

Exploring the Effects of Threat-Based Climate Change Content in Canadian Post-Secondary

Environmental Education

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

When college students are asked how they feel about climate change, instead of motivation or empowerment, the most common response is fear (Hiser & Lynch, 2021; Galway & Field, 2023). Although this is deeply concerning, it comes as no surprise when you consider the material they are exposed to. Climate change is a growing threat to human life (Santamouris, 2020; Shindell et al., 2020; Silva et al., 2017; Lloyd et al., 2016), and this reality is reflected in the news, on social media, and in the classroom (e.g., CBC, 2023; Canada's NDP, 2023; Canadian Climate Institute, 2022; Vieyra-Balboa et al., 2024). As of now, researchers don't know exactly how this threat-based content is affecting students in environmental education programs. However, there is strong evidence that this type of messaging can affect peoples' behaviours (Burke et al., 2010), including their environmental behaviour (Fritsche & Hafner, 2012; Fritsche et al. 2012).

The purpose of my study was to examine the ways that threat-based climate change content affects post-secondary students in environmental studies programs. Two of my primary research objectives were to compare outcomes in 1) students' environmental identities and 2) students' actual short-term pro-environmental behaviour. My third objective was to produce findings that could be used to inform approaches to climate change education and contribute to the growing literature on climate change and mortality threats. I did this by presenting student participants with one of three randomly assigned news articles on an online survey platform: a Threat-Based climate change article, an Informational climate change article, or a Control article unrelated to climate change. After students had read their article, I measured their environmental identity and short-term pro-environmental behaviour so that I could compare the outcomes of students from the three conditions. I found that the news articles did not have a significant effect on identity, but that there was a decrease in pro-environmental behaviour for students who read the climate change articles (significant effect for the Informational and marginally significant for the Threat-Based).

My study produced several academic contributions, including the application of valuable methodological approaches, as well as guidance for future climate change education research. Based on my findings, I would not recommend Threat-based climate change content as a productive avenue for inspiring pro-environmental behaviour in post-secondary environmental education students. However, I recognize the importance of dispelling the reality of the climate crisis, including the threatening components, and make several recommendations for ways to mitigate the risk of behavioural inhibition when presenting this content. These findings can be used to inform educational climate change content so that educators can be empowered to select approaches that foster wellness and action.

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Table of Contents

<i>Author's Declaration</i>	<i>ii</i>
<i>Abstract</i>	<i>iii</i>
<i>Acknowledgements</i>	<i>iv</i>
<i>List of Figures</i>	<i>vii</i>
<i>List of Tables</i>	<i>viii</i>
Chapter 1. Introduction	1
1.1 Thesis Structure	1
1.2 Problem Context	1
1.3 Research Question and Objectives	3
1.4 Literature Review	3
1.4.1 Terror Management Theory.....	3
1.4.2 Existential Threat in Environmental Education.....	6
1.4.3 Environmental Identity	7
1.4.4 Pro-Environmental Behaviour	9
1.5 Methodology	17
1.5.1 Positionality	17
Chapter 2. Exploring The Effects of Threat-Based Climate Change Content in Canadian Post-Secondary Environmental Education	19
2.0 Chapter Summary	19
2.1 Introduction	19
2.1.1 Terror Management Theory.....	21
2.1.2 Existential Threat in Environmental Education.....	22
2.1.3 Environmental Identity and Pro-Environmental Behaviour.....	23
2.2 Methods	25
2.2.1 Participants	25
2.2.2 Measures.....	30
2.2.3 Procedure.....	31
2.2.4 Analyses	33
2.3 Results	35
2.3.1 Response Rates	35
2.3.2 Death Thought Accessibility	35
2.3.3 Environmental Identity	36
2.3.4 Pro-Environmental Behaviour.....	39
2.3.5 Royal Roads University.....	40
2.4 Discussion	42
2.4.1 Null Findings for Identity and Death Thought Accessibility	42
2.4.2 Decreased Pro-Environmental Behaviour in the Climate Change Conditions.....	44
2.4.3 Royal Roads University.....	49
2.5 Conclusions	50
Chapter 3. Conclusions	51
3.0 Chapter Summary	51

3.1 Main Findings.....	51
3.2 Limitations and Future Directions	51
3.3 Contributions.....	52
3.4.1 The Role of Climate Change Content as a Mortality Reminder.....	53
3.4.2 Methods in Terror Management Theory	53
3.4.3 Methods in Environmental Psychology.....	54
3.4.4 Applications in Environmental Education.....	55
References	56
Appendices.....	74
Appendix A. Deception	74
A.A1. Rationale for Deception.....	74
A.A2. Participant Deception Debriefing Material.....	74
Appendix B. Measurement Platforms	77
A.B1. Web-Based Research	77
A.B2. Survey Methods	77
A.B3. Behavioural Paradigms	78
Appendix C. Environmental Identity Scale	78
A.C1. Questions on the Environmental Identity Scale.....	78
A.C2. Seven-Point Response Format	79
A.C3. Slider Response Format	79
Appendix D. Work for Environmental Protection Task	80
Appendix E. News Article Conditions	83
A.E1. Article instructions	83
A.E2. Threat-Based Climate Change Article	83
A.E3. Informational Climate Change Article	84
A.E4. Control Article	85
Appendix F. Pro-Environmental Behaviour Analysis	87
Appendix G. Attrition	87

List of Figures

Figure 1. Psychological Defence to Mortality Reminders in Terror Management Theory adapted from Smith et al. (2022) and Cox et al. (2018).	5
Figure 2. Model of environmental constructs adapted from Walton & Jones (2022).	8
Figure 3. Categories of Pro-Environmental Behaviour (PEB) from Stern (2000), with their main drivers and impacts.	10
Figure 4. Norm Activation Model adapted from Schwartz, 1977	15
Figure 5. Value-belief-norm theory adapted from Stern et al., 1999.	16
Figure 6. Model of environmental constructs adapted from Walton & Jones (2022)	24
Figure 7. Norm-Activation Model adapted from Schwartz, 1977.	24
Figure 8. Value-belief-norm theory adapted from Stern et al., 1999.	25
Figure 9. Proportions of the University of Waterloo sample by ethnicity.	27
Figure 10. Proportions of the University of Waterloo sample by academic stage.	28
Figure 11. Proportions of the Royal Roads University Sample by Academic Stage.	29
Figure 12. Methods procedure adapted from Smith et al. (2022).	32
Figure 13. Distribution of Death Thought Accessibility Scores by Climate Change News Article Condition.	36
Figure 14. Environmental Identity Scores Across Climate Change News Article Conditions and Measurement Times.	38
Figure 15. Change in Average Environmental Identity Score by Climate Change News Article Condition.	39
Figure 16. Distribution of Completed Pages by Climate Change News Article Condition.	40
Figure 17. Environmental identity by climate change news article condition and measurement time.	41
Figure 18. Distribution of Completed Pages by Climate Change News Article Condition.	42
Figure 19. Relevant Components of the Norm Activation Model	45
Figure 20. Relevant Components of Value Belief Norm Theory	46
Figure 21. Psychological Defence to Mortality Reminders in Terror Management Theory (adapted from Smith et al., 2022 and Cox et al., 2019)	47

List of Tables

Table 1. A Summary of the Main Drivers that Can Influence Environmental Behaviour and Behavioural Intentions	13
Table 2. Proportions of the University of Waterloo Sample Demographic Characteristics by Condition.....	29
Table 3. Central Tendency and Standard Deviation of Death Thought Accessibility	35
Table 4. Mean and Standard Deviations of Environmental Identity by News Article Condition	36
Table 5. Mean and Standard Deviations of Environmental Identity Latent Factor Scores by News Article Condition.	37
Table 6. Factor loadings output for each question on the environmental identity scale	37
Table 7. Mean and Standard Deviations of Environmental Identity by News Article Condition	41

Chapter 1. Introduction

1.1 Thesis Structure

This thesis is structured following the manuscript approach. I begin with an introductory chapter (Chapter 1 here), followed by a high-detail manuscript draft chapter written for a peer-reviewed journal (Chapter 2), and finally, a concluding chapter (Chapter 3).

In the introduction chapter, I set the problem context, delineate my research question and objectives, provide a synthesis of the relevant literature, and describe my research methodology.

The high-detail manuscript chapter includes all of the content (plus some additional content) required to stand alone as a submission to the peer-reviewed journal *Environmental Education Research*. I began this chapter with a summary of its contents, then introduced the problem context, research questions and objectives, and relevant literature. Next, I described the methods I used in my study, followed by the study results. Finally, I discussed the findings, addressed the major study limitations, and identified future directions.

In the conclusion chapter, I discussed the main findings of my research, as well as the main contributions it offers to academia and education. I also described the limitations, and future directions in further detail.

1.2 Problem Context

Climate change poses a direct threat to life, livelihood, community, culture, and well-being (IPCC, 2018; Smith et al., 2022; Vesco et al., 2020; Schewe et al., 2019). Mortality rates are predicted to increase due to contributions from volatile temperatures, air pollution, extreme weather, food insecurities, and water insecurities (Santamouris, 2020; Shindell et al., 2020; Silva et al., 2017; Lloyd et al., 2016; Phalkey et al., 2015; Schilling et al., 2020). As humanity continues to exceed planetary boundaries, and the devastating effects of global climate change continue to grow in severity, frequency, and range, the need for significant and rapid action is becoming increasingly urgent (Rockström et al., 2009; IPCC, 2018). The continued disparity between individuals' generally high environmental awareness and generally low engagement demonstrates that the dissemination of knowledge is necessary for action, but not always sufficient (Hornsey et al., 2016; Howarth et al., 2020; Bamberg and Moser 2007; Gräsel 2000; Mobley et al., 2010; Siegel & Bellert, 2018; O'Brien, 2013; Tranter, 2019; Schmitt et al., 2020). Humanity needs people who understand climate change, and who have the capacity and willingness to act on that understanding. Therefore, it is essential that we carefully design our environmental education programs with attention to the empirical findings on the complex social-psychological barriers to pro-environmental behaviour (PEB; Lorenzoni & Whitmarsh, 2014; Schmitt et al., 2020).

The severity of the climate crisis brings threat-based climate change content to the forefront of environmental education, media coverage, and political messaging (e.g., Vieyra-Balboa et al., 2024; CBC, 2023; Macleans, 2022; Canada's NDP, 2023; Canadian Climate

Institute, 2022). Although the definition of threat differs between its predominant theoretical frameworks, a consistent theme among them is that threat undermines a core psychological need, like a cherished goal or intention (Jonas et al., 2014). Threat-based content can cause substantial and variable responses in adults, from anxiety, to avoidance, to vigilance (Gray & McNaughton, 2010; Jonas et al., 2014). This variability is often attributable to the characteristics of the threat message, such as themes of uncertainty, mortality, or low personal control (Harrison et al., 2015). In this study, I distinguished threat-based climate change content from other climate change content based on the theme of mortality, meaning that it includes reminders of the severe consequences for humanity and humanity's life support systems (Reser et al., 2011). Examples of content that meets this definition would be depictions of destruction from an extreme weather event in an occupied area, mortality reports after severe heat waves, or the inclusion of death-related images like skulls. The prevalence of these content themes allows threat-based climate change content to produce existential threat, which is defined by Fritzsche et al. (2010) as the "threat of personal death" (Fritzsche et al., 2010).

This existential threat component means that threat-based climate change content can act as a mortality reminder, which is a reminder of one's inevitable future death. Mortality reminders can be implicit, e.g., a picture of a skull, or explicit, e.g., asking someone how they expect it to feel when they die. Terror Management Theory (TMT) is a well-established sub-field of social psychology. Terror Management researchers have found that mortality reminders can have a significant effect on behaviours (Burke et al., 2010), including pro-environmental behaviour (Fritzsche et al., 2010; Fritzsche & Hafner, 2012; Fritzsche et al. 2012). The psychological defences predicted by TMT are thus important but neglected factors in understanding humanity's climate change responses (Wolfe & Tubi, 2018; Smith et al., 2022; Mitchell et al. 2016; Skurka et al., 2018; Uhl et al., 2017). Responses may be both enhancing or inhibiting, depending on individuals' contextual factors, e.g., pre-existing worldviews, salient norms, close-mindedness, ideology, self-esteem, and identity (Fritzsche et al., 2010, Fritzsche & Hafner, 2012; Routledge et al., 2010; Priyanka et al., 2023). In response to this variability, researchers must analyze the causal relationship(s) between threat-based climate change content and PEB in specific groups of people, so that climate change communication can be contextually optimized to spur PEB.

Institutions of higher education have a particularly high potential for inspiring PEB, as post-secondary environmental education can instill students with unique and crucial competencies for contributing to sustainability interventions (Salgado et al., 2018; Segalàs et al., 2009; Barth et al., 2007; Thomas & Depasquale, 2016). In the context of this research, environmental education is defined as "a process in which individuals gain awareness of their environment and acquire knowledge and skills that enable them to act to solve environmental problems" (UNESCO, 2014). The two main components of this definition are environmental awareness, referring to the level of knowledge a person holds regarding human impact on the environment (Dabbous, 2023), and environmental action (i.e., PEB).

However, there is a distinct lack of research that examines the effectiveness of specific environmental education approaches in inspiring PEB (Zsóka et al., 2013). I designed my research to address this gap by examining the effectiveness of threat-based climate change content for inspiring PEB in post-secondary environmental education. It will also be important for future researchers to consider the possible impacts of threat-based climate change content

beyond just behaviour, seeing as learning and well-being are additional and crucial outcomes of effective environmental education that may be influenced by reminders of mortality. Post-secondary institutions cannot afford to teach environmental education using methods that are ineffective and, potentially, counteractive. This would be a devastating loss of forward progress towards sustainability, not only for current students and staff, but for the long-term execution of these programs if they fail to maintain sufficient enrollment. It is crucial that researchers explore the potential effects of threat-based climate change content on the emotions, learning, and PEBs of post-secondary students, so that environmental education programs can ensure they are fulfilling their purpose far into the future, and so that students can grow to become powerful agents of change in local and global sustainability challenges.

1.3 Research Question and Objectives

Given these considerations, I addressed the following research question:

How does threat-based climate change content affect the environmental identity and actual short-term pro-environmental behaviour of Canadian post-secondary students in environmental education courses?

My research objectives were:

1. Determine the effects of threat-based climate change content on the environmental identity of Canadian post-secondary students in environmental education courses.
2. Investigate the effects of threat-based climate change content on the actual short-term pro-environmental behaviour of Canadian post-secondary students in environmental education courses.
3. Contribute findings to the growing literature on mortality management and climate action and produce information that can be used to inform educational approaches to the communication of threat-based climate change content.

These research objectives are connected to several existing fields of study, including Terror Management Theory, Environmental Psychology, Environmental Education, and Sustainability. I provide a review below of the existing literature that is highly relevant to these objectives.

1.4 Literature Review

I begin the discussion of relevant literature with an overview of TMT foundations, replication failures, and climate change applications. Next, I provide a description of relevant considerations for the educational context of the research. I subsequently address each of the measurement variables, environmental identity and short-term pro-environmental behaviour, to provide a theoretical foundation for their associated predictions and methods.

1.4.1 Terror Management Theory

Terror Management Theory was the central framework I drew on for this project. I emphasized this theoretical framework because it provided a broadly replicated and valid

scientific paradigm for approaching the study of mortality effects (Burke et al., 2010). Even though there have been decades of TMT research, only a small proportion of these studies focused on climate change or environmental issues (Smith et al., 2022). The application of TMT methods to environmental research has the potential to make substantial contributions to progress in climate change communication, within and beyond post-secondary education (Smith et al., 2022).

1.4.1.1 Foundations of Terror Management Theory. Humans, like all animal species, have an innate motivation to survive. Unlike most animals, however, humans can conceptualize distant future events and achieve a complex sense of self-awareness. An extension of self-awareness into this distant future allows humans to recognize that one day they will inevitably die, and this realization may provoke intense feelings of fear and anxiety (Becker, 1973). In response to this observation, Terror Management Theory (TMT) was developed as a framework for exploring the consequences of death anxiety on human behaviour (Greenberg et al., 1986). TMT contains three predominant hypotheses, with the mortality salience hypothesis being the focus of this research project. The mortality salience hypothesis predicts that a reminder of one's mortality can result in the activation of specific psychological defences as a mechanism for managing death anxiety, including cultural worldview defence and self-esteem striving (Schimel et al., 2019; Smith et al., 2022). Cultural worldviews are defined as beliefs and values which are shared among groups of people and used as criteria for living a meaningful life (Pyszczynski et al., 2015; Schimel et al., 2019). Cultural worldviews can provide individuals with a sense of immortality, whether it be literal (e.g., afterlife) or symbolic (e.g., contributing to society). Defence of one's cultural worldview can affect thoughts, emotions, and behaviours (Smith et al. 2022; Burke et al., 2010; Routledge et al., 2010), and in the case of environmental outcomes, it has been identified as an indirect driver of PEB (Walton & Jones, 2022).

In TMT research, cultural worldview defence and self-esteem striving are categorized as distal defences (Schimel et al., 2019). Their counterpart, proximal defences, include denial, distraction, and rationalization (Schimel et al., 2019). My decision to focus on distal defences in this research was related to the nature of the mortality reminders in question. A large proportion of TMT studies present participants with explicit mortality reminders, e.g., “*Describe how you think it will feel to die*” (Burke et al., 2010; Cox et al., 2019). In my research, I exposed participants to an implicit mortality reminder, e.g., seeing an image or text that is perceived as threatening. In a study of distal and proximal defences, Fritzsche et al. (2010) found that implicit mortality reminders directly evoked distal defences, while skipping over the activation phase for proximal defences (Figure 1). Although it would be valuable for future research to assess the impact of explicit climate change mortality reminders, my focus in this research project was on implicit reminders because those are the most likely forms of reminder to appear in environmental education classrooms. Distal defences were also better suited to this research context because of the theoretical connections between cultural worldview defence, environmental identity, and PEB discussed in sections 1.4.3.1 and 1.4.4.2.

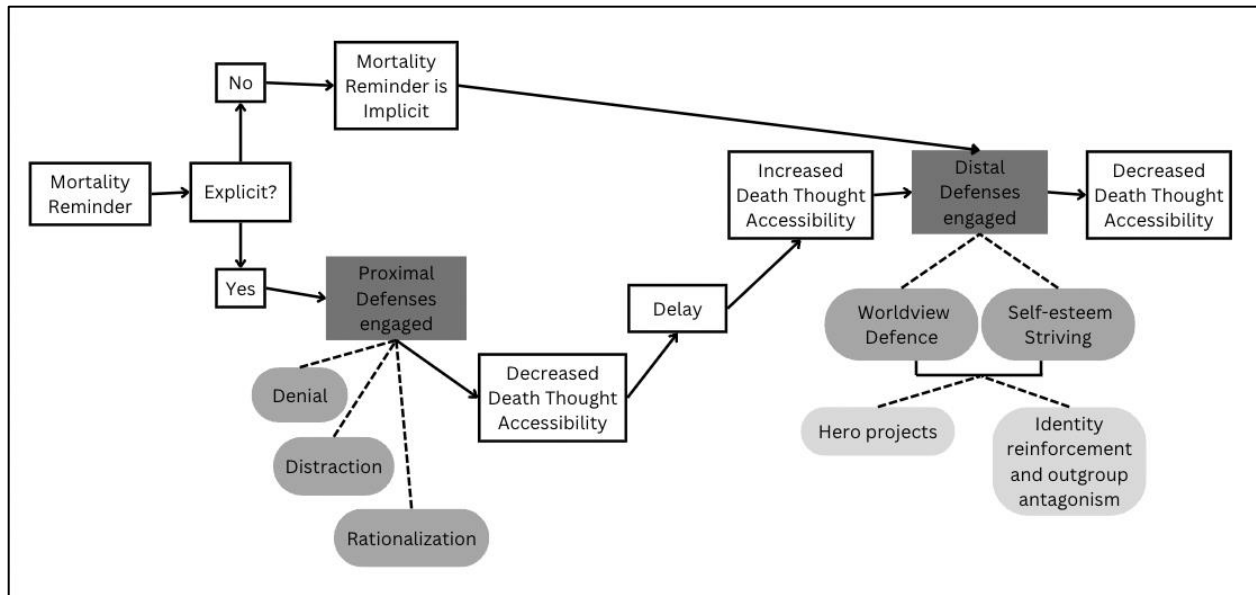


Figure 1. Psychological Defence to Mortality Reminders in Terror Management Theory adapted from Smith et al. (2022) and Cox et al. (2018).

1.4.1.2 Replication Failures in Terror Management Theory. Recent attempts to replicate the key findings of the mortality salience hypothesis have yielded inconsistent results, raising questions about the robustness and generalizability of the hypothesis (Klein et al., 2022; Treger et al., 2023). Klein et al. (2022) explain that their failure to replicate the key findings indicates that either the original finding was a false positive, the conditions needed to replicate it are unknown, or the conditions no longer exist. Treger et al. (2023) added that their replication failure may be partially due to the ease of achieving symbolic immortality with modern technological advancements. These interpretations are consistent with the understanding that the impact of mortality salience is influenced by a variety of nuanced factors, such as environmental conditions and individual differences (Burke et al., 2010). Such is to say that a replication failure in one population, for a specific and potentially outdated worldview defence measurement, does not necessarily diminish the robustness of the hypothesis in other contexts. This distinction was particularly relevant to my research since the defence measures and population that I examined were different from the areas of focus in the studies from Klein et al. (2022) and Treger et al. (2023). Furthermore, my study population was primarily composed of young adults and late teenagers in North America, who tend to experience the most pronounced mortality salience effects (Burke et al., 2010).

To assess the robustness of the mortality salience hypothesis for environmental identity and pro-environmental behaviour in Canadian post-secondary students, a more targeted replication test would be required. In the absence of such studies, and considering the substantive differences between my research and the replication studies, the findings from Klein et al. (2022) and Treger et al. (2023) did not produce sufficient cause to discard the mortality salience hypothesis in my research.

1.4.1.3 Climate Change Applications. Researchers have found that the effects of threatening climate change messages on behaviour and attitudes can closely resemble those of a mortality reminder (Fritzsche et al., 2010; Fritzsche et al., 2012; Fritzsche & Häfner, 2012; Akil et al., 2018;

Barth et al., 2018). The activation of cultural worldview defence and self-esteem striving has been observed in response to hurricane scenarios (Atalay & Meloy, 2020), questions about climate change consequences (Barth et al., 2018), and catastrophic imaging exercises (Pyszczynski et al., 2012). Further research is required to determine which types of climate change messages elicit specific psychological defences, and whether these effects can be attributed to identifiable message elements (Barth et al., 2018; Fritzsche & Häfner, 2012; Pyszczynski et al., 2012; Uhl et al., 2018). For example, Smith and Wolfe (2023) found that threatening water messages produced different participant responses depending on their focus (contaminated water, versus dehydration, versus flooding).

Individual responses to mortality reminders could lead to increased or decreased PEBs depending on a person's worldviews, salient norms, close-mindedness, ideology and group identity (Wolfe & Tubi, 2018; Priyanka et al., 2023). For example, Akil et al. (2018) found that an anxiety-inducing climate video increased consumption behaviour for participants with materialistic worldviews and decreased consumption behaviour for participants with environmental worldviews. It is thus important that scholars carefully consider the variation of worldviews within their study sample and population to maximize the ecological validity of any findings that may be used to inform climate change messaging.

1.4.2 Existential Threat in Environmental Education

When college students are asked to report their feelings about climate change, instead of empowerment, inspiration, or motivation, the most common response is fear (Hiser & Lynch, 2021; Galway & Field, 2023). This is deeply concerning considering that Canadian post-secondary students are already at high risk for mental health issues (American College Health Association, 2016) and that climate change can have dangerous compounding effects on that existing stress (Xu & Huang, 2022; Wu et al., 2020; Swim et al., 2011; Kluttz et al., 2020). There is even preliminary evidence to suggest that an environmental degree focus is related to pronounced feelings of environmental fear and anxiety (Kelly, 2017), although the causality in this relationship remains undetermined. Either way, the prevalence of sadness-related and anxiety-related climate change emotions in this population comes as no surprise when you consider the material that students are to. The climate crisis is a threat to human lives, and this is reflected repeatedly in environmental education content at both UW and RRU (Vieyra-Balboa et al., 2024).

If students are learning and thinking about the existential threat of climate change on a regular basis, this means they are being repeatedly exposed to potential mortality reminders. As previously discussed, these exposures could lead to significant consequences for PEB, the nature of which are currently unknown. What darkens the situation further, are the possible implications for emotions and well-being. Skurka et al. (2023) found that participants exposed repeatedly to threat-based climate change content experienced significantly higher levels of fear compared to participants exposed to low-threat climate change content. While several Terror Management researchers have stated there is no consistent evidence that mortality reminders increase negative affect (e.g., Simon et al., 1997; Arndt et al., 2001), more recent research has attributed this lack of evidence to specific elements of standard TMT experimental design (Tritt et al., 2012; Lambert et al., 2014; Routledge et al., 2010). After correcting for these design elements, Lambert

et al. (2014) detected a significant increase in fear following mortality reminders, while Routledge et al. (2010) observed drops in self-reported well-being among participants with low self-esteem in mortality reminder conditions. These findings, along with the repeated evidence that threat-based climate change content affects PEBs, are cause for serious concern.

It is critical that researchers examine the nature of threat-based climate change content effects in Canadian post-secondary settings so that educators can select approaches that foster empowerment, wellness, and meaningful climate action rather than anxiety and disengagement. Such was the motivation for my third research objective: to produce findings that can be used to inform educational approaches to the communication of threat-based climate change content. In my research, I selected PEB and environmental identity as the outcomes of interest, but it is important to note that a large collection of research will be required to develop an understanding of all the implications of threat-based climate change content, including examinations of emotions and well-being.

1.4.3 Environmental Identity

My first research objective was to determine the effects of threat-based climate change content on students' environmental identities. Environmental identity is defined by Clayton (2003) as "a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world" (pp. 45-46). Identity is not fixed throughout a person's lifetime; researchers have found that education, nature connection, ingroup behaviour modelling and social comparison can all enhance someone's environmental identity (Schmitt et al., 2019; Vesely et al., 2021). Identity is recommended as an ideal focus in pro-environmental behaviour interventions because of its established connection to behaviour (Fritzsche et al., 2018; van der Werff et al., 2014; Whitmarsh & O'Neill, 2010) and the absence of risk to the emotional well-being of participants (Vesely et al., 2021). It is also recommended because of the potential additional benefits of promoting group identity, and enhancing self-esteem by facilitating stronger relationships (Plusnin et al., 2018).

Environmental identity shares some facets with 'sense of place', which is described as an attachment to a space or place that is created through repeated social and material interactions (Ryfield et al., 2019), but differs in its bounds because it can extend beyond spatial attachments. It is also distinct because it always involves nonhuman beings in the natural environment, whereas sense of place can be derived solely from human social and material interactions. Different identities are typically organized into groupings depending on whether they are social or personal in nature, but environmental identity can include both personal and social components (Walton & Jones, 2018; Clayton, 2003; Whitmarsh & O'Neill, 2010).

1.4.3.1 Identity as the Intermediary. In an analysis of climate change behaviours through the lens of social identity, Fielding and Hornsey (2016) describe identity as the natural intermediary between cultural worldview and behaviour. This relationality is mirrored in a model of environmental constructs (Figure 2) that was developed by Walton and Jones (2022). The model in Figure 2 places environmental worldviews as an indirect driver of environmental behaviour, which suggests that any effects of worldview defence on behaviour would occur largely via

changes in identity, attitudes, concerns, and norms, in comparison to a direct driver which would bypass these channels (Walton and Jones, 2022).

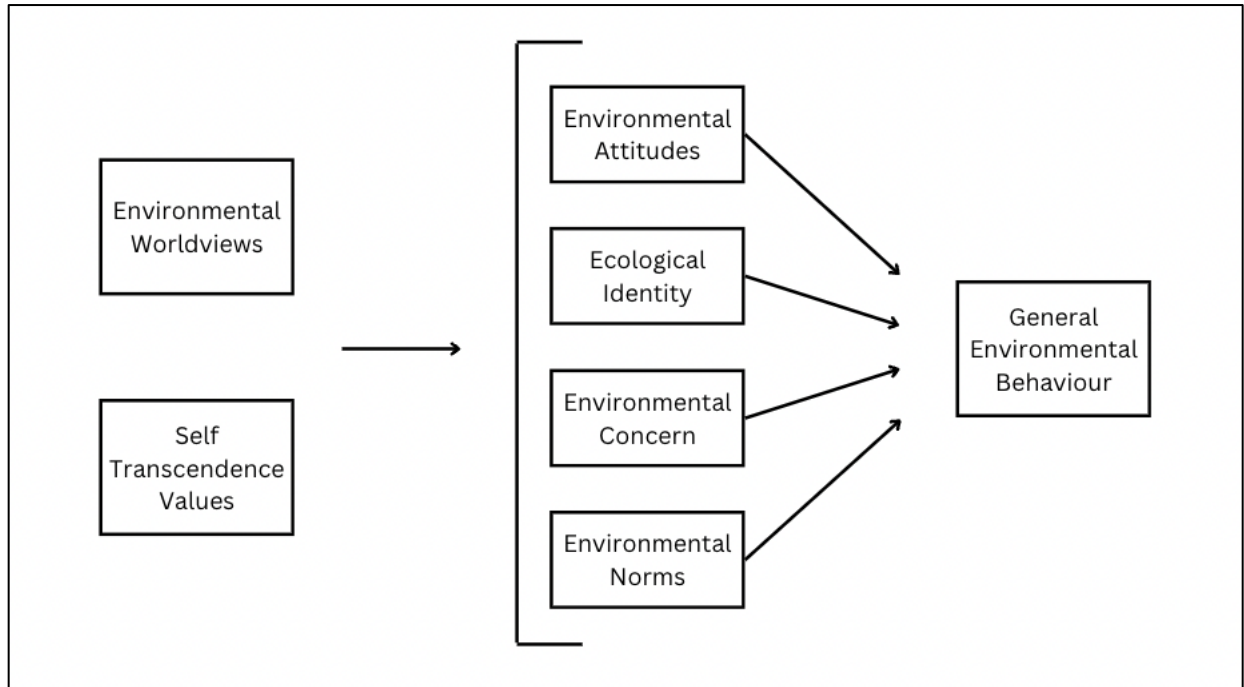


Figure 2. Model of environmental constructs adapted from Walton & Jones (2022).

The connection between worldview and identity aligns with Self-Determination Theory, through which researchers posit that people tend to adopt identities to serve their basic needs, such as a desire for belonging and self-esteem (Ryan & Deci, 2003). This closely resembles TMT’s cultural worldview defence and self-esteem bolstering, which indicates that adopting a stronger environmental identity could serve as an avenue for psychological defence against existential fear in the face of mortality reminders.

The direct observation of PEB outcomes in this study was limited to a single behaviour and did not capture long-term effects. Given the crucial importance of PEBs as an outcome variable in the study of threat-based climate change content impacts, I sought to achieve a higher level of breadth and constancy by also examining environmental identity. In a meta-analysis of 188 published articles, Vesely (2021) found that environmental identity had medium-strong correlations with both PEB intentions ($r=0.62$) and actual PEBs ($r=0.56$). The PEBs associated with a strong environmental identity are diverse (Van der Werff et al., 2013; Whitmarsh & O’Neill, 2010; Fritzsche et al., 2018), and have a tendency to spill over into the performance of additional PEBs (Smith et al., 2019). Furthermore, measuring environmental identity provided the advantage of potentially capturing a relatively stable tendency for PEBs that survive the transition from intention to action (Lapinski et al., 2016), and that resist rebound effects wherein one PEB can inhibit the performance of another (Lacasse, 2016).

1.4.3.2. Environmental Identity Prediction. My prediction was that exposure to threat-based climate change content would cause an increase the environmental identity scores of participants. This was based on the high baseline level of environmental identity in the study population,

which tends to produce increased environmental outcomes in response to mortality reminders (Akil et al., 2018; Vess & Arndt, 2008).

1.4.4 Pro-Environmental Behaviour

Pro-environmental behaviour can be defined as “behavior that strives to minimize the negative impact of one’s own actions on the natural environment” (Kollmuss & Agyeman, 2002, p.214). If humanity is going to effectively respond to severe and urgent environmental threats, massive societal changes will be necessary and PEBs will be an essential component of that change (Nielson et al., 2021; Rockström et al., 2009; IPCC, 2018; Wynes & Nicholas, 2017). PEBs are particularly important for my study’s target population because students’ engagement with post-secondary environmental education is an opportunity to build critical capacities and contributions toward sustainability solutions (Thomas & Depasquale, 2016; Segalàs et al., 2009; Salgado et al., 2018; Barth et al., 2007). Furthermore, the aspirations of many environmental education programs focus not only on enhancing students’ awareness of sustainability challenges but also supporting them in developing the capacity to act on that awareness (Jones et al., 2010; British Columbia Ministry of Education, 2007; Jensen & Schnack, 2006; Birdsall, 2010; Fang, 2023; Mulkey, 2017). This action could be highly impactful for progress towards sustainability, for example, it may manifest as the application of strong sustainability capabilities, like systems thinking or anticipatory skillsets, to enhance the effectiveness of sustainability interventions in a student’s career post-graduation (Thomas & Depasquale, 2016; Segalàs et al., 2009; Salgado et al., 2018). Thus, one of the primary objectives of my research was to investigate the effects of threat-based climate change content on PEB.

1.4.4.1 Dimensions of PEB. Environmental behaviours can be categorized according to various criteria (Larsen et al., 2015). The causal forces that influence PEBs are highly variable depending on the specific PEB in question, so designating a behaviour as part of a category can be a useful step toward identifying the relevant antecedents to the behaviour in question (Stern, 2000).

Stern (2000) suggests four categories of PEBs, as depicted in Figure 3.

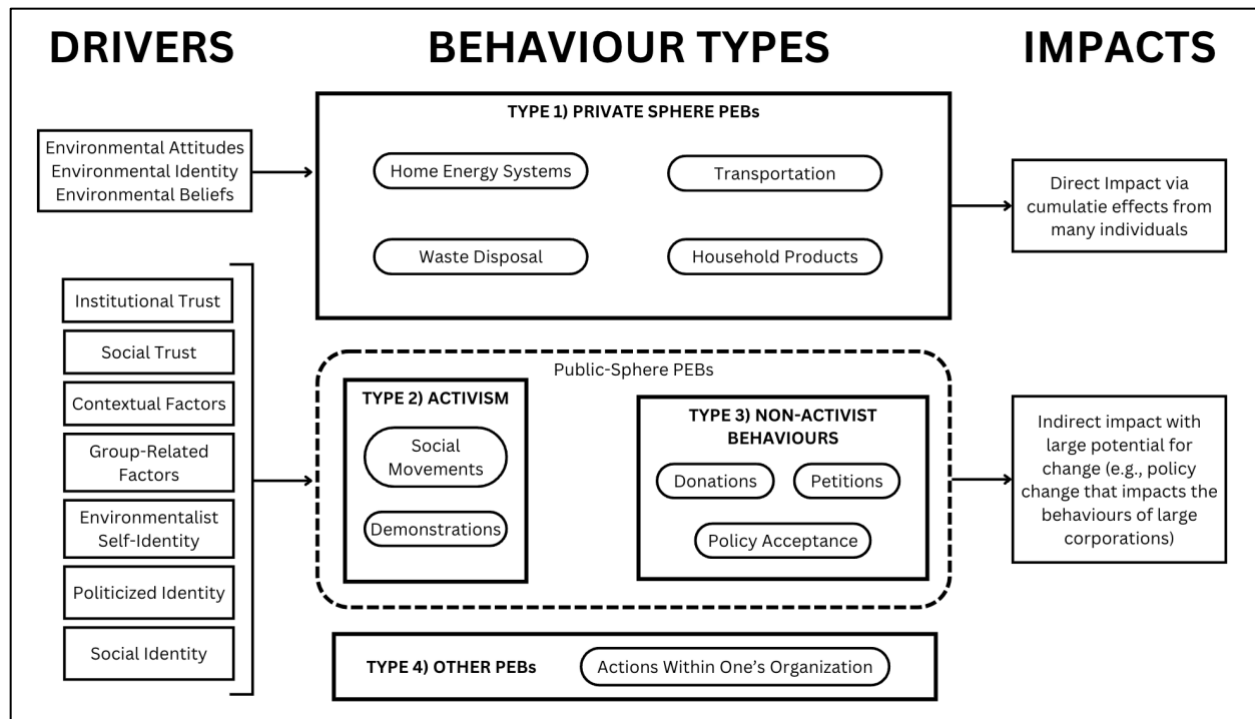


Figure 3. Categories of Pro-Environmental Behaviour (PEB) from Stern (2000), with their main drivers and impacts.

The first category of behaviours is termed ‘private-sphere environmentalism’, and includes behaviours that exist in people’s personal lives, such as household products, home energy systems, transportation, and waste disposal. The second and third categories are activist behaviours and non-activist behaviours, both of which occur in the public-sphere - which encompasses behaviours that resemble collective action (Xing et al., 2022). An example of an activist behaviour would be participating in a protest, whereas a non-activist behaviour would be signing a petition. The fourth category – ‘other environmentally significant behaviours’ – is a catch-all for behaviours that do not fall into any of the three aforementioned categories, with the main example being behaviour that is part of one’s job within their organization.

Behaviours within these four categories are subject to different influences, and are thus explained by distinct predictors (Dono et al., 2010; Alisat and Riemer, 2015). Researchers have found that private-sphere PEBs are mainly driven by intrapersonal factors, such as attitudes, identity, and beliefs (van der Werff and Steg, 2016; Gkargkavouzi et al., 2019), whereas public sphere PEBs are impacted by trust (Song et al. 2019; Xing et al. 2022), context (Fritsche et al., 2018), group-related factors (Schulte et al., 2020), environmentalist self-identity (Xing et al., 2022), politicized identity (Xing et al., 2022) and social identity (van Zomeren et al., 2011). There is further variation within the public-sphere domain, for example, Xing et al. (2022), found that institutional trust was a positive predictor of non-activist behaviour but a negative predictor of activist behaviour.

In this study, the behaviour I am observing occurs within a measurement tool called the Work for Environmental Protection Task (WEPT), and it results in a real environmental donation for every page of a monotonous number identification task that participants complete. Hadler and

Haller (2011) designate donating money as a non-activist public-sphere behaviour, since it has indirect environmental impacts and it extends beyond the actor's personal life. The WEPT closely resembles a donation behaviour in this regard, so it can be categorized as a non-activist public-sphere behaviour. This categorization is significant in my study because it suggests that environmental identity, as a facet of social identity and environmentalist identity, is a relevant predictor of engagement in the WEPT (as are additional factors of trust, context, and group-related variables).

PEBs can also be sorted across a continuum depending on the level of conscious thought involved in their performance (Heimlich & Ardoin, 2008). An individual could not possibly be conscious of every behaviour they perform, so as behaviours are repeated, they become learned habits that a person will perform automatically. At the other end of the continuum, we have critical thinking, which is often favoured in environmental education, and which encourages conscious thought rather than automatic habits (Heimlich & Ardoin, 2008). The WEPT aligns well with this prioritization, since it is not a behaviour that is regularly performed, and would thus engage some degree of critical thinking as to whether the individual performs the behaviour or not.

Another dimension in the categorization of environmental behaviours is impact, which necessitates a definition of environmental behaviour that extends beyond the intent of the actor. For example, one impact-oriented definition of PEBs is, "human behaviors that produce environmental benefits relative to alternative behaviors" (Lange & Dewitte, 2019; Steg & Vlek, 2009). This impact can be further categorized as either direct, e.g., waste disposal, or indirect, e.g., influencing international development policy (Stern, 2000). The environmental impact of monetary donations is indirect, meaning that it manifests as an outcome of some intermediate factor(s) (e.g., which project the money funds, the efficiency of said project, the total amount of money needed for the project). The involvement of intermediate factors makes it difficult to quantify and compare the impact of donations as a PEB. This is illustrated by Wynes and Nicholas (2017), who quantify carbon emissions reductions for a series of behaviours but omit calculations for civic actions, since there is so much variation within this type of behaviour. Although it is important to consider the impact of a PEB, the aforementioned variability in donation behaviour made the intent-oriented definition of PEB better suited to this research context. While it would be valuable for future researchers to examine a behaviour with measurable impact, I chose to proceed with a PEB measurement that had an indirect impact because of the more severe limitations in alternative PEB measurement tools, and because impact was not directly relevant to my research objectives.

A common dimension for PEBs in research methods is the timeline in which they occur. In my study, short-term PEB was distinguished from long-term PEB based on whether or not it occurred within the same day as the intervention. Short-term PEB occurs soon after the intervention, whereas long-term PEB could occur days, months, or years after the intervention. The distinction between short-term versus long-term PEB is important because there are differences in the drivers and impacts of these behaviours. (Stern et al., 2000; Larson et al., 2015). One form of behaviour is not necessarily superior to the other, they just manifest in different ways. For example, a short-term PEB like a one-time neighbourhood clean-up has a direct and tangible impact on the local ecosystem, whereas a long-term lifestyle change like

carpooling to work has a less tangible impact because the degree of greenhouse gas emissions reductions are not immediately visible and will change over time depending on several variables, e.g., frequency of carpooling, number of participants, and the fuel efficiency of vehicle (Larson et al., 2015). My choice to study short-term PEB was primarily based on the constraints of my research timeline, as well as the validity and reliability of the available measurement tools.

When it comes to behaviour change, the multitude of influential factors, e.g., attitudes, perceived behavioural control, and social norms, make it challenging for intervention programs to effectively target all of the relevant components that contribute to behavioural outcomes (Vesely, 2021). A summary of these factors is presented in Table 1. Then, I discuss the factors among these which are highly relevant to the mortality salience hypothesis, since these are variables that would require consideration in decisions about the inclusion or exclusion of threat-based climate change messages.

Table 1. A Summary of the Main Drivers that can Influence Environmental Behaviour and Behavioural Intentions

Driver	Description	Theory	Reference(s)
Values	“a guiding principle for any behaviour based on desirable trans-situational goals, which vary by relative importance” (Schwartz, 1992, p. 21).	Value Belief Norm Theory (VBN); Environmental Constructs Model (ECM)	Stern et al., 1999
Generalized Beliefs	A person’s perceived connections between components of their reality related to human interactions with the natural environment (Ghazali, 2019; Walton & Jones, 2022).	VBN; Reasoned Action Approach (RAA); ECM	Stern et al., 2000
Personal Norms	A person’s standard of behaviour for themselves based on their values and moral obligations (Thøgersen, 2006; Niemiec et al., 2020).	VBN; Norm Activation Model (NAM)	Schwartz, 1977; Stern et al., 1999
Self-Efficacy	A person’s perception of their ability to effectively perform positively impactful behaviours that are relevant to an environmental challenge (Joanes, 2019).	NAM	Schwartz, 1977
Outcome Efficacy	A person’s perception of whether positively impactful behaviours exist for an environmental challenge (Joanes, 2019).	NAM	Schwartz, 1977
Awareness of Consequences	A person’s perception of the impact that their behaviour would have on others (De Groot & Steg; 2009).	NAM	Schwartz, 1977
Awareness of Needs	A person’s perception of the level of requirement for them to engage in the behaviour in order for the problem to be addressed (Savari et al., 2021).	NAM	Schwartz, 1977
Acceptance of Responsibility	A person’s perception of whether they are responsible for the consequences of their behaviour (De Groot & Steg; 2009).	NAM	Schwartz, 1977
Ability	A person’s perception of how easy or difficult it would be to complete the behaviour (Savari et al., 2021).	NAM	Stern et al., 1999
Attitude toward the behaviour	How positively or negatively a person evaluates the behaviour (Abrahamse et al., 2009).	Theory of Planned Behaviour (TPB); RAA	Ajzen, 1991; Fishbein & Ajzen (2010);

Perceived Behavioural Control	A person's perception of their ability or inability to succeed at performing the behaviour (De Groot & Steg, 2009).	TPB; RAA	Ajzen, 1991; Fishbein & Ajzen (2010)
Subjective Norms	A person's perception of other people's beliefs about the behaviour, and whether they approve or disapprove of the behaviour (Kim & Huang, 2020; Shin et al., 2018).	TPB; RAA; ECM	Ajzen, 1991; Fishbein & Ajzen (2010)
Environmental Attitudes	A person's evaluations of environmental problems (e.g., good/bad, desirable/undesirable; Walton & Jones, 2022).	ECM	Walton & Jones (2022)
Environmental Identity	"a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world" (Clayton 2003; pp. 45-46).	ECM	Walton & Jones (2022)
Environmental Concern	The degree to which a person worries (as an affective response) about environmental problems in general (Walton & Jones, 2022).	ECM	Walton & Jones (2022)
Anticipated Feelings of Pride	A person's expectations that they will feel pride: a positive self-evaluative emotion (Pihkala, 2022).	Extended VBN	Onwezen et al., 2013
Anticipated Feelings of Guilt	A person's expectation that they will feel guilt: an aversive feeling induced when they violate their moral standards (Xiao et al., 2022).	Extended VBN	Onwezen et al., 2013
Institutional Trust	The degree to which a person has confidence in, and ascribes good intentions to the relevant institution in their proposed environmental actions and/or policies (Song et al, 2019).	N/A	Song et al. 2019; Xing et al. 2022
Individual and Personality Factors	E.g., stereotypes, emotions, past behaviour, perceived risk.	RAA	Fishbein & Ajzen (2010); Walton & Jones (2022)
Social Factors	E.g., age, education, gender, income. Race, ethnicity, culture.	RAA	Fishbein & Ajzen (2010); Walton & Jones (2022)
Information Factors	E.g., knowledge, media, interventions,	RAA	Fishbein & Ajzen (2010); Walton & Jones (2022)

1.4.4.2 Connecting Pro-Environmental Behaviour to the Mortality Salience Hypothesis. Terror Management research has repeatedly found that mortality reminders can have a significant impact on PEBs (e.g., Akil et al., 2018; Fritsche et al., 2010; Fritsche & Hafner, 2012; Fritsche et al. 2012; Kasser & Sheldon, 2000). These effects have been observed in both general and specific PEBs (Walton & Jones, 2022; Smith et al., 2022). The nature of the mortality reminder's effect, be it enhancing or inhibiting, depends on a variety of individual contextual factors, including pre-existing worldviews, salient norms, close-mindedness, ideology, self-esteem, and identity (Fritsche et al., 2010, Fritsche & Hafner, 2012; Routledge et al., 2010; Priyanka et al., 2023). The influential role of these contextual factors is consistent with the tenets of the Norm-Activation model (NAM; Schwartz, 1977) and the Value-belief-norm theory (VBN; Stern et al., 1999), which both suggest that constructs other than worldview can act as PEB drivers. Since these theories provide useful depictions of the antecedents to PEB, and because they are frequently used in studies of PEB, I discuss each one below (Macovei, 2015; Walton & Jones, 2022; Cordano et al. 2011).

According to the NAM, an individual's perceived personal and moral norms are causal drivers of PEBs, and the influence of a relevant norm depends on whether it is active or not (Figure 4; Schwartz, 1977). In TMT, activation of cultural norms can play a moderating role in the relationship between mortality reminders and decision-making by enhancing cultural worldview defence (Schindler & Reinhart, 2015). These moderating effects are particularly relevant to this research considering that many of the participants were in an environmental education learning setting surrounded by other environment students and staff, which is a context that may activate pro-environmental norms.

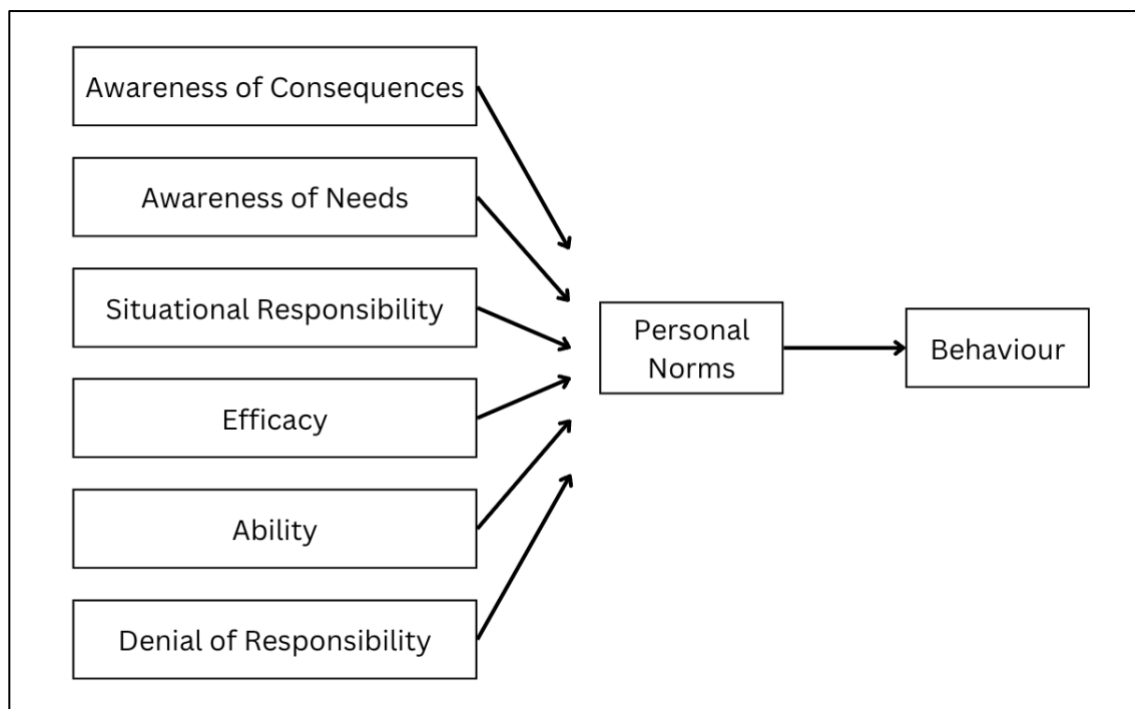


Figure 4. Norm Activation Model adapted from Schwartz, 1977

Building off of this NAM foundation, VBN theory posits that altruistic and biospheric values can act as drivers of beliefs, which influence norm activation and ultimately, behaviour (Figure 5; Stern et al., 1999). Cultural worldviews, according to the definition I established in Section 1.4.1.1, include general beliefs. Thus, it is likely that a person becomes more attached to their beliefs under the activation of cultural worldview defence (Schimel et al., 2019). According to VBN theory, stronger beliefs can drive behaviour. This provides a helpful depiction of one possible avenue by which mortality reminders might lead to significant behavioural effects; cultural worldview defence strengthens generalized beliefs, this enhances awareness of consequences, acceptance of responsibility, and personal norms, which in turn contribute to behavioural intentions and behaviour.

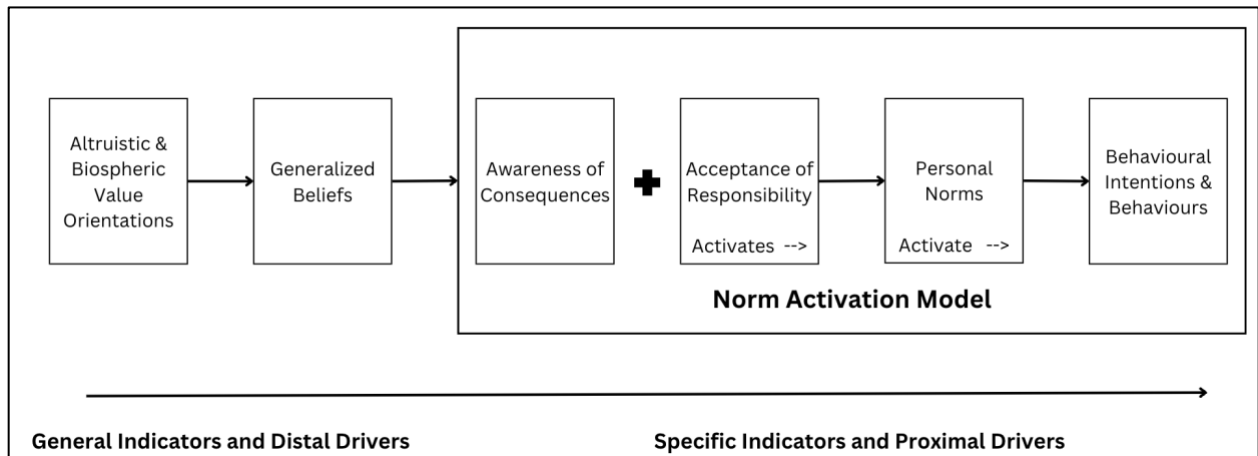


Figure 5. Value-belief-norm theory adapted from Stern et al., 1999.

The NAM (Figure 4) and the VBN (Figure 5), along with the earlier model of environmental constructs (Figure 1), provided valuable frameworks for interpreting the results of my study. An integration of these three theories indicates that cultural worldview defence can strengthen an individual's sense of identity, and this can affect behaviour.

1.4.4.3.Pro-Environmental Behaviour Prediction. I predicted that students exposed to threat-based climate change content would perform significantly higher levels of short-term PEB than those exposed to informational or control content. Existing research indicates that the directionality of mortality reminder effects depends on an individual's environmental identity (Akil et al., 2018; Vess & Arndt, 2008). Participants with strong environmental identities have been found to increase their PEBs in response to a mortality reminder, while participants with weak environmental identities decreased their PEBs (Akil et al., 2018; Vess & Arndt, 2008). There was reason to believe that this study population contained individuals with generally strong environmental identities considering that participating in post-secondary education is associated with higher environmental concern (DeSilva & Ponwall, 2014; Torgler & García-Valiñas, 2007) and that participants had chosen to enroll in an environmental education course, which can be considered a PEB in the form of knowledge seeking (van Horen et al., 2018). These considerations, alongside the strong baseline environmental identity scores across the study sample ($M = 5.55$, $SD = 0.84$) provided theoretical backing for my directional prediction that threat-based climate change content would increase PEB.

1.5 Methodology

In this research project, I collected information on whether and how threat-based climate change content affected Canadian post-secondary environmental education students' environmental identities and actual short-term pro-environmental behaviour. My research question was causal, necessitating an experimental design. The selection of an experimental approach aligned with the postpositivist notion that causes determine effects, otherwise known as determinism (Creswell, 2013). Postpositivists argue that there is such a thing as an objective reality in most cases, but that we cannot claim absolute certainty in our knowledge of this reality (Phillips & Burbules, 2000). Postpositivist thinkers also recognize that the limitations of truth claims are particularly pronounced in examinations of human behaviour (Creswell, 2013). These postpositivist assumptions are compatible with the scientific method, which is generally accepted as a research approach among postpositivists (Creswell, 2013). I hold these postpositivist assumptions, hence my adherence to the scientific method in this research project.

I also believe that peoples' experiences shape their interpretations of the world and that those interpretations are valuable. This perspective is characteristic of a constructivist research philosophy (Creswell, 2013). The notion of multiple participant meanings was not encompassed in my research design because it lacks compatibility with the experimental paradigm. It was also excluded because another project in my research program addressed this component by gathering detailed qualitative information about individual student experiences of post-secondary environmental education (Grant, Personal Communication, June 12th, 2023).

Although suggestions from constructivism were beyond the scope of this project's methods – they do provide valuable insight into some important considerations for future research and for the application of the findings in educational settings. Since one of my research objectives was to produce knowledge that could inform recommendations for the inclusion or exclusion of threat-based climate change content in environmental education courses, it is valuable to recognize that students' and instructors' experiences would be useful for informing the way that the recommendations are formatted and shared.

1.5.1 Positionality

In recognition of the constructivist notion that experiences shape interpretations of the world, it is important to note my positionality in this research. As a student currently enrolled in a Canadian post-secondary environmental education program, I am a member of the target population, and I could potentially be a direct beneficiary of the project outcomes. This vested interest provided me with valuable insights on the project context and a motivation to generate high-quality research. However, my direct involvement could also have produced biases, which I took steps to minimize through rigorous data collection (e.g., random assignment) and analysis (e.g., pre-determined significance cutoff), as suggested by postpositivist research methodologies (Creswell, 2013).

It is important to note that I am a white, able-bodied, cis-gendered female, which puts me in a position of great privilege in this research context. I have had positive experiences with post-secondary education, and I grew up in a geographical and socioeconomic context of low

vulnerability to climate change. My perception of these issues is likely influenced by my personal experiences with them. I took steps to minimize potential biases that could arise from this positionality by executing the study as a randomized control trial. For example, I addressed confirmation bias by using pre-established analyses, pre-established significance thresholds, and random assignment.

I would like to acknowledge that I am of European settler descent and I have spent most of my life in the traditional territories of the Anishinaabe, Algonquin, and Haudenosaunee peoples. This land, and all of the beings who share it, have been integral to my identity and happiness. I feel my greatest joy when I am surrounded by the wind, the trees, the birds, and the mountains. It is this joy and connection that inspires me to continue my work as an environmental researcher and educator. Although my research project did not directly benefit the land or the Anishinaabe, Algonquin, and Haudenosaunee peoples, I have been committed to working with humility and respect, recognizing the ongoing impacts of colonialism on Indigenous peoples and their lands, and engaging in a process of reconciliation and learning. My commitment influenced the meaning that I associated with this research project because I hoped that the findings would inspire collective efforts to protect and preserve the land in ways that are grounded in love, respect, kindness and generosity - values which were shared with me by Metis/Cree reconciliation facilitator Kathi Camilleri (2024). This additional vested interest may have introduced biases to my research, but may also have offered the advantage of bringing forward important considerations.

To summarize, I care deeply about environmental education, environmental stewardship, and reconciliation. As I conducted this research project, I continued to recognize my positionality as a researcher, including the insights that were associated with this, as well as the biases and assumptions.

These considerations are reflected in the manuscript below, which describes the study I conducted to address my first and second research objectives: to determine the effects of threat-based climate change content on 1) the environmental identity, and 2) the pro-environmental behaviour, of Canadian post-secondary students in environmental education courses.

Chapter 2. Exploring The Effects of Threat-Based Climate Change Content in Canadian Post-Secondary Environmental Education

This chapter contains a high-detail draft manuscript for a peer-reviewed journal, including an introduction, methods, results, and discussion section. I plan to submit a condensed version of this manuscript to the journal *Environmental Education Research*, because its' focus is on advancing understandings of environmental and sustainability education, which is one of the primary contributions of my research. This scope is also connected to all three of my research objectives.

2.0 Chapter Summary

When college students are asked how they feel about climate change, instead of motivation or empowerment, the most common response is fear (Hiser & Lynch, 2021; Galway & Field, 2023). Although this is deeply concerning, it comes as no surprise when you consider the material they are exposed to. Climate change is a growing threat to human life (Santamouris, 2020; Shindell et al., 2020; Silva et al., 2017; Lloyd et al., 2016), and this reality is reflected in the news, on social media, and in the classroom (e.g., CBC, 2023; Canada's NDP, 2023; Canadian Climate Institute, 2022). As of now, researchers don't know exactly how this threat-based content is affecting students in environmental education programs. However, there is strong evidence that this type of messaging can affect peoples' behaviours (Burke et al., 2010), including their environmental behaviour (Fritsche & Hafner, 2012; Fritsche et al. 2012).

The purpose of my study was to examine whether and how threat-based climate change content affects post-secondary students in environmental studies programs. I did this by presenting student participants with one of three randomly assigned news articles on an online survey platform: a Threat-Based climate change article, an Informational climate change article, or a Control article unrelated to climate change. Next, I compared environmental outcomes of students from the three conditions to see if there were differences in behaviour and identity. I found that the news articles did not have a significant effect on identity, but that there was a significant decrease in PEB for students who read the Informational article and a marginally-significant decrease for those that read the Threat-Based article.

My study contains several academic contributions, including the application of valuable methodological approaches, as well as guidance for future climate change education research. Based on my findings, I would not recommend Threat-based climate change content as a stand-alone means for inspiring pro-environmental behaviour in post-secondary environmental education students. However, I recognize the importance of dispelling the reality of the climate crisis, including the threatening components, and make several recommendations for ways to mitigate the risk of behavioural inhibition when presenting this content. These findings can be used to inform climate change teaching guidelines so that educators can be empowered to select approaches that foster wellness and action.

2.1 Introduction

Climate change poses a direct threat to life, livelihood, community, culture, and well-being (IPCC, 2018; Smith et al., 2022; Vesco et al., 2020; Schewe et al., 2019). As humanity continues to exceed planetary boundaries, and the devastating effects of global climate change continue to grow in severity, frequency, and range, the need for significant and rapid action is becoming increasingly urgent (Rockström et al., 2009; IPCC, 2018). The continued disparity between individuals' generally high environmental awareness and generally low engagement demonstrates that the dissemination of knowledge is necessary for action, but not always sufficient (Hornsey et al., 2016; Howarth et al., 2020; Bamberg and Moser 2007; Gräsel 2000; Mobley et al., 2010; Siegel & Bellert, 2018; O'Brien, 2013; Tranter, 2019). Humanity needs people who can understand environmental problems, and who have the capacity and willingness to act on that understanding. Therefore, it is essential that we carefully design our environmental education programs with attention to the empirical findings on the complex social-psychological barriers to pro-environmental behaviour (PEB; Lorenzoni & Whitmarsh, 2014).

The life-threatening reality of the climate crisis brings threat-based climate change content to the forefront of environmental education, media coverage, and political messaging (e.g., CBC, 2023; Macleans, 2022; Canada's NDP, 2023; Canadian Climate Institute, 2022). In this study, I distinguished threat-based climate change content from other climate change content based on the theme of mortality, meaning that it must include reminders of the severe consequences for humanity and humanity's life support systems (Reser et al., 2011). Examples of content that meets this definition would be depictions of destruction from an extreme weather event in an occupied area, mortality reports after severe heat waves, or the inclusion of death-related words or images (e.g., skull, cemetery, grave). Based on this definition, threat-based climate change content can act as a mortality reminder, which is a reminder of one's inevitable future death. Mortality reminders can be implicit, e.g., a picture of a skull, or explicit, e.g., asking someone how they expect it to feel when they die. Terror Management Theory (TMT) is a sub-field of social psychology with repeated findings that mortality reminders can have a significant effect on behaviours (Burke et al., 2010), including pro-environmental behaviour (Fritzsche & Hafner, 2012; Fritzsche et al. 2012; PEB). The psychological defences predicted by TMT are thus important but neglected factors in understanding humanity's climate change responses (Wolfe & Tubi, 2018; Smith et al., 2022; Mitchell et al. 2016; Skurka et al., 2018; Uhl et al., 2017). Responses may be both enhancing or inhibiting, depending on individuals' contextual factors, e.g., pre-existing worldviews, salient norms, close-mindedness, ideology, self-esteem, and identity (Fritzsche et al., 2010, Fritzsche & Hafner, 2012; Routledge et al., 2010; Priyanka et al., 2023). In response to this variability, researchers must analyze the causal relationship(s) between threat-based climate change content and PEB in specific groups of people, so that climate change communication can be contextually optimized to spur PEB.

Institutions of higher education have a particularly high potential for inspiring meaningful PEB given that post-secondary environmental education can instill students with unique and crucial competencies for contributing to sustainability interventions (Salgado et al., 2018; Segalàs et al., 2009; Barth et al., 2007; Thomas & Depasquale, 2016). In this study, environmental education is defined as "a process in which individuals gain awareness of their environment and acquire knowledge and skills that enable them to act to solve environmental problems" (UNESCO, 2014). Post-secondary environmental education programs often explicitly state that one of their primary goals is to support students in developing the capacity to act on their environmental

awareness (Clarke et al., 2011; Jones et al., 2010; Government of Canada, 2024; Mangas et al., 1997; British Columbia Ministry of Education, 2007). However, there is a distinct lack of research that examines the effectiveness of specific environmental content in inspiring PEB (Zsóka et al., 2013). My research addresses this gap by examining the effects of threat-based climate change content on PEB. It is also important to consider the possible impacts of threat-based climate change content beyond just behaviour, noting that learning and well-being are additional and crucial outcomes of effective environmental education that may be influenced by mortality reminders. Post-secondary institutions cannot afford to teach environmental education using methods that are ineffective and potentially counteractive. This would be a devastating loss of forward progress towards sustainability, not only for current students and staff, but for the long-term execution of these programs if they fail to maintain sufficient enrollment. Hence, my research question:

How does threat-based climate change content affect the environmental identity and actual short-term pro-environmental behaviour of Canadian post-secondary students in environmental education courses?

It is crucial that researchers explore the potential effects of threat-based climate change content on the emotions, learning, and PEBs of post-secondary students so that environmental education programs can ensure they are fulfilling their purpose far into the future, and so that students can grow to become powerful agents of change in local and global sustainability challenges.

2.1.1 Terror Management Theory

Terror Management Theory was the central framework I drew from for this project. I emphasized this theoretical framework because it provided a broadly replicated and valid scientific paradigm for approaching the study of mortality effects (Burke et al., 2010). Even though there have been decades of TMT research, only a small proportion of these studies focused on climate change or environmental issues (Smith et al., 2022).

Terror Management Theory (TMT) was developed as a framework for exploring the consequences of death anxiety on human behaviour (Greenberg et al., 1986). TMT contains three predominant hypotheses, with the mortality salience hypothesis being the focus of this research project. The mortality salience hypothesis predicts that a reminder of one's mortality can result in the activation of specific psychological defences, including cultural worldview defence and self-esteem striving (Schimel et al., 2019; Smith et al. 2022). Cultural worldviews are defined as beliefs and values which are shared among groups of people and used as criteria for living a meaningful life (Pyszczynski et al., 2015; Schimel et al., 2019). Cultural worldviews can provide individuals with a sense of immortality, whether it be literal (e.g., afterlife) or symbolic (e.g., contributing to society). Defence of one's cultural worldview can affect thoughts, emotions, and behaviours (Smith et al. 2022; Burke et al., 2010; Routledge et al., 2010), and in the case of environmental outcomes, it has been identified as an indirect driver of PEB (Walton & Jones, 2022).

Recent attempts to replicate the key findings of the mortality salience hypothesis have yielded inconsistent results, raising questions about the robustness and generalizability of the hypothesis (Klein et al., 2022; Treger et al., 2023). A more targeted replication test would be required in order to evaluate the robustness of the mortality salience hypothesis for environmental identity and pro-environmental behaviour in Canadian post-secondary students. In the absence of such studies, and considering the substantive differences between my research and the replication studies, the findings from Klein et al. (2022) and Treger et al. (2023) did not produce sufficient cause to disregard the mortality salience hypothesis in my research.

Researchers have found that the effects of threatening climate change messages on behaviour and attitudes can closely resemble those of a mortality reminder (Fritzsche et al., 2010; Fritzsche et al., 2012; Fritzsche & Häfner, 2012). Individual responses to mortality reminders could lead to increased or decreased PEBs depending on a person's worldviews, salient norms, close-mindedness, ideology and group identity (Wolfe & Tubi, 2018; Priyanka et al., 2023). For example, Akil et al. (2018) found that an anxiety-inducing climate video increased consumption behaviour for participants with materialistic worldviews and decreased consumption behaviour for participants with environmental worldviews.

2.1.2 Existential Threat in Environmental Education

When college students are asked to report their feelings about climate change, instead of empowerment, inspiration, or motivation, the most common response is fear (Hiser & Lynch, 2021; Galway & Field, 2023). This is deeply concerning considering that Canadian post-secondary students are already at high risk for mental health issues (American College Health Association, 2016) and that climate change can have dangerous compounding effects on that existing stress (Xu & Huang, 2022; Wu et al., 2020; Swim et al., 2011; Kluttz et al., 2020). There is even preliminary evidence to suggest that an environmental degree focus is related to pronounced feelings of environmental fear and anxiety (Kelly, 2017), although the causality in this relationship is undetermined. This comes as no surprise when you consider the material that students are exposed to. The climate crisis is a threat to human lives, and this is reflected repeatedly in environmental education content at both UW and RRU (Vieyra-Balboa et al., 2024).

If students are learning and thinking about the existential threat of climate change on a regular basis, this means they are being repeatedly exposed to potential mortality reminders. As previously discussed, these exposures could lead to significant consequences for PEB, the nature of which are currently unknown. What darkens the situation further though, are the possible implications for emotions and well-being. Skurka et al. (2023) found that participants exposed repeatedly to threat-based climate change content experienced significantly higher levels of fear compared to participants exposed to low-threat climate change content. While several Terror Management researchers have stated there is no consistent evidence that mortality reminders increase negative affect (e.g., Simon et al., 1997; Arndt et al., 2001), more recent research has attributed this lack of evidence to specific elements of standard TMT experimental design (Tritt et al., 2012; Lambert et al., 2014; Routledge et al., 2010). After correcting for these design elements, Lambert et al. (2014) detected a significant increase in fear following mortality reminders, while Routledge et al. (2010) observed drops in self-reported well-being among

participants with low self-esteem in mortality reminder conditions. These findings, along with the repeated evidence that threat-based climate change content affects PEBs, are cause for serious concern.

It is critical that researchers examine the nature of threat-based climate change content effects in Canadian post-secondary settings so that educators can select approaches that foster empowerment, wellness, and meaningful climate action rather than anxiety and disengagement. Such was the motivation for my third research objective: to produce findings that can be used to inform educational approaches to the communication of threat-based climate change content. In this study, I have selected PEB and environmental identity as the outcomes of interest, but it is important to note that a large collection of research will be required to develop an understanding of all the implications of threat-based climate change content, including examinations of emotions and well-being.

2.1.3 Environmental Identity and Pro-Environmental Behaviour

Two of my primary research objectives were to determine the effects of threat-based climate change content on students', 1) environmental identities, and 2) short-term pro-environmental behaviour. Environmental identity is defined by Clayton (2003) as “a sense of connection to some part of the nonhuman natural environment, based on history, emotional attachment, and/or similarity, that affects the ways in which we perceive and act toward the world” (pp. 45-46). Pro-environmental behaviour can be defined as “behavior that strives to minimize the negative impact of one’s own actions on the natural environment” (Kollmuss & Agyeman, 2002, p.214). If humanity is going to effectively respond to severe and urgent environmental threats, massive societal changes will be necessary and PEBs are an essential component of that change (Nielson et al., 2021; Rockström et al., 2009; IPCC, 2018; Wynes & Nicholas, 2017).

In an analysis of climate change behaviours through the lens of social identity, Fielding and Hornsey (2016) describe identity as the natural intermediary between cultural worldview and behaviour. This relationality is mirrored in a model of environmental constructs (Figure 6) that was developed by Walton and Jones (2022). The model in Figure 6 places environmental worldviews as an indirect driver of environmental behaviour, which suggests that any effects of worldview defence on behaviour would occur largely via changes in identity, attitudes, concerns and norms, in comparison to a direct driver which would bypass these channels (Walton and Jones, 2022).

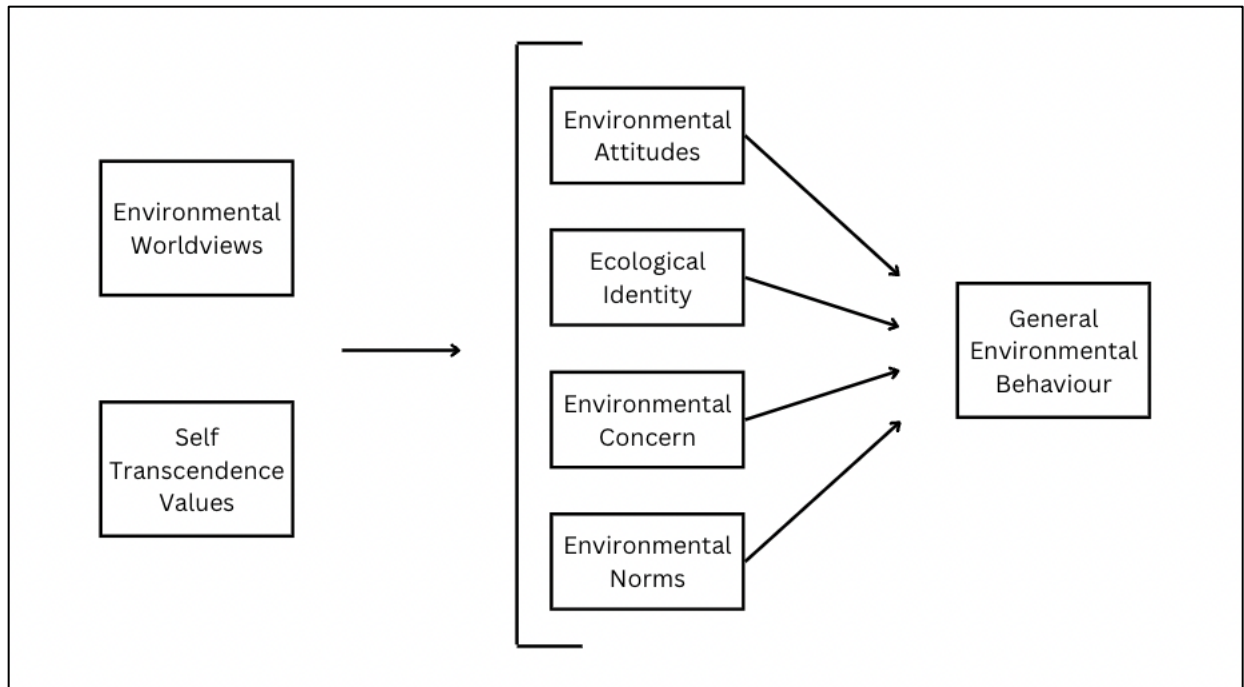


Figure 6. Model of environmental constructs adapted from Walton & Jones (2022)

Two other models that provide useful depictions of the antecedents to PEB are the Norm-Activation model (NAM; Schwartz, 1977) and the Value-belief-norm theory (VBN; Stern et al., 1999). According to the NAM, an individual's perceived personal and moral norms are causal drivers of PEBs, and the influence of a relevant norm depends on whether it is active or not (Figure 2; Schwartz, 1977).

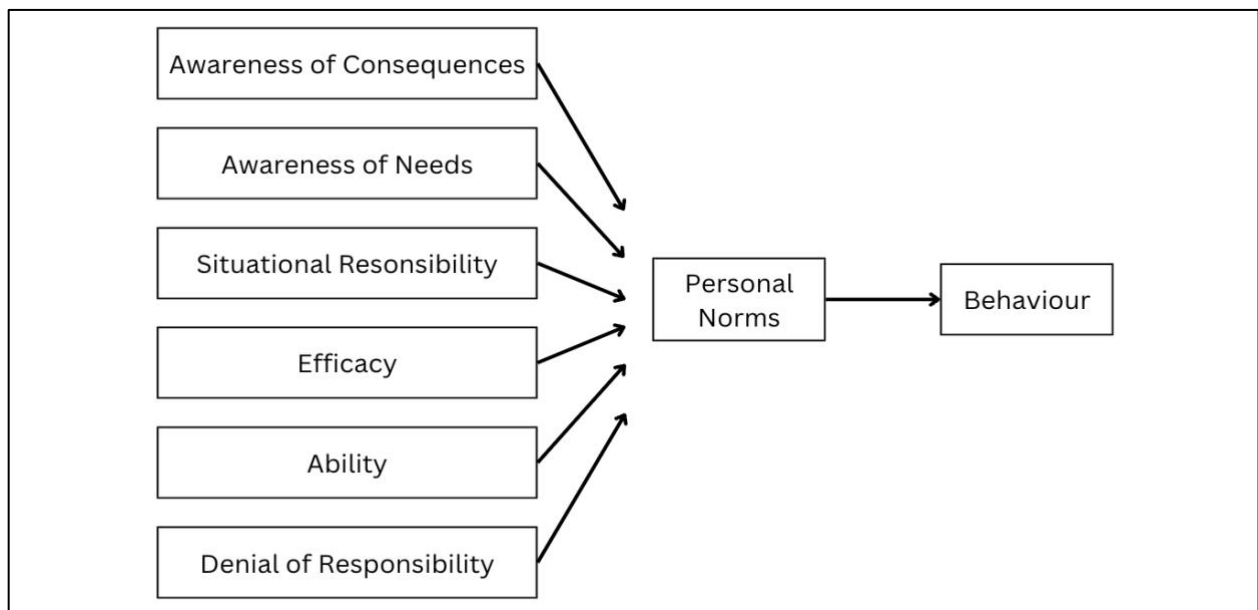


Figure 7. Norm-Activation Model adapted from Schwartz, 1977.

Building off of this NAM foundation, VBN theory posits that altruistic and biospheric values can act as drivers of beliefs, which influence norm activation and ultimately, behaviour

(Figure 3; Stern et al., 1999). Considering the inclusion of general beliefs within cultural worldview (as defined in section 2.1.1), it is likely that a person becomes more attached to their beliefs under the activation of cultural worldview defence (Schimel et al., 2019). According to VBN theory, stronger beliefs can drive behaviour. This provides a helpful depiction of one possible avenue by which mortality reminders might lead to significant behavioural effects; cultural worldview defence strengthens generalized beliefs, this enhances awareness of consequences, acceptance of responsibility, and personal norms, which in turn contribute to behavioural intentions and behaviour.

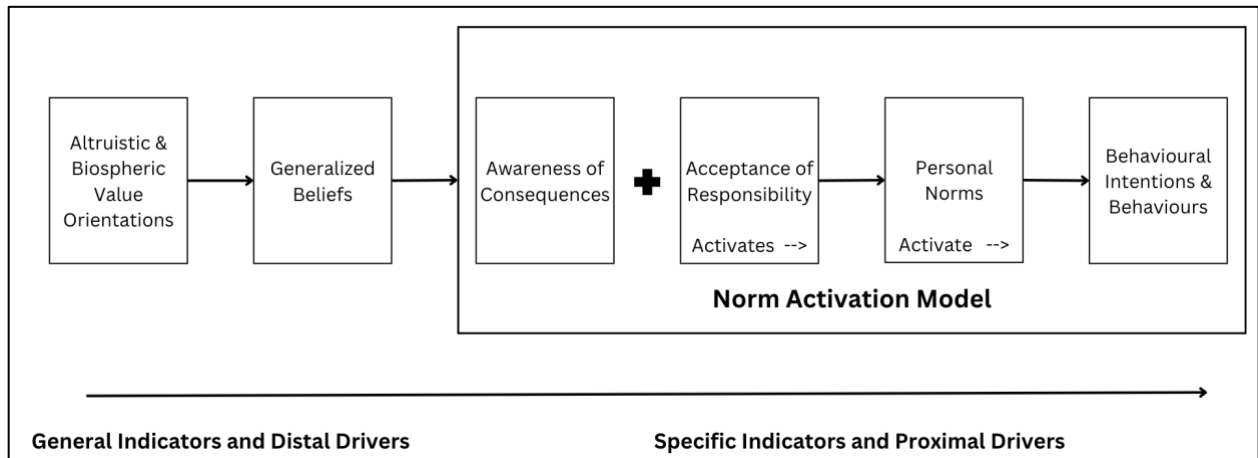


Figure 8. Value-belief-norm theory adapted from Stern et al., 1999.

The NAM (Figure 7) and the VBN (Figure 8), along with the model of environmental constructs (Figure 6), provide valuable information about potential interactions in this study. An integration of these three theories indicates that cultural worldview defence can strengthen an individual's sense of identity, and this can affect behaviour.

In accordance with these theoretical associations and the existing literature on mortality salience and climate change, I predicted that students exposed to threat-based climate change content would show significantly higher levels of PEB, and increases in Environmental Identity, compared to those exposed to an informational or control message.

2.2 Methods

In this section, I describe the participants, measures, procedures, hypotheses, and analyses of my research project in detail. Along with the description of the specific measures that I used, I provide rationales for my choices to use a survey and a behavioural paradigm as the primary methods of data collection.

2.2.1 Participants

My study sample included 83 post-secondary students in IEE courses at the University of Waterloo (UW) and 11 students at Royal Roads University (RRU). To be eligible to participate, students needed to be enrolled in a program that met the following criteria for environmental education (as defined in Chapter 1.0): 1) it instills environmental awareness, and 2) it develops

knowledge and/or skills for solving environmental problems. Students' participation was voluntary: the option to participate in my research was open to students who were registered in undergraduate or graduate programs at the UW Faculty of Environment and Faculty of Science or the RRU School of Environment and Sustainability between September 27th, 2023 and January 31st, 2024. Any participants who did not provide informed consent for their data to be used post-debriefing were excluded from the analysis (N = 70). This occurred almost entirely due to attrition since the final debriefing and re-consent had to be at the end of the survey for ethics purposes, so any participants who stopped before then could not provide the final informed consent (see 2.4.1.2 for associated limitations).

The final UW sample included 58 women (70%), 15 men (18%), 4 gender-diverse folks (5%), and 6 students who chose not to share their gender (5%). This composition has an overrepresentation of women compared to the UW student population which contains approximately 52% women, 45% men and 6% gender-diverse students (University of Waterloo, 2021). This may be the result of sampling bias, if women were more likely to self-select as participants, or it could be the case that environmental education classes contain a greater proportion of women than men compared to the general UW student population. The final RRU sample contained 7 women, 4 men, and 0 gender-diverse folks. Similarly to the UW sample, there is an overrepresentation of women in the RRU sample. However, given the small size, it is likely that these proportions are due to random variation (Lande et al., 2003).

The ages of the students in the UW sample ranged from age 18 to 42 (M = 22 years, SD = 5 years). In the RRU sample, the youngest participant was 29 and the oldest was 59 (M = 39, SD = 9).

UW Participants' self-defined ethnicities included White (43%), Asian (16 %), South Asian (8%), Chinese (10%), Mixed Race (6%), Black (2%), Latino (1%), Middle Eastern (1%), another identity (4%), or chose not to share (8%). Figure 9 presents these proportions.

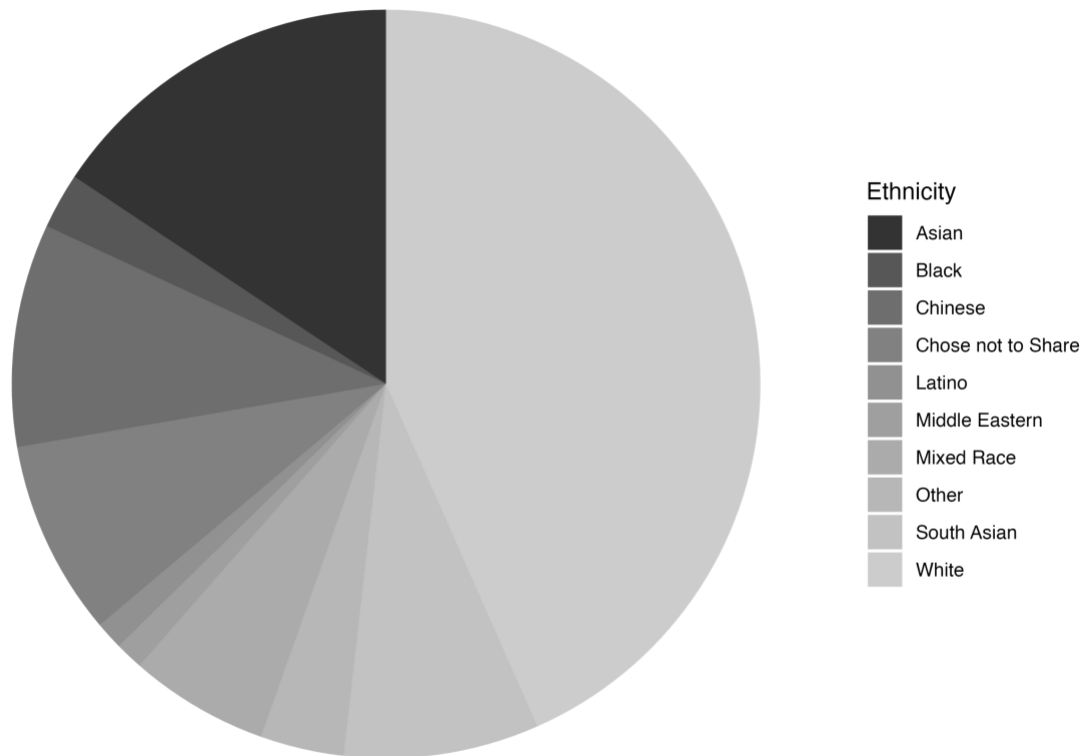


Figure 9. Proportions of the University of Waterloo sample by ethnicity.

RRU students self-defined ethnicities included White (64%), Canadian (27%), and no response (9%). This sample has an underrepresentation of ethnicities other than white and Canadian, which may be due to the small sample size or the demographics of RRU.

The UW sample contained students from a mix of academic stages, with 22% in first-year undergraduate, 17% in second-year undergraduate, 17% in third-year undergraduate, 11% in fourth-year undergraduate, 11% in fifth (or higher) year undergraduate, 12% in first-year masters, 6% in second (or higher) year masters, and 5% did not share (Figure 10).

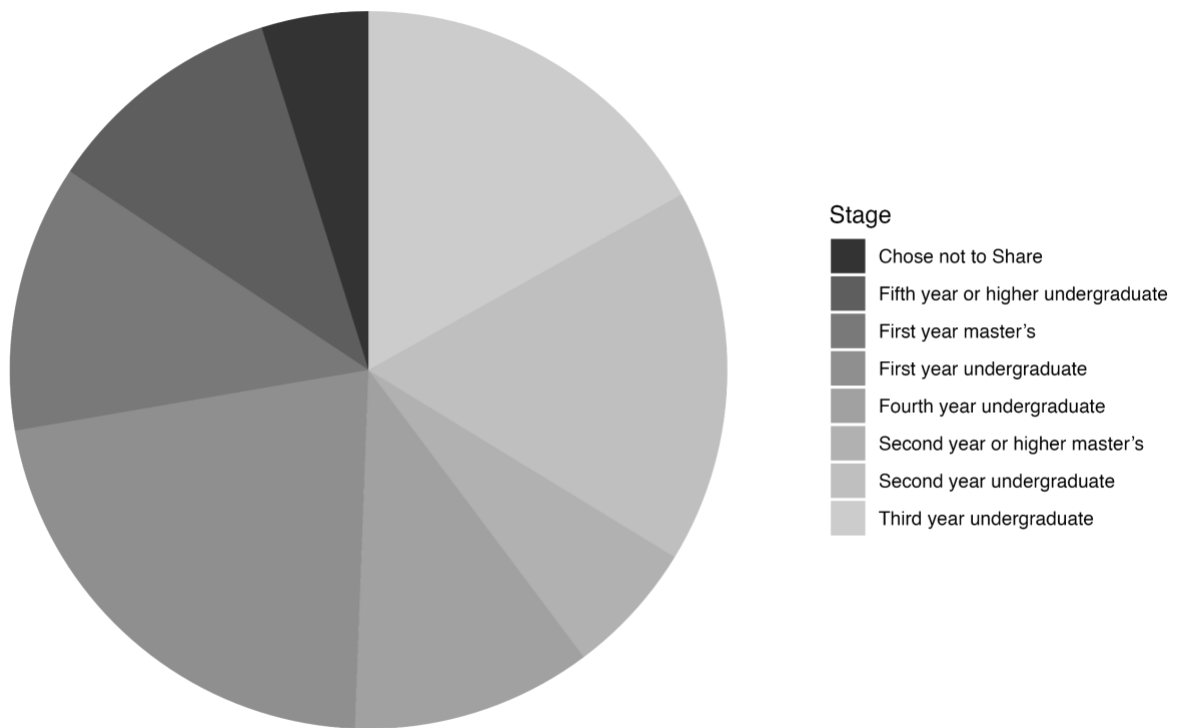


Figure 10. Proportions of the University of Waterloo sample by academic stage.

The RRU sample contained students from a mix of academic stages, with 9% in second-year undergraduate, 27% in fourth-year undergraduate, 9% in fifth (or higher) year undergraduate, 18% in first-year masters, and 36% in second (or higher) year masters (Figure 11).

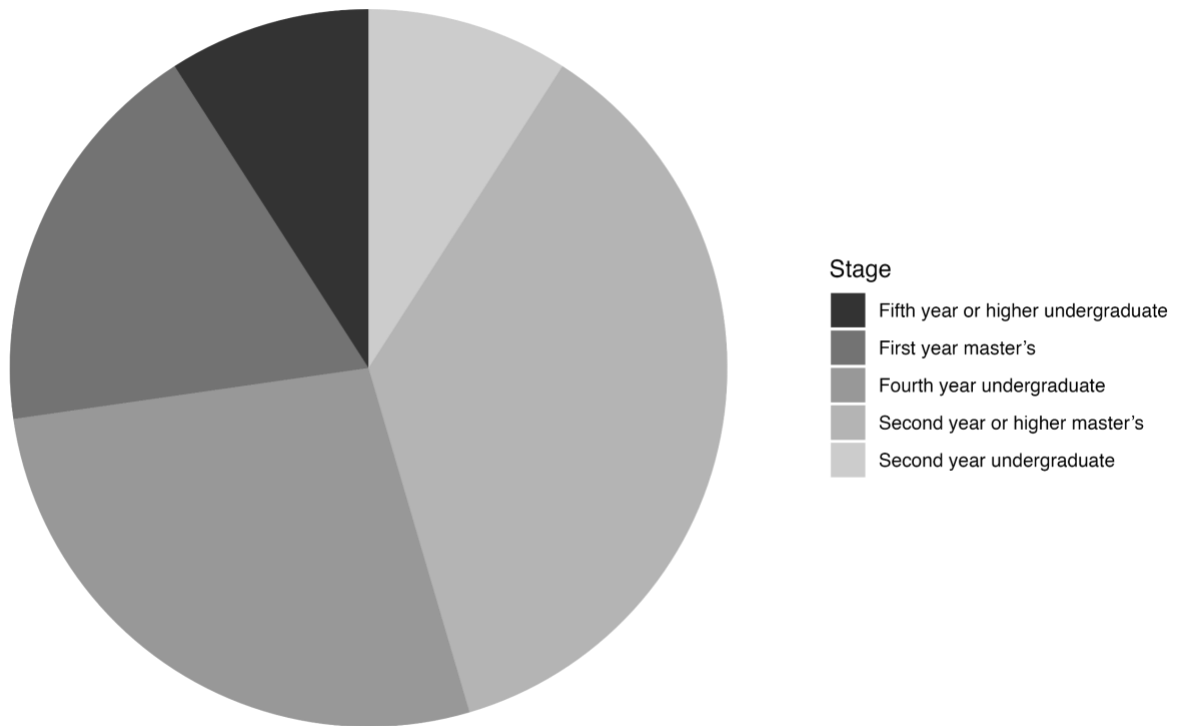


Figure 11. Proportions of the Royal Roads University Sample by Academic Stage.

There were no substantial differences in sample characteristics between the three conditions for the UW sample (Table 2).

Table 2. Proportions of the University of Waterloo Sample Demographic Characteristics by Condition

	Threat-Based (N = 27)	Informational (N = 23)	Control (N = 25)
Gender			
Woman	77%	65%	65%
Man	13%	19%	23%
Gender Diverse	3%	8%	4%
Chose not to Share	6%	8%	8%
Ethnicity			
White	48%	35%	46%
Asian	23%	12%	12%
South Asian	6%	4%	15%
Chinese	10%	12%	8%
Mixed Race	0%	12%	8%

Black	0%	8%	0%
Latino	0%	4%	0%
Middle Eastern	0%	4%	0%
Other	0%	4%	8%
Chose not to Share	13%	8%	4%
Academic Stage			
First Year Undergraduate	12%	26%	30%
Secondar Year Undergraduate	12%	16%	23%
Third Year Undergraduate	27%	13%	12%
Fourth Year Undergraduate	12%	10%	12%
Fifth Year or Higher Undergraduate	19%	6%	8%
First Year Masters	12%	13%	12%
Second Year or Higher Masters	4%	10%	4%
Chose not to Share	4%	6%	4%

The selection of courses for recruitment included both targeted asks – I wanted to have a diversity of academic stages across the two institutions – as well as a snowball sampling method since existing relationships with faculty members facilitated safe and reliable access to potential participants (Cohen et al., 2007). My research posed minimal risk to participants and was verified through both the UW and RRU Human Research Ethics Review Boards. The initial informed consent form presented the study as an investigation of student responses to news articles in environmental studies programs, which was a necessary innocuous cover that is used in similar study designs (e.g., Akil et al., 2018). A full rationale for the use of deception, along with a description of the debriefing that was provided at the end of the survey can be found in Appendix A.

2.2.2 Measures

2.2.2.1 Measurement Platforms. I implemented each of the measures using Qualtrics, a web-based data collection tool. I used survey methods for measuring environmental identity, and a behavioural paradigm for measuring PEB. A behavioural paradigm is a measurement tool designed to mimic the conditions that a person would encounter if they were to perform a similar behaviour in the outside world (Lange, 2022; Lange & Dewitte, 2019). See Appendix B for my rationale and detailed description of these platforms.

2.2.2.3 Environmental Identity Measure. In my research design, environmental identity was measured using the Environmental Identity Scale – Short Version, an 11-item scale (EIS-SV; Clayton, 2003; Clayton et al., 2021). I asked participants to indicate the extent to which each of the items described them by using the appropriate number on a scale from 1 to 7. The 7-point scale was labelled at three points: 1 (*Not at all true of me*), 4 (*Neither true nor untrue*), and 7 (*Completely true of me*). Some examples of items included “*I think of myself as a part of nature, not separate from it*” and “*Behaving responsibly toward nature -- living a sustainable lifestyle -- is important to who I am*” (Appendix C). Clayton et al. (2021) tested the EIS-SV for reliability and validity and found that it met both standards for acceptability (Clayton et al., 2021).

For participants who received a shortened delay between the Baseline and Post-Test measurement (a modification I made to reduce attrition), the second presentation of the EIS-SV was re-formatted. Instead of a 7-point scale, they were asked to respond on a sliding scale which was labelled at its two ends: left (*Not at all true of me*) and right (*Completely true of me*). This was done because repeated use of the same questions within a participant group can be subject to measurement error in the form of memory effects (Rettig et al., 2021; Schwartz et al., 2020). If participants remember their previous responses, this might impact subsequent responses (e.g., trying to be consistent). Revilla et al. (2023) suggest that memory effects are lowest when different response formats are used for the first and second exposures, so I used a slider for the Post-Test format to mitigate memory effects (Appendix C).

2.2.2.4 Death Thought Accessibility Measure. Death Thought Accessibility (DTA) is often measured using a word-stem completion task where certain word fragments can be completed as either death or non-death-related words (Cox et al., 2019). I measured DTA using a modified version of a word-stem task from Greenberg et al. (1994), which included 20 total word-stems, four of which could be completed as neutral or death-related words: *grave*, *death*, *corpse*, and *stiff*. I chose this DTA measure because it was the most frequently used word-stem completion task in the literature, and it had relatively few death-related words compared to other word-stem tasks so it posed a lower risk of priming death-related thoughts (Cox et al., 2019). I removed the word-stem COFF__ (which can be completed as coffee or coffin) from this measure because the neutral word, *coffee*, has contributed to ceiling effects in previous studies due to its higher usage rate in everyday language compared to the death-related counterpart *coffin* (Priyanka et al., 2022).

2.2.2.6 Pro-Environmental Behaviour Measure. I measured actual short-term PEB using the Work for Environmental Protection Task (WEPT; Lange et al., 2018). The WEPT is a web-based measurement tool for PEB where participants can engage in voluntary efforts that lead to actual donations to an environmental organization. In a cross-cultural assessment of the WEPT, Lange and Dewitte (2023) found that it demonstrated both internal reliability and construct validity. In comparison to the self-reported or hypothetical behaviour measures that dominate PEB literature and suffer from significant validity limitations (Steg & Vlek, 2009; Lange & Dewitte, 2019), this measure offers a valuable avenue for measuring behaviour with actual environmental consequences. The environmental impact of the WEPT as a PEB depends on the amount of effort the participant is willing to make. Participants were informed that a value of \$0.10 CAD would be donated to [OroVerde](#) – a rainforest protection fund – for each page that they completed. I selected the \$0.10 CAD donation value and the OroVerde charity to follow the validated parameters from Lange et al. (2018) as closely as possible. Lange et al. (2018) examined various donation amounts paired with different levels of effort, and found that on average, about half of the pages were completed when the \$0.10 donation was paired with the 80-number pages. This provided me with a good margin for differences in my sample so that variations could still be detected if participants completed slightly more or fewer pages on average compared to Lange et al.'s (2018) population. See Appendix D for the instructions I provided participants and the original instructions from Lange et al. (2018).

2.2.3 Procedure

The overall ordering and components of my procedure followed recommendations for mortality research and climate change from Smith et al. (2022) and are shown in Figure 12.

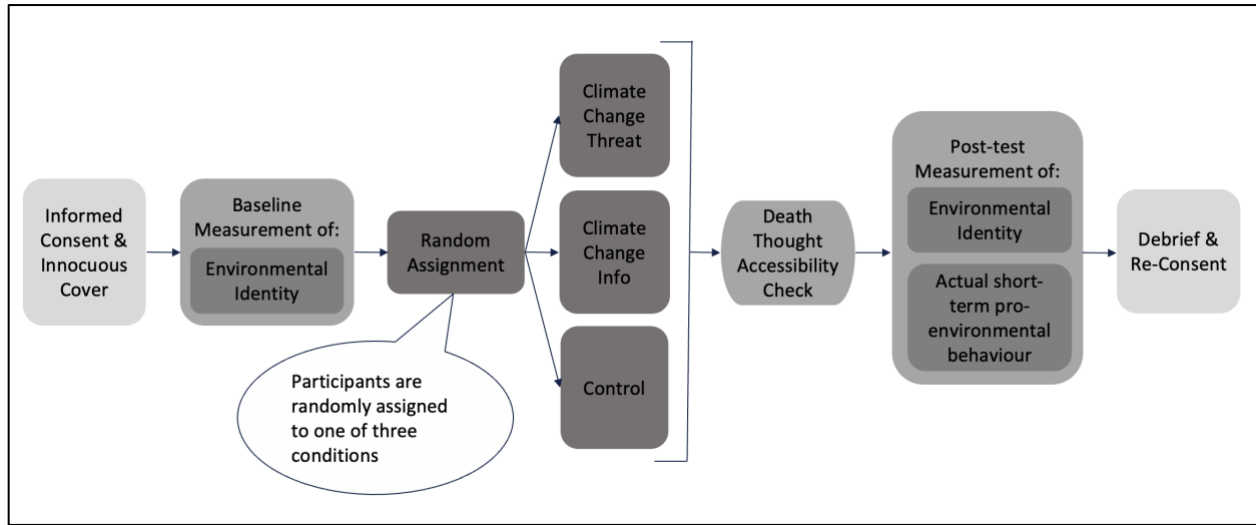


Figure 12. Methods procedure adapted from Smith et al. (2022).

Students received a research participation invitation via their course instructor, a recruitment poster, or their program administrator. This invitation included an explicit statement that participation was voluntary and anonymous. It was important to communicate this clearly to students so that they did not feel pressured to participate due to any concerns about differential treatment by their course instructor. Students who were interested in participating followed the link to the Qualtrics study portal, where they were presented with the letter of information, the consent form, participant code input, and the eligibility screening.

In the first section of the survey, I gathered anonymous demographic information and Baseline responses for each participant's EIS-SV score. Demographic information included age, gender, biological sex, ethnicity, and year/stage of post-secondary study. It was necessary to collect this information so that I could evaluate how representative my sample was of the target population, and so that I could check whether any of the conditions contained disproportionate representations of demographic characteristics. Next, I incorporated a delay period to prevent the implementation of the Baseline EIS-SV from affecting Post-Test responses. Initially, this delay was a minimum of one week, which is a typical buffer time used in other studies measuring identity variables (Wayment et al., 2015; Gardner et al., 2012). Participants were given the option to complete the second segment after a delay of longer than one week to provide them with some scheduling flexibility. Since the data collection suffered from significant attrition following this long delay, I switched to a shorter delay period on November 27th, 2023. For the shorter delay, participants completed the Positive and Negative Affect Schedule (PANAS; Watson et al. 1988), which is standard for delay tasks in TMT research (Cox et al., 2018; Greenberg et al., 2000; Smith et al., 2022).

After the delay, students were randomly assigned to one of three conditions and received either a 1. Threat-Based Climate Change Article, 2. Informational Climate Change Article, or 3. Control Article. In each of these conditions, participants were asked to read an approximately 400-word news segment. I decided to use news articles for my conditions because these are

commonly included as learning materials in environmental education courses (Wolfe, Personal Communication, August 1st, 2023; Horna, Personal Communication, January 26th, 2024). The news articles I chose were adapted from Skurka et al. (2023)'s news article interventions in a study on threatening climate change messages. I chose to use these previously studied articles for my conditions because it would better facilitate future comparisons across different studies. Both of the climate change articles included cautionary statements about the severity of climate change, but only the Threat-Based article contained mortality themes (which was my way of distinguishing threat-based climate change content from other climate change content in this research). The article from the Control condition included themes of pain and discomfort due to migraines, but no mention of any life-threatening conditions. The use of an aversive article for the control condition is common in TMT research because it can facilitate more precise interpretations of the results by eliminating the possibility that observed effects are caused by general threats to self (e.g., threat of pain, threat of embarrassment) rather than the threat of death specifically (Burke et al., 2010; Cox et al., 2019; Smith et al., 2022). I used this reasoning not only in my selection of the Control article, but also in the Informational climate change article, which had been established as threatening in previous research (Skurka et al., 2023), but did not contain any mortality themes. Participants were asked to list two things they remembered from the article, as a confirmation that they read the article, and as a tool to keep the innocuous cover of the study purpose believable. All three articles can be found in Appendix E. The Threat-Based Climate Change Article was selected to act as an implicit mortality reminder. I chose to use an implicit mortality reminder (as opposed to an explicit one), to maximize ecological validity and to minimize any risk to the well-being of student participants. Once participants read the message for their condition, they completed a measure of DTA.

Finally, the participants completed the two measures of cultural worldview defence. They completed the EIS-SV again as a Post-Test measure of environmental identity. After this post-test EIS-SV was complete, participants were presented with the WEPT as a measure of actual short-term PEB. Once participants had completed their chosen number of pages, they were instructed to proceed to the end of the survey, where all participants were debriefed. Informed consent was received again following this debriefing.

2.2.4 Analyses

2.2.4.1 Environmental Identity Analysis. I ran my EID-SV data analysis in R, using the *tidyverse*, *lavaan*, and *lmer* packages (Wickham et al., 2019; Rosseel et al., 2012; Bates et al., 2015). A participant's response for each item on the EID-SV contained a value in the range of 1-7, which contributed to their overall EID-SV score. The conventional approach to creating overall scores—summing or averaging all responses—relies on two oftentimes unsupported assumptions: one, that each question on the scale contributes equally to the latent variable (McNeish & Wolf, 2020), and two, that the space between scale responses is equal (interval scaling) rather than unequal (ordinal scaling). When these assumptions are violated, summed or averaged scores can inaccurately reflect the underlying latent factor.

To avoid relying on these assumptions, I ran a confirmatory factor analysis, which provided an estimated value for the contribution of each question to overall environmental identity. These estimated values were then used to produce latent factor scores for the environmental identity of

each participant, and they were a continuous variable type. Next, I fit the latent factor scores to a linear model where condition was set as a predictor of change in environmental identity score. The basic purpose of fitting this model was to determine whether there were any significant differences between conditions.

The null hypothesis - H_{a0} - reflected the possibility that there was no significant difference in environmental identity change from Baseline to Post-Test between the conditions. Failure to reject the null hypothesis may result from measurement errors. For example, if the range of environmental identity scores measured did not capture the range in which real variation occurred, then differences would not be detected. A rejection of the null hypothesis would indicate that there was evidence of a significant difference between conditions, as described in the alternative hypothesis - H_{a1} .

H_{a0} . *There is no significant difference in the change from Baseline to Post-Test self-reported environmental identity scores between students exposed to a threat-based climate change message, an informational climate change message, and a control message.*

H_{a1} . *There is a significant difference in the change from Baseline to Post-Test self-reported environmental identity scores between students exposed to a threat-based climate change message, an informational climate change message, and a control message.*

2.2.4.2 Pro-Environmental Behaviour Analysis. I ran the analysis of PEB in R, using the *tidyverse* package (Wickham et al., 2019). Since there was excessive loading at the maximum page count value, I used a Hurdle Model for my analysis (see Appendix F for details). A Hurdle Model involves two analysis processes – one for investigating the loaded value, and one for assessing the rest of the value range. First, I conducted a Logistic Regression to determine the likelihood of participants completing all ten pages versus completing fewer than ten pages, based on the condition they were assigned to. Next, I fit a truncated Negative Binomial Regression to quantify the effect of condition on the count of completed pages for all participants who completed fewer than ten pages. Each of these components reflected a separate hypothesis test, but addressed the same set of null (H_{b0}) and alternative (H_{b1}) hypotheses:

H_{b0} . *There is no significant difference in levels of short-term environmental engagement behaviour between students exposed to a threat-based climate change message, an informational climate change message, and a control message.*

H_{b1} . *There is a significant difference in levels of short-term environmental engagement behaviour between students exposed to a mortality-related climate change message, an informational climate change message, and a control message.*

2.2.4.3 Death-Thought Accessibility. The DTA results were count-type data as well, with possible values of zero, one, two, three, four, or five. Although I intended for there to be four death-related options across the 20 words, several participants completed the stem WI_ _OW as widdow, which closely resembles widow. Since they sound identical, and automated spell check was not available to participants, I counted widdow completions as a death-related option. I fit the count data to a Poisson Regression to assess whether there were significant differences in DTA between the three conditions. The ratio of null deviance to degrees of freedom was slightly under one, which meant that the was not overdispersed (Cameron & Trivedi, 1990). I combined this assessment with the visual inspection from Lüdecke et al. (2021) to determine that a Poisson Regression was a good fit for my data.

2.2.4.4 Model Checks. Whenever possible, I conducted a visual inspection of the model predicted distribution compared to the observed data, the homogeneity of variance, the influential observations, overdispersion, and normality of residuals. Following Lüdecke et al. (2021), I used this inspection to determine whether the model was a good fit. I did this inspection using the ‘model_check’ function from the *performance* package (Lüdecke et al., 2021).

2.3 Results

Sections 2.3.2 through 2.3.4 cover the findings for the sample from UW. Section 2.3.5 covers the sample from RRU. The code for all analyses can be found at https://rpubs.com/emma_collette/analysiscode-2024-05-01.

2.3.1 Response Rates

There were a total of 174 students who began my survey, with 144 from UW, 20 from RRU, and 10 who did not meet the program requirements. Since the study design involved deception, I removed the data from any participants who did not reach the debrief and provide re-consent ($N = 70$). This left a final, post-attrition sample size of $N = 83$ in the UW sample and $N = 11$ in the RRU sample. See Appendix G for a more detailed breakdown of the attrition rates across samples.

2.3.2 Death Thought Accessibility

There were no significant differences ($p < 0.05$) in DTA scores between the Control condition and the Threat-Based condition ($z=0.39$, $p = .70$), or between the Control condition and the Informational condition ($z=1.33$, $p = .18$). The central tendencies for each condition are presented in Table 3.

Table 3. Central Tendency and Standard Deviation of Death Thought Accessibility

	Mean	Standard Deviation	Median
Control	0.39	0.50	0
Informational	0.65	0.69	1
Threat-Based	0.45	0.77	0

Possible responses could include anywhere from zero death-related words to five death-related words, but all the participants completed between zero to two death-related words. The distribution of DTA scores across the three conditions is presented in Figure 13.

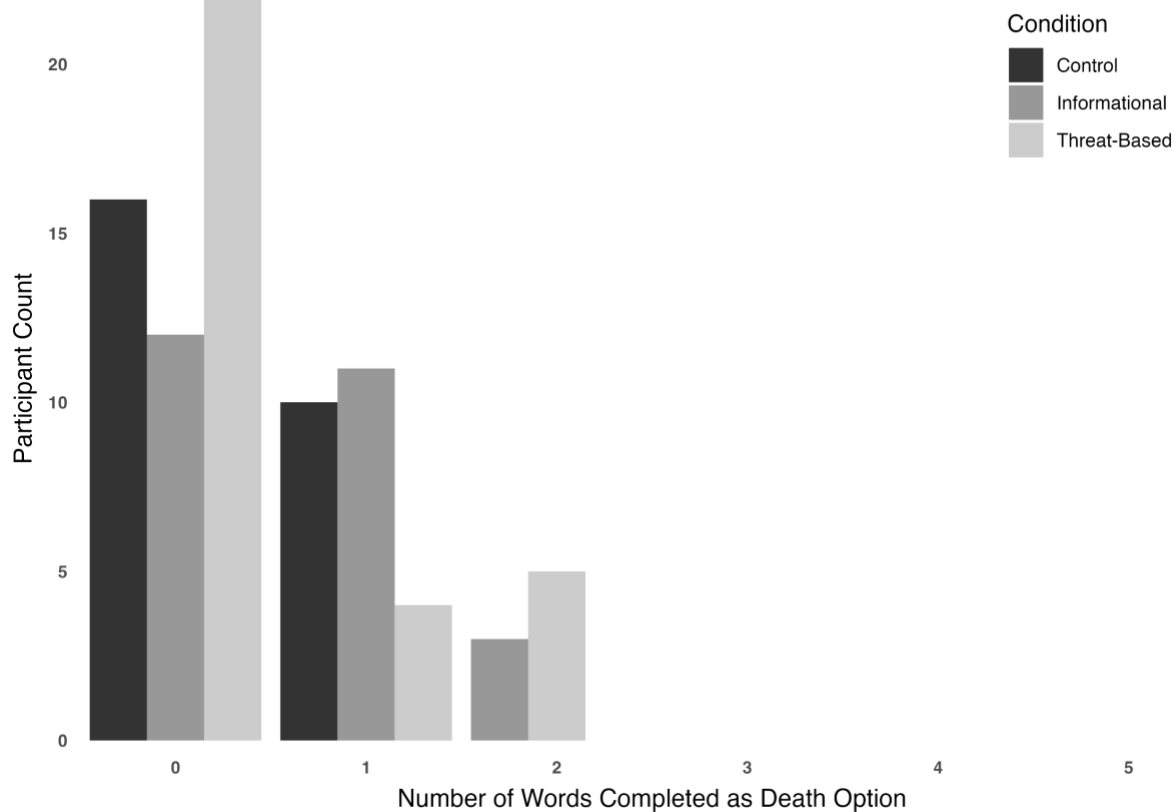


Figure 13. Distribution of Death Thought Accessibility Scores by Climate Change News Article Condition

2.3.3 Environmental Identity

Following the procedure from Clayton et al. (2021), participants were removed from this analysis if they left 50% or more incomplete responses for either the Baseline or Post-Test measurement of environmental identity ($N = 8$). From the sample, this left 79 students who completed the Baseline, 79 students who completed the Post-Test, and 75 students who completed both of the EIS-SV measurements. Descriptive statistics for the raw EIS-SV data by condition are presented in Table 4.

Table 4. Mean and Standard Deviations of Environmental Identity by News Article Condition

	Baseline		Post-Test		Change
	M	SD	M	SD	
Control	5.73	0.76	5.56	0.76	-0.17

Informational	5.49	0.97	5.35	0.97	-0.14
Threat-Based	5.43	0.93	5.45	0.93	0.02

Descriptive statistics for the Confirmatory Factor Analysis (CFA) outputs by condition are presented in Table 5.

Table 5. Mean and Standard Deviations of Environmental Identity Latent Factor Scores by News Article Condition.

	Baseline		Post-Test		Change
	M	SD	M	SD	
Control	0.11	0.59	0.22	0.66	0.11
Informational	-0.077	0.67	-0.20	1.02	-0.12
Threat-Based	-0.060	0.72	0.13	1.00	0.19

The CFA model fit well according to commonly used standards, with the Robust Tucker Index and Comparative Fit Index both showing values above 0.90 (Hu & Bentler, 1999). Among the various approaches for processing missing values, the method I chose to use was pairwise deletion. I made this decision because it was the only method compatible with the ‘ordered=TRUE’ argument that encoded the different levels as ordered (e.g., 1 is less than 2, 2 is less than 3). It was particularly important to include this ‘ordered=TRUE’ argument, not only for the sake of accurately representing the data but also because the model fit was significantly reduced without this argument, such that the Robust Tucker Index and Comparative Fit Index were both below 0.75 (McNeish & Wolf, 2020).

The CFA factor loadings for each of the questions on the EIS-SV are presented in Table 6. The factor loadings for most of the questions appear similar, except for Questions 3, 6, and 7 in the Post-Test measure and Questions 5, 6 and 10 in the Baseline measure, which are lower than the rest. Sometimes a grouping of different factor loadings indicates a subset on the scale (McNeish & Wolf, 2020), so I examined the questions for a common theme. I did not find a theme across the lower-loading questions, so I decided to stick with this format of the latent factor scheme, especially considering the high scores on the Comparative Fit Indices as well as the difference in lower-loading questions between the Baseline and Post-Test measures.

Table 6. Factor loadings output for each question on the environmental identity scale

EIS-SV Question	Factor Loading Score (Baseline)	Factor Loading Score (Post-Test)
1.	1.000	1.000
2.	0.894	0.984
3.	0.986	0.625
4.	1.091	1.106
5.	0.541	0.737
6.	0.676	0.604
7.	0.805	0.508
8.	0.801	0.849

9.	1.098	1.074
10.	0.577	0.827
11.	0.898	1.398

The linear regression on the latent factor scores produced by the CFA resulted in a failure to reject the null hypothesis for both the Informational ($p = 0.89$) and Threat-Based ($p = 0.69$) conditions. As a reminder, the null hypothesis was “*There is no significant difference in the change from Baseline to Post-Test self-reported environmental identity scores between students exposed to a Threat-Based climate change message, an Informational climate change message, and a Control message*”. In other words, there was no significant difference ($p < 0.05$) in EIS-SV change between the three conditions of Informational, Threat-Based, and Control. The Baseline and Post-Test latent factor score means are presented in Figure 14.

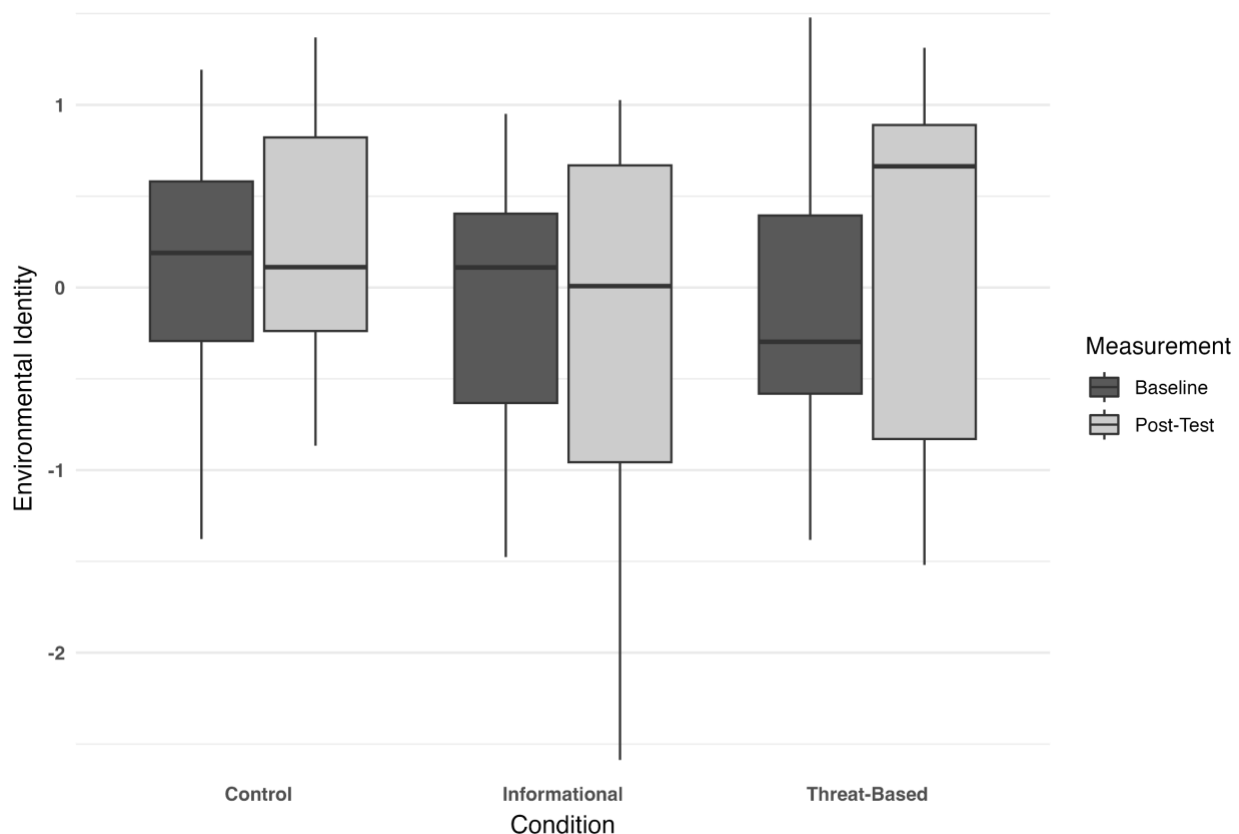


Figure 14. Environmental Identity Scores Across Climate Change News Article Conditions and Measurement Times.

I used multiple imputations to process missing values when fitting the linear regression in order to maximize the accuracy of the results while maintaining the sample size. Multiple imputation was not compatible with the *performance* package or with conventional fit checks (Shapiro-Wilk test, Breusch-Pagan Test, and Plotting residuals). Using *Dynamic Fit Index* cutoffs can be useful in these cases (McNeish & Wolfe, 2023), but they are not compatible with

ordered data yet, so I conducted a visual inspection of the model fit on a standard version without multiple imputation as an approximate. Following Lüdtke et al. (2021) I determined that it was a good fit based on normality of residuals, homogeneity of variance, influential observations linearity and a posterior predictive check.

There was an overall decrease in mean Environmental Identity scores in the Control condition and Informational condition, compared to an increase in the Threat-Based condition. These changes are presented in Figure 15. The slight differences in change values between these model outputs and the subtractions in Table 5 are attributable to the multiple imputation process.

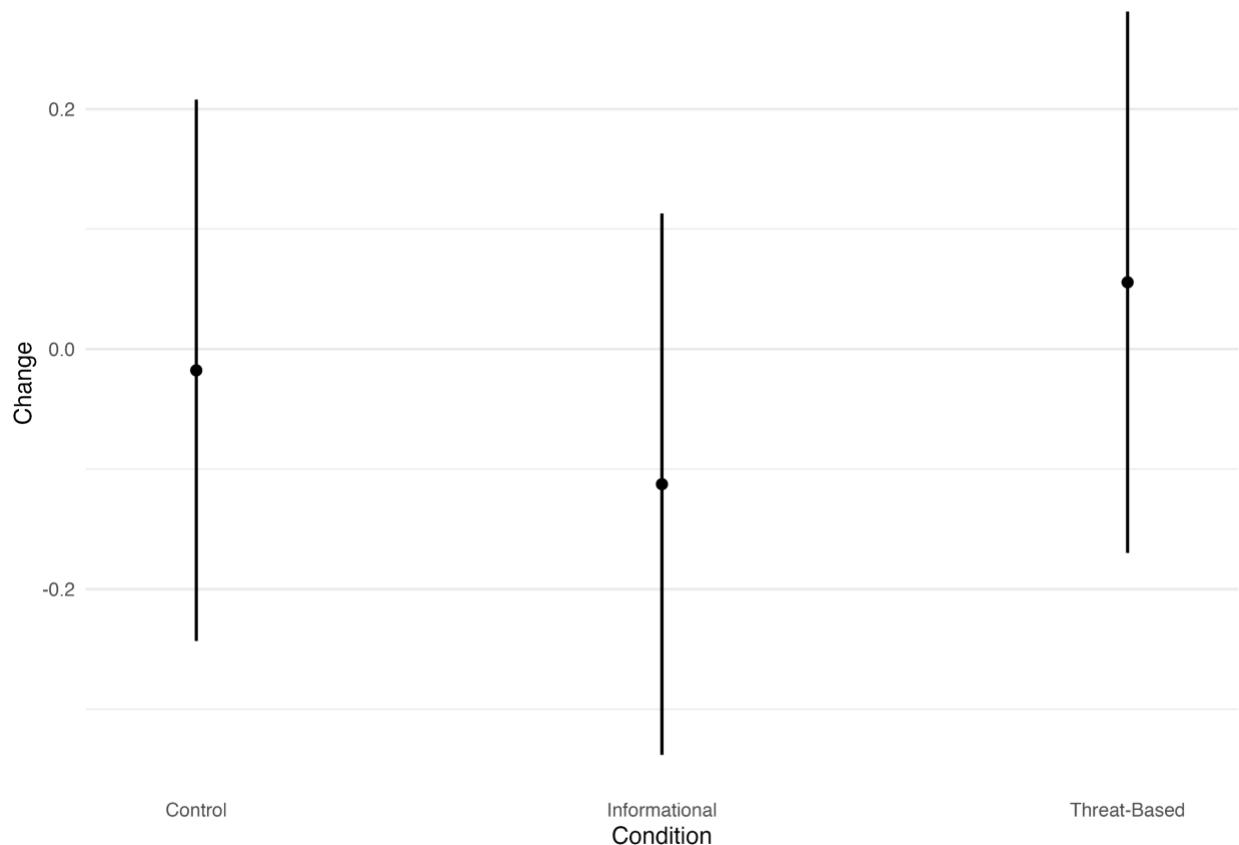


Figure 15. Change in Average Environmental Identity Score by Climate Change News Article Condition.

2.3.4 Pro-Environmental Behaviour

Participants in the Informational climate change condition completed the fewest pages ($M=3.58$, $SD=3.21$), followed by the Threat-Based condition ($M=4.90$, $SD=3.36$), and then the Control group with the greatest number of completed pages ($M=6.04$, $SD=3.88$). The distribution is presented in Figure 16.

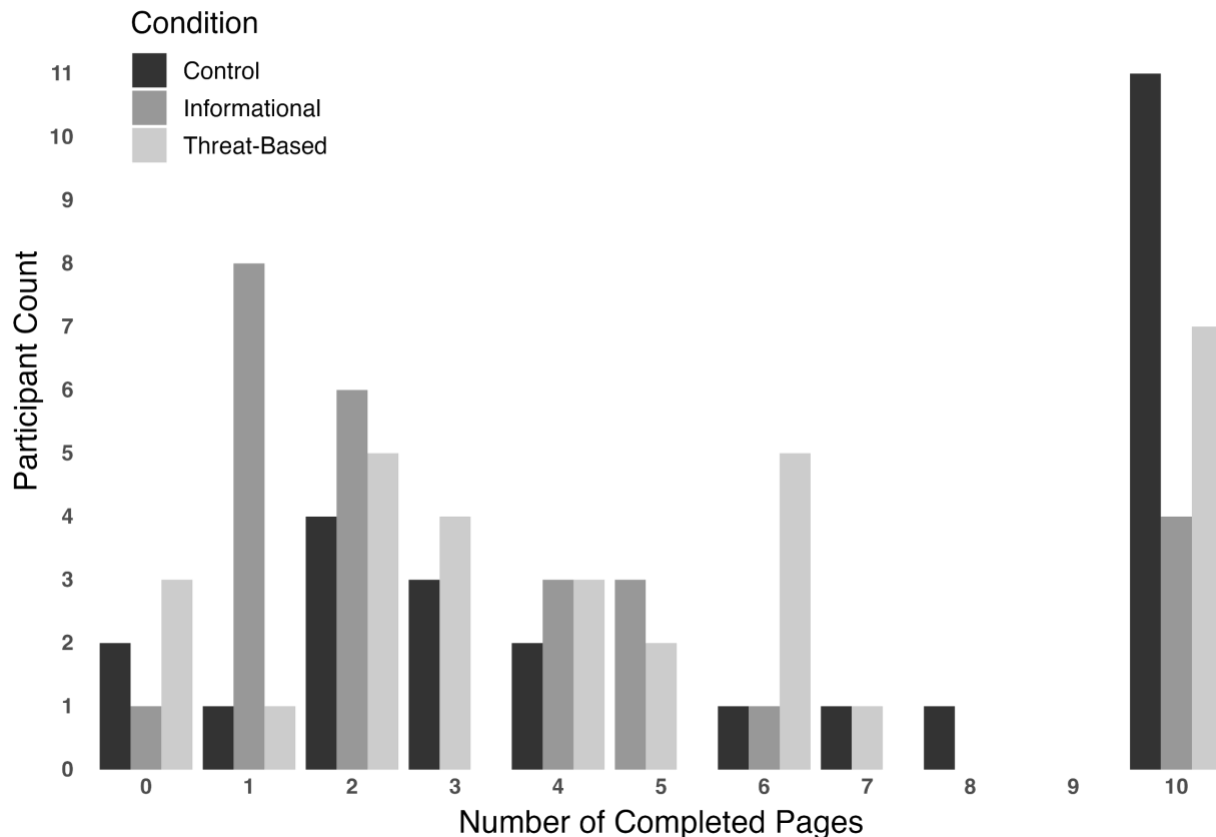


Figure 16. Distribution of Completed Pages by Climate Change News Article Condition.

The results from the first component of the Hurdle Model – the Logistic Regression, indicated that participants in the Informational climate change condition were significantly less likely to complete all ten pages compared to participants in the Control condition ($z=-2.54$, $p = .011$). The difference in behaviour between participants in the Control versus Threat-Based condition was marginally significant ($z=-1.86$, $p = .063$). Following Lüdtke et al. (2021), I conducted a visual inspection of the model fit, including influential observations and normality of residuals, and concluded that the model was a good fit.

In the second phase of the Hurdle Model, the Negative Binomial Regression, there were no significant differences in PEB between the Control condition and the Threat-Based condition ($z=0.40$, $p = .70$), or between the Control condition and the Informational condition ($z=-1.12$, $p = .263$). I conducted another visual inspection of the model fit following Lüdtke et al. (2021) and observed that it was the best fit compared to alternative model choices of the Poisson Regression, or the Quasi Poisson Regression.

2.3.5 Royal Roads University

I did not conduct any analyses on the Royal Roads University sample due to the unfortunately limited sample size ($N = 11$). The distributions of environmental identity scores at

the Baseline and Post-Test measurement for each condition are presented in Figure 17. The minimum and maximum values presented in the boxplots indicate a much larger variation in both Baseline and Post-Test EIS-SV scores in the Threat-Based condition compared to the other conditions.

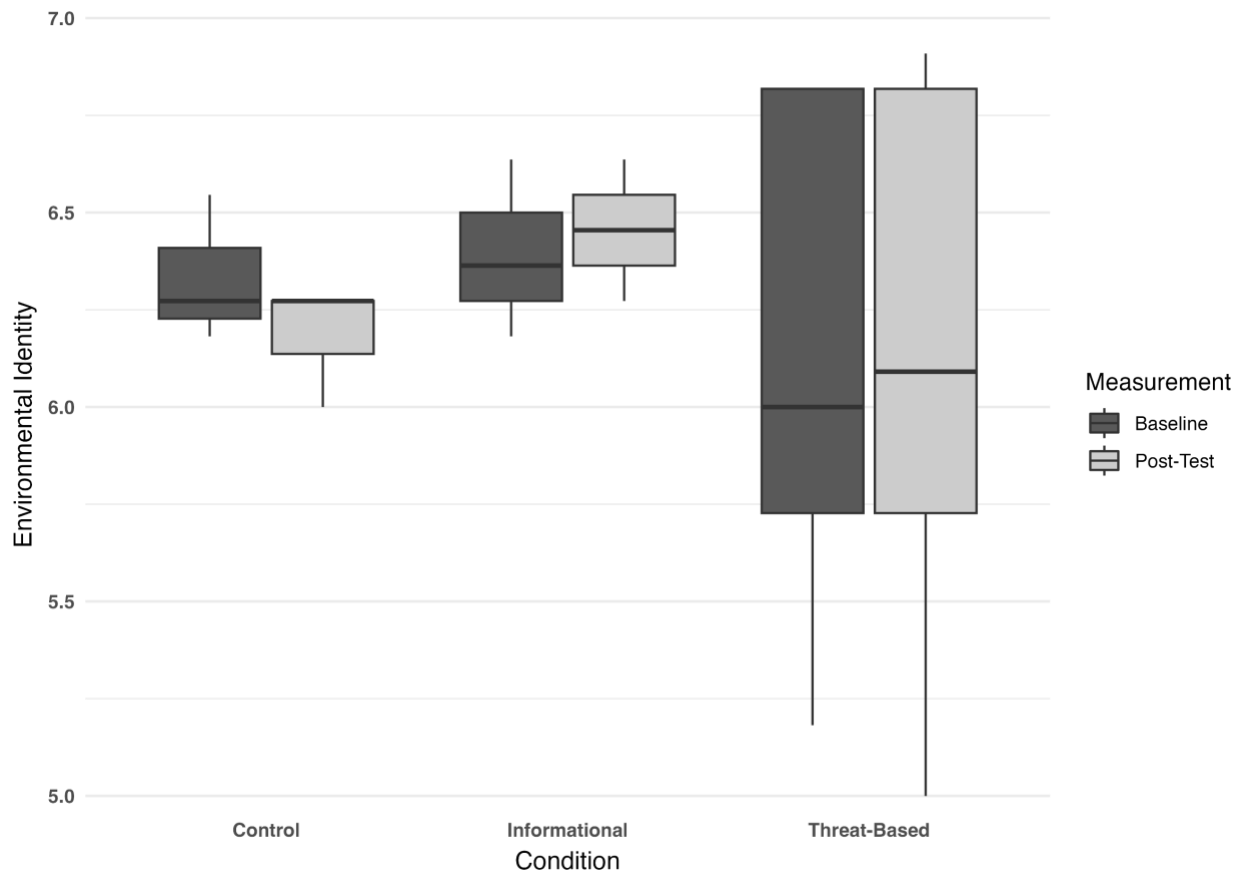


Figure 17. Environmental identity by climate change news article condition and measurement time.

The medians in all three conditions either stayed the same or increased very slightly from the Baseline to the Post-Test measurements (Table 7).

Table 7. Mean and Standard Deviations of Environmental Identity by News Article Condition

	Baseline		Post-Test		Change
	M	SD	M	SD	
Control	6.18	0.19	6.00	0.16	- 0.18
Informational	6.64	0.23	6.64	0.18	0
Threat-Based	6.82	0.71	6.91	0.794	0.09

The distribution of PEB for each condition can be seen in Figure 18. The number of pages completed is spread from 2 to 10 in the Threat-Based condition, 5 to 9 in the Informational

condition and 6 to 10 in the Control condition. Unlike the UW sample, there were no distinct peaks in the distribution, but rather a fairly even spread across the possible outcomes.

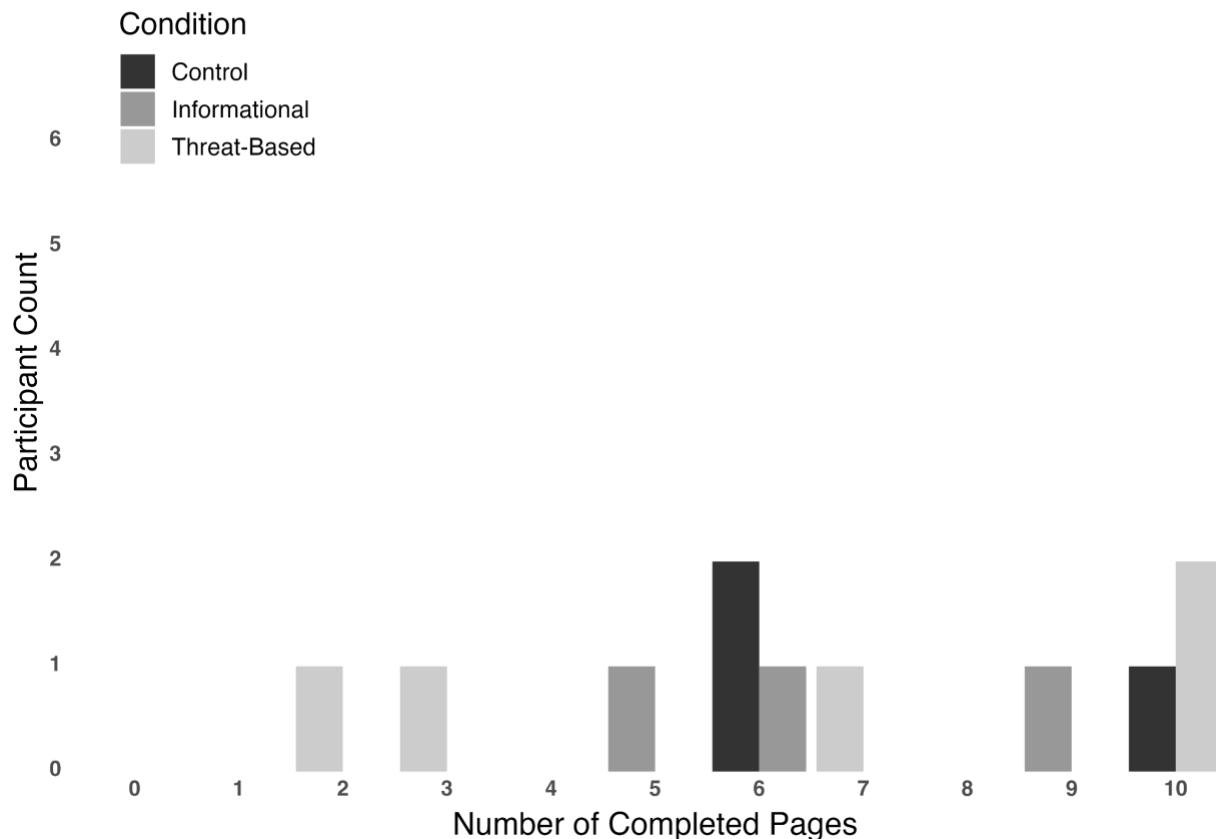


Figure 18. Distribution of Completed Pages by Climate Change News Article Condition

2.4 Discussion

My discussion of the results in Sections 2.4.1 through 2.4.2 are interpretations of the findings for the sample from UW. Section 2.4.3 covers the findings from RRU separately since it was a distinct sample and I was not able to analyze it due to the small sample size.

2.4.1 Null Findings for Identity and Death Thought Accessibility

I found that there were no significant differences between conditions for DTA as well as environmental identity. These outcomes supported the null hypothesis (H₀), which was: “*There is no significant difference in the change from Baseline to Post-Test self-reported environmental identity scores between students exposed to a Threat-Based climate change message, an Informational climate change message, and a Control message*”. I initially predicted that the Threat-Based article would increase environmental identity scores via worldview defence because of the strong pre-existing environmental worldviews in this population. The lack of significant differences between conditions in the DTA and environmental identity measures may

have been indicative of a lack of effects in this population or may have been the product of the study limitations as explored below.

2.4.1.1 A Low Threat Population. It is possible that the article I used in my climate change threat condition did not act as enough of a mortality reminder. It may be the case that the content in the article was generally insufficient for producing mortality salience, or that it was insufficient in this population specifically. UW students may not perceive climate change as a threat of personal death. Although there is a real current and future risk of climate change mortality in Canada (Gasparrini et al., 2017; Robinne et al., 2021), this is not necessarily the perception of all Canadians. Environics Research (2017) conducted a study for Health Canada and found that 55% of Canadians who believe in climate change feel that they are definitely or likely vulnerable to climate change health impacts, but only 42% believe this risk to be moderate or major. In Southern Ontario, where the University of Waterloo is located, Cardwell and Elliot (2013) found that 77% of their sample could identify links between climate change and health impacts, but could not describe how this link connected to their own lives. People also generally have the tendency to perceive climate change risks as being more spatially distant than they actually are (Gifford, 2011; Tvinnereim et al., 2020). Another factor at play is that the students in this sample may have more access to resources and knowledge compared to the general population in Canada, both of which can reduce climate change vulnerability (Thomas et al., 2019).

I expected the Threat-Based climate change article to act as a mortality reminder regardless of whether the population viewed climate change as life-threatening to themselves, because it contained several death-related words that are standard in implicit TMT reminders, such as ‘death’ and ‘dying’ (Cox et al., 2019). However, news articles are not a commonly used format for mortality reminders. The existing studies on implicit climate change mortality reminders have used videos and location-specific questionnaires (Barth et al., 2018; Fritsche et al., 2010; Akil et al., 2018). I chose to use news articles because of the high ecological validity they provided (news articles are often used for educational purposes), and because the pre-existing tools were either inaccessible or not applicable to my sample. It is possible that some element of the news articles impacted their effectiveness as a mortality reminder and low perceived risk is one example of how that might have occurred. Another possibility is that this population has developed a unique set of defensive responses to allow them to cope with the constant exposure to threat-based climate change content that they might experience in their education.

2.4.1.2 Limitations as Possible Contributors to the Null Finding. Small sample size has been reported as a common flaw in TMT research which can lead to insufficient power to detect the relevant effects, including DTA and cultural worldview defence (Chen et al., 2022). For this reason, I conducted a power analysis as part of my study design to ensure that my target sample size was large enough to produce sufficient power. Based on the outcomes of that analysis, I set my sample size goal at 200 students per institution, which left room for approximately 25% attrition. Unfortunately, due to the high attrition rates and limited sampling pool, I was unable to obtain this target sample size within the required timeframe. This resulted in a sample size limitation which may have caused my analysis to have insufficient power. Consequently, it is possible that there was a true significant difference but that the test was not powerful enough to detect it. For future research on this target population, I would suggest targeting programs and

institutions that have pre-established participant pools to ensure that sufficient sample sizes are obtainable (Chen et al., 2022).

Another limitation that may have contributed to these null findings is the length of the delay between the Baseline and Post-Test measurement. I had initially set up the survey in two sections, at least one week apart from each other, to prevent the Baseline measurement from influencing the Post-Test responses (see 2.2.2.3 for details). The decision to shorten this delay was necessary due to the high attrition associated with the long delay. Although precautions were taken to mitigate memory effects in the short-delay version, it is possible that participants provided similar responses to the Baseline measurement in their Post-Test responses in an attempt to be consistent (Little et al., 2020). If this was the case, it would have prevented the measure from capturing any identity effects that may have occurred.

It is also possible that there were limitations in the DTA measurement that contributed to these null findings. Specifically, it appeared that floor effects may have been present in the completion of death-related word fragments. Floor effects occur when a large percentage of the responses are gathered at the lower end of the scale, indicating that the range of the scale may not capture the range where the variation could occur (Hessling et al., 2004; McBee, 2010). I did remove the word fragment COFF__ (coffee or coffin) pre-emptively for this reason as it had been identified as an issue in previous implementations of the word-fragment completion task (Priyanka et al., 2022). Priyanka et al. (2022) acknowledged that it is possible for other word fragments to cause similar issues, which may have been the case with CO__ SE (course or corpse) and GRA__ (grade or grave) in this sample population, considering the salience of the words course and grade for students. However, Priyanka et al. (2022) scanned for floor and ceiling effects in their student sample and did not detect any issues with these word fragments, so any pronounced salience would have been specific to my study (e.g., the educational research focus). This is worth considering for any researchers whose research is presented as being education-related. If the necessary resources are available, future researchers might consider utilizing different DTA measures other than word-fragment completion tasks, such as the lexical decision task, the dot-probe task or the ambiguous pictures task, which have been shown to have superior reliability (Priyanka, 2020).

2.4.2 Decreased Pro-Environmental Behaviour in the Climate Change Conditions

The participants in the Informational and Threat-Based climate change conditions were significantly (and marginally significantly) less likely to complete all ten pages compared to the Control condition. There were no significant differences in the number of pages completed between conditions for participants who completed fewer than ten pages. This suggests that exposing participants to a climate change article decreased their tendency to engage in short-term, effortful PEB. These effects occurred in the opposite direction from my prediction, indicating that there were likely factors at play that had a greater influence than the mortality salience hypothesis.

The Norm Activation Model (NAM) and Value Belief Norm (VBN) Theory (Section 1.3.4.2) provide helpful frameworks for identifying these factors. In my climate change conditions, neither article mentions individual or collective action – only national agreements to

reduce fossil fuels and limit warming (Appendix E). These articles emphasized external agents of change, like governments and large corporations, rather than personal agency. According to the NAM, self-perceived efficacy and denial of responsibility are both factors that have a significant effect on norm activation, which directly impacts behaviour (Figure 19; Chan & Bishop, 2013; Zhang et al., 2013). It is also likely that many of the students in these courses are aware of the magnitude of influence that corporate and political powers could have on progress toward sustainability (Kent, 2009; Schmitt et al., 2019), so a reminder of this may have deterred their sense of personal responsibility to perform the PEB, as well as their perception of the efficacy of this relatively small PEB at contributing substantially to the climate crisis.

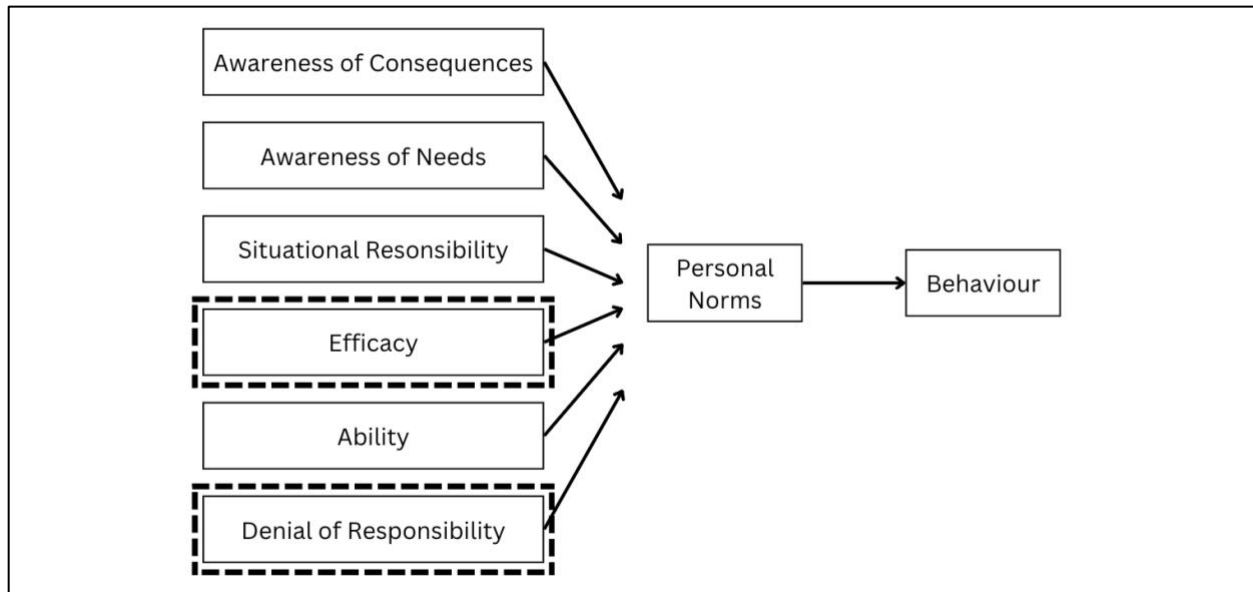


Figure 19. Relevant Components of the Norm Activation Model

Note: The dash-outlined boxes indicate the drivers that may have ultimately contributed to the decrease in pro-environmental behaviour in my study.

In my initial consideration of the NAM and VBN theory, I expected mortality reminders to enhance the activation of participants' personal norms via accentuated beliefs (i.e., cultural worldviews). However, even if this accentuation did occur, acceptance of responsibility and perceived self-efficacy are still critical for norms to be activated and thus drive behaviour (see Figure 20). If the climate change articles decreased participants' perceived self-efficacy and acceptance of responsibility, then it would make sense for pro-environmental behaviour to be reduced according to VBN theory and the NAM.

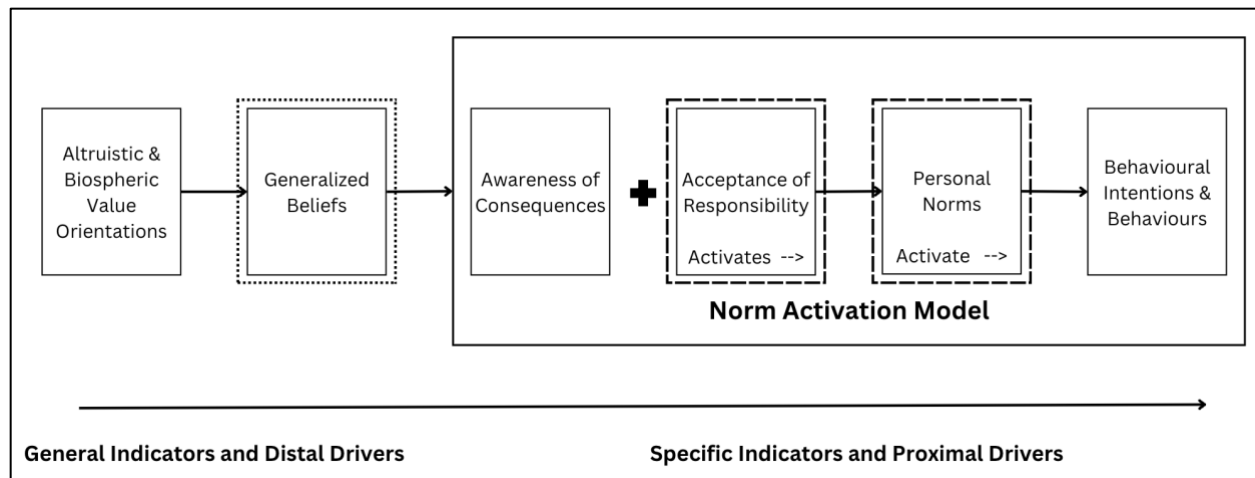


Figure 20. Relevant Components of Value Belief Norm Theory

Note. The dash-outlined boxes signify the drivers that may have ultimately contributed to the decrease in pro-environmental behaviour, and the dot-outlined indicates the driver I predicted would increase pro-environmental behaviour.

The reduction in PEB may also be attributable to the uncontrollable and uncertain nature of climate change threats (Witte & Allen, 2009; Jonas et al., 2014; Gifford, 2011). Although mortality threats are an important component of climate change, these additional characteristics may have played a more influential role under the specific circumstances of my study. In my introduction, I used the following criteria to distinguish a Threat-Based climate change message from an Informational one: “reminders of the severe consequences for humanity and humanity’s life support systems”. This definition was well-suited for singling out climate change content with mortality reminders, but in my discussion below I use the term ‘threat’ more broadly, to encompass the varied types of threats that exist, such as uncertainty, mortality, loss of control, goal conflicts, and perceptual surprises (Jonas et al., 2014). Under this broad definition, both of the climate change articles I used would be considered threatening.

Researchers have found that people often respond to threats to personal control by increasing their belief in an external agent of control, like the government (Kay et al., 2008). Following a VBN theory interpretation, this threat to personal control could decrease self-efficacy, and the pivot to reliance on external agents of control and could facilitate lower acceptance of responsibility, both of which can influence behaviour via personal norms. This pattern was observed in a meta-analysis of public health campaigns, where Witte and Allen (2009) found that threat-based messages with low personal control caused the greatest level of avoidance in responses. Atalay and Meloy (2020) observed similar behavioural changes in emergency evacuations, where increased personal control helped to mitigate behavioural inhibition. These effects are consistent with my findings, where the climate change articles may have unintentionally contained low personal control themes and thus caused avoidance in the PEB task.

Theories on uncertainty in threats posit that threat messages can activate a Behavioural Inhibition System (BIS), which involves passive avoidance similar to the proximal defences of distraction, denial, and rationalization in TMT (Jonas et al., 2014). We did not expect to observe

the TMT proximal defences in our participants because we used an implicit mortality reminder, which bypasses the proximal defence phase (Figure 21; Cox et al., 2019). However, the BIS may have been activated by the uncertainty component instead, which could have contributed to the decreased PEB.

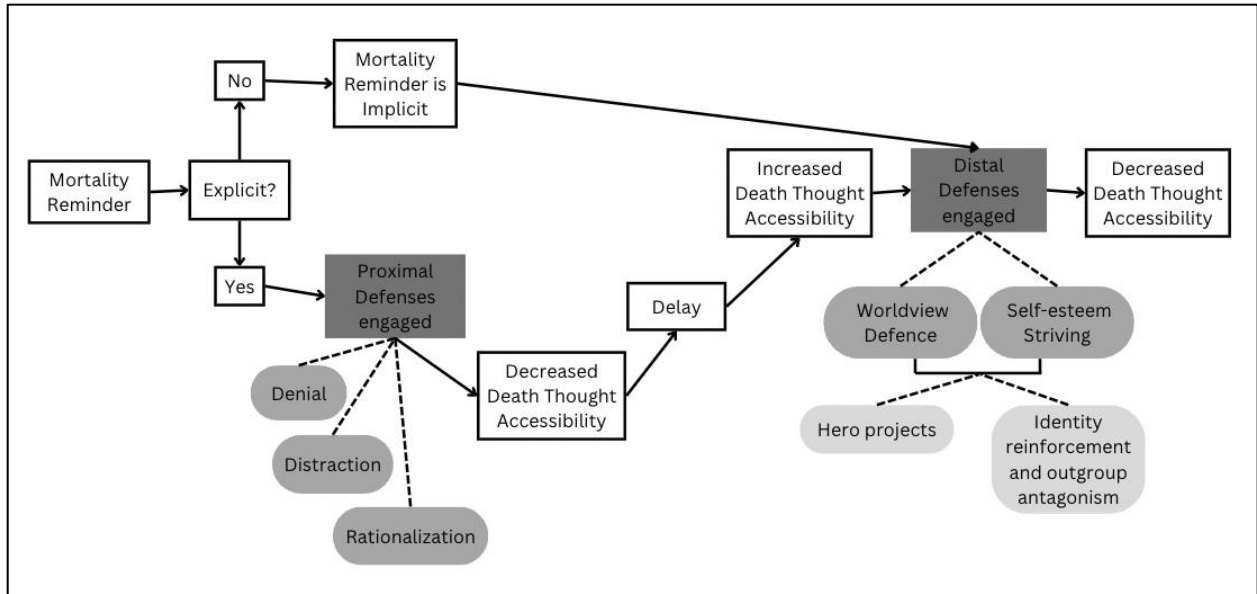


Figure 21. Psychological Defence to Mortality Reminders in Terror Management Theory (adapted from Smith et al., 2022 and Cox et al., 2019)

An additional consideration is the role that emotions more generally may have played in students' responses to the news articles. Emotion is a critical component of environmental risk response when it comes to decision-making (Loewenstein et al., 2001), and has been proposed as a key predictor of environmental behaviour (Van Valkengoed et al., 2022; Brosch & Steg, 2021; Brosch et al., 2023; Dang et al., 2012). Researchers have also found that women in Northern Canada experience stronger climate emotions compared to men (Galway & Beery, 2022), so the overrepresentation of women in my sample may have heightened the impact of emotions on my results (although my sample was located in Southern Canada). It is possible that emotional responses to these news articles, like despair or hopelessness, were a more powerful influence than fear-triggered efforts to defend one's cultural worldview or identity. A partially similar pattern was observed previously in a study on climate change policy support, where researchers found that emotions were stronger predictors than baseline cultural worldviews, although cultural worldview defence was not examined (Smith & Leiserowitz, 2014). Since I did not design my study to observe and analyze emotions, it is hard to say what feelings the participants experienced. However, Grant (Personal Communication, March 14, 2024) found that both anxiety-related emotions and sadness-related emotions were commonly experienced by UW environment students after learning about climate change in their courses. It is possible that the climate change articles caused sadness-related emotions, which have been found to inhibit environmental action in adolescents (Stevenson & Peterson, 2016). Debilitating sadness-related emotions like despair are suspected to occur as a response to the characteristics of the climate crisis (Pihkala, 2022), being that there is great uncertainty and complexity in the issue and that the connections between action and impact are rarely immediate or tangible (Stevenson &

Peterson, 2016). This speculation is consistent with my interpretation of the results, but future research is required to delineate any causal relationships that are involved.

Outside the context of this study, there are a broad array of social-psychological factors that can act as barriers to climate action. In a review of such factors, Gifford (2011) identified 29 “dragons of inaction” that can be obstacles to climate change adaptation and mitigation. Some of the dragons of inaction that Gifford (2011) lists are synonymous with aforementioned interpretations, such as *uncertainty*, and *lack of self-efficacy*. Others can serve as additional interpretative lenses. For example, a *lack of perceived behavioural control* (the perception that one is unable to do anything helpful when it comes to climate change) can inhibit PEB (Gifford, 2011; Ajzen, 2002; Azjen, 1991). This is different from self-efficacy because the focus lies in the ability to perform a behaviour rather than the effectiveness of an action that one might take. Another example of a “dragon of inaction” that may have influenced my results is *temporal risk*. A person’s evaluation of the time required to perform a PEB versus the impact of said PEB may breed hesitation, and subsequent inaction (Gifford, 2011). This “dragon of inaction” could have been enhanced by the sense of urgency that was communicated in both of the climate change articles. Gifford (2011) also explains that for people who are repeatedly or frequently exposed to climate change information, *environmental numbness* can occur and attenuate PEBs. My study population does encounter threat-based content frequently (Vieyra-Balboa et al., 2024), so it is possible that exposure to yet another climate change message enhanced their numbness and thus diminished PEB (Pihkala, 2022). Finally, *the rebound effect* may have been a contributor to the decrease in PEB that I observed. *The rebound effect*, also known as the Jevons paradox (Jevons, 1865) and the Khazzoom-Brooked postulate (Brookes, 1990; Khazzoom, 1980), occurs when the performance of one PEB inhibits engagement with subsequent PEBs (Gifford, 2011). Since knowledge seeking has been recognized as a form of PEB (van Horen et al., 2018), the act of reading a climate change article could have been the first PEB that inhibited the WEPT (a subsequent PEB). It is worth noting that an additional “dragon of inaction” on Gifford’s (2010) list is *worldview*, but worldviews are discussed primarily as barriers to PEB rather than potential enhancers.

Another important consideration in the interpretation of my results are hero projects, which are recognized as an additional unique form of distal defences that can be enhanced by mortality reminders (Becker, 1973; Ross & Wolfe, 2015). Liften (1973) defines hero projects as a “mode of symbolic immortality that is achieved through ‘works’: the mode of creativity, the achievement of enduring human impact; the sense that one’s writing, one’s teaching, one’s human influences, great or humble, will live on’ that one’s contribution will not die” (p.6). Wolfe and Tubi (2019) identified hero projects as an area of focus in environmental applications of TMT with great potential for impact. If certain PEBs are culturally validated by one’s in-group, then engaging in these PEBs could serve as a powerful way to bolster self-esteem and achieve symbolic immortality by contributing to the values of the group, which extend beyond the limits of a human lifetime (Wolfe & Tubi, 2019; Majumdar & Weber, 2023).

One would think that this serves as additional support for my prediction that threat-based climate change content would increase PEB, but in fact, the role of hero projects as distal defences depends on whether they create a legacy or not (Sligte et al., 2013). For example, Sligte et al. (2013) measured creativity (a form of hero project) as a distal defence following a mortality

reminder, and found that participants were more creative when they were told their products would be displayed for up to 100 years compared to those who were told the products would be displayed for up to 1 year. In my study, participant's responses were anonymous, so even though the WEPT had the potential to act as a hero project via enduring human impact, it may have required a legacy component in order for the mortality reminder to enhance engagement (e.g., participants who completed all ten pages have their name on the OroVerde website for 100 years). Another factor to consider is that the human impact of the WEPT donation would only benefit distant and unknown others, which can make people less likely to engage in pro-social behaviour compared to behaviours that benefit known and proximal recipients (Schneider & Weber, 2022). Value affirmation exercises can help motivate prosocial behaviour in these cases (Schneider & Weber, 2022).

The WEPT, although it has far fewer and less severe limitations compared to other methods, is not perfect. The task itself is not related to environmental issues in any conceivable way, which could decrease the ecological validity and lead participants to question its impact. It would be worthwhile for future research to examine other pro-environmental behaviours, to gain a fuller understanding of these relationships. Specifically, it would be fruitful to examine behaviours from the various behavioural categories, such as activist behaviours, and behaviours in the private sphere (Stern, 2000). It would also be meaningful and worthwhile to explore the effect on long-term behaviour since I only examined short-term PEB in this study. Both long-term and short-term behaviours merit investigation since they are subject to different drivers, and their impacts can vary greatly (Stern et al., 2000; Larson et al., 2015). The study of long-term PEBs in this population would have high impact potential since the special PEB competencies that can be facilitated by post-secondary environmental education programs have a good chance of manifesting as long-term PEBs, e.g., enhanced impact in an environmental career (Salgado et al., 2018; Segalàs et al., 2009; Barth et al., 2007; Thomas & Depasquale, 2016).

2.4.3 Royal Roads University

The Royal Roads response rates were very low, with only a final usable sample of N=11. This may have been influenced by the blended and online platform of the environmental programs, by the smaller relative student sampling pool, or by the fact I was affiliated with a different school. Institutional trust has been identified as a predictor for pro-environmental behaviour (Xing et al., 2022), and my distant affiliation may have bred lower levels of trust. With a sample size this small, it was not appropriate to conduct a statistical analysis since there would be nowhere near enough power to detect any significant results. Instead, the response patterns for Environmental Identity can be observed in Figure 20, and for PEB in Figure 21 in Section 2.3. It appears that the patterns are largely quite similar to those from UW, with just a couple of interesting differences. The PEB distribution did not have the same loading at ten pages that the UW sample had, in fact, the responses were fairly evenly distributed across the possible outcomes. Environmental identity did not appear to change substantially between the Baseline and Post-Test measurements, across all three conditions. There was greater variation in EIS-SV scores among the participants in the Threat-Based group condition compared to the other two conditions, but since this difference appeared in both the Baseline and Post-Test measurements it was likely due to chance in the random assignment. This is not surprising given

the small sample size, where stochasticity - random variation - is typically greater (Lande et al., 2003).

2.5 Conclusions

I found that climate change articles did not have a significant impact on environmental identity or death thought accessibility, but that they did decrease PEB to a significant and marginally-significant extent for the Informational and Threat-Based articles respectively. These results were inconsistent with my predictions that the students (who had generally strong pre-existing environmental identities) would respond to the Threat-Based climate change article with increased environmental identity and PEB as products of cultural worldview defence. My predictions were based on the existing TMT environment research, which indicates that climate change content can act as a mortality reminder (Fritsche et al., 2010; Fritsche et al., 2012; Fritsche & Häfner, 2012), and that people with strong environmental identities tend to respond to this with increased PEB (Akil et al., 2018).

Overall, these results suggest that the mortality salience hypothesis was not the most relevant framework for understanding how environmentally inclined students respond to climate change news articles. By no means does this diminish the potential for TMT to act as a useful framework in environmental research – it only provides guidance for which contexts might be more or less relevant, and which methods require additional consideration. For future research using the guidelines from Smith et al (2022), I would suggest always including a standard TMT mortality reminder, even if it is not immediately relevant to the research question, so that more clarity can be achieved regarding the role of climate change content as a mortality reminder.

The significant and marginally-significant findings in the PEB component of my research indicated that Threat-Based climate change content (according to the broad definition that extends beyond mortality reminders), negatively affects PEB. Course instructors in environmental education should consider this when discussing climate change threats, and make sure to accompany their threat content with constructive hope and opportunities for self-efficacy or action (Stevenson & Peterson, 2016). Future researchers should examine this relationship more closely: Are there specific aspects of these articles that caused this effect (e.g., low personal control, external agents of control)? What role do emotions play in these responses?

In conclusion, my findings, both significant and null, are cause for further investigation. Climate change content affects behaviour, and it is important that researchers and educators gain a more complete understanding of which elements of this content are responsible and which types of behaviours are implicated. TMT has been proposed as a useful framework for environmental applications, and its utility likely varies depending on the application. It is important that researchers elucidate the factors that determine its relevance. The climate crisis continues to increase in urgency and severity, and these social-psychological factors play a critical role in the mitigation of this crisis (Rockström et al., 2009; IPCC, 2018).

Chapter 3. Conclusions

3.0 Chapter Summary

In this chapter, I review the main findings from the manuscript in Chapter 2, I discuss some general limitations and opportunities related to my research, and I close with a description of the academic and practical contributions of this project.

3.1 Main Findings

My study was designed to examine the effects of Threat-Based climate change content on students in post-secondary environmental education programs. I collected data on environmental identity in order to address my first research objective: “*Determine the effects of Threat-Based climate change content on the environmental identity of Canadian post-secondary students in environmental education courses*”. I found that Threat-Based climate change content did not have a significant effect on environmental identity. Further research is required to determine whether these findings are a product of population characteristics or methodological limitations.

I observed short-term PEB to address my second research objective: “*Investigate the effects of Threat-Based climate change content on the actual short-term pro-environmental behaviour of Canadian post-secondary students in environmental education courses*”. I found that participants who were presented with the Informational climate change article showed significantly lower PEB than the Control, and those in the Threat-Based article showed marginally significantly lower PEB than the Control. This suggests that Threat-Based climate change content decreases PEB, but that mortality reminders are not the only determining factor in this relationship. Further research is required to identify other factors. It is possible that other elements of threat, such as low personal control or uncertainty, played a role in this.

3.2 Limitations and Future Directions

In addition to the limitations that were specific to the null findings, or the PEB findings, there were several general limitations in my research.

First, a general limitation of my study was the sampling process. I accepted a small amount of sampling bias from the beginning by recruiting via course instructors instead of using random selection, because this was necessary for obtaining the target sample size. Researchers are often unable to conduct random sampling in cases like this where they do not have access to a list of possible observations and they are unable to collect data from random observations (Cox, 2015). However, the degree of sampling bias was increased due to the low response rates and high attrition. These two factors combined meant that the participants who did make it to the end of the survey were a sub-population who self-selected and were thus not representative of the larger population (Cox, 2015). As a result, the generalizability of these findings is limited. There may be opportunities for future research to achieve random sampling if the study is conducted within a program or institution that has a pre-existing student participant pool, which could allow for a list of possible observations, and reduced attrition. An additional element of sampling bias to consider is the possibility that the content of the recruitment materials and the

environmental theme within them attracted a specific type of student who might respond to climate change content differently resulting in a self-selection bias.

Another limitation was the focus on only three conditions: a Threat-Based climate change article, an Informational climate change article, and a Control article. It would be worthwhile for future research to examine the outcomes in other conditions, like a standard TMT mortality reminder or a climate change threat in a non-article format, such as a questionnaire or a video. The use of a standard TMT mortality reminder would provide additional confidence in interpreting results, specifically concerning the function of climate change news articles as mortality reminders. The investigation of other climate change mortality reminder formats would be a useful contribution to the existing knowledge base on environmental applications of TMT, wherein there are remaining questions regarding which specific attributes of environmental threats determine their impact as mortality reminders (Smith et al., 2022; Smith & Wolfe, 2023).

Additionally, my research may have been limited by the Threat-Based climate change article that I used as my mortality reminder. I chose to use an implicit mortality reminder because it would have higher ecological validity (students are likely not being asked how they think it would feel to die in their environment courses), and it would not introduce any mental health risk beyond their day-to-day exposure. Most of the existing studies on environmental applications of TMT used explicit mortality reminders (Smith et al., 2022), and those that used implicit reminders were often location-specific (e.g. Uhl et al., 2017; Barth et al., 2018). As a result, I was not able to use an established climate change mortality reminder, which would have been helpful for the interpretation of my results.

If researchers were to examine the level of perceived threat from climate change in Canadian post-secondary environmental education students, this would provide valuable insights into the interpretation of past and future findings. For example, if I knew that students in this population perceived climate change as a major risk to them, it would help narrow down the possible explanations for my null findings. This clarity could inform methodological modifications and advances related to the measures that I used, as well as the general implementation of randomized control trials.

Another fruitful research avenue could be to examine these patterns at various institutions across Canada, since geographical, cultural, and demographic differences between institutions may produce drastically different responses.

Finally, as suggested in Chapter 1, it is crucial that researchers investigate the effects of Threat-Based climate change content on emotions and learning. These are important factors for the well-being of students, as well as the success of environmental education programs in achieving their goals (Jones et al., 2010; British Columbia Ministry of Education, 2007; Jensen & Schnack, 2006; Birdsall, 2010; Fang, 2023; Mulkey, 2017). Furthermore, these are factors that may influence student responses to climate change threats, so they could provide useful information about the decrease in PEB that I observed following exposure to a climate change article.

3.3 Contributions

3.4.1 The Role of Climate Change Content as a Mortality Reminder

My research contributes broadly to current discussions about the role of climate change content as a mortality reminder in target populations of interest, specifically Canadian post-secondary students in environmental education courses. This population must be examined because A) threatening climate change messages may have severe consequences for students' well-being (Kelly, 2017; Xu & Huang, 2022; Wu et al., 2020; Swim et al., 2011; Kluttz et al., 2020) and B) students in post-secondary environmental education have a relatively high potential for pro-environmental behaviour (PEB) given that higher education can instill students with unique and crucial competencies for contributing to sustainability interventions (Salgado et al., 2018; Segalàs et al., 2009; Barth et al., 2007; Thomas & Depasquale, 2016).

My findings contribute to the body of knowledge on which types of climate change messages act as mortality reminders in the population of interest. Recent research has demonstrated that message topics (e.g., flooding versus drought) can be an important factor in determining whether climate change content acts as a mortality prime (Smith & Wolfe, 2023). Selimbegović et al. (2016) found that the topic of nuclear accidents consistently functioned as a mortality reminder across various formats (visual, verbal, and subliminal). Furthermore, my findings help to identify relevant areas of impact (e.g., identity, behaviour, emotion) for threat responses in the population of interest. For example, environmental identity is an area with high impact-potential for informing climate change communication (Vesely, 2021), but in a review of terror management research with an environmental focus, only a small portion of featured studies examined environmental identity as an outcome variable (Smith et al. 2022).

3.4.2 Methods in Terror Management Theory

My research also contributes valuable information to the literature on Terror Management Theory due to several elements of my methodology. The consequences of these methodological choices can help to inform decisions for future researchers who are using a Terror Management Theory framework.

First, I chose not to include a delay task between the conditions and the dependent variable measures. This exclusion aligned with recommendations from Cox et al. (2018) and Smith et al. (2022) that delay tasks are not required if the mortality reminder is implicit and the outcome variables are distal psychological defences. Yet, there are several recent examples of studies that used implicit mortality reminders, examined distal defences, and still included a delay task (e.g., Barth et al. 2018; Uhl et al. 2018). If effects are consistently observed without a delay, then this is problematic because it inconveniences participants for more time than what is necessary. In my case, the predicted mortality salience effects did not occur, which means further consideration and design revisions may be required. By producing an example of a study that did not use a delay task, my research contributes to possible ethical improvements in this area of research.

Additionally, once participants read the message for their condition, they completed a measure of DTA. DTA is most commonly measured using a word-stem completion task where

certain word fragments can be completed as either death or non-death-related words (Cox et al., 2019). I measured DTA using a modified version of a word-stem task from Greenberg et al. (1994), which included 20 total word-stems, four of which could be completed as neutral or death-related words: coffin, grave, dead, corpse, and stiff. I chose this DTA measure because it was the most frequently used word-stem completion task in the literature, and it had relatively few death-related words compared to other word-stem tasks so it posed a lower risk of priming death-related thoughts (Cox et al., 2019). I removed the word-stem COFF__ (which can be completed as coffee or coffin) from this measure because the neutral word, coffee, had contributed to floor effects in previous studies due to its higher usage rate in everyday language compared to the death-related counterpart coffin (Priyanka et al., 2022). This modification could provide a valuable option for researchers in the future who need to examine DTA since the current selection of tools is riddled with limitations (Priyanka et al., 2022). However, future researchers should take into consideration that my version of the word-stem completion task still showed signs of floor effects so further modifications may be required.

3.4.3 Methods in Environmental Psychology

My data analysis approach could provide a valuable model for environmental psychology research that uses survey measures like the environmental identity scale. Typically, overall scores for this type of survey data are obtained by calculating the mean scale response from all of the items. This approach relies on the oftentimes unsupported assumption that each question on the scale contributes equally to the latent variable (McNeish & Wolf, 2020), which is environmental identity in this case. This approach is also questionable when the data is fit to a linear model, since this involves an underlying assumption of continuous variable inputs that is not met by the ordinal nature of the response scale (which is in a Likert format). In other words, there is no evidence that the differences between each of the response options from 1-7 are equal. A response value of 1 is lower than a response value of 2, but the exact difference between a 1 and a 2 is not known. Instead of using the conventional approach, I ran a confirmatory factor analysis, which provided an estimated value for the contribution of each question to overall environmental identity. These estimated values are called latent factor scores, and they are a continuous variable type which makes them compatible with linear models.

Another aspect of my research that could produce scholarly benefits in environmental psychology is my choice of tool for measuring PEB. Although PEB is featured prominently in environmental psychology research, the available tools for measuring PEB come with substantial limitations (Lange & Dewitte, 2019). Behavioural paradigms provide an opportunity to observe participant behaviour under conditions that systematically present the same consequences that the participant would encounter in the real world (Lange, 2022; Lange & Dewitte, 2019). Successful representation of real-world contingencies gives this measure high external validity (Lange, 2022; Lange & Dewitte, 2019). In addition to the large collection of ad-hoc behavioural paradigms that exist, Lange (2022) identified five validated behavioural paradigms. It is recommended that researchers use a validated measurement tool whenever possible to ensure that they are in fact measuring what they mean to be measuring (Lange, 2022). This field of scholarship could thus benefit from more examples in the literature of studies that implement validated behavioural paradigms.

3.4.4 Applications in Environmental Education

The findings from this research are available to inform the production of specific and targeted guidelines for the use of threat-based content in environmental education programs. The broad impact potential of this research is vast because enhancing environmental education for post-secondary students will help to improve the wellness, learning, agency, and empowerment of society's emerging environmental stewards.

Based on these findings, my suggestion for post-secondary environmental education instructors who are seeking to inspire PEB is to proceed with caution when threat-based climate change content is involved. I recognize that it is necessary in many cases for threat-based material to be shared, considering the reality of the climate crisis (IPCC, 2018; Smith et al., 2022; Vesco et al., 2020; Schewe et al., 2019). Including themes of personal control and material that enhances perceived self-efficacy and responsibility may help to prevent the behavioural inhibition that I observed in my study (Stevenson & Peterson, 2016). This could be accomplished by presenting examples of success in individual and/or collective action, by providing ideas of tangible and achievable actions that students can take, or by giving students the opportunity to actually engage in said actions within learning activities.

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Appendices

Appendix A. Deception

A.A1. Rationale for Deception

The use of deception is a critical tool in standard Terror Management Theory research, as is often the case with subfields of social psychology (Bargh & Chartrand, 2000; Smith et al., 2023). I needed to use partial disclosure in the letter of information to the participants because knowledge of the hypotheses could affect the way that participants responded to the questionnaire, thus reducing data validity. Since I was investigating a causal research question, it was necessary that extraneous variables and confounds were controlled as much as possible, which meant that alternative study designs involving prior full disclosure would have been inadequate to answer the research question. The benefits of the research outweigh the costs to participants because the findings will be available to inform the production of specific and targeted guidelines for the use of threat-based content in environmental education programs. This could have an indirect positive impact on the participants by enhancing environmental education in ways that may help to improve the wellness, learning, agency, and empowerment of post-secondary students. Additional benefits of participating in the research include: the opportunity to learn about current news related to climate change, the opportunity to complete the work for environmental protection task, which will lead to real donations towards a rainforest protection fund, and the opportunity to win one of ten \$10 gift cards.

A.A2. Participant Deception Debriefing Material

Post-Study Information Page

Title of Project:

Exploring the Effects of Threat-Based Climate Change Content in Canadian Post-Secondary Environmental Education

Student Investigator:

Emma Collette, University of Waterloo, e3collet@uwaterloo.ca.

Faculty Supervisor:

Dr. S.E. Wolfe, University of Waterloo and Royal Roads University, sewolfe@uwaterloo.ca and Dr. C. Barbeau, University of Waterloo, cbarbeau@uwaterloo.ca.

We appreciate your participation in our study and thank you for spending the time helping us with our research. The purpose of this post-study information page is to provide additional details about the study you just participated in.

You were originally told that this study was designed to investigate student responses to news articles in Canadian post-secondary education. While we were indeed interested in student responses to news articles, the study objectives were more involved from what we originally explained to you.

In this study, we are actually interested in the effects of threat-based climate change content on students in environmental studies programs. As of now, researchers don't know exactly how threat-based climate change content is affecting students in environmental education programs. However, there is strong evidence that this type of messaging can affect peoples' behaviours (Burke et al., 2010), including their environmental behaviour (Fritsche & Hafner, 2012; Fritsche et al. 2012). This research is important because it will help inform educational practice so that educators can be empowered to select climate change communication approaches that foster wellness and action. A study report is expected to be available by February 1st, 2024, at which time participants may receive a copy of the report if requested.

Participants in this study were randomly assigned to news articles that contained either threat-based climate change content, informational climate change content, or unrelated content as a control. The text in these articles was copied from real news articles which were selected based on the themes they covered (Borenstein, 2018; Doyle, 2019; Sullivan, 2023). You were asked to complete a series of questions and tasks as measures of your environmental identity and actual short-term pro-environmental behaviour so that we can examine whether there are differences in these outcomes depending on which news article students read. The number identification task and donation were not part of the deception. The description of this task was true, and the donation is real. This task was included as a measurement of actual short-term pro-environmental behaviour. The implementation of the task, including the selection of Oro Verde as the charitable fund, was designed according to guidelines from Lange and Dewitte (2021), who designed and validated the task.

The reason we needed to use deception in this study was because we needed participants' behaviour and attitudes to be as natural as possible. To summarize:

1. The purpose of this study was to examine the effects of threat-based climate change content on students in Canadian post-secondary environmental education.
2. You were not told in advance that this study is focused on threat-based climate change messages.
3. The purpose of the deception was to avoid priming you on this topic since it might have impacted the way you responded to the questionnaire.
4. The number identification task and donation were not part of the deception. The description of this task was true, and the donation is real.

We apologize again for not providing you with complete information about the purpose, objectives and procedures for this study, but we hope you understand why this was necessary. Since this study involves some aspects that you were not told about before starting, it is very important that you not discuss your experiences with any other students who potentially could be in this study, until the end of the term. If people come into the study knowing about our specific predictions, as you can imagine, it could influence their results, and the data we collect would not be usable. Also, if you print off a copy of this post-study information page, please do not make it available to other students.

Your identity will be confidential. All of the data will be summarized and no individual could be identified from these summarized results. Any potentially identifying information, such as your

email address, will be collected and stored separately from the data. Electronic data will be stored for 7 years on a secure University of Waterloo drive and then erased. Since some elements of the study are different from what was originally explained, there is another consent form for you to read and complete, if you are willing to allow us to use the information you have provided. This consent is also a record that the full purpose of the study was explained to you. If you do choose to withdraw from the study, you can do so until February 4th, 2024 by following this link **[survey hyperlinked here]** and providing your anonymous participant code.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #45709). If you have questions for the Board, contact the Office of Research Ethics, toll-free at 1-833-643-2379 (Canada and USA), 1-519-888-4440, or reb@uwaterloo.ca. For all other questions contact Emma Collette (student investigator) at e3collet@uwaterloo.ca.

We really appreciate your participation and hope that this has been an interesting experience for you.

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Appendix B. Measurement Platforms

A.B1. Web-Based Research

I implemented each of the measures using Qualtrics, a web-based data collection tool. Web-based research has several limitations relative to paper-based approaches, including reduced comprehension rates and more incomplete responses (Noyes, Garland & Robins, 2004). I addressed these limitations by designing an attractive and comprehensive response platform that was facilitated by the Qualtrics survey feedback function (Monzon & Bayart 2018). Additionally, I was active on my email during the data collection period so that participants were able to ask questions if they ran into any challenges with comprehension – although no such emails arrived. Web-based research also offers various advantages compared to traditional paper-based methods, such as reduced time and implementation cost per participant (Cobanoglu et al., 2001; Schmidt 1997), faster response rates (Yun & Trumbo 2000), and lower barriers to participation overall (Vicente & Reis 2010).

A.B2. Survey Methods

I relied on survey methods for measuring environmental identity. Surveys are a data collection method where participants self-report on the variable(s) of interest by responding to a standardized set of questions (Gifford, 2016; Secor, 2010). The incorporation of participant perspectives enables surveys to offer the critical advantage of providing an avenue for measuring concepts, which are ideas or mental representations that researchers may not have the ability to directly observe (Rickards, 2012). Other methods, such as interviews and focus groups, share this capability, but lack compatibility with experimental design (Gifford, 2016). Thus, a survey was the most suitable option for capturing environmental identity as a conceptual component of my causal research question.

For researchers to measure concepts using surveys, they must rely on participants' reported observations and perspectives. This reliance results in surveys' well-recognized limitation: social desirability bias. Social desirability bias is defined as the overreporting of socially desirable behaviours and underreporting of undesirable behaviours, and it may cause a shift in the central tendency of the results (Koller et al., 2023). One approach for addressing this limitation was to use an experimental design. Since I was looking at a comparison between conditions, I did not expect social desirability bias to affect the results because there was no reason to believe that any one group randomly assigned to a condition would engage in more social desirability bias than another.

An additional limitation of surveys can be the unreliable recollection of events, which is referred to as memory fallibility (Bradburn et al., 1987; Bradburn, 2004). This limitation is also a product of the perspective-based nature of surveys. Memory fallibility can be reduced by ensuring that questions specify the time period of interest and by adjusting the chosen period according to events' saliency or personal significance (Bradburn, 2004). Memory fallibility can be eliminated almost entirely by asking participants questions focused on the present moment, or intentions for the future, although measuring future intentions comes with its own set of limitations (Sheeran, 2002). Since the questions in the environmental identity scale were not explicitly focused on the future, present or past, it is possible that participants' responses were affected by memory fallibility. However, since there was no systematic reason to believe that participants would engage in more memory fallibility in one of the study conditions compared to another, I did not expect the results of the comparison to be affected.

A.B3. Behavioural Paradigms

Behavioural paradigms provide an opportunity to observe participant behaviour under conditions that systematically present the same consequences that the participant would encounter in the real world (Lange, 2022; Lange & Dewitte, 2019). Successful representation of real-world contingencies allows this type of measure high external validity (Lange, 2022; Lange & Dewitte, 2019). Compared to surveys, this measure has relatively low feasibility for measuring multiple behaviours so it would be difficult to capture the diverse domains of PEB, which is why I used the EIS-SV as a complementary measure. Many examples of behavioural paradigms exist for PEB, including asking subjects to participate in an environmental event (e.g., Donmez-Turan & Kiliclar, 2021), providing a link to sign a petition (e.g., Gulliver et al., 2020), or opening an email about a sustainability initiative (e.g., van Horen et al., 2018). Behavioural paradigms are also a common approach to measuring PEB as a response to mortality reminders (e.g., Akil et al., 2018; Fristche et al., 2010; Kasser & Sheldon, 2000). In addition to the large collection of ad-hoc behavioural paradigms that exist, Lange (2022) identified five validated behavioural paradigms. I chose to use one of those five (described in Section 3.2.2.5) because it is recommended that researchers use a validated measurement tool whenever possible to ensure that they are measuring what they mean to be measuring (Lange, 2022).

Appendix C. Environmental Identity Scale

A.C1. Questions on the Environmental Identity Scale

1. I spend a lot of time in natural settings (woods, mountains, desert, lakes, ocean)
2. I think of myself as a part of nature, not separate from it.
3. If I had enough resources such as time or money, I would certainly devote some of it to protect the environment.
4. When I am upset or stressed, I can feel better by spending some time outdoors "communicating with nature".

5. I feel that I have a lot in common with other species.
6. Behaving responsibly toward nature - living a sustainable lifestyle - is part of my moral code.
7. Learning about the natural world should be an important part of every child's upbringing.
8. I would rather live in a small room or house with a nice view than a bigger room or house with a view of other buildings.
9. I would feel that an important part of my life would be missing if I was not able to get out and enjoy nature from time to time.
10. I have never seen a work of art that is as beautiful as a work of nature, like a sunset or a mountain range.
11. I feel that I receive spiritual sustenance from experiences with nature.

A.C2. Seven-Point Response Format

	Not at all true of me		Neither true nor untrue		Completely true of me		Prefer not to answer
	1	2	3	4	5	6	7
1. I spend a lot of time in natural settings (woods, mountains, desert, lakes, ocean)	☐	☐	☐	☐	☐	☐	☐

Figure A.C2.1. Seven-Point Response Format for the EIS-SV

A.C3. Slider Response Format

Please indicate the extent to which each of the following statements describes you by using the appropriate placement on the scale below.

1. I spend a lot of time in natural settings (woods, mountains, desert, lakes, ocean) ☐ Prefer not to answer

Not at all true of me
Completely true of me

Figure A.C3.1. Slider Response Format for the EIS-SV

Appendix D. Work for Environmental Protection Task

In this section, you will be given the opportunity to complete a series of simple number identification tasks. The first task is a short introduction to help familiarize you with the number identification process. Please follow the instructions below, and then proceed to the next page once you have completed the task.

Identify all those stimuli with an even first digit and an odd second digit. For example, you should click on “87” if it’s present, because the first digit (8) is even and the second digit (7) is odd.

☐ 32	☐ 55	☐ 85	☐ 40	☐ 17
☐ 45	☐ 43	☐ 22	☐ 89	☐ 49
☐ 13	☐ 95	☐ 69	☐ 36	☐ 87
☐ 58	☐ 84	☐ 28	☐ 62	☐ 52

Now you have the option to continue with the number-identification task for a little longer.

Figure A.D.1. WEPT Instructions part-one

In the following, we will ask you if you want to complete additional pages of the number-identification task. **For each page that you correctly complete, we will make a donation to OroVerde, an environmental non-profit organization working on the preservation of tropical forests.** OroVerde invests, for example, in reforestation and environmental education in Latin America. It is up to you to decide how much time and effort you want to invest in the task. There are a maximum of 10 pages that you can complete. For each page, we will tell you how many numbers you will have to check (so that you can estimate the effort) and how much money we will donate if you complete the task. **You can then decide, for each page separately, if you want to do this additional effort or not.** Doing this task is completely voluntary. If you want, you can decline checking the numbers (by clicking "no") every time and go directly to the next part of the study. However, **please do not simply close the survey before you have reached the end of it** (otherwise we will not be able to collect your information to enter your name into the draw).



Figure A.D.2. WEPT Instructions part-two

The next page will contain 80 numbers and we will donate \$0.10 CAD for the protection of the rainforest if you complete this page. If you decide to complete this page, please do so thoroughly because we can only count pages that are at least 90% correct. We will not give you feedback, so please check whether your answers are correct before proceeding to the next page.

Do you want to complete this page?

- ☐ Yes
- ☐ No



Figure A.D.3. WEPT Instructions part-three

Identify all those stimuli with an even first digit and an odd second digit. For example, you should click on “87” if it's present, because the first digit (8) is even and the second digit (7) is odd.

☐ 68	☐ 91	☐ 96	☐ 85	☐ 33	☐ 27	☐ 40	☐ 83
☐ 65	☐ 93	☐ 60	☐ 73	☐ 56	☐ 54	☐ 57	☐ 42
☐ 78	☐ 16	☐ 39	☐ 32	☐ 79	☐ 98	☐ 99	☐ 64
☐ 26	☐ 17	☐ 49	☐ 66	☐ 82	☐ 35	☐ 13	☐ 87
☐ 15	☐ 71	☐ 18	☐ 29	☐ 81	☐ 47	☐ 77	☐ 72
☐ 25	☐ 14	☐ 69	☐ 55	☐ 62	☐ 88	☐ 75	☐ 34
☐ 97	☐ 76	☐ 53	☐ 21	☐ 24	☐ 38	☐ 50	☐ 20
☐ 48	☐ 80	☐ 70	☐ 95	☐ 51	☐ 86	☐ 37	☐ 23
☐ 58	☐ 19	☐ 22	☐ 94	☐ 12	☐ 52	☐ 43	☐ 10
☐ 84	☐ 30	☐ 59	☐ 11	☐ 45	☐ 46	☐ 36	☐ 31

Figure A.D.4. WEPT Instructions part-four

Identify all those stimuli with an even first digit and an odd second digit. For example, you should click on "25", because the first digit (2) is even and the second digit is odd (5).

47	72	39	59	15	84	88	82	44	57
☒	☐	☐	☐	☐	☐	☐	☐	☐	☐
59	38	68	46	32	81	67	71	69	84
☐	☐	☐	☐	☐	☒	☒	☐	☒	☐
35	48	25	78	73	87	18	87	74	89
☐	☐	☒	☐	☐	☐	☐	☐	☐	☐
32	75	28	82	29	82	62	51	74	66
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

The next page will contain **40 numbers** and we will donate **0.20 Euro** for the protection of the rainforest if you complete this page.

If you decide to complete this page, please do so thoroughly because we can only count pages that are at least 90% correct. We will not give you feedback, so please check whether your answers are correct before proceeding to the next page.

Do you want to complete this page?

yes
no

☒
☐

Figure A.D.5. Participant instructions in the Work for Environmental Protection Task from Lange et al. (2018)

Appendix E. News Article Conditions

A.E1. Article instructions

Please read the following article carefully, and click next once you have completed the article. This article takes approximately 2-3m to read. The citation for the article will be provided after you are finished with your participation in the study.

A.E2. Threat-Based Climate Change Article

UN report on global warming carries life-or-death warning

Preventing an extra single degree of heat could make a life-or-death difference in the next few decades for multitudes of people and ecosystems on this fast-warming planet, an international panel of scientists reported Sunday. But they provide little hope the world will rise to the challenge.

The Nobel Prize-winning Intergovernmental Panel on Climate Change issued its gloomy report at a meeting in Incheon, South Korea.

In the 728-page document, the U.N. organization detailed how Earth's weather, health and ecosystems would be in better shape if the world's leaders could somehow limit future human-caused warming to just 0.9 degrees Fahrenheit (a half degree Celsius) from now, instead of the globally agreed-upon goal of 1.8 degrees F (1 degree C). Among other things:

- Half as many people would suffer from lack of water.
- There would be fewer deaths and illnesses from heat, smog and infectious diseases.
- Seas would rise nearly 4 inches (0.1 meters) less.
- Half as many animals with back bones and plants would lose the majority of their habitats.
- There would be substantially fewer heat waves, downpours and droughts.
- The West Antarctic ice sheet might not kick into irreversible melting.
- And it just may be enough to save most of the world's coral reefs from dying.

“For some people this is a life-or-death situation without a doubt,” said Cornell University climate scientist Natalie Mahowald, a lead author on the report.

Limiting warming to 0.9 degrees from now means the world can keep “a semblance” of the ecosystems we have. Adding another 0.9 degrees on top of that — the looser global goal — essentially means a different and more challenging Earth for people and species, said another of the report's lead authors, Ove Hoegh-Guldberg, director of the Global Change Institute at the University of Queensland, Australia.

But meeting the more ambitious goal of slightly less warming would require immediate, draconian cuts in emissions of heat-trapping gases and dramatic changes in the energy field. While the U.N. panel says technically that's possible, it saw little chance of the needed adjustments happening.

In 2010, international negotiators adopted a goal of limiting warming to 2 degrees C (3.6 degrees F) since pre-industrial times. It's called the 2-degree goal. In 2015, when the nations of the world agreed to the historic Paris climate agreement, they set dual goals: 2 degrees C and a more demanding target of 1.5 degrees C from pre-industrial times. The 1.5 was at the urging of vulnerable countries that called 2 degrees a death sentence.

A.E3. Informational Climate Change Article

Oceans warming faster than expected, set heat record in 2018, say scientists

The oceans are warming faster than previously estimated, setting a new temperature record in 2018 in a trend that is damaging marine life, scientists said on Thursday.

New measurements, aided by an international network of 3,900 floats deployed in the oceans since 2000, showed more warming since 1971 than calculated by the latest U.N. assessment of climate change in 2013, they said.

And “observational records of ocean heat content show that ocean warming is accelerating,” the authors in China and the United States wrote in the journal *Science* of ocean waters down to 2,000 meters (6,600 ft).

Man-made greenhouse gas emissions are warming the atmosphere, according to the overwhelming majority of climate scientists, and a large part of the heat gets absorbed by the oceans. That in turn is forcing fish to flee to cooler waters.

“Global warming is here, and has major consequences already. There is no doubt, none!” the authors wrote in a statement.

Almost 200 nations plan to phase out fossil fuels this century under the 2015 Paris climate agreement to limit warming. U.S. President Donald Trump, who wants to promote U.S. fossil fuels, plans to pull out of the pact in 2020.

Data due for publication next week will show “2018 was the warmest year on record for the global ocean, surpassing 2017,” said lead author Lijing Cheng, of the Institute of Atmospheric Physics at the Chinese Academy of Sciences.

He told Reuters that records for ocean warming had been broken almost yearly since 2000.

Overall, temperatures in the ocean down to 2,000 meters rose about 0.1 degree Celsius (0.18F) from 1971-2010, he said. The 2013 U.N. assessment estimated slower rates of heat uptake but did not give a single comparable number.

A separate study on Monday, by the European Union’s Copernicus Climate Change Service, said 2018 was the fourth warmest year for global surface temperatures in records dating back to the 19th century.

Ocean temperatures are less influenced by year-to-year variations in the weather. It can take more than 1,000 years for deep ocean temperatures to adjust to changes at the surface.

“The deep ocean reflects the climate of the deep and uncertain past,” Kevin Trenberth, of the U.S. National Center for Atmospheric Research and a co-author of Thursday’s study, told Reuters.

Among effects, extra warmth can reduce oxygen in the oceans and damages coral reefs that are nurseries for fish, the scientists said. Warmer seas release more moisture that can stoke more powerful storms.

Warmer ocean water also raises sea levels by melting ice, including around the edges of Antarctica and Greenland.

A.E4. Control Article

Migraines and cluster headaches are linked to the body's internal clock, research finds

Two severe types of headaches are strongly linked to the [body's internal clock](#), a meta-analysis published Wednesday found.

[Cluster headaches](#) are a rare type of headache that cause bursts of intense pain around the eye. Each burst lasts about 15 minutes, but an attack can last between one and three hours. The condition is more common in males than in females. The opposite is true for [migraines](#), a severe headache condition that is three times more prevalent in females than in males.

And while cluster headaches commonly occur during the night, migraines usually come on during the day, the meta-analysis found.

“[Cluster headache](#) is known to be circadian, but it was surprising how circadian migraine is,” said Dr. Mark Burish, the study’s lead author and the director of the Will Erwin Headache Research Center at UTHealth Houston.

The meta-analysis included 72 studies on how circadian rhythm —the body’s internal clock — appears to be involved in either headache disorder, which together impact more than 40 million people in the U.S.

The studies included data on the time of day or time of year a person got a headache, and whether or not the headaches came on just before, during, or [just after sleep](#). Some of the studies also included research on whether certain genes associated with circadian rhythm are more common in people who got these types of headaches. One study was a genetic analysis conducted in nonhuman primates, but the rest were based on humans.

The [results](#) were published Wednesday in *Neurology*, the American Academy of Neurology’s medical journal.

Cluster headaches were closely tied to circadian cycles, especially during season changes in the spring and fall, the researchers found. More than 70% of people included in 16 studies on cluster headaches reported more attacks during these seasons and said they usually occurred between the late hours of the night and early hours of the morning.

When it came to genetic predisposition, the studies showed that five of the nine genes associated with cluster headaches were also involved in regulating circadian rhythms.

What came as a surprise to the researchers was that half of migraine headaches across eight studies were associated with clear ebbs and flows throughout the day as well as the year. Most people had migraines during the morning, day or evening, and there was a stark drop off in the headaches from 11 p.m. to 7 a.m. They also reported more or worse migraines between April and October.

Many genes are associated with risk for migraine, and the study found 110 of these genes were also tied to circadian rhythm.

Burish said that understanding the link between circadian rhythm and these [headache disorders](#) could lead to better treatments.

Appendix F. Pro-Environmental Behaviour Analysis

Following Lange and Dewitte (2021), pages were marked as complete based on the amount of time spent working, with the cutoff time being set at two standard deviations below the mean. None of the pages that had been started were excluded based on this criterion. I classified WEPT as a count variable because it contains discrete values which represent the number of occurrences of an event (Coxe et al., 2009). Count variables are typically not suitable for Ordinary Least Squares (OLS) regression because they can violate the assumptions of these models, leading to biased and inefficient results (Gardner et al., 1995; Long, 1997). Instead, I used a Negative Binomial Regression, which is compatible with count variables because it does not rely on the assumption of a normal distribution (Coxe et al., 2009). I used a Negative Binomial Regression instead of a Poisson Regression because there was overdispersion in the data. Overdispersion occurs when the variance in the dataset is greater than the mean; this can impact the standard error estimates, parameter estimates, significance, and confidence limits (Coxe et al., 2009). Using a Negative Binomial Regression addressed this limitation because it assumes heterogeneity among the sample and thus accounts for overdispersion (Coxe et al., 2009).

The Negative Binomial Regression was still not a good enough fit with the data because there were a large number of students who completed all ten pages, and this peak was isolated from the distribution curve. This is an issue that researchers often encounter with count data, although typically the excessive loading is at the zero value rather than the maximum value, and it is known as zero-inflated data (Lambert, 1992). Since Poisson Regressions and Negative Binomial Regressions cannot account for this inflation, the two recommended modelling approaches in these instances are the Zero-Inflated Poisson and the Hurdle Model (Feng, 2021; Heilbron, 1994). I used a Hurdle Model because it aligned more closely with my second research objective – to investigate the effect of threat-based climate change content on PEB – since it allowed for exploration of the loading pattern that arose in PEB outcomes. The Hurdle Model was also better suited for my data compared to a Zero-Inflated Poisson because some levels of the predictor variable had less inflation (Feng, 2021).

Appendix G. Attrition

Table A.E.1. Attrition across study samples from the University of Waterloo and Royal Roads University.

Sample	Participants who began the survey	Participants who provided re-consent	Percent Attrition
Full UW	144	83	42%
Long-Delay UW	120	72	40%
Short-Delay UW	24	11	54%
Full RRU	20	11	45%

Note. The full UW sample contains responses from the short-delay UW and long-delay UW samples. There was no long delay sample for RRU students.