

Climate Emotions, Pro-environmental Behaviours, and Activism among Canadian Youth

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ABSTRACT

Psychological research has made significant contributions to the current understanding of the role of emotions in promoting or hindering a person's ability to engage with pro-environmental behaviours and climate action. While international research on this topic continues expanding, there is little research documenting the emotional impacts of climate change on Canadian youth, and the role emotions play in their ability to stay actively engaged with this global challenge. This study examines several psychological constructs (e.g., climate anxiety, generalized anxiety and depression, negative and positive affect, and emotional responses to climate change) known to be associated with different levels of engagement with climate activism and pro-environmental behaviours in a sample of 912 first- and second-year Canadian university students. Using data gathered online, we conducted a series of statistical analyses that revealed that climate worry and concern were common among our participants. Results also showed that participants experienced many different emotions towards climate change. Factor analysis led to a categorization of emotional responses into four factors: externalizing negative emotions, internalizing negative emotions, positive emotions, and neutral emotions. Further statistical modeling showed that, while common, negative emotions did not inhibit climate activism or pro-environmental behaviours, which instead were predicted by positive emotions. We interpret the findings in the context of positive psychology frameworks such as Fredrickson's Broaden and Built theory and draw insights that may guide further research investigation in the burgeoning field of the psychology of climate emotions.

Keywords: *Climate emotions; climate action; activism; pro-environmental behaviours; youth; Canada*

INTRODUCTION

The unfolding effects of the climate and ecological crises are undeniably becoming more evident in all corners of the world (IPCC, 2022). Even Canada, once a place hardly associated with climate change impacts, made international news when in the summer of 2023, more than 6,000 forest fires sprawled

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across several provinces and territories, burning an outstanding 18.5 million hectares of land, an area comparable to the size of the country of Greece (Canadian Interagency Forest Fire Centre Inc., 2023).

Impacts of climate change, however, have been evident in Canada long before 2023, especially among Northern Indigenous peoples who for decades have been adapting to the rapid changes in their Arctic land caused by global warming (Middleton et al, 2020; Ford et al, 2014).

With Canada's rate of temperature increases estimated to be twice as much as other countries in the Northern Hemisphere (Bush & Lemmen, 2019), extreme weather conditions are only expected to become more frequent and severe across all provinces and territories. Not surprisingly, a poll conducted by Leger in the fall of 2022 found that approximately 70% of Canadians worried about how climate change would impact their own lives and that of their loved ones (Leger/The Canadian Press, 2022). Also, Galway and Beery (2022) found that more than 60% of Northern Canadian adults reported experiencing feeling worried, frustrated, sad, and scared when thinking about climate change. Furthermore, Galway and Field (2022) found that a significant proportion of Canadian youth had experienced climate-related fear, sadness, and anxiety. These findings echo international research on emotional responses to climate change that has also found that more than two-thirds of young people across six continents feel worried, concerned and anxious when contemplating this global phenomenon (Hickman et al., 2021).

The mounting evidence of psychological distress experienced by young individuals across the globe is at odds with the paucity of research on this topic among Canadian youth. The dearth of research on emotional responses to climate change among the general Canadian youth population stands in contrast to the productive line of inquiry on the impacts of adaptive responses to climate change, specifically among Northern Canadian Indigenous peoples, as exemplified by the works of Middleton et al. (2020) and Ford et al. (2014).

Furthermore, a limitation of the current body of knowledge on climate emotions in general, and among Canadian youth in particular (Galway and Field, 2022), is that it tends to focus on categorizing emotions rather than empirically examining the associations between these emotions, psychological well-being, climate action, and other socio-demographic factors (Ojala & Bengtsson, 2019).

Therefore, this study aims to add to the growing evidence on how Canadian youth feel in response to climate change, but also to extend such knowledge by empirically examining how climate emotions are associated with socio-demographic factors, psychological well-being, and engagement with climate action. More specifically, the research question we wish to address is whether there are specific types of emotions that are more likely to predict a young person's capacity for engaging with climate action, thus furthering the current understanding of the processes implicated in the psychological adaptation to the climate crisis among Canadian youth.

In what follows, we begin distinguishing between emotions that one would expect in response to climate change, such as worry, concern and anxiety, and other emotions that may or may not motivate someone to further engage with the issue of climate change or become involved in climate action. Next, we present the methods, analysis, and results of a study we conducted in a Canadian University campus in the fall of 2021. We conclude the paper with a discussion of the relevant findings which we comment on in the context of the extant literature.

Worry, Concern, and Anxiety

Worry, concern and anxiety are emotional states that have attracted significant attention from climate change researchers. Studies have shown these emotions to be common responses experienced by young people in a variety of international contexts (Clayton & Karazsia, 2020; Hickman et al., 2021; Ojala et al. 2021; Pihkala 2020; Stewart, 2021; Whitmarsh et al., 2022).

Worry, concern and anxiety associated with climate change have emerged in public discourses outside of academia under various terms, such as climate anxiety, eco-anxiety, or eco-distress. The term eco-anxiety, in particular, has reached far beyond the scientific community, and according to Wray (2022), its popularity may be symptomatic of how widespread 'ecologically linked distress' is in the general population (page 24).

Eco-anxiety (or climate anxiety) can be described as anxiety that we experience when pondering the potential devastating effects that climate change may have on our lives, those of loved ones (Clayton & Karazsia, 2020), and of the more-than-human world (Abram, 1997). Worry and concern may be understood as dimensions of eco-anxiety, and together, these three emotions play a special role in climate action (Ojala, 2005; Pihkala, 2022b).

Similarly, evolutionary psychologists have argued that anxiety may be necessary to initiate self-preservation responses (Bateson et al., 2011), which in turn motivates us to try and eliminate the source of distress. Therefore, being anxious about climate change is a sign that we recognize it as a threat, and given the gravity of the situation, being anxious, worried, or concerned about climate change is expected of anyone who cares about the future of their planet.

Analogous to the fundamental role of emotions in risk appraisal and decision-making (Loewenstein et al., 2001; Slovic et al., 2002; Slovic et al., 2005), anxiety, worry, and concern are thought to be important motivators of pro-environmental behaviours and climate activism (Davidson & Kecinski, 2021; Gifford, 2011; Salas Reyes et al., 2021). For example, Bouman et al. (2020) and Galway et al. (2021) found worry to be positively associated with individual-level climate actions, such as recycling and volunteering; Brosch (2021) showed that worry about climate change was one of the most important predictors of climate policy support; and Whitmarsh et al. (2022) found that climate anxiety predicted a composite measure of pro-environmental behaviour and actions, such as promoting recycling and energy conservation.

However, anxiety, worry, and concern are not the only emotions that people experience in relation to climate change. Research has shown that climate change can elicit several emotions in the same person, who may be angry or depressed at one time, and hopeful and compassionate at another (Galway & Beery, 2022; Galway & Field, 2022; Hickman et al., 2021; Iniguez-Gallardo et al., 2021). Despite knowing that climate change is causing us to experience complex and sometimes contradictory emotions, we still have a limited understanding of how specific emotions (other than worry, concern, and anxiety) may help or inhibit our ability to engage with climate action. In this study, we will investigate how different emotions are associated with climate action once the effects of worry, concern, and anxiety are accounted for.

Climate Emotions

Social science research has been interested in the psychological dimensions of climate change for over two decades (Rachlinski, 2000; Swim et al., 2009). For example, recent psychological research has studied psychoterratic states (Albrecht, 2019), solastalgia (Albrecht, 2007), climate anxiety (Clayton & Karazsia, 2020), and ecological grief (Cunsolo & Ellis, 2018). Some terms that broadly describe emotions (e.g., grief) and affective states (e.g., anxiety) have struck a chord with a public confronted with new emotions that are challenging to label. While the term eco-anxiety has reached far beyond the scientific community to describe a general sense of dread associated with the acknowledgement of climate change, it is important to concede that the emotional states brought upon by climate change are more complex than a single term can capture. Indeed, Ojala (2005, 2012a, 2012b, 2021) and Cunsolo and Ellis (2018) have offered nuanced empirical and theoretical discussions of the complexities inherent in

climate emotions, not only those associated with worry and anxiety, but also grief, frustration, hope, and trust.

For example, Ojala has documented hope's important role in motivating climate action in younger generations and showed that climate change-related hope is positively associated with engagement in climate change issues and pro-environmental behaviours (Ojala 2015, 2016, 2023). Likewise, Smith and Leiserowitz (2013) showed that hope, as well as worry, were strongly associated with support for global warming policies. This research offers a significant contribution to the field in that it highlights that focusing narrowly on worry and anxiety does not account for the importance of positive emotions in explaining climate action (Schneider et al., 2021). Therefore, to add to the empirical evidence on the role of different types of emotions implicated in climate action, in this study we will examine several emotions with positive (e.g., hope, compassion), negative (e.g., fear, anger) and neutral (e.g., indifference, disengagement) connotation and their associations with climate action.

Furthermore, the limited set of emotional responses analyzed in past climate emotion research, generally, has also overlooked how socio-cultural contexts influence the ways in which climate emotions are experienced (Davidson & Kecinski, 2021; Galway et al., 2019). This is supported by international research showing that in the global north, anxiety and grief are common climate emotions, whereas, in the global south, indifference and anger appear to dominate (Iniguez-Gallardo et al., 2021). Therefore, in this study we will examine the association between climate emotions and climate action in a sample of Canadian youth while also accounting for socio-demographic factors, such as gender, immigration status, whether participants grew up in rural or remote settings, and their current place of residence.

METHODS

Participants and Procedure

In the context of Mochi4ThePlanet (<https://mochi4theplanet.com/>), a youth-led research and social media initiative designed to support young people's climate emotional resilience, we developed a comprehensive survey designed to measure various cognitive, affective, and behavioural dimensions of climate change among Canadian youth. Nine-hundred and ninety-two participants were recruited through a university-administered survey pool at a Canadian University. All participants were enrolled in first- and second-year Psychology courses and were granted a 0.5-course credit upon completion of the survey. Of the enrolled participants, 73 did not complete the survey and were excluded from this study. An additional 17 participants were excluded due to missing data for climate emotions. In total, the final sample was composed of 902 participants. The survey was conducted online using Qualtrics and was approved by the University Research Ethics Board (Clearance #116016).

Socio-Demographic Characteristics

All participants were between 17 and 30 years of age ($M = 19.64$ and $SD = 3.05$). One-quarter of the participants identified as male ($n = 225$), 73% identified as female ($n = 658$), and 2% identified as other ($n = 19$). Approximately 75% ($n = 679$) and 25% ($n = 223$) of the participants were born in Canada and abroad, respectively. One-third ($n = 326$) of the participants lived in a suburban residential environment during their childhood compared to 24% ($n = 212$) in a city centre, 21% ($n = 192$) in green spaces, and 18% ($n = 167$) in rural villages. In contrast, about one-third of participants lived in the city centre or the suburbs at the time of data collection ($n = 302$ and $n = 282$, respectively), while 25% ($n = 223$) reported living in green spaces and 10% ($n = 90$) in rural villages. Five participants reported their childhood and current residential environment as a Northern remote community. Most participants self-reported as

being neither spiritual nor religious ($n = 390$ or 43%) compared to 22% ($n = 204$) who self-reported being spiritual, 18% ($n = 163$) who self-reported being religious, and 16% ($n = 145$) who self-reported being both religious and spiritual. Seven missing responses on four demographic variables were set to the most common value in the sample.

Measuring Climate Emotions

Participants were asked, “Have you ever felt the following emotions when thinking about climate change?” on a 3-point scale (1 = never; 2 = sometimes; 3 = often) in relation to 45 emotions: disgust, hatred, outrage, frustration, rage, resentment, retaliation, distrust, vengeance, irritation, anger, disappointment, disapproval, indignation, devotion, pride, appreciation, engagement, compassion, gratification, enthusiasm, happiness, optimism, interest, motivation, hope, courage, solidarity, grief, overwhelmed, anxiety, sadness, isolation, loneliness, distress, desperation, fear, helplessness, guilt, pity, disconnection, melancholy, shame, boredom, and indifference. The three-point scale employed in this survey is consistent with measurement standards in the field of climate emotions (Hickman et al., 2021).

The 45 emotions included in this study capture a variety of feelings with positive, negative, or neutral connotations. Some of the featured emotions, such as anger and hope, were chosen because they frequently appear in the literature on climate change (Marczak et al., 2021; Ojala, 2012b; Smith & Leiserowitz, 2013; Verlie et al., 2021); while others were included to offer a more diverse semantic space for participants with different linguistic backgrounds (Cowen & Keltner, 2017). For example, closely related emotions that can be captured with different semantic labels, such as sadness and melancholy, and anger and rage, were added to the list. Emotions typically excluded in research on this topic (e.g., enthusiasm, pride, retaliation, boredom) were also included to broaden the spectrum of emotions that participants from different cultural backgrounds might be likely to recognize as personally relevant (Iniguez-Gallardo et al., 2021), and to capture previously overlooked emotions that could also be motivators for climate action (e.g., vengeance, devotion, gratification).

Outcome Variables

Three variables were used to measure climate action: pro-environmental behaviour, leadership in environmental activism, and participation in environmental activism. Descriptive statistics for outcome variables are presented in **Table 1**. The *Pro-environmental Behaviour* scale (PBS) was used to measure the tendency of participants’ engagement in pro-environmental behaviours in the last six months. The PBS is composed of 11 items (Ojala, 2012a, 2012b) measured on a five-point scale (1= never; 2 = sometimes, 3 = about half the time; 4 = most of the time; 5 = always) and included questions such as “*I bike or walk to school or work instead of using the car*” and “*I help my parents or the people I live with sort garbage and the recycling bin*”. The scale demonstrated good internal consistency (Cronbach’s alpha = 0.87).

The *Environmental Activism Scale* (EAS) was used to measure how often survey participants were involved in leadership or participatory actions that promoted environmental sustainability in the last six months (Alisat & Reimer, 2015). The EAS scale included 18 questions. Ten questions captured participatory actions (e.g., “*I have participated in an educational event related to the environment*” and “*I have become involved with an environmental group or political party*”). Eight questions captured leadership actions (“*I organized an educational event related to environmental issues*” and “*I organized an environmental protest or rally*”). Responses to each question on the PBS and the EAS were on a 5-point scale (1 = never; 2 = sometimes; 3 = about half the time; 4 = most of the time; 5 = all of the time).

Participatory and leadership environmental activism demonstrated good internal consistency (Cronbach's alpha = 0.93 and 0.96, respectively).

Table 1. Descriptive Statistics for composite measures

Variable	M/N	SD/%
Pro-environmental behaviours (M, SD)	3.12	0.90
Environmental activism (M, SD)		
Leadership activism (M, SD)	1.42	0.82
Participatory activism (M, SD)	1.93	0.92
Climate Anxiety Scale (M, SD)		
Cognitive Impairment (M, SD)	12.73	6.24
Functional Impairment (M, SD)	7.92	4.23
Worry about climate change (M, SD)	14.02	2.52
Depression (M, SD)	30.6	9.07
Anxiety (M, SD)	11.96	3.01
Affect		
Negative Affect (M, SD)	18.88	6.16
Positive Affect (M, SD)	8.07	2.16
Concern (N, %)		
Not at all concerned	31	3.44
Somewhat concerned	403	44.68
Very concerned	324	35.92
Extremely concerned	144	15.96

For the regression analyses, composite outcome variables measuring pro-environmental behaviour, leadership in environmental activism, and participation in environmental activism were derived by averaging the responses to each group of survey items. Sensitivity analyses were conducted using composite outcome variables derived via confirmatory factor analytic (CFA) models. The results of the regression models using the CFA-derived outcome variables were virtually identical to those presented in Table 6.

Control Variables

In addition to the socio-demographic characteristics, eight control variables previously explored in studies of climate emotion and climate action were included in the analysis (**Table 1**): cognitive-emotional impairment due to climate anxiety, functional impairment due to climate anxiety, concern about climate change, worry about climate change, depression, positive affect, negative affect, and generalized anxiety disorder. Depression, affect, and generalized anxiety were included to adjust for the associations between climate action and affective states not specifically associated with climate change.

The *Climate Anxiety Scale* (CAS) was designed to measure the degree to which thinking about climate change elicits anxious responses that impact day-to-day functioning. As proposed by Clayton & Karazsia (2020), the CAS is composed of 13 items with a 5-point response scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = almost always). Eight items captured cognitive-emotional impairment and included, for example, "Thinking about climate change makes it difficult for me to concentrate" and "I find myself crying because of climate change". Five items captured functional impairment, or how climate change interfered with socializing or remaining focused while performing a task, such as "My concerns about climate change make it hard for me to have fun with my family or friends" and "My concerns about climate change undermine my ability to work to my potential". Composite variables

measuring cognitive-emotional and functional impairment due to climate anxiety were created using CFA models. Both composite variables had high internal consistency (Cronbach's $\alpha = 0.93$).

Concern about climate change (Ojala, 2012b) was measured using a single question with a 4-point response scale (1 = not at all concerned; 2 = somewhat concerned; 3 = very concerned; 4 = extremely concerned): *"To what extent are you concerned about the climate change problem in general?"*. Worry about climate change (Ojala, 2012b) was measured using five items that each queried the degree to which participants felt worried about the consequences caused by climate change, for example, *"I am worried that my friends and family will be negatively affected by climate change"* and *"I am worried that animals and/or nature will be negatively affected by climate change"*. Each item was rated on a 3-point response scale (1 = disagree; 2 = neither disagree nor agree; 3 = agree). A CFA model was used to create a single composite variable that showed good internal reliability (Cronbach's $\alpha = 0.85$).

Depression was measured using the self-report scale developed by the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), where participants were asked to respond to 12 items on a 4-point response scale (1 = rarely or none of the time; 2 = some or little of the time; 3 = occasionally or a moderate amount of time; 4 = most or all the time). The scale demonstrated good internal reliability (Cronbach's $\alpha = 0.84$).

Positive and negative affect were measured using the adapted version of the CES-D Scale targeted to young adults (Radloff, 1977; Weissman et al., 1980). The scale consisted of ten items that were rated on a four-point scale (1 = not at all; 2 = occasionally; 3 = most of the time; 4 = all of the time); seven items captured negative affect (e.g., *"I've felt like I want to cry"*) and three items captured positive affect (e.g., *"I've been laughing"*). Negative and positive affect composite variables created using CFA models showed good internal consistency (Cronbach's $\alpha = 0.88$ and 0.76 , respectively).

Finally, Generalized Anxiety Disorder (GAD) was measured using the GAD subscale from the Ontario Child Health Study – Emotional Behavioural Scales (OCHS-EBS, 2018). The six-item subscale included prompts such as *"I am anxious or on edge"* and *"I am nervous or tense"* and had a 3-point scale (1 = never or not true, 2 = sometimes or somewhat true; 3 = often or very true). The scale demonstrated good internal consistency with our present sample (Cronbach's $\alpha = 0.86$).

Analyses

All statistical analyses were conducted using R (4.2.1; R core Team, 2022). The *psych* (Revelle, 2023) and *lavaan* (Rosseel, 2012) packages were used to conduct exploratory and confirmatory factor analyses, respectively. The *car* (Weisberg, 2019) and *rstatix* (Kassambara, 2023) packages were used to conduct mean and multiple comparison tests.

To identify the underlying factors among the 45 climate emotions, a full sample of 902 participants was randomly split in half, and an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA) were applied separately to each half. Socio-demographic characteristics for the subsamples are shown in **Appendix Table 1**. Exploratory scree plots, Kaiser's criterion, and parallel analyses were used to determine the number of factors to be extracted from the EFA (Horn, 1965; Kaiser, 1960). A Principal Axis Factoring (PAF) with oblique rotation and polychoric correlation matrix was employed. The polychoric correlation matrix accounts for the ordinal 3-point scales of each emotional response item (Holgado-Tello et al., 2010) and the oblique rotations allow for between-factor correlations to be estimated. Following the EFA, a CFA model was conducted on the second half of the sample to verify the factor structure. Acceptable model fit was characterized by the following: Comparative fit index (CFI) $> .95$, Tucker-Lewis index (TLI) $> .95$, root mean square error of approximation (RMSEA) $< .06$, and standardized root mean square residual (SRMR) $< .08$ (Hu & Bentler, 1999).

After running an EFA and a CFA, factor scores for each climate emotion factor were created by running a CFA for the full sample ($n = 902$). The factor scores were used to conduct mean comparison tests (one-way ANOVA, independent samples t-test, Welch's ANOVA and Welch's t-test) to explore how climate emotions varied between different socio-demographic groups. Additionally, Tukey-Kramer or Games-Howell multiple comparison tests were used to identify which sub-group in each socio-demographic group differed significantly. The Bonferroni correction was used to control for seven multiple comparison tests (i.e., the significance level was adjusted to $p < 0.007$).

Following the mean and multiple comparison tests, linear regression models were conducted on the full sample ($n = 902$) to quantify the associations between climate actions and the four factors of climate emotions. The three outcome variables (i.e., pro-environmental behaviours, leadership in environmental activism, and participatory environmental activism) were analyzed in separate models. For each outcome variable, three models were considered. Model 1 analyzed the association between climate action and the socio-demographic and control variables. Model 2 added the four variables previously shown to explain climate action: concern about climate change, worry about climate change, and climate anxiety realized through cognitive-emotional and functional impairment. Finally, Model 3 added the four factors of climate emotions derived from the list of climate emotions. All continuous variables derived using the CFA models were standardized and normalized for analysis in the regression models.

RESULTS

Frequency of Worry, Concern, and Climate Emotions

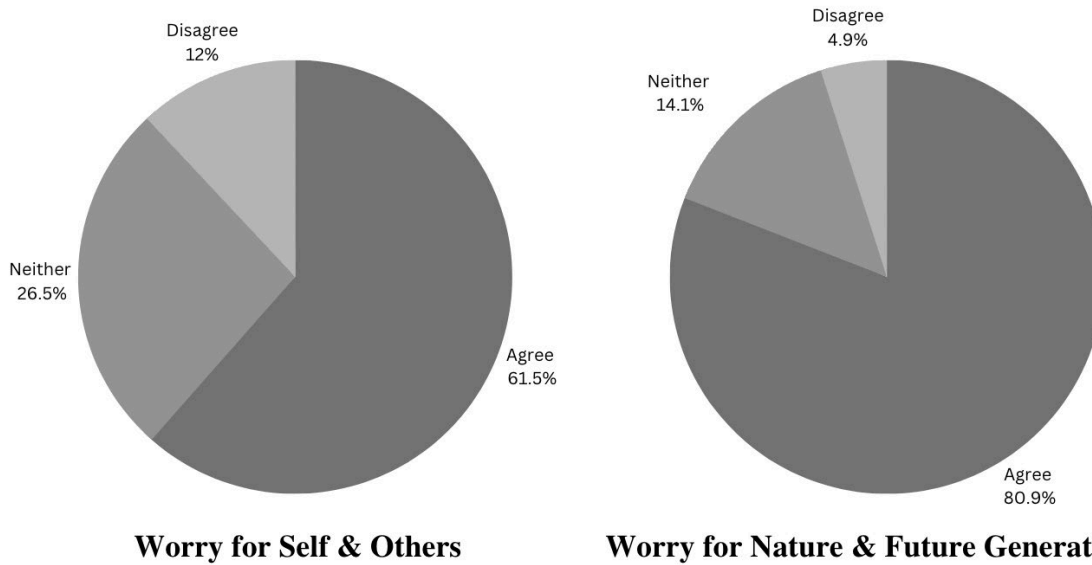
Climate-related worry (**Figure 1**) and concern (**Figure 2**) were found to be common among our study participants. For example, 44.4% were somewhat concerned about climate change, and 52% were either extremely or very concerned, compared to about 3.5% who reported being not at all concerned about climate change. Similarly, 61.5% of participants were worried that climate change would negatively affect them and their loved ones, and 80.9% were worried that climate change would negatively affect animals, nature, and future generations.

The most common climate emotions reported by participants in the present study were negative and included disappointment, frustration, helplessness, fear, sadness, anxiety, shame, disgust, and guilt. At least one-third of participants experienced these emotions often and sometimes. At least one in four participants also reported often or sometimes experiencing positive emotions, with interest, compassion, and hope being the most common. A substantial percentage of participants (~50%) indicated they never felt disconnected, bored, or indifferent about climate change. The frequencies for each climate emotion are shown in **Appendix Table 2**.

Climate Emotions Factor Analysis Results

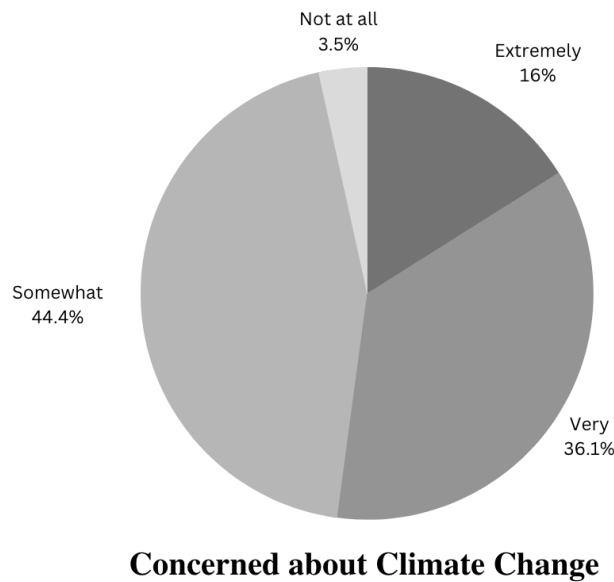
The scree plot, Kaiser's criterion, and parallel analysis from the EFA suggested a four-factor solution. The EFA factor loadings are shown in **Appendix Table 3**. The CFA model specified with this four-factor solution demonstrated acceptable fit (CFI = 0.986, TLI = 0.985, RMSEA = 0.072, SRMR = 0.089). To derive the factors, only items with statistically significant ($p < 0.05$) loadings were included. Standardized factor loadings are displayed in **Table 2**.

Figure 1. Frequency of climate-related worry



Notes: Participants were asked to indicate the extent to which they agreed with the following statements: “I worry that I myself will be negatively affected by climate change”, “I am worried that my friends and family will be negatively affected by climate change”, “I worry that future generations will be affected by climate change”, “I am worried that animals and/or nature will be negatively affected by climate change”, and “I am concerned that people living in poor countries will be negatively affected by climate change”

Figure 2. Frequency of climate-related concern



Notes: Climate-related concern was measured with a 4-point response scale where participants were asked: “To what extent are you concerned about the climate change problem in general?”.

Table 2. CFA standardized factor loadings

	Unpleasant internalizing	Unpleasant externalizing	Pleasant	Neutral
Grief	0.83			
Pity	0.72			
Resentment	0.89			
Disappointment	0.78			
Overwhelmed	0.82			
Anxiety	0.83			
Sadness	0.82			
Distress	0.89			
Desperation	0.83			
Disapproval	0.71			
Fear	0.84			
Helplessness	0.68			
Melancholy	0.78			
Guilt	0.75			
Shame	0.78			
Disgust		0.79		
Indignation		0.76		
Hatred		0.85		
Outrage		0.86		
Frustration		0.87		
Rage		0.85		
Retaliation		0.81		
Distrust		0.76		
Vengeance		0.77		
Irritation		0.84		
Anger		0.87		
Pride			0.70	
Solidarity			0.85	
Appreciation			0.69	
Engagement			0.86	
Devotion			0.88	
Compassion			0.79	
Gratification			0.70	
Enthusiasm			0.69	
Happiness			0.66	
Optimism			0.60	
Interest			0.73	
Motivation			0.84	
Hope			0.54	
Courage			0.79	
Boredom				0.27
Disconnection				0.78
Isolation				0.87
Loneliness				0.85
Indifference				0.23
Cronbach's alpha	0.94	0.92	0.90	0.68

The first factor included distress, desperation, grief, and sadness and captured *unpleasant internalizing emotions* because the emotions are commonly associated with negative valence and directed towards oneself. The second factor was labeled *unpleasant externalizing*, which included emotions commonly associated with negative valence oriented towards someone or something other

than oneself, such as anger, rage, hatred, frustration, and outrage. The third factor was labeled *pleasant emotions* because it included emotions such as engagement, optimism, and motivation. The fourth factor was associated with emotions such as boredom, indifference, and disconnection, and was labelled *neutral emotions*. All four factors had acceptable internal consistency in the CFA subsample as measured by Cronbach's alpha (**Table 2**).

Table 3. Socio-demographic differences in climate emotions factors based on mean comparison tests

Demographic variables	Unpleasant Internalizing	Unpleasant externalizing	Pleasant	Neutral
	M(SD)	M(SD)	M(SD)	M(SD)
Gender				
Female	0.10 (0.98)	0.07 (0.99)	0.02 (0.99)	0.05 (1.02)
Male	-0.36 (0.96)	-0.26 (0.98)	-0.05 (1.01)	-0.17 (0.91)
Other	0.82(0.85)	0.57 (0.98)	0.07 (1.24)	0.29 (1.14)
Test	24.96* ¹	12.81* ¹	0.40 ¹	5.19* ²
Birthplace				
Canada	0.06 (1.02)	0.06 (1.02)	-0.03 (0.99)	0.005(1.00)
Abroad	-0.17 (0.90)	-0.17 (0.90)	0.10 (1.02)	-0.01(0.99)
Test	3.10* ⁴	3.20* ⁴	-1.66 ³	0.24 ³
Religion				
Religious	-0.18 (0.96)	-0.14 (0.94)	0.12 (1.08)	0.09 (1.08)
Spiritual	0.35 (1.01)	0.34 (1.05)	0.14 (0.98)	0.23 (1.06)
Both religious and spiritual	-0.08 (0.99)	-0.05 (0.95)	0.13 (0.98)	-0.05 (0.99)
Neither religious nor spiritual	-0.08 (0.98)	-0.10 (0.98)	-0.17 (0.96)	-0.14 (0.91)
Test ¹	11.62* ¹	10.58* ¹	6.75* ¹	6.64* ²
Childhood environment				
City centre	-0.10 (0.96)	-0.06 (0.92)	0.10 (1.04)	0.10 (1.05)
Green spaces	-0.04 (1.04)	-0.06 (1.03)	-0.03 (1.03)	-0.06 (0.94)
Suburbs	0.06 (1.03)	0.03 (1.04)	-0.03 (0.98)	0.01 (1.02)
Rural villages	0.05 (0.94)	0.07 (0.98)	-0.04 (0.94)	-0.10 (0.95)
Northern/remote	0.22 (1.03)	0.14 (1.06)	0.29 (0.93)	0.39 (1.17)
Test ¹	1.14 ¹	0.73 ¹	0.83 ¹	1.28 ¹
Current environment				
City centre	-0.02 (1.00)	0.04 (0.99)	0.01 (1.03)	0.02 (1.04)
Green spaces	-0.09 (1.03)	-0.15 (1.01)	-0.05 (0.97)	-0.09 (0.97)
Suburbs	0.11 (1.01)	0.06 (1.02)	0.04 (1.00)	0.10 (1.02)
Rural villages	0.003 (0.89)	0.07 (0.94)	-0.06 (0.99)	-0.15 (0.89)
Northern/remote	-0.62 (0.42)	-0.52 (0.55)	-0.09 (0.66)	-0.38 (0.77)
Test ¹	1.84 ¹	2.01 ¹	0.36 ¹	1.92 ¹

Notes: * $p < 0.05$; ¹ One-Way ANOVA; ² Welch's ANOVA; ³ Independent samples t-test; ⁴ Welch's t-test

Climate Emotions and Socio-demographic Factors

Table 3 and **Table 4** display the results of the mean and the multiple comparison tests, respectively. Significant gender differences in unpleasant externalizing, unpleasant internalizing, and neutral emotions were observed, where female participants reported higher mean scores than male participants. On the other hand, participants in the non-binary gender category had significantly higher mean scores than males with unpleasant externalizing emotions and females and males with unpleasant internalizing emotions.

Mean scores in unpleasant externalizing and unpleasant internalizing emotions were significantly different based on participants' birthplace. Specifically, participants born in Canada had a higher tendency to feel unpleasant externalizing and unpleasant internalizing emotions than those who were born abroad. Significant differences for all four climate emotion factors were also identified for religion, where a multiple comparison test revealed that participants who reported being spiritual were more likely to feel unpleasant externalizing and unpleasant internalizing emotions than all other sub-groups. Additionally, participants who reported being spiritual were more likely to feel pleasant and neutral emotions than those who reported being neither spiritual nor religious.

Table 4. Socio-demographic differences between climate emotions factors based on multiple comparison tests

M-CES Factor	Group 1	Group 2	95% CI
Gender			
Unpleasant internalizing ¹	Male	Female	[-0.63, -0.28]* †
Unpleasant internalizing ¹	Other	Female	[0.19, 1.26]* †
Unpleasant internalizing ¹	Other	Male	[0.63, 1.72]* †
Unpleasant externalizing ¹	Male	Female	[-0.51, -0.15]* †
Unpleasant externalizing ¹	Other	Female	[-0.04, 1.04]
Unpleasant externalizing ¹	Other	Male	[0.28, 1.39]* †
Neutral ²	Male	Female	[-0.39, -0.05]* †
Neutral ²	Other	Female	[-0.43, 0.92]
Neutral ²	Other	Male	[-0.22, 1.14]
Religion			
Unpleasant internalizing ¹	Spiritual	Religious	[0.26, 0.79]* †
Unpleasant internalizing ¹	Spiritual	Both	[-0.71, -0.16]* †
Unpleasant internalizing ¹	Spiritual	Neither	[-0.65, -0.21]* †
Unpleasant internalizing ¹	Religious	Both	[-0.19, 0.39]
Unpleasant internalizing ¹	Religious	Neither	[-0.14, 0.33]
Unpleasant internalizing ¹	Neither	Both	[-0.25, 0.25]
Unpleasant externalizing ¹	Spiritual	Religious	[0.21, 0.74]* †
Unpleasant externalizing ¹	Spiritual	Both	[-0.67, -0.12]* †
Unpleasant externalizing ¹	Spiritual	Neither	[-0.66, -0.22]* †
Unpleasant externalizing ¹	Religious	Both	[-0.20, 0.37]
Unpleasant externalizing ¹	Religious	Neither	[-0.20, 0.28]
Unpleasant externalizing ¹	Neither	Both	[-0.29, 0.20]
Pleasant ¹	Spiritual	Religious	[-0.24, 0.29]
Pleasant ¹	Spiritual	Both	[-0.29, 0.26]
Pleasant ¹	Spiritual	Neither	[-0.53, -0.09]* †
Pleasant ¹	Religious	Both	[-0.28, 0.30]
Pleasant ¹	Religious	Neither	[-0.52, -0.05]*
Pleasant ¹	Neither	Both	[-0.55, -0.05]*
Neutral ²	Spiritual	Religious	[-0.15, 0.43]
Neutral ²	Spiritual	Both	[-0.57, 0.002]
Neutral ²	Spiritual	Neither	[-0.60, -0.15]* †
Neutral ²	Religious	Both	[-0.45, 0.16]
Neutral ²	Religious	Neither	[-0.48, 0.02]
Neutral ²	Neither	Both	[-0.33, 0.16]

Notes: * $p < 0.05$; † Bonferroni correction $p < 0.007$; ¹ Tukey-Kramer test; ² Games-Howell test

Climate Emotions and Climate Action Results

Model fit statistics from the three regression models specified for pro-environmental behaviour, leadership environmental activism, and participatory environmental activism are shown in **Table 5**.

Model 3, which included the socio-demographic and mental health characteristics, climate anxiety, worry, and concern, as well as the four climate emotion factors, was found to have the best model fit for all outcome variables, as indicated by the largest adjusted R^2 and the smallest AIC values.

Table 5. Model fit diagnostics from the regression models analyzing the association between climate action and climate emotions factors

Outcome variable	Model fit statistic	Model 1	Model 2	Model 3
Pro-environmental behaviour	Adjusted R^2	0.03	0.25	0.31
	AIC	-4.24	-229.08	-304.70
Leadership in environmental activism	Adjusted R^2	0.07	0.41	0.44
	AIC	-42.72	-453.63	-488.21
Participatory environmental activism	Adjusted R^2	0.06	0.39	0.44
	AIC	-39.93	-419.32	-494.55

Notes: AIC denotes the Akaike Information Criterion (AIC).

Table 6 shows the regression model results for Model 3 as applied to the three outcome variables. The results of Models 1 and 2 are shown in **Appendix – Tables 4, 5, and 6**. Pleasant emotions ($\beta = 0.29$, $p < .001$) were positively associated with engagement in pro-environmental behaviour. In other words, participants who reported experiencing pleasant emotions had higher engagement with pro-environmental behaviours. Non-climate-related positive affect ($\beta = -0.09$, $p = 0.01$) was negatively associated with engagement in pro-environmental behaviours, whereas both functional impairment ($\beta = 0.16$, $p < .001$) and climate worry ($\beta = 0.16$, $p < .001$) were positively associated with engagement in pro-environmental behaviours. On average, participants who were very ($\beta = 0.29$, $p < .001$) or extremely concerned ($\beta = 0.42$, $p < .001$) about climate change were more likely to be engaged in pro-environmental behaviours than participants who were somewhat concerned about climate change. Additionally, participants who at the time of the study lived in urban greenspace environments ($\beta = 0.23$, $p = 0.01$) had significantly higher levels of engagement in pro-environmental behaviours than persons who lived in suburban environments.

Participants with pleasant ($\beta = 0.14$, $p < .001$) and neutral ($\beta = 0.10$, $p = 0.01$) emotions showed significant positive associations with leadership in activism, whereas those with negative internalizing ($\beta = -0.13$, $p = 0.02$) emotions showed significant negative associations with leadership in activism. Functional ($\beta = 0.30$, $p < .001$) and cognitive ($\beta = 0.26$, $p < .001$) impairment were positively associated with leadership in activism, whereas climate worry ($\beta = -0.12$, $p < .001$) was negatively associated with leadership in activism, adjusting for all other covariates.

Like pro-environmental behaviours and leadership activism, pleasant emotions ($\beta = 0.28$, $p < .001$) were positively and significantly associated with participatory activism. General positive affect ($\beta = -0.09$, $p < .001$) was negatively associated with participatory activism. Additionally, generalized anxiety ($\beta = -0.07$, $p = 0.04$) was negatively associated with participatory activism. Both functional ($\beta = 0.32$, $p < .001$) and cognitive ($\beta = 0.14$, $p < .001$) impairment due to climate anxiety were associated with increased participatory activism. Participants who were very ($\beta = 0.15$, $p = 0.02$) or extremely ($\beta = 0.33$, $p < .001$) concerned about climate change were shown to have higher levels of engagement in participatory activism than persons who were somewhat concerned.

Table 6. Model 3 results for mean pro-environmental behaviours, leadership in environmental activism, and participatory environmental activism scores

	Pro-environmental behaviours	Leadership in environmental activism	Participatory environmental activism
Intercept	-0.29 (0.08) *	0.15 (0.07) *	-0.08 (0.07)
Age	-0.01 (0.01)	-0.02 (0.01) *	-0.01 (0.01)
Gender			
Male	-0.04 (0.07)	-0.07 (0.06)	-0.13 (0.06) *
Other	-0.22 (0.20)	-0.16 (0.18)	-0.13 (0.18)
Born outside of Canada	0.13 (0.07)	0.13 (0.07)	0.04 (0.07)
Religion			
Religious	0.02 (0.08)	-0.04 (0.07)	0.03 (0.07)
Spiritual	0.04 (0.08)	-0.06 (0.07)	0.01 (0.07)
Both	0.08 (0.08)	-0.14 (0.08)	0.07 (0.08)
Childhood environment			
City centre	-0.09 (0.09)	0.02 (0.08)	0.03 (0.08)
Greenspace	0.03 (0.09)	0.05 (0.08)	0.06 (0.08)
Rural village	0.08 (0.09)	-0.03 (0.08)	-0.01 (0.08)
Remote	-0.03 (0.42)	-0.10 (0.38)	-0.47 (0.37)
Current environment			
City centre	0.14 (0.08)	-0.06 (0.07)	-0.05 (0.07)
Greenspace	0.23 (0.09) *	-0.07 (0.08)	0.02 (0.08)
Rural village	-0.03 (0.12)	-0.06 (0.11)	-0.08 (0.11)
Remote	-0.35 (0.42)	-0.57 (0.38)	-0.18 (0.38)
Affect			
Negative affect	-0.05 (0.05)	0.05 (0.04)	0.06 (0.04)
Positive affect	-0.09 (-0.03) *	-0.04 (0.03)	-0.09 (0.03) *
Depression	0.09 (0.05)	0.02 (0.04)	0.06 (0.04)
Anxiety	-0.04 (0.04)	-0.06 (0.03)	-0.07 (0.03) *
Climate anxiety scale			
Functional-impairment	0.16 (0.04) *	0.30 (0.04) *	0.32 (0.04) *
Cognitive-impairment	-0.02 (0.05)	0.26 (0.04) *	0.14 (0.04) *
Climate worry	0.16 (0.04) *	-0.12 (0.03) *	-0.02 (0.03)
Climate concern			
Not at all concerned	-0.08 (0.17)	-0.15 (0.16)	0.07 (0.16)
Very concerned	0.29 (0.07) *	-0.06 (0.06)	0.15 (0.06) *
Extremely concerned	0.42 (0.10) *	-0.14 (0.09)	0.33 (0.09) *
CES emotional responses			
Unpleasant externalizing	-0.01 (0.06)	0.09 (0.06)	0.01 (0.06)
Unpleasant internalizing	0.09 (0.06)	-0.13 (0.06) *	-0.04 (0.06)
Pleasant	0.29 (0.04) *	0.14 (0.03) *	0.28 (0.03) *
Neutral	-0.06 (0.04)	0.10 (0.04) *	0.02 (0.04)

Notes: The standard errors are in parentheses. The asterisks indicate statistically significant coefficients at $p < 0.05$.

DISCUSSION

The present study adds to the sparse literature on the climate emotions experienced by Canadian youth by showing how common and varied these emotions are in our study population. We also offer further empirical support to theoretical arguments hypothesizing that emotions are important determinants of climate action (Davidson & Keciński, 2021; Loewenstein et al. 2001; Salas Reyes et al., 2021; Slovic et al., 2001; Slovic et al., 2005).

Canadian Youth Experience a Wide Range of Climate Emotions

Descriptive analyses revealed that most of the study participants were worried and concerned about climate change but had also experienced several positive and negative emotions in response to climate change. A smaller percentage of participants reported having often experienced neutral climate emotions. While these results are broadly consistent with past research, our study found that this sample of Canadian university students experienced climate emotions at higher frequencies than those reported in other published research. For example, Galway and Field (2022) report that 48% of the participants worry that climate change would be a threat to people and the planet, whereas 61% of the participants in this study worry that climate change would impact themselves or others, and 80% worry for nature, animals and future generations. Likewise, Galway and Field (2022) find that 21% of participants are optimistic compared to 64% of participants in this study.

One explanation for the differences in self-reported climate emotions may be the sampling strategies and the study participants. The present study uses a convenience sample of university students that cannot be assumed to be representative of the general youth population, whereas both Galway and Field (2022) and Hickman et al. (2021) use a random sample of participants from the general population. It is possible that Canadian university students are more attuned, knowledgeable, and informed about climate change than other population groups; however, this interpretation deserves further investigation.

Climate Emotions Can Be Grouped into Four Factors

The results of the CFA models showed that, in this sample of Canadian university students, climate emotions can be grouped into four main factors: unpleasant externalizing, unpleasant internalizing, pleasant, and neutral. The two factors capturing unpleasant emotions were distinguished by the directionality of the emotions. While emotions such as anger, frustration, and distrust may be thought of as emotions directed 'away' from the individual, guilt, grief, and helplessness can be conceptualized as emotions directed 'towards' the individual. The difference between 'externalizing' and 'internalizing' unpleasant emotions aligns with the developmental literature that acknowledges the difference between internalizing and externalizing behaviours (Achenbach, 1995). Assigning a directionality to the two groups of unpleasant emotions may be criticized as some emotions, such as anger and frustration, can be directed both 'away' from and 'towards' the individual (Pihkala, 2022a). However, the results of this study show that, at the empirical level, this distinction exists and, as such, deserves further examination. Broadly, the results of the factor analysis models suggest that both direction (i.e., externalizing vs internalizing) and valence (i.e., pleasant, unpleasant, or neutral) are important characteristics of climate emotions that should be measured and considered when analyzing the drivers of climate action.

Different Groups of People Experience Different Kinds of Climate Emotions

When examining participants' responses to the list of climate emotions, we found that emotional experiences of climate change varied by socio-demographic factors. For example, while there were no gender differences in how often people experience pleasant climate emotions, females were more likely to report unpleasant externalizing, unpleasant internalizing, and neutral emotions than males. Furthermore, despite the small number of participants who identified with a non-binary gender, these participants were more likely to experience unpleasant externalizing emotions than male participants and unpleasant internalizing emotions than both self-identified female and male participants.

Canadian-born participants were also found to experience more unpleasant externalizing and internalizing emotions than non-Canadian-born participants. We also examined whether being religious

and/or spiritual was associated with different climate emotions. This analysis generated a complex set of results whose adequate interpretation goes beyond the scope of this paper. Nonetheless, it is important to underscore the importance of religion and spirituality when studying socio-cultural dimensions of climate change (Saryal, 2022) and the need to further investigate the role of religion and spirituality as determinants of climate emotions.

When examining the associations between socio-demographic characteristics and climate action, the results of this study suggest that only gender and current living environment were significant predictors of pro-environmental behaviours and activism. Specifically, after adjusting for affect, depression, anxiety, worry, concern, climate anxiety and climate emotions, we found that male participants were less likely to engage in participatory environmental activism than female participants. This is consistent with the results of past research (Autio & Heinonen, 2004; Ojala, 2015; Ojala & Bengtsson, 2019) which suggest that females tend to be more ecologically conscious than males and therefore have a stronger urge to engage in pro-environmental behaviours (Autio & Heinonen, 2004; Hunter et al., 2004; Li et al., 2022). According to Swim et al. (2011), women see climate change as posing a bigger risk than men, which may be one reason women are more involved in climate change mitigation efforts. Additional studies have discovered that women employ more problem-focused coping mechanisms than men, which may explain why they are more likely to engage in environmental activism (Ojala, 2015; Ojala & Bengtsson, 2019).

Our study also found that participants who resided in urban greenspace environments at the time of data collection were more likely to engage in pro-environmental behaviours. Like gender, this aligns with past research showing that residents of high greenspace urban areas reported more pro-environmental behaviours than residents of low greenspace urban areas (Alcock et al., 2020).

Pleasant Emotions Are Positively Associated with Climate Action

One of the main findings of this study was that pleasant emotions were positively associated with all three climate actions, whereas the unpleasant internalizing emotions factor was solely associated with negative engagement in climate activism, specifically leadership in activism. This aligns with past studies on the broaden-and-build theory of positive emotions (Fredrickson, 2013, 2001). According to this theory, negative emotions have the short-term benefit of focusing one's attention on producing a response that specifically addresses an immediate threat. For example, fear may lead someone to run away from what scares them, but running away is not something we would typically do in response to anger. Fredrickson (2001) explains that while negative emotions 'narrow down' the repertoire of possible actions to threat-specific responses, discrete positive emotions (e.g., hope, joy, interest) tend to produce non-specific, generalized responses, and they do so by tapping into cognitive processes that are associated with flexibility, creativity, and information seeking. Fredrickson and colleagues (2000) further suggest that positive emotions have the ability to 'undo' the effect of negative emotions, which may explain why climate action is more likely among participants who reported higher scores in the pleasant emotions factor, while at the same time experiencing unpleasant climate emotions.

Broadly, this study adds to the literature in two ways. First, we have demonstrated that feeling negative or unpleasant emotions does not appear to inhibit climate action (in our models, unpleasant emotions were not significant predictors of climate inaction), but rather, that it is the capacity to experience positive emotions, even in the presence of negative emotions, that promotes engagement in different types of climate action. Second, we demonstrated that when it comes to predicting climate action, capturing the general valence of the emotion (pleasant versus unpleasant) may be sufficient if other important factors, such as worry/concern and anxiety are taken into account. In other words, assuming that being worried or experiencing climate anxiety is an expected response to climate change,

the specific positive emotion that people feel when confronted with this crisis may not be important. This is because, unlike negative emotions that elicit specific behavioural responses (e.g., fear leads to escape), discrete positive emotions tend to activate more generalized cognitive and affective processes that are conducive to long-term planning and action (Fredrickson, 2001).

The association between positive climate emotions and climate actions may also be interpreted in the context of meaning-focused coping. Like the broaden-and-build theory, meaning-focused coping involves cognitive restructuring, positive thinking, and trust in society and political organizations (Ojala, 2012b, 2013; Ojala & Bengtsson, 2019). Past research has found that meaning-focused coping is significantly associated with engagement in climate action among Swedish youth, perhaps because youth can derive benefits and find meaning from taking action on environmental issues (Ojala, 2012b). In fact, when young people use meaning-focused coping strategies, they experience less negative affect, more life satisfaction, and more positive affect, effectively channeling anxiety into pro-environmental behaviours. Our results provide indirect evidence in support of the effectiveness of meaning-focused coping among Canadian youth by highlighting the role of positive emotions in predicting higher levels of climate action.

Neutral Emotions May Also Serve a Purpose in Sustaining Climate Action

In addition to the important role of positive emotions, neutral emotions were positively associated with more frequent engagement with leadership in activism. This suggests that emotions with a neutral connotation may have different influences depending on the type of climate action, whether it focuses on the individual (e.g., recycling, promoting climate awareness among friends and families, using bicycles) or the collective (e.g., following, organizing, or leading a movement). While emotional disengagement is generally not compatible with climate action, it is possible that young activists (leaders and organizers), but not followers, require emotional distance from climate change in order to stay involved in the long run. Similar themes were observed by Hoggett and Randall (2018), who found that, while climate activists and climate scientists were equally confronted with difficult climate emotions, the activists had more effective ways to cope with these emotions as they balance their emotional responses by maintaining a normal life (while living coherently to address climate change) and moving away from an intense preoccupation with the facts and the associated pain. The need for emotional disengagement in the context of sustained climate action may, in fact, be a part of self-care and self-preservation strategies that are a healthy part of living with climate change (Pihkala, 2022b).

CONCLUSION

This study adds to the literature on climate emotions in significant ways. First, we highlighted that most Canadian university students in our sample experience various types of climate emotions. Second, we demonstrated that emotional valence may be an important dimension of climate emotions that can help predict climate action among younger populations. Finally, we showed that there may be different emotional pathways leading to specific types of climate action.

This study has a few limitations. First, because this study is cross-sectional, it is not possible to measure or analyze the causal associations between climate emotions and climate action. Another limitation is the homogeneity of the sample of participants and, specifically, the lack of participants representing Indigenous peoples and other minority groups. As such, it is not possible to analyze how historical, social, and cultural factors influence climate emotions or actions among this sample of Canadian youth. Furthermore, we did not sample participants outside of the university setting, which limits the generalizability of our findings to the broader population.

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AVAILABILITY OF DATA AND MATERIALS

Requests for data access or to obtain supplemental information about this study may be sent to stefaniamaggi@cunet.carleton.ca.

Supplemental materials for this study can be found at <http://doi.org/10.5281/zenodo.10443325>

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the University Research Ethics Board (Clearance #116016)

CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

Authors declare that they have no conflicts of interest to report.

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