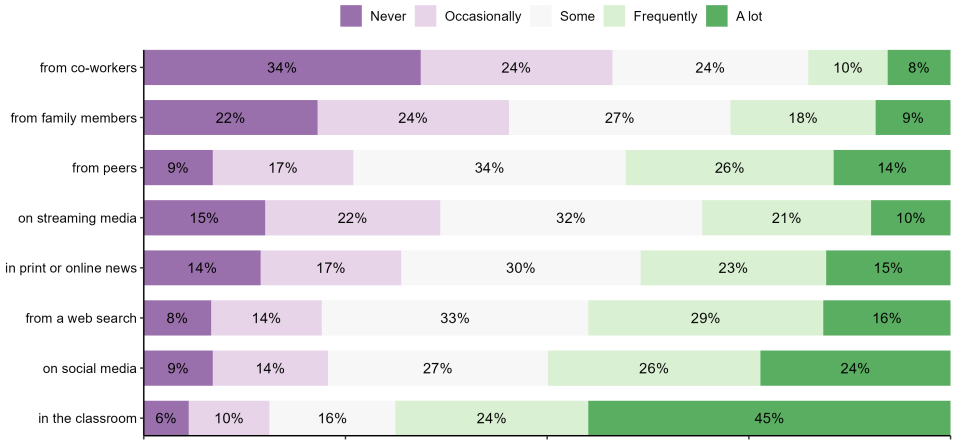

Figure 3. Distribution of student responses to items measuring frequency of exposure to climate information from various sources. Rounding of percentages within each response category has resulted in row sums unequal to 100% in some cases.

Climate as a top concern. Respondents were asked to rank their top three concerns in life from a list of 12 concerns (personal relationships, personal health, family health, access to health care, air pollution, water scarcity, social and environmental justice, finances, academic performance, air pollution, climate change, and land and wildlife conservation; Figure 4). *Climate as a top concern* is a categorical variable indicating whether climate change was listed among the top three concerns for each respondent (14.8% listed climate change in one of their top three concerns).

General anxiety (GAD-7; $M = 11.1$, $SD = 6.92$, Cronbach's $\alpha = 0.91$, McDonald's $\omega = 0.93$; Figures 2B and S1B) was a summative index of seven items measured on 5-point Likert scales (1 = "Not at all," 5 = "Nearly every day") developed by [29]. Respondents were asked how often, in the last two weeks, they experienced: "feeling nervous, anxious, or on edge," "not being able to stop or control worrying," "worrying too much about different things," "trouble relaxing," "being so restless that it's hard to sit still," "becoming easily annoyed or irritable," and "feeling afraid as if something awful might happen."

3.3. Data Analysis

We used R version 4.4.0 (2024-04-24 ucrt) for all our analyses. We employed descriptive statistics to examine which emotional responses students most frequently associate with climate change (RQ1). We conducted standardized major axis (SMA) regression using the CAI and GAD-7 measures to address H1. SMA differs from ordinary least squares (OLS) regression because it assumes the variables on both axes have error and calculates a symmetrical best-fit line such that the regression will be consistent regardless of which variable is plotted on axes. In short, neither variable is assumed to be dependent. We also used *t*-tests to compare GAD-7 and CAI scores (RQ2), and frequency of exposure to climate information from various sources (RQ3) between groups of respondents by gender, race and major.

To further address H1 and research questions 2–4, we conducted hierarchical OLS regression modeling to examine what factors predict CAI among students. We probed several interactions in the model using the Johnson–Neyman technique [62]; these were centered and entered in a single block in the last model. Independent variables were entered

into the model in assumed causal order based on theoretical considerations. Constituent variables of the interaction terms were centered prior to entering them into the model. We did not include race or political ideology in interactions included in the model as our sample consisted of primarily White individuals (69.3% White) who reported being left-leaning (63.1% of respondents scored below 3 on the five-point scale measuring conservatism). Visual inspection of residual diagnostic plots indicated that assumptions of normality and homoscedasticity were met for each model. Multicollinearity diagnostic tests showed that variance inflation factors (VIFs) for parameters within each model are within an acceptable range (<2 for Models 1–3) or signify moderate collinearity (4.3–6.9) for related items (e.g., information sources in Model 4; Table S1).

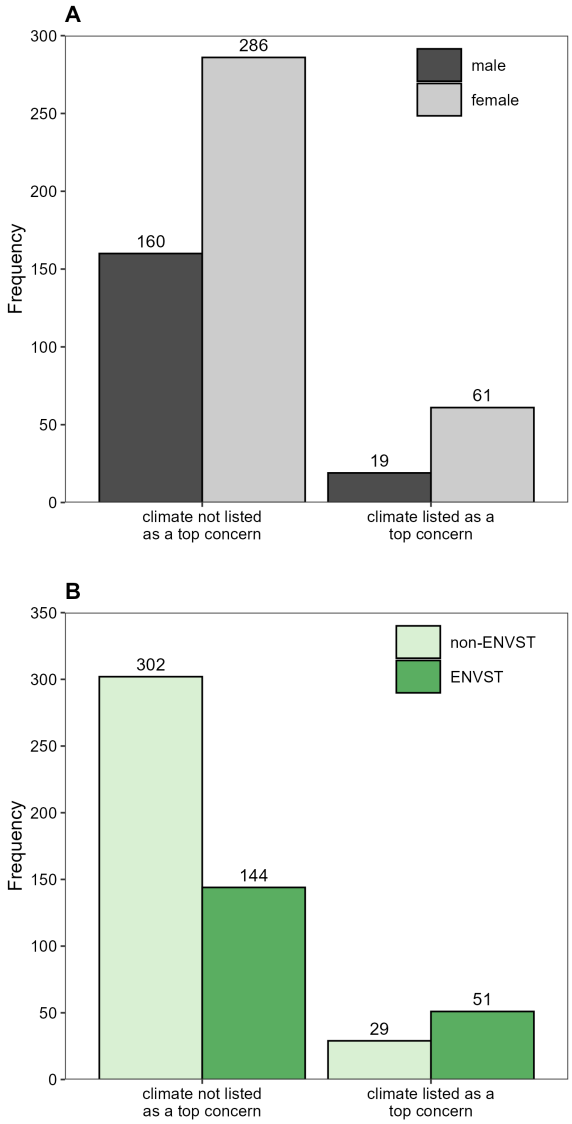

Figure 4. Frequency of students who listed climate change as one of their top 3 concerns by (**A**) gender and (**B**) major.

4. Results

Powerlessness (32%) and frustration (29%) were reported by students as the most common (i.e., "A Lot" category) responses evoked by climate change, followed by anger/outrage, anxiousness, fearful, and worried/stressed (all 20–22%; Figure 1). When also accounting for responses in the "Frequently" category, feelings of powerlessness and frustration were identified by just over half of survey participants (54% and 55%, respec-

tively), and anger/outrage, anxiousness, fearful, and worried/stress were reported by 43% to 46% of respondents. Feelings of hope and optimism were reported as being felt "A Lot" by only 4% of students, whereas less than one-third of students reported "Never" feeling these emotions. Yet, over one-third of students identified feelings of hope (40%) and optimism (38%) when considering responses in the "A Lot" through "Some" categories. Nearly one-third to over half of students reported "Never" feeling happiness (58%), indifference (44%) or numbness (32%).

Prior to Z-scoring, the CAI and GAD-7, both summative scales, ranged from 0 to 40 and 0 to 28, respectively. The mean score of CAI in our sample was 21.4 ($SD = 8.7$). Although the distribution of CAI in our sample was skewed left (Figure S1A), we found the opposite (i.e., right skew) in the distribution of GAD-7 in our sample ($M = 11.1$, $SD = 6.9$; Figure S1B).

The SMA between CAI and GAD-7 compared the slope and elevation of the fitted lines for students who are majoring in ENVST with those of non-majors (Figure 5). We found positive correlations between CAI and GAD-7 among ENVST majors (slope = 0.89; 95% confidence interval [CI]: 0.78, 1.01; $R^2 = 0.17$, $p < 0.001$) and non-majors (slope = 0.99; 95% CI: 0.90, 1.09, $R^2 = 0.18$, $p < 0.001$). Although the slopes of the lines among ENVST majors and non-majors are statistically equal to each other (likelihood ratio statistic = 1.78, $p = 0.18$), there was a significant difference in elevation between the groups (Wald statistic = 72.0, $p < 0.001$). The estimate of elevation for students who are majoring in ENVST was 0.47 (95% CI: 0.34, 0.60), while the estimate of elevation for non-majors was −0.28 (95% CI: −0.16, −0.39). These results indicate ENVST majors had greater climate anxiety than non-majors across all levels of generalized anxiety and depression, although the relationship between CAI and GAD-7 was similar across both groups.

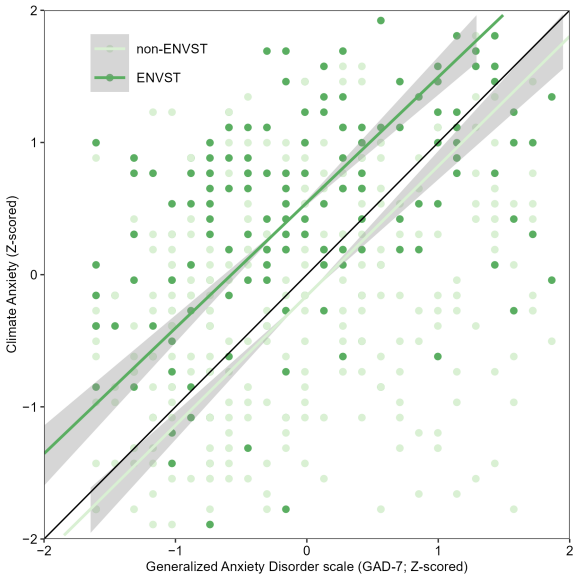

Figure 5. Standardized major axis estimation (SMA) between climate anxiety and general anxiety comparing students who are Environmental Studies (ENVST) majors (dark green circles and regression line) to non-majors (light green circles and regression line). Grey shading around regressions lines represent 95% confidence intervals.

We also conducted *t*-tests to examine whether GAD-7, CAI, and frequency of exposure to climate information from various sources varied by individual characteristics, including race, gender, and major (Figures 6 and 7). We found a significant difference in GAD-7 scores among male and female students, with female students scoring higher, on average, on this scale ($t(354) = -4.93$, $p < 0.001$; Figure 6A). Climate anxiety scores were significantly

different by gender ($t(370) = -4.70$, $p < 0.001$), race ($t(311) = -2.90$, $p = 0.004$) and major ($t(472) = -7.77$, $p < 0.001$); White students, females, and ENVST majors scored higher on CAI (Figure 6D–F). Regarding frequency of exposure to climate information in the classroom, online or through interpersonal interactions, ENVST majors had greater mean frequency of exposure relative to non-ENVST majors in all categories (all $p < 0.001$; Figure 7).

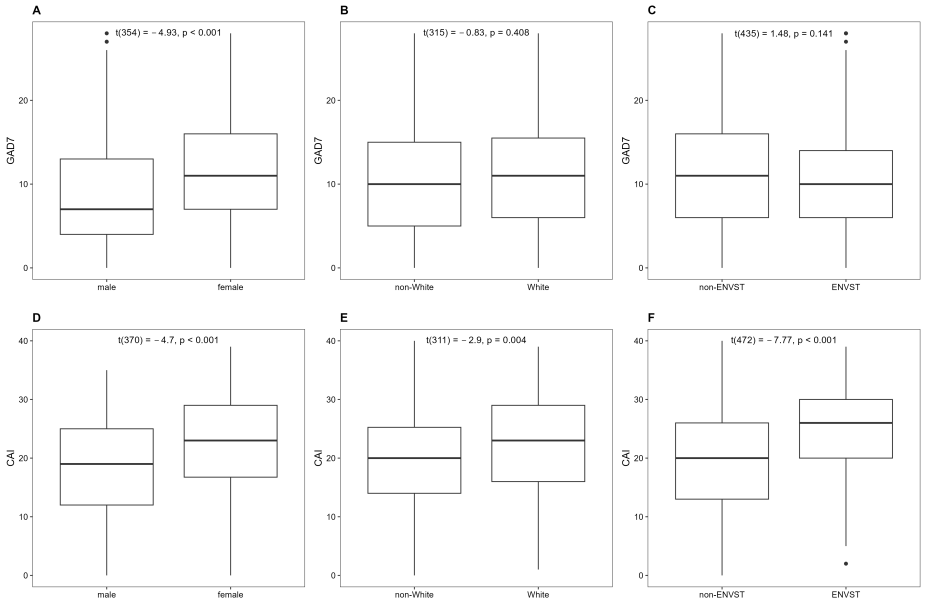

Figure 6. Boxplots of general anxiety (GAD-7; (**A**–**C**)) and climate anxiety (CAI; (**D**–**F**)) by gender, race, and major. Black circles indicate responses outside of the 25% and 75% quartiles.

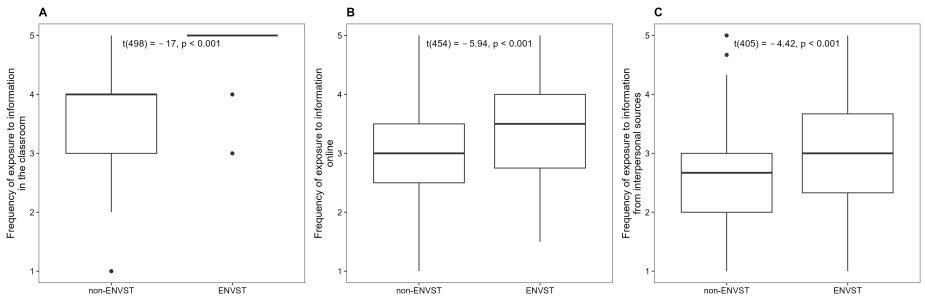

Figure 7. Boxplots of frequency of exposure to climate information (**A**) in the classroom, (**B**) online, and (**C**) from interpersonal sources by major. Black circles indicate responses outside of the 25% and 75% quartiles.

To address the remaining hypotheses and research questions, we fit an OLS regression model predicting CAI (*Z*-scored). The variables in the final regression model accounted for 52% of the variance in CAI (Table 1). In the final model, neither gender nor race predicted CAI. Surprisingly, CAI was not significantly correlated with students' major (ENVST vs. non-ENVST majors).

As expected, political ideology (conservative coded high) and CAI had a negative association. Frequency of exposure to climate information in the classroom and online both positively predicted CAI. Exposure to climate information through interpersonal sources was not related to climate anxiety. As also evinced by the SMA, general and climate anxiety were positively correlated. We included students' rankings of climate change as a top concern in our model. Unsurprisingly, students who listed climate change as a top concern also had higher CAI scores.

Of the interactions between individual factors and exposure to climate information from the various sources that we tested, we found only one to be significant. Students' major interacted with frequency of exposure to online information sources, thus predicting CAI (Figure 8). Specifically, among non-ENVST majors in our sample, frequency of exposure to climate information from online sources was significantly associated with increasing CAI. A simple slopes analysis resulted in a slope estimate of 0.26 ($p = 0.02$) among non-ENVST majors. Among students majoring in ENVST, the slope of this line was not significant (slope estimate = 0.06, $p = 0.61$). Therefore, there is no statistical difference in CAI between ENVST students who have more or less exposure to climate information online. Only among non-majors was this relationship between frequency of exposure to climate information online and CAI significant.

Table 1. Standardized regression coefficients and standard errors (in parentheses in hierarchical OLS models predicting climate anxiety (CAI; Z-scored) among students). All continuous predictors are mean-centered and scaled by 1 standard deviation. The outcome variable is in its original units.

	Model 1	Model 2	Model 3	Model 4
Constant	−0.42 *** (0.09)	−0.25 ** (0.08)	−0.23 ** (0.07)	−0.25 ** (0.08)
Gender (female)	0.23 ** (0.08)	0.19 ** (0.07)	0.09 (0.07)	0.11 (0.07)
Race (White)	0.14 (0.08)	0.11 (0.07)	0.08 (0.07)	0.08 (0.07)
Political ideology (conservative)	−0.41 *** (0.04)	−0.28 *** (0.04)	−0.22 *** (0.03)	−0.21 *** (0.03)
Major (ENVST)	0.41 *** (0.08)	0.08 (0.08)	0.12 (0.08)	0.10 (0.11)
Info source: Classroom		0.23 *** (0.04)	0.23 *** (0.04)	0.15 * (0.07)
Info source: Online sources		0.27 *** (0.04)	0.25 *** (0.04)	0.28 *** (0.08)
Info source: Interpersonal sources		0.05 (0.04)	0.02 (0.04)	0.08 (0.07)
Climate as a top concern			0.35 *** (0.09)	0.36 *** (0.09)
General anxiety (GAD-7)			0.27 *** (0.03)	0.28 *** (0.03)
Gender × Information source: Classroom				0.05 (0.08)
Gender × Information source: Online sources				0.05 (0.09)
Gender × Information source: Interpersonal				−0.02 (0.08)
Major × Information source: Classroom				0.14 (0.14)
Major × Information source: Online sources				−0.17 * (0.08)
Major × Information source: Interpersonal				−0.09 (0.08)
N	524	524	524	524
Adj. R-squared	0.29	0.44	0.52	0.52
F	53.39	60.32	63.63	39.22
df	4.00	7.00	9.00	15.00
p	0.00	0.00	0.00	0.00

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

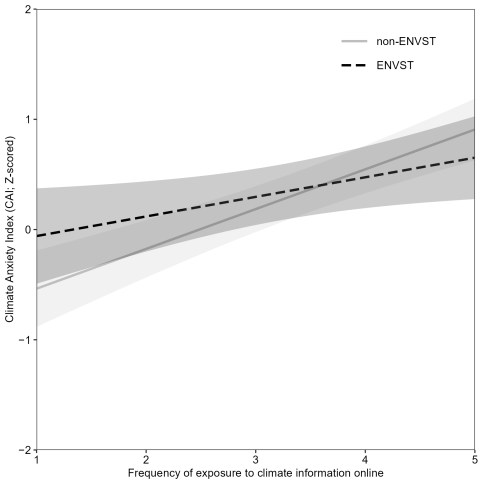

Figure 8. Interactive effect of major (ENVST, black dashed line; non-ENVST, solid grey line) and frequency of exposure to climate information online (including social media) on climate anxiety. Grey shading around regression lines represent 95% confidence intervals.

5. Discussion

5.1. Emotional Responses to Climate Change

Undesirable affective responses (e.g., 'powerlessness' and 'frustration') were most identified by undergraduate students who completed our survey. These affective responses are often associated with climate anxiety [1,27,28]. Yet, feelings of hope and optimism still persist among students who participated in our study, albeit at low levels of frequency. These results are unsurprising, given they corroborate other studies of adolescent and young adult affective responses to climate change at regional to global scales [15,63].

It is encouraging that the majority of students in our survey felt *some* emotion with respect to climate change, whether a positive or negative affective response. Identification and acknowledgment of affective responses are important steps toward activating coping strategies [7], climate action [2,64,65], or support for various policy strategies related to climate mitigation and adaptation [66,67]. The ability to channel emotions into engagement with respect to climate adaptation and mitigation remains possible, as long as indifference and numbness are rare responses, and affective responses do not debilitate daily activities [68].

5.2. Predictors of Climate Anxiety

5.2.1. Generalized Anxiety

We found that generalized anxiety is a predictor of climate anxiety in our study population, reinforcing results of previous studies of undergraduate populations [25] and broader groups of individuals [14,34–38]. The power of the GAD-7 index for predicting climate anxiety is notable because, unlike other the CAS or HEAS indices (Clayton and Karazia, 2020 [27]; Hogg et al., 2023 [28]), the way we assessed climate anxiety did not include questions related to general affective state or behaviors that are similar to questions included in the GAD-7 questionnaire. Our climate anxiety questionnaire also is shorter in length, increasing the likelihood that individuals will complete the survey [69,70].

Differences in the distributions of the GAD-7 and CAI indices suggest that students who participated in our survey more commonly identify with climate anxiety at moderate to high intensities, while generalized anxiety is more commonly experienced at low-to-moderate intensities. However, nearly isometric scaling between normalized scores of the GAD-7 index and our CAI indicates feelings of generalized anxiety and climate anxiety are proportional among the students surveyed for this study. This scaling between GAD-7 and CAI is based on standardized major axis regression that does not assume cause and effect, providing some evidence that these phenomena are correlated, yet independent (supporting hypothesis H1), and potentially have reciprocal influences.

5.2.2. Climate Change as a Top Concern

Climate as a top concern was among the strongest and most significant predictors of CAI in the present study, adding to the growing evidence demonstrating that higher perceived seriousness, worry, or risk is strongly associated with greater climate anxiety [14,25,35,37,38,71,72]. The majority of students in our survey worry about climate change (61%) "A Lot" or "Frequently", consistent with adolescents and young adults around the world [15]. In addition, worrying about climate change in iGen and Millennial generations has recently intensified to a greater degree relative to older generations of adults [58]. It is perhaps unsurprising that *climate as a top concern* was a strong predictor of climate anxiety as assessed in this this study, given that our CAI included questions about climate concern. Yet, it is striking that our survey participants often ranked *climate as a top concern* lower than other concerns, such as relationships, finance, and academic performance. These concerns have more immediate consequences on a daily basis, which is borne

out in broad-scale assessments of stressors undergraduates face [32,33]. Concern for climate thus has an additive effect that may amplify generalized anxiety. Consequently, interventions that help students address climate anxiety may also alleviate generalized anxiety.

5.2.3. Gender

Gender was a significant predictor of CAI in our study's first two regression models, but was no longer significant when we accounted for GAD-7 index responses. We found generalized anxiety to be, on average, greater for females relative to males, supporting results from studies of adults ([39,41], but see Whitmarsh et al., 2022 [14]). This gendered difference in generalized anxiety explains why gender was ultimately a non-significant predictor of CAI in our regression models. Ref. [23] also found females more likely to suffer from climate anxiety than males and non-binary individuals in a survey of 461 Mexican undergraduate students. However, female and male undergraduate students were equally susceptible to generalized anxiety in that study, leading the authors to conclude that climate anxiety is a distinct phenomenon from generalized anxiety. In contrast, both climate anxiety and generalized anxiety and depression were on average more pronounced for females in our study relative to males. This finding may be an indication of non-independence between climate anxiety and generalized anxiety and depression or the manifestation of heightened female perceptions of risk in multiple spheres of life [42].

Females have disproportionately participated in many studies of climate anxiety within undergraduate populations, ranging from 54% [16] to 75% [17] of survey respondents. Yet, gender is not consistently controlled for when assessing the link between generalized anxiety and climate anxiety, obscuring the ability to generalize the effect of climate anxiety on cisgendered individuals. Furthermore, non-cisgendered students have represented <5% of participants in studies to date—including the present study—indicating more effort is needed to characterize the experiences of individuals identifying as non-binary.

5.2.4. Race and Political Ideology

Identified race was not a predictor of CAI in our study, though *t*-tests showed White students had significantly higher CAI scores than non-White students but similar levels of generalized anxiety and depression. However, racial diversity was lacking among the individuals who completed our survey, representing a significant study limitation. Aggregating responses from all non-White students may have masked important experiences or perspectives unique to particular races that influences susceptibility to climate anxiety. Ref. [17] found weak support for race as contributing to perceptions of climate change to be a source of stress in a study of 305 mostly White students at a primarily undergraduate institution in the U.S. Specifically, Asian students were less stressed by climate change relative to students identifying as White, Black or other races. Although climate anxiety is common among students in nations differing in dominant racial groups (e.g., [16,17,23,26]), it is still unclear how race affects climate anxiety within a shared cultural framework. Future studies of climate anxiety within undergraduate populations at Minority Serving Institutions or Historically Black Colleges and Universities in the U.S. would fill an important knowledge gap.

Political ideology was a strong predictor of CAI in our study, with more liberal students reporting higher intensity of climate anxiety. Participation in our survey was dominated by students identifying with moderate-to-liberal ideologies, representing another study limitation. Few studies of climate anxiety within undergraduate populations have explored the role of political ideology. However, ref. [17] surveyed a more even distribution of students identifying as Democrat, Republican and Independent than the present study, finding that those identifying as Republican or Independent were less stressed about

climate change. These trends support patterns between political ideology and concern for climate change observed at national to global scales, explained by perceptions of social and scientific consensus about causes and consequences of climate change, relative concern for economic stability, and the propensity to adhere to social constructs among family and friends [39].

5.2.5. Major

Our results indicated that students majoring in ENVST on average had greater CAI scores than non-ENVST majors, and this difference was consistent per level of generalized anxiety. These results support our second hypothesis (H2) and are consistent with previous findings [16,24] showing that students in environmental degrees have a greater propensity to climate anxiety. Notably, the intensity of climate anxiety ranged widely for both ENVST and non-ENVST students, including reports of severe climate anxiety in both categories. Hence, climate anxiety is an experience shared among many undergraduate students who participated in our study, regardless of major. Consequently, declared major was a significant predictor of climate anxiety only in our initial regression model. Major designation was not a significant predictor of CAI once sources of climate news were included in regression models, although ENVST students reporting a greater frequency of exposure to climate news from classes, online media, and interpersonal interactions relative to non-ENVST majors. The greater exposure of ENVST majors to climate news from various sources suggest that students majoring in environmental degrees may seek out more information about climate change due to their intrinsic interest in environmental issues.

Our study population included students majoring in Communications, a degree program with elective courses that focus on climate change. The Communication students who participated in our study are attuned to mainstream local media, which frequently runs stories about ecological decline (e.g., drying of the Great Salt Lake and hazards, such as wildfires) influenced by shifts in climate. Thus, students majoring in Communications at the University of Utah may actually represent a group similar to students majoring in Environmental Studies. Yet, many majors at the study institution and other institutions of higher education can make connections to the topic of climate change, suggesting that climate anxiety may be common across a broader number of majors.

5.2.6. Sources of Information—In the Classroom

We found that more exposure to climate information in classrooms is a predictor of CAI, supporting other studies showing that more knowledge about climate change is correlated to climate anxiety [16,23–25]. However, higher CAI scores for ENVST majors relative to non-ENVST majors was not related to differences in exposure to information about climate change obtained in the classroom, refuting our second hypothesis (H2). Hence, academic units with courses on climate change, regardless of degree program, may wish to initiate efforts for addressing emotional responses and exploring ways to affect change [13,20,21,73]. For example, the ENVST program at the University of Utah has hosted Good Grief Circles, based on training and materials offered by the Good Grief Network (https://goodgriefnetwork.org/), that provide a safe space for students to share their responses to climate change.

Climate science can be better digested when individuals understand and are empowered to take actions to address climate challenges [2,3,64]. Information about climate mitigation and adaptation approaches is embedded within ENVST coursework. In addition, high-impact teaching practices (HIPs; e.g., community engaged learning, internships, and research) are a key feature of the ENVST program. These experiences are critical for demonstrating agency and allowing for adaptive responses among students [13].

Nonetheless, the influence of pedagogy on climate anxiety may be limited due to the strong role played by social media within undergraduate populations [17,22,58]. Wide variation exists in student awareness of bias in media [19]. Thus, training students to critically assess information, identify trustworthy sources, and recognize perspectives of bias is essential for both mitigating climate anxiety within undergraduate populations and inspiring students to address future climate-related challenges [17].

5.2.7. Sources of Information—Online Media

Our research corroborates previous studies demonstrating a strong positive correlation between exposure to climate information through (online) media sources and climate anxiety [17,22,74,75]. The way information about climate change is delivered can exacerbate or alleviate climate grief. Messages that induce fear and guilt can lead people to shut down creative thinking and distrust climate science or advocacy [76], especially if one does not feel empowered to effect change (e.g., [64], p. 54). Climate change news has been criticized for becoming more negative or even alarmist [77] to encourage continued engagement with media [78]. Conversely, some have denounced media for sharing too little information about the severity of climate change detrimental effects or ways to effectively engage in climate adaptation and mitigation [79].

Yet, the pre-existing severity of climate anxiety experienced by a media consumer may determine an individual's response to it. Ref. [22] found positive correlations between the attention paid to climate change in media sources and measures of individual and collective self-efficacy, a finding made possible because study participants did not experience a debilitating level of climate anxiety. At mild-to-moderate levels of climate anxiety, as reported by many of our study participants, increased exposure to climate news from media may invoke an adaptive response towards engagement in climate science, policy or advocacy that induces a stronger sense of self- or collective-efficacy [6,17,22].

The weak interaction we observed between majors with respect to the relationship between climate anxiety and exposure to online media may be related to students' capacity for adaptive response. Students with greater awareness of how to transform anxiety into adaptive action may be more resilient to online information about climate change, regardless of its nature [24]. Furthermore, students with a greater sense of self-efficacy may seek out more information online that conveys hopeful stories about climate change and ways to meaningfully engage on the topic. Anecdotally, several ENVST students have shared that they engage in 'hopescrolling', to purposely steer their media feed away from negative content. This may be one reason why increased exposure to information from online sources did not strongly affect CAI scores among the ENVST students who participated in our study.

5.2.8. Sources of Information—Interpersonal Interactions

Interpersonal interactions—including those with peers, family members, or co-workers—was not a strong predictor of CAI in the present study. Climate change may be an uncommon topic of conversation for undergraduates who participated in our survey, despite broader trends that suggest otherwise [58]. Few students (<30%) reported they obtained climate information from family members or co-workers 'A lot' or 'Frequently', and obtaining information from peers was only slightly more common (40%). It is possible that students are reticent to engage in the topic of climate change because they are surrounded by like-minded individuals [80], lack the skills to engage in effective communication about a potentially controversial topic, or sense climate change is a taboo topic in social conversation [81]. Yet, social support groups and open discussions to help students cope with emotions elicited by climate change news were the ideas most commonly sug-

gested by students in our survey's open-ended questions [7], indicating students desire *more* opportunities to engage in the topic of climate change in social settings.

5.3. Study Limitations

Our study is based on self-reported data derived from voluntary surveys collected via convenience sampling. Hence, our results are correlational, cross-sectional, and local, limiting generalization. However, collection of data from voluntary surveys is an approach consistent with previous studies of climate anxiety among undergraduate students (e.g., [16,17,23,24]). Convenience sampling allowed for a relatively large total sample size, but resulted in few data representing important demographic groups including non-cisgendered individuals and distinct races or ethnic groups who may have different experiences with and predictors of climate anxiety. Furthermore, we distributed surveys via an LMS technology in classes offered by just two academic units, whose degree programs and student body (e.g., information ecosystem) may be more similar than we understood at the outset of the study. These limitations may be overcome in future studies by designing standardized methodological approaches that collect data more evenly across diverse student populations (i.e., race/ethnicity, gender, major) at multiple institutions—including those with larger populations of non-binary individuals and people of color—or conducting synthesis analyses across published studies of climate anxiety in undergraduate students.

Our CAI has some advantages over other existing climate anxiety scales and shows promise for describing degrees of climate anxiety and factors influencing climate anxiety. However, and importantly, we did not set out to create a new psychometric tool. Our index thus should not be employed in that manner unless robustly tested using standard methods, including but not limited to validity analyses (e.g., confirmatory, convergent, discriminant, and cross-cultural validation), test–retest procedures, and controlled comparisons with established climate anxiety scales followed by peer review and evaluation in a clinical setting.

6. Conclusions and Recommendations

Our study is among the growing number of studies examining climate anxiety among young adults, and specifically undergraduate students at institutions of higher education. We found that undergraduate affective responses to climate change in the population we surveyed are predominantly 'undesirable'. Yet, experiencing emotions with respect to climate change, even unpleasant ones, was critical for motivating individuals to have concern for climate [65,67]. Concern for climate was a strong predictor of climate anxiety in the present study, particularly if a student also suffers from moderate-to-intense generalized anxiety, has a high frequency of exposure to climate information via online media and in classrooms, and is left-leaning in political ideology. These trends hold for undergraduate students who are not majors of an environmental degree program, underscoring the potential widespread nature of climate anxiety at the study institution. Among all studies of undergraduate students to date, climate anxiety emerges as a complex and multifaceted phenomenon representing a correlate of mental health risk, a marker of environmental awareness, and a potential driver of meaningful behavioral change.

Our results have implications for health care provided to undergraduate students. Given that climate anxiety and generalized anxiety and depression are correlated in many studies, medical and counseling professionals may wish to inquire about climate change concerns when an undergraduate student presents with moderate-to-intense generalized anxiety and depression. They may also choose to offer patients and clients resources about organizations dedicated to processing feelings about climate change, or to organizations focused on climate advocacy, mitigation and adaptation.

Our results also have ramifications for operations and instruction at institutions of higher education. Administrators at the highest level of governance must acknowledge that climate anxiety is a phenomenon experienced by a significant number of students on college campuses and consider taking action to mitigate the problem. Specific actions include (1) the development of climate anxiety groups in their counseling centers so students have ease of access for support on campuses and (2) funds to support open forums of discussion within different academic units across campuses. Academic units could offer informal conversations about climate change via social hours or by partnering with a group, like the Good Grief Network, to help students process emotional responses to climate change in community [21]. Instructors who teach about climate science, policy and advocacy may wish to prepare students to expect emotional responses and incorporate into curricula structured individual or group reflective exercises to identify affective responses, without dismissing any as 'bad' or 'maladaptive' [21,73]. Instructors are also encouraged to teach students to critically evaluate climate news [17] and incorporate into curricula experiences for students to channel anxiety into adaptive responses [13]. Collectively, these measures are likely to provide support for students suffering from climate anxiety, encourage ongoing engagement in climate science, policy and advocacy, and ease conversation about climate anxiety.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su18157944/s1, Figure S1: Frequency distribution of (A) climate anxiety (CAI) and (B) general anxiety (GAD-7) indices; Table S1: Variance inflation factors (VIFs) for the predictors in ordinary least squares (OLS) hierarchical regression models.

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