Do Climate Anxiety and Pro-Environmental Behaviour Affect One Another?

A Longitudinal Investigation

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Abstract

Anthropogenic climate change poses a serious threat to psychological wellbeing. One particular negative emotional response gaining scholarly attention is climate anxiety: anxious feelings arising from climate change, even among people not yet personally impacted by this global environmental crisis. Research suggests that climate anxiety might be implicated in pro-environmental behaviour. Specifically, climate anxiety may motivate individuals to act in ways that, if widely adopted, could mitigate the damage caused by climate change. Furthermore, there is a common assumption that these sustainable behaviours will alleviate climate anxiety, creating a mutually beneficial cycle where pro-climate actions increase and distressing anxiety is eased. However, these ideas are not well supported by empirical and theoretical evidence.

This study aimed to test the hypotheses that 1) climate anxiety causes pro-environmental behaviour to increase over time, and 2) pro-environmental behaviour causes climate anxiety to decrease over time. A sample of 700 Australian and New Zealand adults was recruited via the online research platform Prolific and surveyed monthly on five occasions. Data were analysed using a random intercept cross-lagged panel model, which controlled for stable, between-person differences while focusing on dynamic within-person changes over time.

The study found no evidence of a causal relationship between climate anxiety and pro-environmental behaviour. Higher levels of climate anxiety at one wave were not significantly associated with higher levels of pro-environmental behaviour at the following wave, and higher levels of pro-environmental behaviour at one wave were not significantly associated with lower levels of climate anxiety at the next wave. Furthermore, levels of climate anxiety were very low across the sample, indicating that climate anxiety, experienced

at a level that causes clinically significant emotional and cognitive impairment, is relatively rare.

These findings suggest that climate anxiety is unlikely to have the helpful side effect of increasing an individual's engagement in pro-environmental behaviour, but neither will it deter a person from taking action. Moreover, taking action is unlikely to reduce climate anxiety. Further scholarship is needed to investigate climate anxiety and its complex relationship with pro-environmental behaviour.

Keywords: climate anxiety, CCAS, pro-environmental behaviour, climate change, random intercept cross-lagged panel model

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1. Introduction

> I don't want you to be hopeful. I want you to panic. I want you to feel the fear I feel every day. And then I want you to act. I want you to act as you would in a crisis. I want you to act as if the house is on fire. Because it is.
>
> –Greta Thunberg, climate activist, 2019

Climate change, and the existential threat it poses to humanity, has become a defining feature of the 21st century. Increased carbon dioxide concentrations in the atmosphere are warming the earth (Intergovernmental Panel on Climate Change, 2021) and endangering human health (McMichael et al., 2006), including mental health (Berry et al., 2010). Scholars warn that the psychological impact of our degrading planet will be substantial, with predicted increases in worry, fear, grief, despair and anxiety among populations worldwide (Hayes et al., 2018). One particular negative psychological response gaining scholarly attention is climate anxiety: anxious feelings arising from the climate crisis, even among people only distantly impacted by this deepening environmental emergency (Clayton, 2020; Cunsolo et al., 2020). Recent literature suggests the experience is not uncommon, and can cause significant cognitive and emotional impairment (Clayton & Karazsia, 2020).

There is some suggestion that climate anxiety might serve a functional purpose by spurring anxious individuals to adopt pro-environmental behaviours such as making greener food and transportation choices (Doherty & Clayton, 2011; Verplanken et al., 2020; Verplanken & Roy, 2013). Furthermore, it is often assumed that engaging in these behaviours will alleviate climate anxiety (e.g., Cunsolo et al., 2020; Lewis, 2018). Pro-environmental behaviours are routinely prescribed by academic and mental health specialists as a "treatment" for overwhelming anxiety about the declining state of the planet (Baudon &

Jachens, 2021). How these climate change responses relate to one another is of critical importance. Increasing pro-environmental behaviours, particularly those deemed to be high impact (Girod et al., 2013), is an urgent requirement if global emissions targets are to be met (Intergovernmental Panel on Climate Change, 2022b). Thus, the notion that climate anxiety might help people engage in the very behaviours that, if widely adopted, could mitigate the damage caused by climate change, is an important one, with considerable ramifications for the future of civilisation. That these behaviours could, in turn, soothe distress and relieve climate anxiety is appealing, and ultimately suggests a virtuous feedback loop that benefits both the person and the planet.

Stated as a research question, this thesis asks: How do climate anxiety and pro-environmental behaviour affect each other? It is anticipated that the findings will help inform both psychological interventions for climate anxiety, as well as governmental policy on climate change mitigation strategies. Psychology, as the study of mind and behaviour (VandenBos, 2007), is well positioned to explore these relationships. Professional psychological bodies around the world, such as the American Psychological Association (2022), have urged psychologists to engage more deeply with such topics in the context of climate change, and some scholars (Charlson et al., 2022; Hogg et al., 2021) have highlighted this particular research need. However, to date, despite the lively scholarly discussion and growing focus on both climate anxiety and pro-environmental behaviour, there is surprisingly little empirical research that is capable of credibly estimating the causal effects of these variables on one another. This work thus fills a research gap not currently addressed in the psychology literature.

2. Literature Review

The Climate Crisis

Anthropogenic climate change can be defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and which is in addition to natural climate variability observed over comparable time periods" (United Nations General Assembly, 1992, p. 7). This phenomenon poses a significant threat to planetary ecosystems. Increasing greenhouse gas emissions, together with the clearing of the forests and grasslands that capture and store gases, have lifted the earth's surface temperature by about 1.1°C since 1880, with most change occurring since 1975 (Intergovernmental Panel on Climate Change, 2021). Rising temperatures are driving up sea levels, melting polar ice, and increasing the frequency of severe storms, flooding, heatwaves, drought, and wildfire (Wuebbles et al., 2017).

Alongside the environmental degradation and harm to animal species, climate change is having a profound impact on human life. Societal impacts include weather damage to infrastructure, property, crops and water supplies, and the subsequent disruptions to economies, schooling and social services, destruction of culturally important sites and resources, intergroup and international conflict, and population displacements (Al-Delaimy et al., 2020; Xu et al., 2020). Rising temperatures and climate events also increase the prevalence and severity of heat-related illnesses, and cardiovascular and respiratory conditions (Parker et al., 2019; Watts et al., 2021). There is even some evidence that climate change may have influenced the emergence and transmission of COVID-19 (Gupta et al., 2021). Furthermore, this imbalance in the earth's homeostasis may be increasing the number of people experiencing symptoms of mental health conditions such as post-traumatic stress disorder, anxiety, depression, and substance abuse (Lawrance et al., 2022).

It is now commonly accepted among climate scientists (Lynas et al., 2021) and a growing proportion of the general public (Leiserowitz et al., 2019; Milfont et al., 2021) that anthropogenic climate change is occurring. There is also broad consensus that unless drastic reductions in greenhouse gas emissions are made quickly, by about 2030, the earth's average surface temperature will continue to rise and climate change will intensify, with widespread and irreversible consequences for humanity. The Paris Agreement, adopted in 2015 under the United Nations General Assembly (1992), commits to ensuring that all ratifying parties aim to keep the global average temperature below 2°C above pre-industrial levels. To date, 197 parties, including New Zealand and Australia, have ratified the convention. Achieving this goal looks increasingly unlikely, according to a report by the World Meteorological Association (2023), which warns that emissions reduction targets need to be seven times higher to be in line with Paris Agreement objectives.

Concern about climate change has grown rapidly this century. Between 2007 and 2020, academic literature on climate change and health increased 11-fold, while media reports increased about 75% (Romanello et al., 2021). Climate scientists increasingly agree that the internationally agreed temperature targets will not be met, and express alarm that governments are not responding (Carrington, 2024). In New Zealand, scholars predict the climate change impacts will be so wide-ranging as to transgress the borders of research disciplines, industry sectors and policy systems (Macinnis-Ng et al., 2023). Climate change is now widely regarded by the public as the greatest global threat (Poushter et al., 2022), with large-scale protests becoming more commonplace both among the general population (Fisher & Nasrin, 2021) and within the scientific community (Osborne, 2022). Students in New Zealand have taken to the streets to protest (New Zealand Herald, 2021) and the government declared a climate emergency (Ardern, 2020), publicly recognising the urgent need for action. Similar declarations have been made elsewhere around the globe (Cedamia, 2022) as

more public bodies, corporations and individuals call for climate change to be more urgently addressed.

The Psychological Impact of Climate Change

While the environmental and human physical health effects of climate change have been well documented, the mental health impacts have received relatively less research attention (Charlson et al., 2021; Cianconi et al., 2020; Hayes et al., 2018). Furthermore, political attention and policies that consider the relationship between climate change and mental health have been lacking (Lawrance et al., 2022). Nevertheless, there is a fast-growing evidence base to suggest that psychological impacts are emerging as a consequence of emotional, behavioural and physiological responses to climate change-related threats (Berry et al., 2010; Bourque & Willox, 2014; Doherty & Clayton, 2011). The Intergovernmental Panel on Climate Change (IPCC, 2023) recently concluded, with very high confidence, that climate change has adversely impacted the mental health of individuals in the evaluated regions. Likewise, the World Health Organization (2022) states that climate change is causing more intense and prolonged effects on individuals, which can affect their mental and psychosocial health. In response, professional psychology bodies worldwide, including the American Psychological Association (2022), British Psychological Society (2023), and the New Zealand Psychological Society Climate Psychology Task Force (2018), are increasingly focused on enhancing mental health practitioners' capacity to support distressed clients. They also aim to advance climate change research within psychological science and advocate to businesses and governments to mitigate the impact of the crisis on mental health.

Pathways to Psychological Impacts

The psychological impacts of climate change differ depending on the nature of an individual's exposure to it. Clayton (2021) provides a useful framework for understanding the

pathways through which climate change affects mental health, via discrete events, gradual changes, indirect effects, and effects associated with perceptions.

Discrete Events. It is difficult to conclusively determine that any single extreme weather event is caused by climate change. However, it is widely accepted that climate change *will* increase the frequency and intensity of extreme weather events, and these discrete events do directly impact mental health. A systematic review, which included pre- and post-test studies only, concluded that depression and post-traumatic stress disorder (PTSD) were the mental health disorders most likely to increase following a natural disaster (Beaglehole et al., 2019). These conditions were prevalent following hurricanes and flooding events (Boscarino et al., 2014; Fernandez et al., 2015) and also following fires. Rates of PTSD, psychological distress, and depression were high following Australia's Black Saturday bushfires of 2009 (Bryant et al., 2014), and persisted long after the event (Bryant et al., 2018). Even drought, with its less immediate impact, has been linked to increased suicide among Australian farmers (Edwards et al., 2015). Other negative psychological responses to direct exposure to a climate event include complicated grief, survivor guilt, vicarious trauma and recovery fatigue (Hayes et al., 2018). The psychological impact appears to be greater for those with the most concentrated exposure to the event, and for emergency responders, women, Indigenous or minority groups, and people with fewer resources (Clayton, 2021).

Gradual Changes. Changes occurring slowly over time, such as rising sea levels, warmer temperatures, altered rain patterns and reduced air quality, can also impact mental health. Clayton (2021) argues that, while less visible, such gradual changes ultimately impact a much larger proportion of the world's population. Most research attention has focused on the impact of warming, and suggests that hotter temperatures will increase the likelihood of aggression and violence, including homicides (Miles-Novelo & Anderson, 2019), although a recent meta-analysis found no support for this view (Lynott et al., 2023). Higher temperatures

are also associated with poorer cognitive function (Zivin et al., 2020), increased mental health-related hospitalisations (Chan et al., 2018), and higher suicide rates (Burke et al., 2018; Williams et al., 2015). For instance, Williams et al. (2015) found that "irregular" (random) day-to-day variation in temperature was associated with suicide rates. The number of possible third variables that could affect this component of temperature variation is very small, reducing the risk that the relationship is due to confounding variables. Another important study compared climate data with reported mental health difficulties collected from nearly two million randomly sampled Americans over a decade and found year-on-year warming increased the prevalence of mental health issues (Obradovich et al., 2018). Reasons for these effects are not clear, but these authors argue that uncomfortable temperatures increase stress and frustration and reduce opportunities for sleep and exercise. Gradual changes in air quality caused by the burning of fossils fuels have also been associated with depression, anxiety and suicide (Braithwaite et al., 2019) and schizophrenia (Attademo et al., 2017).

Indirect Impacts. Climate change can also impact mental health indirectly, via a range of challenging societal problems it provokes. For instance, food insecurity and economic volatility occur as crops fail and employment needs shift as a result of climate change (IPCC, 2023), ultimately increasing stress and the mental health burden. Poverty may increase due to disruptions to much-needed social support systems (e.g., Orengo-Aguayo et al., 2019). Climate change also increases involuntary migration as populations of "climate refugees" are forced to relocate from low-lying, uninhabitable islands and coastlines (Podesta, 2019). People who migrate involuntarily often experience significant discrimination, prejudice, acculturation stress and higher rates of mental health problems, particularly depression, anxiety and PTSD (Pumariega et al., 2005). A third indirect cause of psychological problems is increased conflict between groups and between countries (Hsiang

et al., 2011), which, like displacement, is linked to multiple stressors and poor mental health outcomes (Lawrance et al., 2021).

Perceptual Impacts. There is growing evidence that those who are not directly or indirectly impacted by climate change still have an overarching awareness and concern about the phenomenon that can impact their mental health (Doherty & Clayton, 2011; Fritze et al., 2008). While the impacts of climate change are becoming increasingly overt, most people still currently experience it as a more distant phenomenon. However, as knowledge and understanding of climate change deepens, and environmental degradation becomes further pronounced, more people are likely to view it as a menacing global environmental threat to civilisation that challenges social and emotional wellbeing (Fritze et al., 2008). Fritze et al. (2008) name distress and anxiety as common emotional reactions, but also describe being scared, sad, depressed, numb, helpless and hopeless, frustrated and angry, and even resigned and sceptical. In particular, learning about degradation and human suffering elsewhere on the planet could cause vicarious trauma (Doherty & Clayton, 2018). Furthermore, knowledge of the global scale and complexity of climate change, together with the social system that contributes to the problem, gives rise to distressing ethical dilemmas and social criticism of modern society (Cianconi et al., 2023). People working in the field of climate change, including academics, policymakers and activists, are particularly impacted at a distance (Climate Critical, 2023; Tollefson, 2021). Swedish climate activist Greta Thunberg is a high-profile example of an individual psychologically impacted by the ecological crisis, influenced not by any direct material climate-related impacts, but through her awareness of the issue (Thunberg et al., 2020). The recent proliferation of news articles and social media commentary on climate change ensures more people than ever are learning of the threat, and as a result may question lifestyle or purchasing decisions (Doherty & Clayton, 2011).

Accounts of overarching environmentally-related distress are prevalent. Anecdotal evidence from TikTok (Basch et al., 2022) and media reports (Barry, 2022; Dennett, 2022; Gomez, 2022; Taylor & Murray, 2020) suggest people are worried about the future of their planet, humanity and, in particular, future generations of their family, with some even considering not procreating due to the threat (Helm et al., 2021, Zimmermann et al., 2024). National surveys are beginning to detect the emotional toll of climate change on a large scale. For instance, an American Psychological Association (2020) poll found 55% of participants listed climate change as a somewhat or significant source of stress. Likewise, an online survey (Randle & Eckersley, 2015) reported that 54% of 4,000 adults in the United States, United Kingdom, Canada and Australia were concerned about climate change. Climate change concerns have also entered the psychotherapy room (Cianconi et al., 2020; Hayes et al., 2018; Lewis, 2018; Trost et al., 2024), and psychologists globally are considering their role in supporting those who experience significant impairment as a result of their climate-related distress (Anderson et al., 2024; Clayton, 2020; Patrick et al., 2021).

Summary. As climate change advances, the psychological impacts via all four pathways will likely grow (Clayton, 2021). It should be noted that while the impacts described here are largely negative, some psychological reactions will include positive experiences of empathy, compassion, altruism, hope, optimism, empowerment and post-traumatic growth (Weissbecker, 2011). In fact, some may even welcome the prospect of warmer weather (Pihkala, 2019). However, the net effects are unequivocally negative (Charlson et al., 2021). While direct and indirect experiences are important, and represent the front line of psychological response to climate change, many people still experience it via a more peripheral awareness of the phenomenon, as a threat or otherwise.

Types of Environmentally-Induced Distress

As a significant and far-reaching ecological and social calamity, climate change can evoke a variety of negative psychological responses (Cianconi et al., 2023; Cunsolo et al., 2020). As outlined above, direct exposure to a discrete climate event has been associated with DSM-described psychiatric disorders such as PTSD, generalised anxiety disorder (GAD) and major depressive disorder (MDD), and related outcomes including suicide, addiction and aggression (Chique et al., 2021). Emotional responses, most commonly being anxious, scared, sad, frustrated and angry, are also reported by people who are either directly or distantly impacted by climate change (Fritze et al., 2008). Several other eco-psychological responses, sometimes called psychoterratic or earth-related mental syndromes (Albrecht, 2011), have been defined more recently. These terms tend to be concerned with not just climate change but all environmental calamities, including biodiversity loss, air and chemical pollution, ocean acidification and ozone depletion. Certain concepts, such as solastalgia, ecological grief, and eco-anxiety, have been fairly well described (Albrecht, 2011), while others such as Anthropocene horror (Clark et al., 2020), eco-angst (Goleman, 2009), eco-anger and eco-depression (Stanley et al., 2021), and biospheric concern (Snelgar, 2006), are lesser known and still lack a clear definition. Moreover, several terms describe very similar psychological phenomena, and it is often not clear what relationship they have to established psychiatric disorders. Pihkala (2020) recently called for more discussion to better define and measure these concepts. Key terms used to describe types of environmentally-induced distress are now discussed.

Solastalgia. Solastalgia is defined as distress resulting from environmental changes to one's home environment (Albrecht et al., 2007). The term is derived from nostalgia, but instead of feeling melancholic about past homes and communities, solastalgia is distress experienced when a person is still directly connected to their home environment. Albrecht

(2007) first used the phrase to describe the psychological responses of Australian farmers who were troubled about major agriculture, power generation and open-cut mining developments.

Ecological Grief. Closely related to solastalgia is the concept of ecological grief, in which individuals grieve the loss of ecological features, species, natural habitats and experiences. Also known as eco-grief, the phenomenon is described as a relatively new form of human grief that embodies a feeling of loss, hopelessness, and despair regarding past and expected future environmental degradation (Cunsolo & Ellis, 2018). According to these authors, ecological grief is experienced as a deep emotional pain, and may particularly impact Indigenous peoples (Cunsolo et al., 2020), as well as environmental researchers, scientists, and activists (Conroy, 2019).

Eco-Paralysis. Eco-paralysis refers to the inability to meaningfully respond to climate and ecological challenges (Albrecht, 2011). It may arise from either the sudden emotional shock caused by the threat or from the dilemma of facing too many, and at times contradictory, choices for action (Davenport, 2017).

Eco-Guilt. Eco-guilt is guilt that arises when a person behaves in ways that are harmful to the environment (Mallett, 2012). It has been found that eco-guilt may motivate people to behave in more environmentally positive ways (Harth et al., 2013).

Habitual Ecological Worry. Habitual ecological worry relates to serious, repetitive worrying about the environment. The term was developed by Verplanken and Roy (2013) who argued that, like eco-guilt, such worrying could be constructive and adaptive and therefore healthy, as opposed to pathological worry. These scholars hoped their research would help prevent stigmatisation of people who cared about the environment, and thus worried about the future of the planet.

Eco-Anxiety and Climate Anxiety. Eco-anxiety and climate anxiety are among the more widely discussed eco-psychological responses to the environment. Eco-anxiety, according to the mostly widely cited definitions, is described as "the generalised sense that the ecological foundations of existence are in the process of collapse" (Albrecht, 2012, p. 250), and, alternatively, the "chronic fear of environmental doom" (Clayton et al., 2017, p. 68). These authors explain that the sense of escalating crisis and impending doom heightens feelings of risk, helplessness, guilt and general anxiety. Like the aforementioned constructs, eco-anxiety captures distress related to environmental destruction more broadly, also taking in other critical ecological problems such as pollution, deforestation, mining and urban sprawl (Hogg et al., 2021). The term climate anxiety is often used to more specifically describe anxiety caused by anthropogenic climate change, encompassing global warming, rising sea levels and increased frequency of natural disasters and extreme weather events (Clayton, 2020; Clayton & Karazsia, 2020; Pihkala, 2020). While these scholars consider climate anxiety a subset of eco-anxiety, other academics, and many members of the media and the public, use the two phrases interchangeably, to describe climate-related distress (Coffey et al., 2021). Given our[1] particular focus on anxiety related to climate change, in order to avoid confusion, we will use the term climate anxiety henceforth.

Climate Anxiety

Climate anxiety can be defined as an apprehension and stress about anticipated threats to ecosystems by climate change (Cunsolo et al., 2020). It has also been expressed as a "severe and debilitating worry related to a changing and uncertain natural environment" (Helm et al., 2018, p. 158), or alternatively, as "a chronic fear of environmental doom"

[1] The research conducted in this thesis is my own. However, as I consulted with, and received advice and direction from, my supervisors, I have chosen to use the words "we" and "our" throughout. I have also used these words occasionally to refer to what is known—or not known—in the wider scientific community.

(Clayton et al., 2017, p. 68). Furthermore, climate anxiety has been described variously as involving dread, distress, anxiety, difficult feelings, and intense negative emotions. Thus, like many eco-psychological responses, this construct lacks a single guiding definition. Nevertheless, climate anxiety is the preferred terminology for this thesis for several reasons.

Firstly, when compared with other eco-psychological responses, the term climate anxiety strikes a careful balance between capturing a broader range of symptoms than, say, eco-guilt or eco-paralysis, whilst being sufficiently narrow so as not to include *all* negative emotional reactions to environmental problems. Secondly, unlike eco-anxiety, the term climate anxiety allows us to filter out reactions to other environmental problems such as mass pollution and deforestation, which may prompt a broader and more amorphous range of responses (Hogg et al., 2021). Importantly, the term's narrower focus helps address a specific form of environmental degradation that is global, large-scale, irreversible, and undeniably threatening. Among all environmental challenges facing the planet, none is more pressing or potentially catastrophic than climate change. Climate anxiety is also part of everyday lexicon, widely used on social media and in traditional news formats (Clayton, 2020), and has been identified as a common Google search term (Cunsolo et al., 2020), indicating it is familiar, relatable terminology. The following section discusses the conceptualisation and measurement of climate anxiety, as well as its prevalence, demographics, and relationship to mental health and behaviour.

Conceptualising Climate Anxiety

While the term climate anxiety itself has the potential to facilitate clarity, as outlined above, researchers in this area have nevertheless defined it in numerous, often contradictory ways. This lack of conceptual clarity was highlighted in a recent scoping review of eco-anxiety, that included climate anxiety (Coffey et al., 2021). This review identified more than

20 distinct definitions of these terms in existing literature, suggesting there is little consensus between scholars. These authors also note that the terms eco-anxiety, climate anxiety, climate change distress, and environmental or ecological anxiety are often used interchangeably. In other cases, academics make careful distinctions, for example, delineating climate anxiety as a specific type of eco-anxiety focused on climate change (Hogg et al., 2021). Another conceptual issue is that some definitions treat climate anxiety as a catch-all term for negative psychological reactions to environmental threats (Coffey et al., 2021). Pihkala (2020) makes a similar observation in a literature review that found eco-anxiety has multiple dimensions and is routinely linked to feelings of grief, solastalgia, guilt, shame, despair, worry, fear, and, to a lesser extent, anger. These definitions are inconsistent with how anxiety is defined elsewhere in psychology, especially in clinical psychology where it is generally considered to be an unpleasant, uncontrollable state of apprehensive anticipation about future dangers with accompanying emotional, cognitive, behavioural, and physiological components (Barlow, 2004).

This lack of a clear consensus definition for climate anxiety is likely due to the relative infancy of the phenomenon, as well as the intrinsic multidisciplinary nature of the research on climate change, with an array of disciplines (e.g., environmental sciences, psychology, theology, philosophy) contributing to the field. Attempts by various disciplines (see Coffey et al., 2021; Martin et al., 2022; Pihkala, 2020) to try to make sense of climate anxiety, while valuable, have likely contributed to difficulties with conceptual clarity and heterogeneity in how the concept is defined. Unsurprisingly, these matters present a challenge for those trying to develop a theoretical base for climate anxiety that is distinct from other related concepts.

Scholars also differ in their opinions on how climate anxiety is experienced. For some, climate anxiety is described specifically as emotion-focused experience, the act of

feeling anxious (or worried or fearful) about climate change (e.g., Hickman et al., 2021; Sangervo et al., 2022; Stanley et al., 2021). Others suggest the experience might be more complex. Multi-dimensional operationalisations tend to involve several components, including feelings of anxiety about climate change, as well as behavioural symptoms (for instance, poor sleep, tension in muscles, constant alertness, crying), cognitive symptoms (negative thoughts), and sometimes functional and social-related impairment (for instance, affected performance in school/work, conflicts with others) (Ágoston, Urbán, et al., 2022; Clayton & Karazsia, 2020; Hogg et al., 2021). These dimensions map closely onto the elements of anxiety described in clinical psychology (Carr & McNulty, 2016), and therefore seem more likely to be capturing the complexity of the climate anxiety experience. They also closely resemble the GAD criteria in the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 2013), which includes similar emotional, cognitive and behavioural difficulties.

Despite many ambiguities and inconsistencies in the literature, there are some areas of consensus. Firstly, scholars tend to agree that climate anxiety experiences can fall along a continuum ranging from milder distress to more clinically significant responses (Clayton & Karazsia, 2020; Lutz et al., 2023; Pihkala, 2020), and this spectrum of milder to more severe symptoms maps on to what people describe in qualitative accounts (Ágoston, Csaba, et al., 2022; Berglund, 2019; Nairn, 2019). Therefore, climate anxiety might be more maladaptive for some people than others. This is a view also taken of the broader concept of anxiety (Lazarus, 1991). Furthermore, there is a general consensus among researchers that care should be taken not to pathologise climate anxiety, at least at the milder end of the spectrum, because doing so assumes the response is maladaptive, or disproportionate to the threat posed by the crisis (Clayton, 2020; Hickman et al., 2021).

Given the lack of clarity around the concept and how it is experienced, it is important we, as researchers studying this phenomenon, are clear about what climate anxiety means in the context of this thesis. Hence, we used a definition of climate anxiety as "anxiety associated with perceptions about climate change, even among people who have not personally experienced any direct impacts" (Clayton, 2020, p. 2). This definition purposely focuses on anxiety, with its multiple psychological and physical components and particular focal stimuli: in this case, climate change. We differentiated climate anxiety from worry and fear, which are related but phenomenologically distinct types of anxiety, and expressly excluded shame, guilt, grief and other emotions sometimes used in conjunction with the construct. Defining climate anxiety this way also narrows the context of the experience to climate change only, as opposed to environmental degradation more generally, and explicitly includes the experiences of people more peripherally impacted by the crisis, as many of our Australasian participants were likely to be. However, given the wide variety of terminology and interpretations of the concept in the literature, and limited availability of climate anxiety-focused papers, it was difficult to uphold one strict definition throughout this review. Instead, it includes papers using a broad range of closely-related terms, noting the discrepancies and limitations throughout.

Measuring Climate Anxiety

Climate anxiety also lacks well-established and well-validated measurement tools. Over the past 30 years, several psychometric tools have been developed to measure climate change distress, which include anxiety along with other emotions (Helm et al., 2018; Hepp et al., 2023; Kelly, 2017; Reser et al., 2012; Searle & Gow, 2010; Stanley et al., 2021). These scales tend to focus mostly on the negative emotions (e.g., anxiety, worry) that arise when thinking about climate change, ignoring other potentially important cognitive and behavioural characteristics of climate anxiety. More recently, scales have been developed that focus

explicitly on eco-anxiety, as it is broadly defined, capturing two (Ágoston, Urbán, et al., 2022) and four dimensions (Hogg et al., 2021) of the construct.

At the time of writing this review, the only instrument specifically designed to measure climate anxiety was the Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020), a tool comprising 13 statements, which assesses impairments across two dimensions[2]. The first dimension is cognitive and emotional impairments in response to climate change, which includes items on thinking too much, crying, or having nightmares about climate change. The second dimension is functional impairments, such as the impact on the ability to socialise, work or concentrate at work or school. Most items were adapted from either the ruminative responses scale (Treynor & Gonzalez, 2003), to assess the extent to which people were thinking about climate change, or the Weiss functional impairment rating scale (Weiss, 2000), to assess whether these experiences were interfering with people's ability to function. The CCAS asks participants how often they have experienced particular symptoms. All items are measured on a 5-point frequency response scale with options of options of *never* (1), *rarely* (2), *sometimes* (3), *often* (4), and *almost always* (5). The initial CCAS scale validation study also included items relating to behavioural engagement with climate change. The authors did not intend these items to contribute to the measure, but instead wanted to see whether behavioural engagement was associated with climate anxiety, which they found it not to be.

The CCAS has been the subject of several validation studies, with mixed results. Many validations generally conclude that the scale is psychometrically sound (Heeren, Mouguiama-Daouda, & McNally, 2022; Mouguiama-Daouda et al., 2022; Simon et al., 2022). However, other scholars found the two-factor structure could not be satisfactorily

[2] An additional scale, the Hogg Climate Anxiety Scale (Hogg et al., 2024), was introduced just prior to thesis submission.

replicated (Wullenkord et al., 2021) and did not meet preregistered criteria for good fit (Feather & Williams, 2022). Some have posited that the CCAS may capture various impairments arising from the climate crisis, rather than the emotional experience of climate anxiety (Lutz et al., 2023; Wullenkord et al., 2021). In particular, Wullenkord et al. (2021) question why the measure does not assess a range of anxiety-related feelings, such as worry, fear, and anxiety, or capture difficult feelings of uncertainty, unpredictability, and uncontrollability typical in anxiety presentations. These scholars, like others (Feather & Williams, 2022) also query whether items drawn from the rumination scale were suitable inclusions in the CCAS given rumination tends to be a feature of depression, not anxiety.

Scholars also comment that the CCAS has notably low mean scores, considerably below the midpoint, which suggests the measure might capture more severe form of distress than scales measuring similar constructs and thus may have difficulty in detecting more mild climate anxiety experiences (Lutz et al., 2023; Wullenkord et al., 2021). On the other hand, by focusing on more severe expressions of climate anxiety, the CCAS is arguably assessing the part of the continuum that many researchers, and especially clinicians, are most concerned with, although the measure is not designed to be a clinical assessment (Clayton & Karazsia, 2020). Finally, the scale's two factors may not contribute equally to the construct, as suggested by a recent network analysis that showed the cognitive-emotional component yielded the highest expected influence and node predictability values, and may be the hallmark characteristic of climate anxiety (Heeren, Mouguiama-Daouda, & McNally, 2022). Regardless, the CCAS is currently the most established measure of climate anxiety, and it is more widely validated than measures of similar constructs such as eco-anxiety. While concerns have been raised about the scale's factor structure, it makes a convincing attempt to capture the various cognitive, emotional and behavioural elements of climate anxiety. Therefore, it was the psychometric scale of choice for this thesis.

Climate Anxiety Prevalence

A plethora of national and international surveys show 50 per cent or more of some populations are at least somewhat concerned or worried about climate change (e.g., Firebaugh et al., 2021; Hao & Song, 2020; Hickman et al., 2021). A New Zealand study found 37% were either very or extremely worried about climate change, and a further 38% were fairly worried (Ministry for the Environment, 2018), while data from Australia shows the crisis was perceived as *very much* a problem by 66% of a 5,500-person sample (Patrick et al., 2021). However, surveys specifically measuring climate anxiety with the CCAS, with its focus on impairment, suggest the number of people experiencing a reasonably substantial level of climate anxiety symptoms is considerably lower. In most of the validation studies (e.g., Clayton & Karazsia, 2020; Wullenkord et al., 2021) mean score responses across participants and items were below 2 (experienced *rarely*). In an Australasian validation (Feather & Williams, 2022), just 6% of participants scored above the midpoint (3, or *sometimes*) for CCAS scores.

Despite generally low mean scores, there is some evidence that climate anxiety is experienced more intensely by a significant proportion of some populations. Clayton and Karazsia (2020) note that about a fifth of respondents (17-19%) scored over the midpoint on cognitive impairment, and more than a quarter (26-27%) above the midpoint on functional impairment, meaning this substantial group experienced impairments more than s*ometimes*. Slightly lower but nonetheless significant midpoint rates of 11% and 21% for each factor respectively were reported by Heeren, Mouguiama-Daouda and Contreras (2022) in their survey of 2,080 African and European participants. While there is not yet any clear agreement on what frequency of CCAS symptoms might constitute a mild climate anxiety experience compared with a more severe one, or where the cut-off between the two might sit,

findings in both studies do suggest anxiety about climate change is starting to significantly impact mental health.

Climate Anxiety Demographics

Certain populations appear to be more vulnerable to experiencing climate anxiety than others, although the research is somewhat mixed. The many surveys measuring broader concepts, such as concern or distress related to climate change, generally report higher rates among people who are younger (e.g., Ágoston et al., 2024; Baker et al., 2021; Hickman et al., 2021) female (Searle & Gow, 2010), and Indigenous (Middleton et al., 2020). However, the data from studies using the CCAS is more ambiguous. For instance, increased impairment in younger people was identified in most CCAS studies (Clayton & Karazsia, 2020; Heeren, Mouguiama-Daouda, & Contreras, 2022; Larionow et al., 2022; Whitmarsh et al., 2022) although not all (Wullenkord et al., 2021). Younger people may be more impacted because they have less control over their own behaviour (Ojala, 2012), and will live to experience more drastic personal and societal consequences of climate change (Magidson, 2020; Milburn, 2019). Alternatively, these findings may just reflect higher rates of anxiety experienced by younger people more generally (Eisenberg et al., 2007).

Regarding gender, several CCAS studies observed higher rates of climate anxiety among women (Heeren, Mouguiama-Daouda, & Contreras, 2022; Larionow et al., 2022; Wullenkord et al., 2021), which could reflect women's perceived relative lack of power when facing a threat (World Health Organization, 2014), or relatively higher rates of general anxiety (Scott et al., 2018). Other CCAS studies found no gender differences (Clayton & Karazsia, 2020; Whitmarsh et al., 2022). CCAS studies generally found no differences in climate anxiety on the basis of education or income (e.g., Whitmarsh et al., 2022; Wullenkord et al., 2021). Rates of climate anxiety among Indigenous cultures have not been well explored; however, it seems likely these communities are (or will be) particularly impacted.

Indigenous communities are often more vulnerable to the effects of climate change, because many live in low-lying coastal, mountainous or arctic areas that are more impacted by the crisis (Vecchio et al., 2022). Furthermore, Indigenous cultures often emphasise greater interdependence with, and respect for, the natural world, and are thus more emotionally and spiritually impacted by the threat of degradation (Middleton et al., 2020; Tassell-Matamua et al., 2020).

Is Climate Anxiety Adaptive?

With growing interest in the prevalence and demographics of climate anxiety comes increased focus on whether this phenomenon might serve a useful purpose. More specifically, is climate anxiety a predominantly maladaptive condition similar to generalised anxiety disorder — that is, something always better avoided — or could it perhaps perform a helpful function in relation to climate change? The qualitative literature often depicts climate anxiety as an upsetting and overwhelming experience that can impact daily functioning and inhibit individuals from engaging in meaningful behaviour (Berglund, 2019; Gooch, 2005; Nairn, 2019). Furthermore, multiple studies have found climate anxiety is negatively correlated with wellbeing (for a meta-analysis, see Gago et al. (2024)) and highly negatively correlated with symptoms of psychiatric disorders such as GAD (Clayton & Karazsia, 2020; Feather & Williams, 2022; Innocenti et al., 2021; Wullenkord et al., 2021), and, to a lesser extent, depression (e.g., Innocenti et al., 2021; Wullenkord et al., 2021). Indeed, some clinicians advocate for climate anxiety to be included in the DSM, at least as a V-code (Charlson & Crandon, 2023; Rajalakshmi, 2022), and there is some public interest in recognising it as a mental disorder (Vukičević & Liu, 2024).

As outlined previously, climate anxiety does seem to share the features of accepted anxiety disorders, including subjective distress, sleep disturbance, somatic disturbance, negative affect and hopelessness (Clayton & Karazsia, 2020), and may even involve similar

changes in the brain (Carlson et al., 2024). It seems feasible that, like anxiety, climate anxiety might also lead to negative passive reactions such as avoidance behaviour (Maner & Schmidt, 2006) and an inability to meaningfully respond, known as paralysis (McEvoy & Mahoney, 2012). As Clayton and Karazsia (2020)'s initial validation found, there may be a portion of the population – those experiencing the CCAS impairments more than *sometimes* – for whom climate anxiety impairs cognitive processes, impacts emotions and makes it difficult to function. This more severe and debilitating level of climate anxiety could warrant clinical attention (Clayton & Karazsia, 2020; Hickman et al., 2021; Hogg et al., 2021; Pihkala, 2020). Framed thus, climate anxiety could be viewed as a potentially maladaptive, pathological-type condition that could pose a threat to mental health.

Equally, it can also be argued that, despite potential psychological impacts, climate anxiety can be viewed as a rational, even helpful, response to a very real and frightening global crisis (Clayton, 2020; Hickman et al., 2021; Pihkala, 2020). Of critical interest, there is growing body of scholarship to suggest that climate anxiety may have an adaptive function, motivating people to act in ways that may help to avoid anticipated environmentally disastrous outcomes (Verplanken & Roy, 2013). This is not dissimilar to general anxiety, which has future-oriented apprehension that can lead to appropriate, adaptive preparations for forthcoming performances (Yerkes & Dodson, 1908) or precautions against possible threats (Barlow, 2004). It might be that lower levels of climate anxiety are enough to prompt individuals to make positive behavioural changes that alleviate environmental impacts, perhaps without causing much distress or paralysis (Clayton & Karazsia, 2020). Framed thus, climate anxiety can be viewed as a primarily normal reaction to a significant problem, with the potential to act as a motivator. However, the reality is probably more complex, encompassing a spectrum of responses where climate anxiety might cause paralysis for some,

serve as a catalyst for action for others, or elicit a combination of both reactions, influenced by individual differences and societal factors.

Climate Anxiety and Pro-Environmental Behaviour

With the increased focus on climate anxiety comes a growing debate over whether the negative psychological response could be useful for mitigating climate change impacts. A key target here has been pro-environmental behaviour, with literature suggesting that anxious feelings about the climate crisis might be encouraging people to make environmentally-informed decisions around how they live (Doherty & Clayton, 2011). Furthermore, these behaviours are widely promoted by scholars and health and environmental commentators as a means of alleviating climate anxiety (Kennedy-Woodard & Kennedy-Williams, 2022; Lewis, 2018; O'Brien & Elders, 2021). With the likelihood of reaching emissions targets dependent, at least in part, on wide-spread uptake of high-impact, pro-environmental behaviours (IPCC, 2022b), the relationship between these two variables can be deemed critical. Moreover, this relationship has important implications for clinical psychologists looking to effectively and meaningfully support people with climate anxiety. Before the relationship between these variables can be explored, we must first turn to the concept of pro-environmental behaviour, including how it is defined and measured, and its relationship with climate change.

Defining Pro-Environmental Behaviour

The term pro-environmental behaviour has been used widely in psychology since the 1960s to describe "behaviour that harms the environment as little as possible, or even benefits the environment" (Steg & Vlek, 2009, p. 309). This class of behaviour has been examined under a plethora of different names, including environmentally responsible behaviour, prosocial behaviour and behavioural engagement, and in various disciplines and subdisciplines within the behavioural sciences including organisational psychology (Norton et al., 2015), environmental education (Kollmuss & Agyeman, 2002), behaviour analysis

(Lehman & Geller, 2004), environmental psychology and consumer research. Pro-environmental behaviours take many forms across various domains such as water usage, transportation, electricity consumption, food choices, material use, waste management, and different types of activism. These behaviours include actions that benefit the natural environment (e.g., recycling) as well as those that avoid harming it (e.g., choosing not to take flights).

Scholars in the field tend to differentiate between private-sphere behaviours such as recycling and green consumerism, and behaviours in the public sphere that are carried out more collectively, like protesting and petitioning on environmental issues (Larson et al., 2015; Stern, 2000). Pro-environmental behaviours also differ from one another in several distinct ways: how easy they are to perform, what motivates a person to do them, and the impact they have on the environment (that is, global vs local, small-scale vs large, immediate vs delayed, and short and long-term) (Larson et al., 2015). Descriptions of pro-environmental behaviour often assume acts are carried out intentionally in order to minimise one's negative impact on the natural world (Balundė et al., 2019). However, with our definition stated in the first sentence of this subsection (Steg & Vlek, 2009), we are explicitly including behaviours that can be considered to be pro-environmental regardless of the intentions of the actor.

Pro-Environmental Behaviour and Climate Change

Pro-environmental behaviour is a crucial component of mitigating climate change. Human behaviour is commonly accepted as a major contributor to climate change (Wynes & Nicholas, 2017), and changing that behaviour will reduce climate change impacts and support long-term climate targets (Dietz et al., 2009). Critically, the IPCC (2022a) has warned that the goal of reaching net zero emissions relies not just on technological advancement, and policy and investment changes, but in major changes to the way individuals consume and interact with goods and services. The agency indicates that changes in behaviour by

governments, industry — and also individuals — could reduce CO_2 emissions by 40% to 70% by 2050, compared with current policies.

Global North[3] countries such as Australia and New Zealand are the largest generators of greenhouse gas emissions per capita, with our highest-earning households among the biggest polluting culprits (Chancel, 2022). While it is commonly accepted that unprecedented changes to individual lifestyles and household consumption levels are needed to limit global warming to 1.5°C or lower (IPCC, 2021), and people express a willingness to behave pro-environmentally (Andre et al., 2024), humans generally do not do as much as they can to reduce their climate impact (Hall et al., 2018; Steg et al., 2015). Australians and New Zealanders specifically tend to be quite environmentally active (Wolf et al., 2022); however, the total consumption of citizens in both nations is too high to reach emissions targets (Wackernagel & Beyers, 2019; WWF, 2022). The Global Footprint Network (2022) calculates an Earth Overshoot Day, a date when humanity's demand for ecological resources in a given year exceeds what Earth can regenerate in that year. This day currently falls in late July, but if all humanity consumed like Australians or New Zealanders, this date would fall in mid-March and mid-April 2022 respectively.

Somewhat surprisingly, the literature on pro-environmental behaviour focuses predominantly on behaviours that benefit the environment broadly, rather than those most helpful for mitigating climate change. Scholarship that *is* focused on climate change shows some particular pro-environmental behaviours deliver larger mitigation benefits. Specifically, taking fewer international flights, reducing vehicle use, and having fewer children have been found to have the most significant impact on emissions levels (Ivanova et al., 2020; Wynes &

[3] Global North is a term used to describe wealthy, industrialised nations, and generally includes United States, Canada, England, most nations of the European Union, as well as Singapore, Japan, South Korea, Australia and New Zealand (Castree et al., 2013).

Nicholas, 2017). Also helpful is reduced meat consumption, reduced waste and reduced standby power consumption, each found to have a moderate impact on climate change (Grießhammer et al., 2010; Hedenus et al., 2014; Ivanova et al., 2020; Wynes & Nicholas, 2017). Many of these higher-impact pro-environmental behaviours consist of avoiding actions which are particularly commonplace among high-income individuals in countries like New Zealand and Australia.

Some scholars suggest that focusing societal efforts on public-sphere pro-environmentalism, such as funding and volunteering for climate projects, rather than on private-sphere behaviours, might be more effective for significantly mitigating carbon emissions (Ockwell et al., 2009; Roser-Renouf et al., 2014). In fact, it has been argued that collective activism that results in significant socio-political and government policy change trumps individually-focused efforts, which may inadvertently undermine support for the substantive climate policies needed (Adams, 2021; Mann, 2021). Additionally, another challenge for private sphere behaviours is the general public's limited knowledge of which behaviours most effectively offset greenhouse gas emissions (Cologna et al., 2022). This research found people tend to either under- or over-estimate the potential of certain actions to reduce climate change impacts.

Measuring Pro-Environmental Behaviour

Accurately measuring pro-environmental behaviour is key to identifying factors that both promote and hinder these behaviours, thereby contributing to efforts to mitigate climate change. However, as with climate anxiety, the psychometric landscape is murky and unfocused. While this behaviour can be measured via field and laboratory observations, most researchers prefer the relative ease, efficiency and low cost of self-report measures. A recent review (Lange & Dewitte, 2019) found more than 20 established multi-item self-report scales for general pro-environmental behaviour, half of which employed a multidimensional

conceptualisation. Most of these emphasise private-sphere behaviours, although several also include public-sphere behaviours like policy support and activism. A further 13 scales focus on a specific domain of this behaviour, such as car purchasing or recycling. Despite widespread availability of established and validated pre-existing psychometric tools, Lange and Dewitte (2019) note that most researchers opt unnecessarily to create their own ad hoc single-use measures. Furthermore, many measures focus on pro-environmental intentions, not behaviour (e.g., Hornsey & Fielding, 2016; Sundblad et al., 2014), despite evidence of a sizeable gap between intentions and behaviours (Hassan et al., 2016). For that reason, we were primarily interested in impact-oriented scales that focus on behaviours. Such scales may capture behaviours that are not intentionally pro-environmental, driven instead by financial or circumstantial motivators; nevertheless, these still fit within our broader definition of pro-environmental behaviour as outlined earlier.

Few measures of pro-environmental behaviour are particularly interested in behaviours deemed important for mitigating climate change. Instead most tools (e.g., Casey & Scott, 2006; Larson et al., 2015; Schultz et al., 2005) focus on behaviours like recycling, littering, wildlife and nature protection and protesting and activism which, while no doubt benefiting the environment, have a less overt impact on global emissions reduction (Cologna et al., 2022; Girod et al., 2013). Even research focused on climate change mitigation often includes predominantly low impact pro-environmental behaviour items with negligible impact on climate outcomes. For example, Simon et al. (2022) primarily emphasize recycling in their study. Other climate change-related research did not consider specific behaviours at all, instead asking people whether they acted pro-environmentally (Wullenkord et al., 2021).

The Pro-Environmental Behaviour Scale (PEBS; Markle, 2013) is one of the few psychometric tools to explicitly consider environmental impact when selecting individual behaviour items. The 19-item scale is based on evidence that consumer transportation, food,

and household operations are responsible for the majority of air and water pollution, global warming and habitat alteration (Brower & Leon, 1999). Hence, Markle (2013) deliberately sought to include moderate- and high-impact behaviours, such as eating less meat and using alternative transport options. Several environmental citizenship behaviours were also added on the basis that, although they only influence the environment indirectly, they can influence public policy and change the behaviours of many, including governments and large corporations (Stern, 2000). The original validation study confirmed the scale had good convergent and discriminant validity, as well as good factorial validity across the four dimensions of conservation, environmental citizenship, food, and transportation (Markle, 2013). Unlike the CCAS, the PEBS has not been validated elsewhere, although one Italian study found a slightly adapted version confirmed the four-factor structure, and found psychometrics properties, including criterion, convergent and divergent validity, were good or better (Menardo et al., 2020).

The Relationship Between Climate Anxiety and Pro-Environmental Behaviour

Beyond their ability to be defined and measured, albeit problematically, climate anxiety and pro-environmental behaviour share other features. Both can occur as responses to climate change, both are arguably rational and understandable, and both are likely to become more prominently discussed in the climate change literature and mainstream media as anthropomorphic degradation progresses and the crisis deepens. The notion that these phenomena impact one another, especially in a way that improves the state of the planet, is an alluring one, as is the idea that performing such good deeds can improve one's mental health. But what evidence is there to support these assumptions? This review will now turn to the crux of this thesis: Are these two constructs correlated and, if so, does one affect the other? The following section will explore in some depth whether these ideas are well supported by the empirical and theoretical evidence. First, we examine whether these concepts may be

correlated, and in what way, before moving to research that that explores possible causal relationships. A range of theoretical explanations for these causal relationships will also be discussed.

Climate Anxiety and Pro-Environmental Behaviour: Correlational Research

The exploration of the relationship between climate anxiety and pro-environmental behaviour necessarily starts with correlational research, where most of the scholarly literature has been focused. This section will first briefly review correlational studies that found a positive correlation followed by those with negative correlations, before canvassing some of the key issues involved in interpreting these papers. It should be noted that this review includes studies with very specific applications of these variables (for instance, those operationalising climate anxiety using the CCAS, and pro-environmentalism with Markle's PEBS), as well as other studies using more broadly related constructs (e.g., climate-related distress and pro-environmental intentions, rather than behaviour). Including a broad range of studies maximises the breadth of discussion, although it should be noted that the findings on the relationship between these phenomena will be influenced by the specific psychometric tools employed to measure them. This review is also largely limited to studies in adult populations, as this is the target population for the current research, and focuses, where possible, on research from Australasia, and other countries in the Global North with similar climate-related exposure and pro-environmental opportunities.

Overall, most correlational studies show climate anxiety and pro-environmental behaviour are positively related to a moderate degree (associations generally ranging from .3 to .5). This is particularly true of studies using the CCAS and a measure of pro-environmentalism (Heeren, Mouguiama-Daouda, & Contreras, 2022; Heeren, Mouguiama-Daouda, & McNally, 2022; Innocenti et al., 2021; Simon et al., 2022; Wullenkord et al., 2021). The largest of these (Heeren, Mouguiama-Daouda, & Contreras, 2022) investigated

the relationship between CCAS and five pro-environmental behaviour items in a sample of 2,080 adults from eight African and European countries, reporting a medium correlation (r = .41, $p < .001$). Another study involving 1553 Canadians tested the relationship between the CCAS and the six behavioural engagement items originally included in the CCAS (Lukacs et al., 2023). Their regression analysis found that every unit increase in CCAS was associated with a 0.31 unit increase in behavioural engagement (B = 0.31, 95% CI: 0.25 to 0.36, $p < 0.001$), when controlling for psychological distress, political orientation, and several other demographic variables. It should be noted that original CCAS validation (Clayton & Karazsia, 2020) was one of the few CCAS studies that did *not* find the constructs were positively correlated. The validation, which included behavioural engagement items asking about recycling and energy use, found, surprisingly, that the phenomena were uncorrelated (r = -.01 with each of the CCAS subscales).

Interestingly, some studies using the CCAS (Heeren, Mouguiama-Daouda, & McNally, 2022; Simon et al., 2022) investigated how pro-environmentalism related to each of the two CCAS subscales and found the behaviour was positively correlated relatively equally to both cognitive emotional impairment and functional impairment. However, another found cognitive-emotional impairment was a much stronger predictor of pro-environmental behaviour than functional impairment (Tam et al., 2023). One CCAS study (Whitmarsh et al., 2022) investigated the relationship between climate anxiety and specific pro-environmental behaviours and found a select few (for example, buying second-hand items, and encouraging others to save energy) positively correlated to climate anxiety, while others were not significantly correlated (eating red meat) or were negatively correlated (recycling). Another CCAS study found climate anxiety was positively correlated with collective pro-environmental actions, but not individual actions (Schwartz et al., 2022).

Positive associations with pro-environmental behaviour were also found in several other studies using variables broadly similar to climate anxiety, including climate change distress (Reser et al., 2012), eco-anxiety (Jain & Jain, 2022; Sjöstrand & Hansen, 2020), and a range of negative emotions including anxiety and fear (Hepp et al., 2023; Hornsey et al., 2016; Ogunbode et al., 2022; Stanley et al., 2021; Van Zomeren et al., 2008). For instance, Hepp et al. (2023) measured climate change distress and impairment separately on 5-point Likert scales with 22 items related to anxiety, anger and sadness, to see whether they predicted pro-environmental behaviour, measured by responses to a social dilemma scenario in 500 European participants. No other predictors were included in the model. Results showed higher levels of both climate change distress (B = 0.394, 95% CI [0.300; 0.481]) and impairment (B = 0.277, 95% CI [0.180; 0.370]) were significantly associated with an increased likelihood of pro-environmental behaviour.

A larger study investigated the link in a sample of almost 11,000 university students in 28 countries, including Australia but not New Zealand (Ogunbode et al., 2022). Negative climate-related emotions were measured with a 7-item scale based on the state anxiety component of the State-Trait Anxiety Inventory (Spielberger, 1983), which asked participants how calm, tense, relaxed, anxious, peaceful, worried or terrified they felt about climate change. Pro-environmental behaviour was measured with an 8-item index of sustainable consumption behaviours, including saving energy at home, using public transportation, and avoiding food waste. Results showed negative climate-related emotions had a small but significant positive relationship with pro-environmental behaviour (B = .12, 95% CI [.08 - .16], p <.001), when controlling for climate-related media exposure, extreme weather experiences, perceived social norms, age and gender. The addition of random slopes to the model showed this relationship varied significantly across countries, and was only significant

in 13 countries, including Australia, and other predominantly wealthy, democratic European countries.

Finally, multiple studies found a moderate-to-strong positive association between pro-environmental behaviour and worry about climate change (Bouman et al., 2020; Ojala, 2008; Sundblad et al., 2014; Verplanken et al., 2020; Verplanken & Roy, 2013; Wullenkord & Ojala, 2023). Worry and climate anxiety are conceptually related, with worry widely considered a key facet of climate anxiety (Ojala et al., 2021; Verplanken et al., 2020), and of generalised anxiety disorder, to which climate anxiety is closely related (Clayton & Karazsia, 2020). The two concepts differ in that climate worry represents one cognitive facet of climate anxiety, while the latter includes a broader range of cognitive, emotional and physical symptoms. Furthermore, anxiety is often conceptualised as trait-like, and worry as state-like (Borkovec et al., 1998). Nevertheless, the concepts are similar enough to warrant inclusion here, in the absence of more climate anxiety-specific empirical research. A positive relationship was also found between worry and concepts close to pro-environmental behaviours, specifically support for abstract climate policies (Smith & Leiserowitz, 2014) and for general public action (van der Linden et al., 2015).

Fewer studies suggest that climate anxiety and pro-environmental behaviours might be negatively related. Generally, a negative relationship has tended to only emerge after running regressions or structural equation modelling in which other variables were controlled (Coelho et al., 2017; Helm et al., 2019; Stanley et al., 2021; Stevenson & Peterson, 2015). Some support for a negative relationship between climate anxiety and pro-environmental behaviours can be drawn from research into positive emotions, positive affect and wellbeing. Literature shows these phenomena — which stand in contrast to the generally negative experience of climate anxiety — are positively correlated with pro-environmental behaviours (Bissing-Olson et al., 2013; Kasser, 2017; Meneses, 2010; Zawadzki et al., 2020). While this

research potentially supports the argument for a negative correlation between our two key variables, it is also likely that both positive and negative psychological experiences are linked to pro-environmentalism (Kleres & Wettergren, 2017; Nairn, 2019). Thus, overall, it seems most plausible these two constructs are positively correlated at the zero-order level.

There are several issues with interpretation of this correlational research, including the fact that many (e.g., Hornsey et al., 2016; Sundblad et al., 2014; Wullenkord et al., 2021) measured pro-environmental intentions, not behaviour, leaving some uncertainty about whether actual behaviours were performed. Furthermore, some of the climate anxiety-like concepts included here arguably differ so much from one another they cannot readily be compared. Ad hoc, unvalidated tools were often applied, and very few studies (Ogunbode et al., 2022; Patrick et al., 2022) included Australasian data. Finally, while their cross-sectional design helps establish association, it precludes confident causal inferences.

Climate Anxiety and Pro-Environmental Behaviour: Causal Research

With a relationship between these variables established, we turn now to determining what effect these variables might have on one another. Despite the positive correlation, the effects could be either positive, negative or zero. This is because it is possible that third variable effects might have produced positive correlations between these two phenomena, even if their causal effects on one another are mixed or negative. The remainder of this review focuses on research and theoretical arguments associated with the following five possible causal relationships. In the general population, climate anxiety either 1) increases 2) decreases or 3) has a non-linear effect on pro-environmental behaviour, and conversely, pro-environmental behaviour either 4) decreases or 5) increases climate anxiety. We do not investigate non-linear effects of pro-environmental behaviour on climate anxiety as we have no theoretical reason to expect a relationship here. Experiments would provide the strongest

evidence for these five relationships; however, due to inherent practical and ethical difficulties with randomly assigning participants to experience climate anxiety to test its effect on pro-environmental behaviour, and vice-versa, no such experiments with our particular variables exist. Instead, we look to experiments and longitudinal research involving related concepts, such as pro-environmental intentions, as well as studies employing quasi-experimental designs, which make some attempt to establish cause and effect. These include case-control studies and one-group pre-test–post-test design studies. Qualitative studies are also included, when themes arising from interviews can contribute to understanding causal relationships. As with the correlational research, this review of causal research prioritises the inclusion of studies carried out among adults in the general population, in Australasia or other nations in the Global North, and those specifically measuring climate change-mitigating behaviours and climate anxiety. Several studies focus on climate activists, a group of notable interest given they are more likely to experience climate anxiety and behave pro-environmentally; however, their experiences may not be generalisable to the broader adult population. Furthermore, given the paucity of available research in this area, this section often draws on studies more tangentially connected to the topic, in order to consider causal connections.

Does Climate Anxiety Increase Pro-Environmental Behaviour?

Most of the scholarly debate on causality on this topic tends to frame climate anxiety as an agent of positive change, a motivator that encourages people to engage in pro-environmental behaviour that will contribute to climate change mitigation (Bingley et al., 2021; Budziszewska & Jonsson, 2021; Cunsolo et al., 2020). Certainly, a positive effect of climate anxiety on pro-environmental behaviours is consistent with the aforementioned correlational studies showing a positive association, although this association may have other explanations, including the effects of potential third variables.

There is some empirical evidence of a positive causal effect of climate anxiety on pro-environmental behaviour. The most convincing evidence can be drawn from a longitudinal study involving 167 French adults who were questioned about eco-anxiety, measured with the Hogg Eco-Anxiety Scale, and pro-environmental behaviour, measured with the PEBS, on two occasions one month apart (Pavani et al., 2023). The study, published after the present study was completed, found that eco-anxiety at time 1 significantly and positively predicted pro-environmental behaviour at time 2 over and above pro-environmental behaviours at time 1 ($B = 0.15$, $p < 0.01$), particularly among individuals who scored low on pro-environmental behaviour at the first wave. This study, possibly the first longitudinal study pertaining to the effect of eco-anxiety on pro-environmental behaviour, has several limitations, namely the relatively small sample, limited waves and its focus primarily on between-individual differences. The authors themselves note that their two-wave design mainly captures between-individual effects, thus limiting the ability to discern within-person changes over time. As such, their findings might not fully account for the dynamic, situational variations in how eco-anxiety influences pro-environmental behaviour at an individual level.

Other evidence is found in experimental research exploring fear appeals: the notion that inducing fear-type emotions in a person can lead them to behave pro-environmentally. Several studies (Gao et al., 2021; Hine & Gifford, 1991; van Zomeren et al., 2010) randomly assigned participants into fear-induced and non-fear-induced groups using photographs and editorial text, and found pro-environmental intentions were significantly higher in the fear-induced groups. For instance, in their consumer marketing study, Gao et al. (2021) randomly assigned 300 Chinese economics undergraduates to be shown images of environmental degradation that were either deemed to be low- or high-anxiety provoking. They then read a text about a tree-planting event that required them to purchase their own sapling, and completed a 3-item intentions scale tailored to the example. The researchers found the pro-

environmental intentions of the high-anxiety images group (M_{PEBI} = 4.26, SD = 0.61) were significantly higher than the participants in the low anxiety group, (M_{PEBI} = 3.63, SD = 0.90). Thus, the researchers concluded that climate anxiety can effectively stimulate a consumer's pro-environmental intentions. A similar study by Hine and Gifford (1991) found the anxiety-exposed group donated ten times more money than those in the control group in a real-life scenario. These results suggest anxiety about the environment might lead to action; however, it should be noted that these papers assume the induced anxiety in experiments has similar impacts on behaviour to longer-term chronic anxiety, despite there being little support for this notion. Furthermore, they do not specifically focus on climate change, or, with the exception of Hine and Gifford (1991), on actual behaviour change.

There is a dearth of other quantitative research supporting causal claims, perhaps due to the relatively recent development of the climate anxiety concept and the expense of multiple-wave research. There are some qualitative studies that lend some support to the perspective of climate anxiety as a motivator. Ágoston, Csaba, et al. (2022) analysed data from semi-structured interviews with 17 Hungarian activists, students and teachers to better understand to what extent eco-anxiety facilitates eco-friendly behaviour. Participants reported that while climate anxiety initially made it difficult to function, many successfully mobilised various coping strategies to alleviate anxiety, including the uptake of pro-environmental behaviours. Similarly, in qualitative work from New Zealand (Nairn, 2019), emotions were recognised as significant catalysts, spurring people to take action (e.g., reducing emissions by cycling and buying less red meat) and to join climate activism groups at their high school and in their community. Likewise, Kleres and Wettergren (2017) analysed emotional themes in interviews with 41 predominantly European environmental activists who largely reported their perception that fear encouraged and motivated their climate action by raising awareness of the threat of climate catastrophe. It was often accompanied by hope, which they believed

helped stop fear from becoming immobilising. These qualitative studies capture nuance and human complexity, but self-reported accounts of behavioural and emotional pathways are not always accurate, and offer no evidence of a causal relationship. What they do tell us is that people believe this relationship exists. It is possible these findings reflect a human tendency to attribute behaviours to moods (Schwarz & Clore, 1983); in this case, participants' folk theory that their anxious feelings were what motivated them to engage pro-environmentally. The experiences of climate activists, with their deep connection to the environment and intense involvement in pro-environmentalism, may also differ to those of non-activists.

Theoretical arguments to explain how climate anxiety might drive up pro-environmental behaviour are diverse. One idea is that climate anxiety creates not distress but eustress, a type of good stress that produces a positive response (Selye, 1976). Framed thus, climate anxiety can be viewed as a positive, practical anxiety that supports information-seeking and problem-solving to cope with and help avoid perceived future threats (Kurth, 2018). This view aligns with basic anxiety theory, which describes anxiety as part of an ancient defence system (Gray, 1990), as well as with Barlow (2004)'s argument that anxiety is often necessary in order to get anything accomplished. Basic research on worry, a key component of anxiety, also offers convincing explanations for climate anxiety's constructive, motivational ability (Sweeny & Dooley, 2017). These authors suggest worry signals that something is wrong and therefore motivates people to deal with the problem. Worry also helps keep the situation front of mind to ensure some sort of action is taken. Lastly, worry is unpleasant and thus people are motivated to address the cause to help alleviate the unpleasantness. Looking to other arguments, it has been suggested climate anxiety might encourage action by increasing a person's sense of perceived personal responsibility (Bouman et al., 2020; Kleres & Wettergren, 2017), levels of self-efficacy (Higginbotham et al., 2014; Maran & Begotti, 2021), or via the process of psychological adaptation (Bradley &

Reser, 2017). These ideas lend support to the perspective that experiencing climate anxiety may lead to increases in pro-environmental behaviour.

Another possible argument for climate anxiety as a driver of pro-environmental behaviour can be drawn from cognitive dissonance theory (Festinger, 1957). We suggest that individuals could experience a cognitive discrepancy between their beliefs about climate change and what they are doing to help mitigate it. If a person believed climate change was real and dangerous but also felt they were not doing enough to address it, this inconsistency could create a feeling of dissonance or uncomfortable psychological tension which, in in our reading of the theory, presents as climate anxiety. It has been established that climate change beliefs influence pro-environmental actions (Stern et al., 1999), and these usually positively correlate (e.g. Kwon et al., 2019; Reichl et al., 2021). As such, it seems feasible that a discrepancy between belief and action could create a feeling that things do not make sense, that you are not in control and cannot predict what will happen, all of these being challenging experiences that could create a form of anxiety. This anxiety then motivates the person to reduce the dissonance. Framed thus, climate anxiety might act as a driver to resolve the mismatch between climate change beliefs and pro-environmental behaviour.

The idea that climate anxiety encourages environmental action is indeed appealing: this emotional experience, while difficult and unpleasant, might serve a practical purpose in bringing about the positive behavioural change urgently required to address climate change. Some scholars even warn against efforts by mental health specialists to treat or reduce climate anxiety, saying such an approach leads to individualisation, medicalisation and pathologising of a psychological state that is understandable and serves a critical function (Cunsolo et al., 2020; van Valkengoed & Steg, 2023). A related argument states that experiencing climate anxiety might be a sign of integrity (Head et al., 2016), and such people with climate anxiety have an important role as signallers to the rest of humanity that the

situation has reached a critical level and needs urgent action (Budziszewska & Jonsson, 2021). Certainly, it is this motivational quality of climate anxiety that Greta Thunberg was speaking to when she told the World Economic Forum "I want you to panic. I want you to feel the fear I feel every day. And then I want you to act" (Thunberg, 2019, para. 14). Despite the appeal of this idea that climate anxiety increases pro-environmental behaviour, and a range of theoretical ideas to support it, there is, as yet, no strong empirical evidence to support it.

Does Climate Anxiety Decrease Pro-Environmental Behaviour?

The suggestion that climate anxiety might have a negative effect on pro-environmental behaviour is somewhat less supported. Certainly, some fear appeal research does indicate that anxious feelings might inhibit people from taking adaptive steps (Howell, 2014; Lorenzoni et al., 2007; Moser & Dilling, 2004; O'Neill & Nicholson-Cole, 2009). In their mixed methods study, O'Neill and Nicholson-Cole (2009) showed climate change imagery, such as melting ice, flooding, and graphs depicting temperatures rising to British participants. Results analysed with Q-methodology showed that the images that elicited greater fear responses were also those most likely to leave participants feeling scared, helpless, overwhelmed and unwilling to engage in behaviours that mitigate climate change. Instead, these authors recommend the use of non-threatening imagery and icons that link to individuals' everyday emotions and concerns about climate change to successfully engage people in pro-environmental behaviour. Interviews with New Zealand activists also lend some support to the idea that climate anxiety reduces pro-climate behaviours (Nairn, 2019). Specifically, activists describe anxiety leading to overwhelming feelings of hopelessness and despair that prompted retreat from pro-environmental projects, at least for a time. However, it is unclear whether the climate activists' experience of these variables and how they causally relate mirrors that of the wider population. Furthermore, as with all qualitative work, it is

difficult to draw credible conclusions about the causal directions at play. So, while some evidence exists for this relationship, none is particularly compelling.

The quantitative work in this area is also not particularly convincing. Geiger et al. (2021) examined the extent to which anxiety predicts intentions to engage in public-sphere climate action in almost 5,000 American zoo visitors. These respondents were asked how they felt about engaging in various public-sphere pro-environmental behaviours, with results showing that the level of anxiety they experienced when contemplating taking action had virtually no relationship to behavioural intentions. This cross-sectional correlational study makes no attempt to rule out confounding variables, and hence does not provide good evidence of causal effects, but it is worthy of mention given its framing of anxiety as an experience arising from thinking about doing climate-relevant pro-environmental behaviours, as this may very well be one of the ways climate anxiety arises. While not evidence that climate anxiety *decreases* pro-environmental behaviours per se, these findings do suggest climate anxiety might *not increase* these behaviours.

Scholars exploring the inhibiting effects of climate anxiety often cite eco-paralysis, (Albrecht, 2011), in which fear, helplessness and sadness regarding the scale of ecological damage can leave people unable to take any meaningful action. This paralysis might be brought on by the shock of the threat, or the dilemma of what to do in response to it (Davenport, 2017). Others suggest it might be that small, individual actions appear insignificant when compared with the scale of the problem (Hayes et al., 2018; Ray, 2020). The threat to all life and planetary health might be perceived as too great to face, so a person simply does nothing. Indeed, social cognitive theories of behaviour change hypothesise that anxiety can reduce self-efficacy and hence decrease the chance of effective behaviour change (Bandura, 1988). It is also possible that the tendency to catastrophise, a cognitive distortion common in anxiety, might be interfering with adaptive responses to anxiety (McDonald et al.,

2015). These authors suggest that thinking forward to the worst possible outcome can, in the context of climate change, be so frightening that it leads to denial and avoidance, thus reducing pro-environmental behaviour. Furthermore, adoption of these behaviours requires physical, social and psychological resources, which people high in negative emotions often do not have (Coelho et al., 2017). These scholars also argue that pursuing pro-environmentalism involves short-term costs and long-term gains for the individual, when people high in negative emotion tend to choose actions that offer immediate benefits.

Finally, terror management theory (Greenberg et al., 1997) may also contribute some understanding as to why climate anxiety could reduce pro-environmental behaviour. This theory suggests that climate change and its life-threatening impacts remind humans of their inevitable death. This awareness can result in paralyzing anxiety (i.e., terror), which is buffered by performing behaviours that conform to a person's cultural norms and values. In the context of climate change, that could mean making more materialistic rather than pro-environmental consumption choices, as research has shown (Akil et al., 2018). These various ideas can explain why a climate-distressed individual might not engage in pro-climate actions.

Is There a Non-Linear Effect of Climate Anxiety on Pro-Environmental Behaviour?

Another possibility is that the true effect of climate anxiety on pro-environmental behaviour takes an inverted-u shape, as some have speculated (e.g., Wullenkord et al., 2021). That is, while moderate levels of anxiety may be conducive to pro-environmental behaviour (Clayton, 2020), too little could reduce motivation to engage (Dodds, 2021), while too much could lead to paralysis, disengagement and denial (Albrecht, 2011). A dose-dependent response could also be explained by optimal arousal theory (Yerkes & Dodson, 1908), which suggests an optimal level of anxiety or stress for maximal performance. Excessive anxiety might result in avoidance or inactivity, potentially intensifying feelings of climate-related

distress through emotions like guilt or shame. This sweet spot, where climate anxiety is sufficiently high but not overwhelming, referred to as the Goldilocks zone, represents an ideal state for motivating action (Heeren & Asmundson, 2023).

While these ideas are plausible, there is little empirical research testing the non-linearity in these relationships. One cross-sectional study (Heeren, Mouguiama-Daouda, & Contreras, 2022) investigated non-linearity among French-speaking participants from eight African and European countries. They found that the CCAS mean score correlated significantly more strongly ($z = 3.96$, $p < 0.001$) with pro-environmental behaviours in people scoring below the CCAS midpoint ($r = 0.40$, $p < 0.001$) than those scoring above ($r = 0.15$, $p = 0.02$). These findings suggest diminishing returns at high levels of climate anxiety, although the relationship was monotonic. Similarly, Hogg et al. (2024) found significant linear relationships between eco-anxiety and pro-environmental behaviour. While there was no strong evidence of a downturn at high levels of eco-anxiety, they observed a point of diminishing returns where high levels of eco-anxiety only contributed to small incremental gains. Another study by Latkin et al. (2022) graphically analysed the association between climate change distress and climate change actions. They found the relationship was largely linear but for a drop-off at the extreme right-hand tail of the climate change distress distribution, suggesting that severe levels of distress may be associated with lower levels of pro-environmentalism. While these studies suggest elements of non-linearity, this relationship requires further exploration, particularly with regards to causality. Furthermore, as with the previously discussed linear causal pathways, there is no comprehensive theory of the relationship between climate anxiety and pro-environmental behaviour that accounts for this non-linearity.

Does Pro-Environmental Behaviour Decrease Climate Anxiety?

Up to this point, the discussion has framed climate anxiety as impacting a person's engagement in pro-environmental behaviour. There is a separate and distinct area of scholarship focused on whether behaving pro-environmentally can impact an individual's level of climate anxiety. Most research in this area is devoted to the idea that pro-environmental behaviours reduce climate anxiety, thereby acting as an effective treatment. For instance, the assumption that pro-environmentalism reduces climate anxiety is prominent in academic literature (e.g., Baker et al., 2021; Cunsolo et al., 2020; Lewis, 2018; Sampaio & Sequeira, 2022). The action-as-treatment approach is one of the most widely advocated strategies for alleviating negative psychological symptoms of climate anxiety, as evidenced by recent reviews (Baudon & Jachens, 2021; Dailianis, 2021), and current community and online therapeutic programmes run by groups like Climate Psychology Alliance (https://www.climatepsychologyalliance.org) and the Good Grief Network (https://www.goodgriefnetwork.org). In New Zealand, too, pro-environmental behaviours are often promoted as a therapy for climate anxiety both within academia (O'Brien & Elders, 2021) and to the public (Anxiety New Zealand, 2024; Healthify, 2024). This approach is also advocated in the media (Busby, 2019; Taylor & Murray, 2020) and in several recent self-help books focused on climate anxiety (Grose, 2020; Kennedy-Woodard & Kennedy-Williams, 2022; Ray, 2020; Salamon & Gage, 2020; Verlie, 2021).

The popularity of the 'action as treatment' approach is unsurprising. It is an endearing notion that behaving in a way that is better for the environment is also better for you. Despite this widespread endorsement, there is little empirical evidence this behaviour does reduce climate anxiety. Studies interested in the influence of behaviour on psychological state tend to be based on reporting outcomes from community conservation programmes. A Cochrane review by Husk et al. (2016) assessed the mental health impacts of participating in

environmental enhancement and conservation activities. Of the five quantitative studies included, two suggested improvements to mental health. The first, a small longitudinal study (O'Brien et al., 2010), found mean scores on a scale of emotional state (ranging from 1 – 85) increased by 4.8 after a 3-week woodland volunteering exercise, although it is possible that this improvement was driven simply by social interaction or being in nature (Cox et al., 2017). The second, a non-intervention retrospective cohort study (Pillemer et al., 2010) found a reduction over time in the likelihood of being depressed amongst participants who self-described as environmental volunteers compared to other volunteers when controlling at baseline for age, gender, education and marital status. However, the difference between the groups all but disappeared when also controlling for social isolation and chronic conditions. Neither study applied true experimental designs, or measured climate anxiety as an outcome, and they were not interested in private pro-environmental behaviours, thus limiting their relevance here. Their findings were also somewhat undermined by two other quantitative papers included in the review, both one-group pre-test–post-test design studies (Barton, 2009; Wilson, 2009), which found no significant improvement to mental health after environmental volunteering.

Some support for the notion that behaviour might decrease climate anxiety can also be drawn from a large body of qualitative literature, usually via interviews with climate activists who believe environmental engagement improved their mental health (Ágoston, Csaba, et al., 2022; Berglund, 2019; Patrick et al., 2021). This is best summed up by an activist who describes their pro-environmentalism as "a form of anxiety management" (Berglund, 2019, p. 33), and another who states: "My climate anxiety has lessened by being active, and it is also why I am active." (p. 34). Other papers similarly suggest pro-environmentalism relieved climate anxiety among non-activists (Büchs et al., 2015; Budziszewska & Jonsson, 2021; Verlie, 2021). While these studies show people believe these behaviours can reduce anxiety,

they do not provide convincing evidence of a causal relationship as there is no objective way of knowing whether participants' climate anxiety actually reduced, or (if so) whether pro-environmental behaviour was the cause. It is possible these studies are capturing participants' folk beliefs that these behaviours reduce anxiety, thus demonstrating not causality, but rather attribution of improved mood to the action that preceded it (Schwarz & Clore, 1983). Most of these studies also focus on public sphere rather than private sphere behaviours or high-impact behaviours, do not measure climate anxiety per se, and tend to concentrate on climate-sensitive populations, making it more difficult to draw conclusions.

Interestingly, despite the many papers promoting the benefits of pro-environmentalism for alleviating mental distress, few offer proposed mechanisms for such a relationship. Instead, it is presented as self-explanatory that engaging in these types of behaviours will help. Scholars who do offer evidence often point to social prescribing, a process whereby anxiety symptoms might be relieved through work to reduce the underlying threat (Cunsolo et al., 2020). This argument is somewhat limited by the fact that, on a person-by-person basis, individual pro-environmental behaviours do virtually nothing to reduce the threat of climate change (Hickel, 2020). More plausibly, it can also be argued that pro-environmental behaviours might decrease climate anxiety because they are intrinsically meaningful (Venhoeven et al., 2016, 2020). These authors argue that the meaningfulness of a behaviour reflects the extent to which that behaviour is perceived by someone as important, significant, and the morally right thing to do. Acting sustainably, in particular, is often perceived as a morally good choice and thus as a meaningful course of action (Venhoeven et al., 2020). Consequently, performing meaningful behaviours makes people feel good about themselves, which enhances their subjective wellbeing (Binder & Blankenberg, 2017; Taufik et al., 2016; Venhoeven et al., 2020). Alternatively, it is possible that engaging in these

behaviours provides education and new knowledge about climate change mitigation possibilities (Khatibi et al., 2021), which could, if hopeful, feasibly reduce anxiety.

Problematically, many of the theories considered here are not drawn from climate anxiety literature, and are more interested in how the behaviours make you feel good, as opposed to how they might improve your anxious state. Nevertheless, they go some way towards explaining why pro-environmentalism might help mitigate symptoms of climate anxiety.

Does Pro-Environmental Behaviour Increase Climate Anxiety?

Finally, the notion that pro-environmental behaviour increases climate anxiety has perhaps the least empirical support. The suggestion is that active involvement in pro-environmentalism, whether it be re-planting programmes, or changing your lifestyle to make greener choices, could leave you feeling more overwhelmed and anxious about the state of the world. There are no quantitative studies that produce any causal evidence for this effect. Qualitatively, two older Australian studies (Christie, 2004; Gooch, 2005) report some distress-type symptoms from carrying out environmental projects, and feelings of futility and pointlessness with regard to pro-environmental tasks given the poor state of the environment. However, it is unclear if that is an impact of the behaviour or the state of the environment. Similarly, interviews with young New Zealand climate activists (Nairn, 2019) found that while hope and aspiration for change motivated people to join environmental groups, many volunteers inevitably suffered burnout, experienced as hopelessness and despair. As with other qualitative studies discussed, these works offer little firm evidence of a causal relationship between these variables.

Theoretical arguments for this effect are scarce, and are not specifically related to climate anxiety. Research into the relationship between pro-environmental behaviour and wellbeing suggests that these behaviours are often viewed by society as difficult,

uncomfortable, inconvenient and threatening to quality of life (Venhoeven et al., 2013). For instance, riding your bike rather than your car to work avoids emissions, but is physically more difficult and takes longer. However, whether these difficulties, and the loss of wellbeing associated with them, would increase climate anxiety is less clear. A better argument comes from Ojala (2013) who describes how problem-focused coping, of which pro-environmental behaviour is an outcome, often involves ruminating on climate change and ways to address it, which can understandably cause distress. Additionally, this process often involves a form of psychological adaptation, as described by Bradley and Reser (2017), where attention to and immersion in the realities and implications of climate change can predict increased pro-environmental behaviour but also relate to heightened concern and distress. This adaptation can be confronting and uncomfortable, particularly if individuals feel their actions are insignificant or futile.

Finally, research following natural disasters has found that problem-focused 'active coping' is not effective at reducing stress or anxiety when one's individual actions cannot actually alleviate the problem (Bistricky et al., 2019; Glass et al., 2009). In the case of climate change, it is feasible that individuals might not feel their pro-environmental actions are making a difference, and this perceived lack of progress could lead to increased anxiety (Kovan & Dirkx, 2003). Engaging in pro-environmental behaviours could also provide education about climate change mitigation, and this knowledge, if hopeless, could increase anxiety (Randall, 2015). In these scenarios, it is not the behaviour itself, but the feedback from engaging in it, that increases anxiety.

3. The Current Study

Rationale for the Current Study

Existing research suggests climate anxiety and pro-environmental behaviour are related, but there are few studies with causal identification strategies that allow us to determine which causal effects are responsible for this relationship. The cross-sectional research that dominates this field indicates a moderate-to-strong positive correlation between these variables. However, as these studies measure variables just once and simultaneously, it is impossible to ascertain how they impact one another. The few longitudinal studies that do exist in the field generally focus on public-sphere sustainability programmes, not personal pro-environmental behaviours, do not specifically focus on climate anxiety, and lack suitable data analysis methods to enable credible causal inferences to be made. Furthermore, results are mixed. Of the quantitative research conducted, surveys and experiments varied widely in the way they assessed climate anxiety and related phenomena, and pro-environmental behaviour, with many using unvalidated or ad hoc measurement tools.

Two studies emerge as notable exceptions, each offering key insights into the temporal interactions between climate anxiety and pro-environmental behaviour. The first, a French study by Pavani et al. (2023) previously discussed in the Literature Review, found that eco-anxiety significantly and positively predicted pro-environmental behaviour over time when measured at two time points one month apart. The second, a recent pre-registered study by Contreras et al. (2024), investigated the daily temporal relationship between climate anxiety, using an ad hoc single-item measure, and pro-environmental behaviour over 60 days, finding no significant reciprocal effects. Like the Pavani study, the Contreras research was published after our data collection was completed, and thus did not influence the planning of our study. Despite some very strong methodological characteristics, the study has limitations,

including a relatively small sample size of 102 and single item measures of the variables. While these studies provide some of the strongest causal evidence to date, substantial uncertainties about this relationship remain.

This study is interested in the interplay between these variables in Australia and New Zealand specifically. In terms of climate impacts felt by these countries, each will be affected differently. Australia, with its vast desert interiors and highly variable climate, will be prone to more frequent and intense cyclones, bushfires, droughts and possibly dangerous wet-bulb temperature events (Beggs et al., 2021). Furthermore, as these scholars elucidate, Australia faces the social challenge of being situated nearer the climate refugee frontline, and therefore will need to manage increased legal and illegal migration. New Zealand is more buffered by its remote location and oceanic climate than Australia; however, it will likely be more affected by ocean-related impacts such as sea level rise, increased rain and air moisture and glacial melt (Bodeker et al., 2022; Macinnis-Ng et al., 2023). In terms of contributions to the climate crisis, both countries are among the world's biggest per capita polluters. A comparative analysis (Our World in Data, 2021) put Australia's greenhouse gas emission at 23.24 tonnes per capita in 2021, and New Zealand's at 13.42, both higher than almost all European countries (e.g., Spain on 5.99) and far beyond emissions by African nations (e.g., Rwanda on 0.76).

Against this backdrop of per capita emissions above the global average, increasing vulnerability to challenging climatic changes and events, and exposure to climate changes in other parts of the world, mental health and behaviour will be impacted. Specifically, climate anxiety will likely increase as the crisis deepens, as will the urgency for our populations to adopt the pro-environmental behaviour needed to counter rising greenhouse gases (IPCC, 2022a), so this is an important and relevant research topic for Australasia. However, to date, there has been little scholarship from this region focused on the relationship between these

variables (But see Hogg et al., 2021; Nairn, 2019; O'Brien & Elders, 2021; Sciberras & Fernando, 2022; Stanley et al., 2021).

Research Question and Hypotheses

This thesis asks: Do climate anxiety and pro-environmental behaviour affect one another? This question is addressed in a methodologically robust and resource-intensive way, using a longitudinal design. Two hypotheses were proposed.

Hypothesis 1

Existing research indicates that people experiencing climate anxiety may increase engagement in pro-environmental behaviour (Ágoston, Csaba, et al., 2022; Gao et al., 2021; Pavani et al., 2023; van Zomeren et al., 2010). Correlational research showing a moderate positive association between these variables (e.g., Innocenti et al., 2021; Wullenkord et al., 2021) may also support this effect. Therefore, we hypothesised that:

H1: When controlling for pro-environmental behaviour at time t-1, higher levels of climate anxiety at time t-1 will be associated with higher levels of pro-environmental behaviour at time t.

While this thesis is applied in focus and is not intended as a test of any one individual theory, H1 is consistent with several relevant theories: in particular, that climate anxiety increases pro-environmental behaviour by acting as a motivator (Barlow, 2004), by supporting information-seeking and problem solving (Kurth, 2018), by increasing one's sense of personal responsibility (Bouman et al., 2020), or by reducing cognitive dissonance (Festinger, 1957).

Hypothesis 2

Some existing research indicates that people who engage in pro-environmental behaviour may experience a reduction in climate anxiety (Berglund, 2019; O'Brien et al., 2010; Verlie, 2021). Therefore, we hypothesised that:

H2: When controlling for climate anxiety at time t-1, higher levels of pro-environmental behaviour at time t-1 will be associated with lower levels of climate anxiety at time t.

As noted above, this work was not designed to test any one causal theory; however, H2 is consistent with several relevant theories. In particular, it suggests that pro-environmental behaviour can decrease climate anxiety by enhancing an individual's sense of meaning and purpose (Venhoeven et al., 2016, 2020), or by providing education and new knowledge about climate change mitigation possibilities (Khatibi et al., 2021). Furthermore, the popularity of the 'action as treatment' approach and self-help recommendations (e.g., Cunsolo et al., 2020; Kennedy-Woodard & Kennedy-Williams, 2022) that implicitly assume the veracity of this hypothesis make it important to test.

4. Method

Design

This study used a longitudinal survey design in which the same cohort of participants was invited to complete surveys measuring climate anxiety and pro-environmental behaviour on five occasions over four months. Given the focus of the present study on causal effects, perhaps the best design would be experimental, whereby participants are randomised to exposure to climate anxiety-inducing experiences or to a control condition, and opportunities to undertake pro-environmental behaviours, with pre- and post-exposure measures to capture the influence of each variable on the other. However, such an experiment would pose substantial challenges, particularly the ethical concerns of deliberately inducing anxiety in participants, and the self-selection bias likely through the informed consent process (American Psychological Association, 2002). Furthermore, on a practical level, it would be difficult to induce climate anxiety in a standardised way across participants, accurately measure pro-environmental behaviour in response to the exposure, and maintain a control group free from contamination or unintentional exposure in a real world setting (Cook et al., 2002). Hence, an observational longitudinal study was deemed a suitable alternative. While it cannot establish causality as definitively (Caruana et al., 2015), this approach allowed us to explore the cause-and-effect relationships between climate anxiety and pro-environmental behaviour as they varied over time.

Procedure

Recruitment Procedure

Participants were recruited from Prolific, a worldwide behavioural research recruitment website where participants are financially compensated for their time (Palan & Schitter, 2018). This site, accessible through both desktop and mobile devices, gathers high-

quality data and achieves high retention rates in longitudinal studies (Kothe & Ling, 2019; Peer et al., 2022). The opening and closing dates for each survey are listed in Table 1. For the first data collection wave, starting 3 November 2022, Prolific workers from Australia or New Zealand were able to view an information sheet advertising the survey and informing readers of the length, themes and renumeration involved (see Appendix A: Survey Materials). People who wished to participate clicked the survey link, taking them directly to a question asking for their consent. Those who clicked "yes" could begin the survey. Participants then responded to several demographic questions and items relating to potential climate anxiety correlates before completing two psychometric scales operationalising climate anxiety and pro-environmental behaviour. See the Measures subsection for more information about the survey.

Table 1

Dates of Survey Waves

Wave	Survey open date	Survey close date	*n* after exclusions	Percent of wave 1 sample ($N = 700$)
1	3 November 2022	10 November 2022	700	100
2	3 December 2022	10 December 2022	606	87
3	3 January 2023	10 January 2023	604	86
4	3 February 2023	10 February 2023	600	86
5	3 March 2023	10 March 2023	548	78

Wave 1. The first wave of the survey was advertised on Prolific to recruit 750 participants, with interested people directed to the survey hosted on Qualtrics. A brief information sheet provided details about the study, including that there would be 44 questions in total, it would take approximately five minutes and respondents would be paid a small

reward of GBP 0.75 (NZD 1.50) to compensate for their time. In the final section of the survey, all participants were asked if they would like to receive a summary of findings. Those who selected "yes" to this question were sent a study summary (see Appendix B: Summary of Findings for Participants) via the website's messaging service once this thesis was submitted. Wave 1 data collection ran for 7 days, as stipulated in preregistration, and was manually stopped on 10 November 2022.

Waves 2–5. After completion of the first wave, exclusion criteria (detailed below) were applied to identify which participants would be invited back for subsequent surveys. These 743 participants were added to a custom allow list using Prolific IDs as identification. These surveys did not include demographic or potential climate anxiety correlate items and, as such, were shorter, containing 34 questions, taking approximately three minutes to complete. Participants were paid for GBP 0.60 (NZD 1.15) for the survey at wave 2, 4 and 5. Renumeration was increased to GBP 0.70 (NZD 1.40) for wave 3 only, to encourage more participants to respond. As with wave 1, these surveys were manually stopped after 7 days. On day 4 of each wave, reminder messages were sent to all eligible Prolific participants who had not yet responded to that survey. Data collection concluded on 10 March 2023.

Inclusion Criteria

Eligible participants were adults (18+) currently living in New Zealand or Australia. A Prolific pre-screening criterion required participants to have completed at least 20 prior studies on the platform, indicating they had a reasonably substantial level of engagement, and thus might plausibly keep returning to the website for longitudinal study waves. Participants were also required to have an approval rate on prior Prolific submissions of 95%. Prolific operationalises the approval rate as the upper limit of the 95% confidence interval based on a participant's prior submissions. Finally, pre-screening also ensured that only participants residing in New Zealand and Australia were considered for the study. To our knowledge

there is no New Zealand-specific recruitment platform that could deliver a sample of the size needed, for the number of waves needed, within the budgetary constraints of the research. Thus, the decision was made to include both Australians and New Zealanders, which provided a sufficiently large sampling frame when using the selected recruitment platform. The experiences of climate anxiety and pro-environmental behaviours, as well as the experiences of climate change itself, were deemed similar enough across the two countries to reasonably pool the results. The chosen sample also brought some much-needed focus to Australasian experiences of climate change in an area dominated by data drawn from North America and Europe. The broad age range aligned with Prolific's requirements to only allow adults 18+ to participate.

Exclusion Criteria

Exclusions at Wave 1. Participants who met any of the following criteria were excluded entirely from the study:

1. Answered "no" to the consent item. Branches were put in place to prevent further participation if a respondent failed to provide the required responses to this question.
2. Indicated they reside in a country other than New Zealand or Australia. As above, branches were used to prevent participation from those who selected "other" for this item. This criterion was added to check that Prolific pre-screening conditions were met.
3. Did not provide a correct response to the attention check item. See Measures subsection for more information about attention checks.
4. Had a study duration (recorded by Qualtrics) of less than 88 seconds (total number of items multiplied by two) in wave 1. It was deemed unlikely that participants

completing a survey faster than this could have been fully reading the items (Huang et al., 2012).

5. Responses where the participant did not reach the end point of a given survey (as recorded by Qualtrics), or they exceeded the maximum time allowed to complete the survey (recorded as "timed out" by Prolific).
6. Returned their submission on Prolific, indicating they revoked consent.
7. Responses that were identified as preview, test or duplicate responses by Qualtrics.
8. While not excluded at wave 1 per se, participants who reached the end of the wave 1 survey, but did not reach the endpoint of a survey at any other wave, were retrospectively excluded from the study.

Exclusions at any Subsequent Wave. Participants who met any of the below criteria at waves 2–5 were excluded from that individual wave, but were still invited back to subsequent waves.

1. Did not provide a correct response to the attention check.
2. Had a study duration in seconds of less than the total number of items (32) multiplied by two.
3. Returned their submission on Prolific, indicating they revoked consent.
4. Had a submission that was identified as preview, test or a duplicate by Qualtrics. For duplicate submissions, the most recent submission was retained.
5. Had a submission where the participant did not reach the end point of a given survey (as recorded by Qualtrics).

Participants

Sample Size Determination

Sample size is best determined using power calculations for your chosen data analysis method. However, the method employed in this study, a multiple indicator random intercept cross-lagged panel model (RI-CLPM; see Data Analysis), is complex and, to our knowledge, no closed-form formulae for estimating power for this model have been developed in the statistical literature. As a result, we instead determined our sample size (in terms of the number of participants and waves) based on recent power analyses using the simpler single-indicator RI-CLPM, which showed that larger samples and more observations are needed for more stable attributes (Williams et al., 2024). Of course, multiple indicator RI-CLPMs may have somewhat different power characteristics to a single-indicator RI-CLPM, but this power analysis provides some heuristic evidence in favour of a sample of this size.

Our variables, climate anxiety and pro-environmental behaviour, have been shown to vary little over time (Markle, 2013; Whitmarsh et al., 2022). For the sake of being conservative, we assumed these variables had relatively little intra-individual variance and assumed a high intraclass correlation coefficient (ICC) of 0.9, where there is a lot of variance between people rather than within people. Williams et al. (2024) determined that assuming an ICC of 0.9, five waves and 700 participants were needed to achieve 80% power to detect a small to moderate cross-lagged effect (Standardised B = .2). This also assumes a small correlation between the random intercepts and within-person residuals at each time point (r = 0.2), and large autoregressive effects (0.7). The target sample was increased to 750 to help protect against attrition (see the Data Analysis subsection for more information on missing data).

Attrition Across Surveys

The number of respondents completing surveys at each wave gradually declined over the course of the study (see Table 1 above and Table 2 below). However, this attrition was relatively modest, with 78% of eligible participants from wave 1 still participating at the final data collection point (wave 5).

Table 2

Summary of Attrition

Number of waves responded to	*n* of participants	Percent of wave 1 sample (N = 700)
2 or more	700	100
3 or more	646	92.3
4 or more	572	81.7
5	440	62.5

Note. The frequencies in this table differ from those in Table 1 due to some participants missing a wave but then returning for a later wave. Participants who *only* completed wave 1 (n = 43) were excluded from the study and, hence, are not listed here.

Demographic Characteristics of Final Sample

After the exclusion process, 700 participants remained, which was the target number implied by the power analysis. Participant demographic information is summarised in Table 3. Participants' ages ranged from 18 to 85 years, with a mean age of 36.3 (SD = 12.7). The most common age group was 28 to 34, which accounted for 34.7% of participants. Overall, 73.9% of participants resided at the time in Australia, while the remaining 26.1% resided in New Zealand. Regarding ethnicity, the majority of the Australian sample (69.4%) identified

as European. Aboriginal or Torres Strait Islander people made up just 0.6% of the Australian sample. Of the New Zealand sample, 62.7% identified as European or Pākehā. NZ Māori made up 6.0%. About a quarter of both country samples identified as Asian. Most respondents lived in a suburban location (65%). Females were over-represented, with 57.3% of participants being female compared to 41.1% male and 1.6% who named an alternative gender identification. Among remaining demographic data, the majority of the sample had a university undergraduate degree or higher (67%), were employed fulltime (51.4%), and were married or in a defacto relationship (56.3%). Income was relatively evenly split across all income bands.

Table 3

Demographic Characteristics of the Final Sample (N= 700)

Variables	Category	*n*	%
Country			
	Australia	517	73.9
	New Zealand	183	26.1
Ethnicity – Australia[a]			
	European/White	372	69.4
	Asian (incl South Asian)	135	25.2
	Aboriginal or Torres Strait Islander	3	0.6
	Other	26	4.9
Ethnicity – New Zealand[a]			
	European or Pākehā	126	62.7
	NZ Māori	12	6.0
	Asian (incl South Asian)	47	23.4
	Pacific peoples	5	2.5
	Other	11	5.5
Location			
	Urban	190	27.1
	Suburban	455	65.0
	Rural or remote	55	7.9
Gender			
	Male	288	41.1
	Female	401	57.3
	Other gender identified	11	1.6

Variables	Category	*n*	%
Age			
	18–24	124	17.7
	25–34	243	34.7
	35–44	163	23.3
	45–54	101	14.4
	55–64	46	6.6
	65–74	19	2.7
	75+	4	0.6
Education Level			
	Doctoral degree	37	5.3
	Postgraduate degree	135	19.3
	Undergraduate degree	297	42.4
	Other tertiary qualification	112	16.0
	Completed high school	107	15.3
	Some high school	12	1.7
	No high school	0	0
Employment			
	Working full-time	360	51.4
	Working part-time	152	21.7
	Unemployed and looking for work	35	5.0
	Homemaker/stay-at-home parent	31	4.4
	Student	71	10.1
	Retired	24	3.4
	Other	26	3.7
	(Missing)	1	0.1
Income – Australia[b]			
	Less than $20,000	105	20.3
	$20,000 - $39,999	81	15.7
	$40,000 - $59,999	79	15.3
	$60,000 - $79,999	82	15.9
	$80,000 - $99,999	73	14.1
	$100,000 or more	94	18.2
	(Missing)	3	0.6
Income – New Zealand[b]			
	Less than $20,000	42	23.0
	$20,000 - $39,999	23	12.6
	$40,000 - $59,999	31	16.9
	$60,000 - $79,999	32	17.5
	$80,000 - $99,999	23	12.6
	$100,000 or more	32	17.5

Variables	Category	*n*	%
Marital status	Married	207	29.6
	In a civil union/de facto/partnered relationship	187	26.7
	Widowed	5	0.7
	Divorced/separated	43	6.1
	Single	257	36.7
	(Missing)	1	0.1

Note. [a]Frequency and percentage for ethnicity includes more than the full sample because participants were able to select multiple responses. [b]Income is AUD or NZD depending which country the respondent resided in.

Measures

The study included two psychometric scales, used across all waves, selected using guidelines set out by Flake and Fried (2020). A range of demographic items and some correlates of climate anxiety were included at wave 1 only.

Climate Change Anxiety Scale (CCAS)

Climate anxiety was measured with the CCAS (Clayton & Karazsia, 2020), a 13-item scale that assesses the negative cognitive and emotional impacts and functional impairment related to perceptions of climate change. It includes two subscales, cognitive emotional impairment (8 items) and functional impairment (5 items). Items in the cognitive emotional impairment subscale include "I go away by myself and think about why I feel this way about climate change," while the functional impairment subscale includes items such as "My concerns about climate change interfere with my ability to get work or school assignments done." See the Measuring Climate Anxiety sub-section of the Literature Review for more on the development of the CCAS.

Some changes were made to the original scale. First, an introductory line was added, stating “The following statements relate to particular climate change experiences.” This was followed by the original preamble, which was adjusted slightly to include a response timeframe, as follows: “Please rate how often the following statements have been true of you in the past three weeks.” Additionally, this response timeframe (“in the past three weeks”) was added to each statement in the scale. This timeframe was designed to capture experiences from one monthly survey wave to the next, minus the one week that the survey remained open, so the response period did not overlap with the previous survey. Finally, one item focused on concerns about sustainability was excluded as it appeared to be measuring pro-environmental behaviour more than climate anxiety. A list of the final 12 included items can be found in Table 4. Items were randomised so respondents encountered questions in any order. Responses were reported using a 5-point rating scale, with response options of 1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*, 5 = *almost always*.

For descriptive purposes, a total score was created by summing and dividing items by 12, with higher scores reflecting higher climate anxiety. For a rationale for treating the CCAS as unidimensional, see the Confirmatory Analysis subsection further below. A validation study by Whitmarsh et al. (2022) reported excellent internal consistency reliability for the total scale (Cronbach’s alpha of .93). In the current study, the Cronbach’s alpha coefficient, calculated with wave 1 data, was .89 (good reliability).

Table 4

CCAS Items

Topic	Item wording	M (SD) using wave 1 only[a]
Concentrate	In the past three weeks, thinking about climate change has made it difficult for me to concentrate.	1.35 (0.67)
Sleep	In the past three weeks, thinking about climate change has made it difficult for me to sleep.	1.23 (0.55)
Nightmares	In the past three weeks, I have had nightmares about climate change.	1.14 (0.47)
Cry	In the past three weeks, I have found myself crying because of climate change.	1.09 (0.38)
Handle	In the past three weeks, I have thought, “why can’t I handle climate change better?”	1.38 (0.75)
Away	In the past three weeks, I have gone away by myself and thought about why I feel this way about climate change.	1.27 (0.66)
Write	In the past three weeks, I have written down my thoughts about climate change and analysed them.	1.10 (0.43)
React	In the past three weeks, I have thought, “why do I react to climate change this way?”	1.30 (0.65)
Fun	In the past three weeks, my concerns about climate change have made it hard for me to have fun with my family or friends.	1.27 (0.58)
Work	In the past three weeks, my concerns about climate change have interfered with my ability to get work or school assignments done.	1.17 (0.49)
Potential	In the past three weeks, my concerns about climate change have undermined my ability to work to my potential.	1.22 (0.55)
Friends	In the past three weeks, my friends have said I think about climate change too much.	1.12 (0.45)

Note. [a]Means and standard deviations calculated across all participants at wave 1, with possible scores ranging from 1 to 5. Adapted from "Development and validation of a measure of climate change anxiety" by S. Clayton and B. Karazsia, 2020, *Journal of Environmental Psychology*, *69*. Copyright 2020 by Elsevier. Reproduced with permission.

Adapted Pro-Environmental Behaviour Scale (PEBS)

Pro-environmental behaviour was operationalised with an adapted version of the PEBS (Markle, 2013), a 19-item scale measuring four different dimensions of pro-environmentalism: conservation, environmental citizenship, food, and transportation. Items cover a broad range of behaviours, including water and lights usage, dietary choices and engagement with environmental issues. This scale was selected not only for its psychometric properties but also because it is relatively recent, of a moderate length and includes content relevant to people living in Australasia. Crucially, it is also one of the few pro-environmental measures to capture behavioural choices such as eating less meat and using alternative transport options that, if employed, could reasonably be expected to help lower greenhouse gas emissions (Girod et al., 2013; Hedenus et al., 2014).

Several adjustments were made to the original scale, as follows. First, an introductory line was added to the scale, stating: “The following questions ask you to what extent you have engaged in particular 'sustainable' behaviours in the past 3-week period.” Additionally, as with the CCAS, a response timeframe (“in the past three weeks”) was added to each item, to capture responses limited to the time between the current survey and the closing date of the survey at the previous wave. Two items (membership of any environmental group, and fuel efficiency of the main household vehicle) were excluded on the grounds that participant responses to these questions were unlikely to change in between surveys. A further three items (consumption of organic fruit and vegetables, pork and poultry) were excluded as these dietary choices were deemed not to have a significant bearing on greenhouse gas emissions (Hoolohan et al., 2013).

Two new items were added to capture high-impact behaviours not previously included in the scale: reduced aviation use and reduced food waste, both deemed helpful for

mitigating climate change (Cologna et al., 2022). A third item was added to capture lamb consumption, which is prevalent in Australasia and carries a substantial carbon footprint (Dougherty et al., 2018). Finally, the beef consumption item was adjusted to capture quantities consumed rather than decreases in consumption, which participants might have difficulty estimating in a 3-week period. The new lamb item also used this same format. The serving size of 65 grams referenced in these two items was selected based on current recommended red meat portion sizes in Australia and New Zealand (Ministry of Health, 2020; National Health and Medical Research Council, 2013). Servings were categorised into five response options by creating an interval measurement where the increments had approximately the same meaning (that is, a one-point increase on the scale equals approximately 3 more servings). To view this item, see Appendix A: Survey Material.

Response ranges in the adapted PEBS included a 5-point and 3-point Likert scale, and dichotomous yes/no options. Most items measured frequency, but some were organised by quantity (e.g., red meat items), or category (e.g., washing in cold, warm or hot water). The final list of 17 items and their response formats can be found in Table 5. All items were coded according to guidelines provided by Markle (2013), with scores on any single item ranging from 1 for the least pro-environmental option, to 5 for the most pro-environmental option. For the two items using a dichotomous scale, the non-pro-environmental response was given a 1 and the pro-environmental response scored a 5. For descriptive purposes, items were summed and divided by 17 to create a total score ranging from 1 to 5, with higher scores reflecting higher pro-environmentalism. A subscale of pro-environmental behaviours deemed most helpful for mitigating climate change was also created by summing scores for four items representing high impact behaviours (Items with topic names *Walk*, *Bus*, *Carpool* and *Flights*) and four items representing moderate impact behaviours (*Beef*, *Lamb*, *Waste* and *Appliances*).

For a rationale for treating the adapted PEBS as unidimensional, see the Confirmatory Analysis subsection. The order of the adapted PEBS items was not randomised because items on the scale are grouped into subgroups with matching response formats. The original development study showed a satisfactory internal consistency for the scale (Cronbach's alpha = .76) and subscales (Cronbach's alpha ranging from .62 to .74), and strong test-retest correlations (r = .85, p <.01) (Markle, 2013). In the current study, the Cronbach's alpha coefficient for wave 1 data was .66, indicating questionable reliability. However, the primary analyses in this study are not impacted by this reliability coefficient, as they predominantly concern the variance within participants over time rather than between items at wave 1. See Results for relevant assessments of reliability and measurement invariance.

Table 5

Adapted PEBS Items

Topic	Item wording	Response Format	Source	Mean (SD)[a]
Lights	In the past three weeks, how often have you turned off the lights when leaving a room?	5-point Likert (never - always)	From original PEBS	4.29 (0.70)
Appliances[b]	In the past three weeks, how often have you switched off standby modes of appliances or electronic devices?	5-point Likert (never - always)	From original PEBS	3.15 (1.22)
Heating	In the past three weeks, how often have you cut down on heating or air conditioning to limit energy use?	5-point Likert (never - always)	From original PEBS	3.61 (1.12)
TV	In the past three weeks, how often have you turned off the TV when leaving a room?	5-point Likert (never - always)	From original PEBS	4.10 (1.11)
Shower	In the past three weeks, how often have you limited your time in the shower in order to conserve water?	5-point Likert (never - always)	From original PEBS	3.05 (1.24)
Load	In the past three weeks, how often have you waited until you have a full load to use	5-point Likert (never - always)	From original PEBS	4.39 (0.94)

	the washing machine or dishwasher?			
Topic	Item wording	Response Format	Source	Mean (SD)
Temperature	In the past three weeks, at which temperature have you washed most of your clothes?	3-pt Likert (hot - cold)	From original PEBS	4.19 (1.15)
Flights[b]	In the past three weeks, have you taken a domestic or international flight?	Dichotomous (yes - no)	Constructed for this study	4.62 (1.18)
Wildlife	During the past three weeks, have you contributed money to an environmental, conservation, or wildlife protection group?	Dichotomous (yes - no)	From original PEBS	1.30 (1.06)
Walk[b]	In the past three weeks, how often have you walked or cycled instead of driving?	3-pt Likert (never – frequently)	From original PEBS	2.86 (1.58)
Waste[b]	In the past three weeks, how often have you thrown away cooked or uncooked food that could have been eaten?	3-pt Likert (never – frequently)	Constructed for this study	3.96 (1.08)
Programmes	In the past three weeks, how frequently have you watched television programs, movies, or internet videos about environmental issues?	5-pt Likert (never – constantly)	From original PEBS	1.93 (0.89)
Talk	In the past three weeks, how often have you talked to others about their environmental behaviour?	5-pt Likert (never – constantly)	From original PEBS	1.95 (0.92)
Beef[b*]	In the past three weeks, how many servings of beef have you consumed? One serving is 65 grams (the size of a pack of playing cards).	5-pt Likert (none – 16+ servings)	Adapted from the original PEBS	3.80 (0.98)
Lamb[b*]	In the past three weeks, how many servings of lamb have you consumed? One serving is 65 grams (the size of a pack of playing cards).	5-pt Likert (none – 16+ servings)	Constructed for this study	4.55 (0.62)
Car pool[b]	In the past three weeks, how often have you car-pooled?	3-pt Likert (never – frequently)	From original PEBS	1.91 (1.29)

Bus[b]	In the past three weeks, how often have you used public transportation?	3-pt Likert (never – frequently)	From original PEBS	2.46 (1.65)

Note. [a]Means and standard deviations calculated across all participants at wave 1, with possible scores ranging from 1 to 5. [b]Denotes items deemed high impact behaviours. [*]Reverse-coded. Adapted from "Pro-Environmental Behavior: Does It Matter How It's Measured? Development and Validation of the Pro-Environmental Behavior Scale (PEBS)" by G. Markle, 2013, *Human Ecology*, *41*(6), p. 905-914. Copyright 2013 by Springer. Reproduced with permission.

Demographics

Participants responded to a range of demographic questions in wave 1 only. These were: age (in years), country of residence, location (urban, suburban or rural), gender, highest level of education, income, marital status and ethnicity. These details were used for descriptive purposes only. Participants' Prolific ID numbers were also collected at every wave to ensure that responses from the same person could be linked over time.

Correlates of Climate Anxiety

Participants were also asked about climate change denial and climate change worry at wave 1 to provide data for supplementary exploratory analyses. Climate change denial was measured with a single-item scale by Krange et al. (2019) that captures two key aspects of climate denial (Rahmstorf, 2004): denial that climate change is taking place (trend scepticism), and denial that humans are causing it (attribution scepticism). The scale asked participants for one of four responses: 1: climate change is happening now, caused mainly by human activities, 2: climate change is happening now, but caused mainly by natural forces, 3: climate change is not happening now, or 4: unsure/don't have an opinion. This item was recoded to swap the order of responses 3 and 4, so that greater numbers on the scale

represented greater denial. Prior research suggests climate change denial is negatively associated with the CCAS (Wullenkord et al., 2021).

Climate change worry was measured with a single item asking how worried about climate change a participant was on a 5-point Likert scale ranging from *not very worried* to *extremely worried*. Existing research (Innocenti et al., 2022) suggests the CCAS and worry are positively correlated, possibly because worry is a cognitive correlate of anxiety (Borkovec et al., 1983). We included these measures for basic validation of the CCAS, thereby building on prior studies that suggested these relationships. If valid, the CCAS should correlate negatively with denial and positively with worry.

Attention Checks

An attention check was included in each of the surveys in an attempt to identify participants who rushed through the survey without paying attention (Hauser et al., 2018). Attention checks can help ensure participants read instructions carefully and adequately consider their responses (Oppenheimer et al., 2009). It could be reasonably assumed that those who fail attention checks may also fail to give adequate attention to other questions in the survey, thus jeopardising the quality of the data collected. Oppenheimer et al. (2009) suggest that excluding respondents who fail such checks may increase the statistical power of the data by minimising the number of participants answering at random. An attention check was embedded between questions 6 and 7 in the adapted PEBS scale, with a different check included at each wave. As per the Prolific (2023) policy, attention checks took the form of either an instructional manipulation check, for example, “What is the usual colour of fresh grass? This is an attention check. The correct answer is green”, or a nonsensical item, for example, “I climb Mount Everest to get to work every day”. Prolific required that any nonsensical items must use a scale response where only one or two responses can be justified as objectively correct. To access all attention checks, see Appendix A: Survey Materials.

Ethics

This project was assessed by the research team as requiring only a low risk ethics notification because the nature of the harm was deemed to be "minimal and no more than is normally encountered in daily life" (Massey University, 2015, p. 1). For full details, see Appendix C: Low Risk Ethics Notification. This decision was supported when peer reviewed by the confirmation panel prior to data collection. One ethical issue pertaining to this research was the risk of discomfort to participants by asking about their experiences of climate anxiety. Literature suggests that most individuals tolerate survey questions about sensitive topics and mental health well, and there is no reasonable basis to believe they will be caused any discomfort or harm (Labott et al., 2016; McMurtrie, 2022). However, given that it was nevertheless possible that some questions might provoke worry or embarrassment, this risk was mitigated by ensuring there was no obligation to complete the survey, and respondents could stop participating at any time and for any reason. Further, no deception was required in the survey. Finally, participants who completed a survey at any wave were offered links to mental health agencies that provide free phone counselling and anxiety-related support in Australia and New Zealand. Respondents were encouraged to contact these helplines if they felt any discomfort.

Informed consent and confidentiality were other important ethical considerations. Regarding informed consent, all participants were presented with a detailed information sheet, which included study details, the risks involved, the recruitment method and incentives, the data management processes, participant rights, and researcher contact details, before agreeing to participate in the study. After reading the information, participants were explicitly asked to select whether they agreed to participate in the study, with only those who chose to do so able to proceed to answer the survey questions. Regarding confidentiality, IP addresses and Prolific ID numbers were removed from the data before they were uploaded to

the Open Science Framework. No contact information was collected, given that Prolific clients are contactable via their account identity numbers.

The cultural appropriateness of the study was also considered. Climate change may disproportionately impact the wellbeing of Indigenous peoples who are often more connected to place than their colonial counterparts (Middleton et al., 2020). Furthermore, research from New Zealand shows Māori cultural identity is positively correlated with pro-environmental behaviour (Tassell-Matamua et al., 2020), which, if taken together, could suggest that the relationship between climate anxiety and pro-environmental behaviour might be particularly relevant to Māori, and possibly Aboriginal and Torres Strait Islander people. This relevance extends to Pasifika peoples, for whom the mental health impact of climate change is also likely profound (Newport et al., 2024). This study, however, was not able to empirically examine such ethnic differences, given that too few Prolific participants identified as being of an Indigenous ethnicity. Therefore, we were not able to make statistical inferences about impacts on these populations. We did, however, decide to collect basic ethnicity data from our sample (see Table 3) in order to accurately describe participants and demonstrate who our findings may and may not generalise to (Henrich et al., 2010), a decision deemed appropriate by the Massey cultural advisor we consulted.

Preregistration and Data Sharing

This study was preregistered on the Open Science Framework prior to data collection. The preregistration included the study's theoretical underpinnings, hypotheses, sample size, data analysis plan and inferential criteria. The preregistration is available at https://osf.io/qrksx/?view_only=428faa9d6dea4e7cb0be22205f1b7a7c (and is replicated in Appendix D: OSF Preregistration for convenience). The full project, including de-identified data, R scripts, preregistration and additional materials, is available to view at https://osf.io/2bhcm/?view_only=0819cf204733478f85cb25c80213eaed to enable other

researchers to replicate the findings. The sharing of this research data aligns with the open data guidelines stipulated in Massey University's (2017) code of ethical conduct for research, teaching and evaluation involving human participants.

Preregistration is an important aspect of psychology's response to the field's reproducibility crisis (Maxwell et al., 2015). In preregistering a study, researchers disclose their predicted hypotheses, collection and analysis methods before embarking on their research, thus making it clearer whether results gained from confirmatory (hypothesis-testing) research were in fact based on decisions made *a priori.* Preregistration details are shared publicly, typically time-stamped in an online depository where the original version cannot be edited. On publication, researchers then explicitly declare which analyses were preregistered and which were exploratory (hypothesis-generating). While preregistration has gained popularity in psychology (Nosek et al., 2019; Nosek & Lindsay, 2018), the practice has not been widely employed in climate anxiety research. Only a handful of studies in the current literature have been preregistered (e.g., Feather & Williams, 2022; Lutz et al., 2023; Mouguiama-Daouda et al., 2022; Tam et al., 2023). The intention of preregistering in this case was to support replication, increase transparency, and ensure our research was well designed and carefully considered at the outset.

Data Analysis

All analyses were performed using RStudio and the R programming language version 4.2.0 (R Core Team, 2022). Our main analysis was conducted with lavaan (v0.6.16; Rosseel, 2012). Other statistical packages that supported the study included ICC (v2.4.0; Wolak et al., 2012), lme4 (v1.1.34; Bates et al., 2014) and psych (v2.3.9; Revelle, 2022). The full analysis scripts are available on the Open Science Framework, which can be accessed at https://osf.io/2bhcm/?view_only=0819cf204733478f85cb25c80213eaed.

Missing Data

As demonstrated in the Participants subsection, there was some attrition across waves, with respondents missing some waves but not others. Missing data also took the form of individual datapoints missing from the main scales of interest, the CCAS and adapted PEBS. These were relatively rare; on four occasions, a single item on the adapted PEBS was missed, and on two other occasions all 12 CCAS items were missed, presumably when the participant accidentally skipped a page of the survey. In both circumstances, all data were retained for the analysis using full information maximum likelihood estimation in lavaan (i.e., setting the missing = "ML" argument when calling the fitting function). This estimation approach has been found to outperform casewise and listwise deletion, and is designed to handle chunks of missing data by using available datapoints from other waves to inform estimates (Enders & Bandalos, 2001). Furthermore, it produces unbiased estimates even when data are not missing completely at random (MCAR), where missingness is independent of both observed and unobserved data, but are missing at random (MAR), where the missingness is systematically related to the observed data but can be considered random within those constraints (for further details, see Confirmatory Analysis).

Confirmatory Analysis

The main analysis employed a random intercept cross-lagged panel model (RI-CLPM) with multiple indicators (Mulder & Hamaker, 2021). This allowed us to test directly whether changes in climate anxiety are associated with subsequent changes in pro-environmental behaviour (and vice versa) within the same person. A single model was used to test H1 and H2. A cross-lagged panel model was deemed most appropriate for this study as it allows researchers to explore the effect of two or more variables on each other over time. More specifically, we used a cross-lagged panel model with a random intercept (the RI-CLPM) because it allows stable "trait-like" between-person components to be separated out

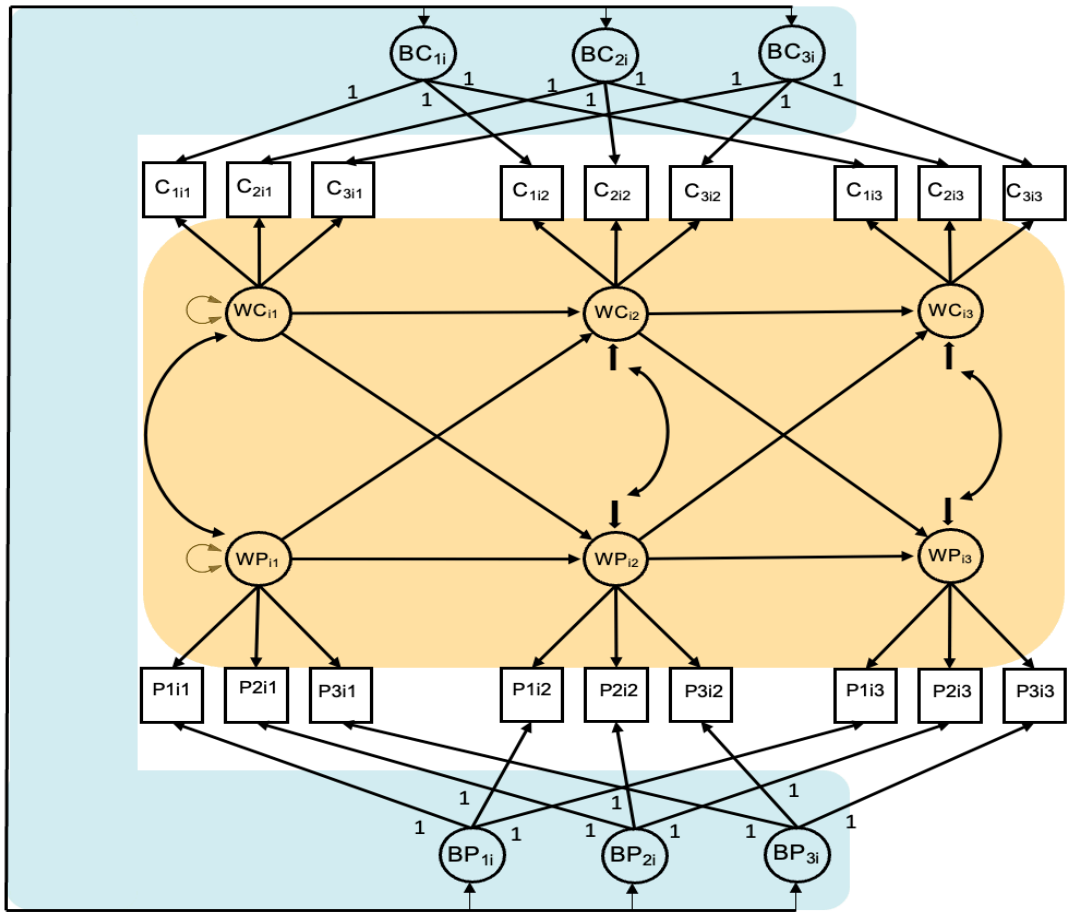
from the dynamic “state-like” within-person components that vary over time, hence allowing all stable individual difference confounds to be implicitly controlled for (Hamaker et al., 2015). This model is more appropriate for variables that are to some extent trait-like, such as climate anxiety, and avoids critical limitations of the original cross-lagged panel model (Rogosa, 1980), which cannot discriminate between- and within-person variation, thereby over-estimating causal paths. It should be noted that while RI-CLPMs can adjust for stable confounders by estimating and removing the individual-specific intercepts, these models are less adept at accounting for time-varying confounders (Rohrer & Murayama, 2023). As a result, these models do not provide the protection against confounding variables that experimental designs are able to offer through random assignment.

Our version of the RI-CLPM included multiple indicators for each of the latent constructs, that is, each of the 12 CCAS items and 17 adapted PEBS items that make up the two scales (see Figure 1 for a simplified depiction of the model. The full model would not fit on the page). Including each item creates a more complex model than the single indicator variant, which contains just one observed variable, usually a total score, for each latent construct. A model with multiple indicators has more factor loadings, variances, and covariances to be estimated, is more difficult to fit and interpret, and carries greater computational demands. However, specifying multiple indicators increases the reliability of the measurement model by accounting for measurement errors unique to items. The result is a more nuanced, reliable, and valid representation of the underlying multi-faceted latent constructs when compared with the single indicator variant, and one which avoids the assumption that the variables are measured without any error. The main parameters of interest for our hypotheses are the cross-lagged parameters. These indicate at the within-person level whether different-from-usual scores from one variable (e.g., climate anxiety) are associated with different-from-usual scores on the other variable (e.g., pro-environmental

behaviour) at the next time point after controlling for the first variable at the first time point (e.g., climate anxiety). The model also allows for testing reciprocal effects and can explicitly model the reciprocal relationship proposed in the hypotheses.

Figure 1

A Simplified RI-CLPM Depicting Three Data Collection Waves



Note. B = Between-person, W = Within-person, C = Climate Anxiety, P = Pro-Environmental Behaviour. This simplified model contains three items instead of 12 items for climate anxiety, three items instead of 17 for pro-environmental behaviour, and 3 waves instead of five. The area coloured yellow illustrates the cross-lagged effects of interest.

In summary, by using cross-lagged longitudinal data we were able to estimate the effect of climate anxiety on pro-environmental behaviour without our estimate of that effect being distorted by a potential effect of pro-environmental behaviour on climate anxiety (and vice versa). By applying the RI-CLPM, we could implicitly control for any stable individual difference confounding variables that affected both climate anxiety and pro-environmental behaviour. Furthermore, by applying the multi-indicator RI-CLPM we could explicitly model and account for measurement error, which might otherwise bias our estimates of effects. However, the estimated effects might still be biased if there were any time-varying confounding variables.

Regarding assumptions, our RI-CLPM model assumed that within-person factor loadings, intercepts, cross-lagged, and autoregressive parameters remained constant across waves. Within-person factor loadings refer to the strength and direction of relationships between observed variables and their underlying latent factors at the individual level, capturing the variability in responses that is attributable to dynamic, time-specific influences. Similarly, within-person intercepts represent the baseline level of the latent factor for individuals, accounting for their unique, stable characteristics. Applying constant, time-invariant factor loadings and intercepts implies at least weak factorial invariance, and allows for meaningful comparison of the constructs over time (Meredith, 1993). Random intercepts were assigned to each of the 12 CCAS items and 17 adapted PEBS items, and all 29 random intercept terms were permitted to correlate. The pairs of within-person factors (at wave 1) and their residuals (at wave 2 onwards) were permitted to correlate at each wave.

The within-person components of the latent variables (climate anxiety and pro-environmental behaviour) were treated as unidimensional, with no correlated error terms in each case. The decision to treat the latent variables as unidimensional was perhaps unusual, given that the original CCAS has two dimensions and the original PEBS has four. However,

our hypotheses pertained to the overarching constructs of climate anxiety and pro-environmental behaviour, not dimensions thereof. Furthermore, the original factor analyses reporting multidimensional models for these scales would have been based mainly on inter-individual differences, not within-person variance, and the factor structure of within-person differences will not necessarily be the same as that of inter-individual differences (Molenaar, 2004). Therefore, there was no clear basis for preferring a specific competing multidimensional model. Moreover, treating these variables as multidimensional would have even further increased the complexity and computational challenges inherent in the models.

As specified in our preregistered analysis plan, our model was first estimated using maximum likelihood with Huber-White standard errors and a scaled test statistic (MLR in lavaan), with missing data accounted for by full information maximum likelihood. This estimation method prioritises accounting for missing data, which can be a substantial concern given the use of a longitudinal design. It can also account for non-normal data, which makes up a substantial portion of this dataset, given the use of ordinal rating scale data. However, this estimation method is prone to convergence failures when used for RI-CLPMs. Therefore, we pre-registered a rule that if MLR produced an error message or a warning message about impossible parameter values, we would switch estimation methods to full information maximum likelihood (i.e., estimator = “ML”, missing = “ML” in lavaan syntax). This estimator is simpler and is less likely to cause convergence failures than MLR and, like MLR, also prioritises accounting for missing data. However, ML does assume multivariate normal data, an assumption that was breached in our dataset given that our item responses were ordered categories, and not continuous normal distributions.

Our analysis involved a 3-step process described by Mulder and Hamaker (2021) which allowed us to report tests of measurement invariance across time. At step 1, we tested a factor model with configural invariance (i.e., factor loadings were estimated freely over

time). At step 2, we tested a model with weak factorial invariance (loadings constant across time), which, if supported, is sufficient to test relations between variables over time (Van de Schoot et al., 2012). Finally, at step 3, we tested a model of strong factorial invariance, with loadings and intercepts constant across time. As pre-registered in our analysis plan, it was only at this final stage, step 3, where our hypotheses were tested. The earlier steps were additional exploratory analyses only, designed to test measurement invariance. The step 3 model was interpreted regardless of the findings of these invariance tests. Where there was evidence against measurement invariance we interpreted this as reason to regard the main results as having additional uncertainty attached.

Inferential Criteria

An important feature of a preregistration is the inclusion of inferential criteria, clearly specifying what criteria need to be met for a hypothesis to be considered supported. This reduces the potential impact of researcher bias in determining what findings constitute support for a hypothesis. Our preregistered inferential criteria stated that H1 would be considered to be supported if the within-person effect (cross-lagged path) from climate anxiety to pro-environmental behaviour was positive and significant, with p less than 0.05 (2-tailed). H2 was considered to be supported if the within-person effect (cross-lagged path) from pro-environmental behaviour to climate anxiety was negative and significant, with p less than 0.05 (2-tailed). The conventional alpha level of 0.05 was selected due to challenges inherent in power analyses for these models, limiting our capacity to achieve sufficient power with a more stringent threshold like 0.005 (Benjamin et al., 2018). However, the choice of alpha level should also be justified based on the study context (Lakens, Adolfi et al., 2018).

Regarding model fit, we preregistered that we would report the following statistics: The root mean square error of approximation (RMSEA), and associated confidence intervals; the standardised root mean square residual (SRMR); and the comparative fit index (CFI). As

stated in our pre-registered plan, model fit would be deemed supported if all the following criteria were met (as similar to Masselink et al., 2018): The RMSEA was less than or equal to 0.06; the SRMR was less than or equal to 0.08; and the CFI was equal to or greater than 0.95 (Hu & Bentler, 1999). The model would be considered to have a poor fit if none of the above criteria were met. If all of the fit statistics were met, it would be considered to have a good fit. If only some fit statistics were met, then fit would be considered ambiguous. However, we stated that the fit statistics would not be used to determine if the hypotheses were supported; they are best regarded as reflecting on auxiliary measurement assumptions.

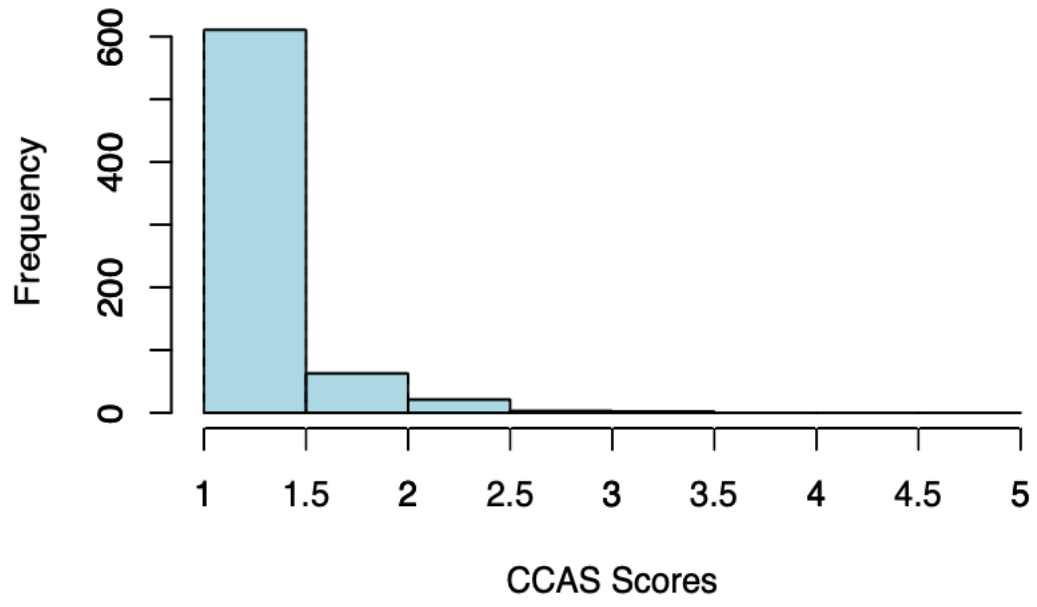
Results

Descriptives

Climate anxiety scores were very low overall, with a mean score across all waves of 1.19 on a 1–5 scale. The distribution of CCAS scores is depicted in Figure 2. Average scores for individuals over the five waves show just two participants (0.29%) scored over the midpoint of 3 on the CCAS, indicating they experienced climate anxiety-related impairments more than *sometimes* in the past three weeks on average across all items and waves. A substantial portion of the sample — 96.1% or 673 participants — reported average scores below 2, indicative of infrequent experiences of climate anxiety-related impairments. Furthermore, 30.1% of the sample (211 participants) reported never experiencing any climate anxiety symptoms at any wave.

Figure 2

Distribution of Mean CCAS Scores Across all 5 Waves



Mean and standard deviation statistics for climate anxiety and pro-environmental behaviour at each wave are displayed in Table 6. Mean climate anxiety scores decreased slightly from 1.22 (*SD* = 0.38) at wave 1 to 1.16 (*SD* = 0.33) at wave 5. This is despite severe weather events in Australia and New Zealand in January and February 2023, in the latter half of the study (Bureau of Meteorology, 2023; Graham-McLay, 2023; Harrington et al., 2023). No trend was observed with mean pro-environmental behaviour scores, which decreased and then increased marginally from wave 1 to 5. For analyses describing relationships between climate anxiety and pro-environmental behaviour means at wave 1 and various demographic data, see Appendix E: Additional Analyses.

Table 6

Descriptive Statistics for Climate Anxiety and Pro-Environmental Behaviour at each Wave (N = 700)

	Wave 1 M *(SD)*	Wave 2 M *(SD)*	Wave 3 M *(SD)*	Wave 4 M *(SD)*	Wave 5 M *(SD)*
Climate Anxiety	1.22 (0.38)	1.21 (0.37)	1.18 (0.34)	1.18 (0.35)	1.16 (0.33)
Pro-Environmental Behaviour	3.30 (0.44)	3.28 (0.45)	3.24 (0.45)	3.26 (0.45)	3.27 (0.46)

The mean level of agreement for each item on each of the two scales at each wave is displayed in Figures 3 and 4. Several behaviours increased or decreased during the course of the four-month study, but settled close to wave 1 levels by the time the study ended. While climate anxiety items have similar levels of agreement to one another, pro-environmental behaviours showed more variance in agreement across items. CCAS items with the highest mean responses were *Handle* (I have thought, “why can’t I handle climate change better?”) and *Concentrate* (thinking about climate change has made it difficult for me to concentrate).

The Adapted-PEBS items with the highest mean response for pro-environmental behaviour were *Lamb* (lamb consumption) and *Flights* (international and domestic flights).

Figure 3

Changes in Mean Agreement with Climate Anxiety Items over Time

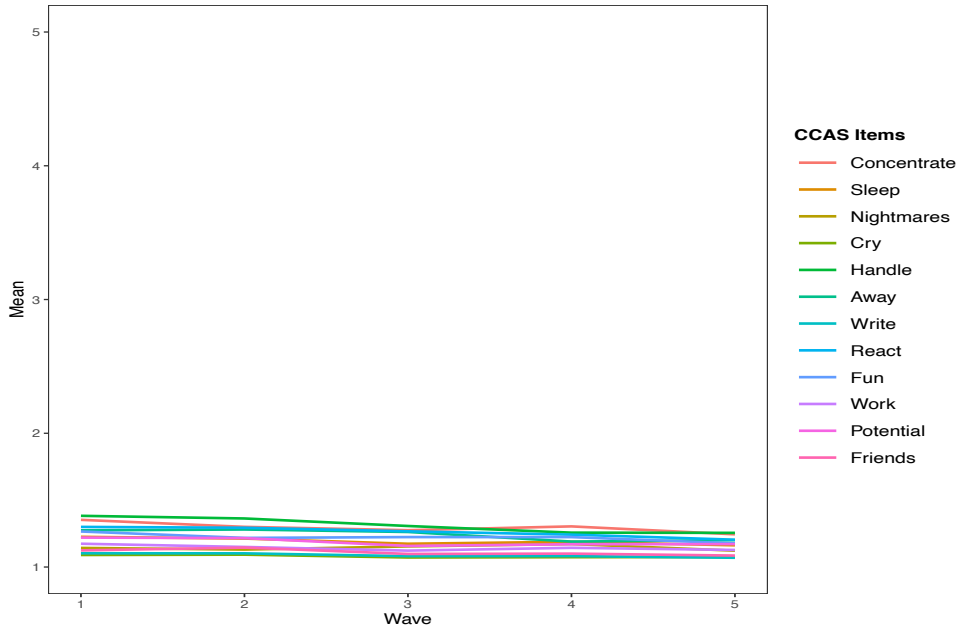
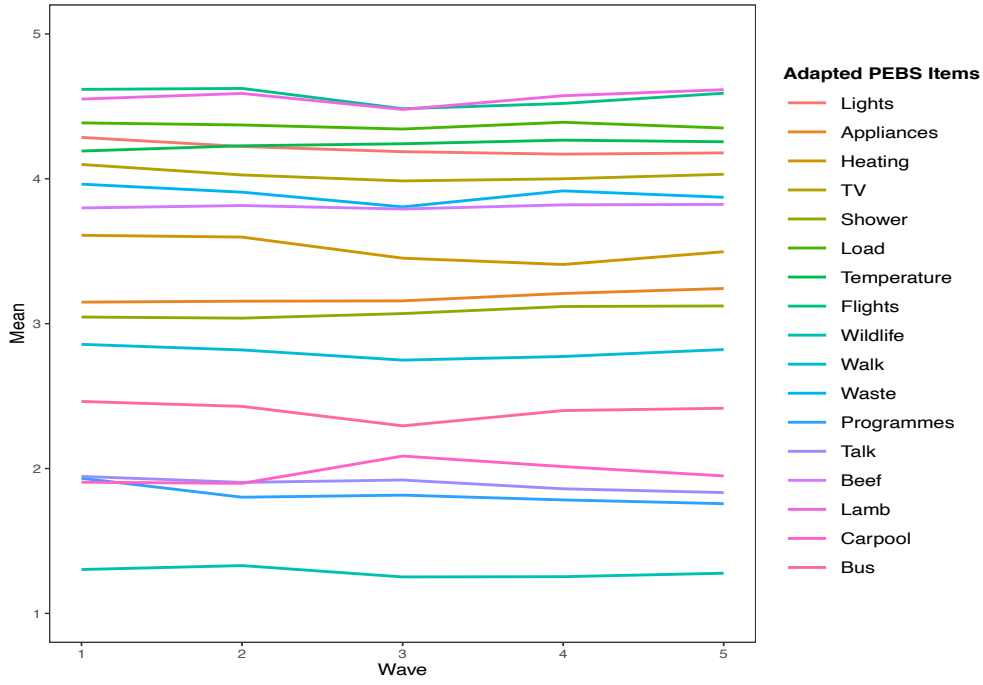


Figure 4

Changes in Mean Agreement with Pro-Environmental Behaviour Items over Time



Intraclass correlations (ICCs) were also calculated to examine the relative proportions of between-person and within-person variance in our two primary variables. The ICC for climate anxiety was 0.67 and for pro-environmental behaviour was 0.81. These ICC values indicate that 33% and 19% of the total variance in climate anxiety and pro-environmental behaviour, respectively, was *not* attributable to between-person differences, essentially highlighting the presence of moderate within-person variations.

Regarding our supplementary measure of climate change denial, most respondents (86.7%) acknowledged that climate change is happening and is caused by humans. A smaller but not insubstantial proportion (9.7%) believed that climate change is happening but is mainly caused by natural events. Of the remainder, nine people (1.3%) reported that climate change is not happening, and 16 (2.3%) were unsure or did not have an opinion. Regarding our second supplementary measure of climate change worry, half of the respondents (49.9%) reported being either ‘very’ or ‘extremely’ worried about climate change. A further 37.4% were ‘somewhat’ worried, while 12.7% were either not at all worried or not very worried.

A Pearson’s correlation analysis was conducted to examine relationships between climate change worry (measured at wave 1 only), and climate anxiety and pro-environmental behaviour (using each participant’s average score across all five waves). Results showed a moderate positive correlation between pro-environmental behaviour and climate anxiety, $r(698) = .35$, $p < .001$. Climate change worry demonstrated a moderate positive correlation with both climate anxiety, $r(698) = .38$, $p < .001$, and pro-environmental behaviour, $r(698) = .38$, $p < .001$. Correlations between these three variables and climate change denial (measured at wave 1 only) were examined using Spearman's rank correlation coefficient (ρ) due to the ordinal nature of the denial variable. This variable has four ranked responses representing different levels of agreement regarding climate change, where the distances between each rank cannot be assumed equal. Climate change denial showed a weak negative correlation

with climate anxiety, ρ(698) = -.17, $p < .001$, and a weak negative correlation with pro-environmental behaviour, ρ(698) = -.19, $p < .001$. A strong negative correlation was observed between climate change worry and climate change denial, ρ(698) = -.46, $p < .001$. Results for both the Pearson and Spearman correlations are presented in Table 7.

Table 7

Intercorrelations Between Climate Anxiety, Pro-Environmental Behaviour and Climate Change Worry (N = 700)

Variables	Climate Anxiety[a]	Pro-Environmental Behaviour[a]	Climate Change Worry[b]
Climate Anxiety	1		
Pro-Environmental Behaviour	.35*	1	
Climate Change Worry	.38*	.38*	1

Note. *Statistically significant at $p < .001$. [a] Calculated using each participant's average score on these variables across all waves. [b]Calculated at wave 1 only. All correlations are Pearson correlation coefficients.

Confirmatory Analysis

A multiple indicator RI-CLPM was tested to investigate the cross-lagged effects between climate anxiety and pro-environmental behaviour over time using the pre-registered 3-step process described by Mulder and Hamaker (2021) and outlined in the Method chapter. The first two steps act as exploratory analyses to test measurement invariance. The model was first estimated using MLR as set out in our pre-registration. At step 1, we tested a factor model with configural invariance, where factor loadings were estimated freely over time and

we allowed item-specific residual covariances. We received warnings that the covariance matrix of of estimated parameters and or latent variables was not positive definite, and the model did not converge. However, an inspection of the matrix revealed just one eigenvalue was very slightly negative, suggesting this was not a major issue. We opted to proceed to step 2, where we constrained factor loadings to be equal over time (i.e., weak invariance). The same warnings were given, but the model ran successfully. We were unable to generate robust statistics in lavaan, so we chose not to use robust corrections for our fit statistics. As a result, the fit indices for steps 2 and 3, shown in Table 8, are not adjusted for non-normality using the conventional robust methods. However, the MLR estimator inherently accounts for non-normality in its estimation process, including adjustments for all fit indices and the chi-square statistic, ensuring that our model evaluation remains reliable and reflective of the data's actual distribution.

Table 8

Scaled Model Fit Indices at Each Step for the Confirmatory RI-CLPM

Model Fit Indices	Step 1	Step 2	Step 3
Chi-square	–	14465.29	14715.15
RMSEA[a]	–	0.025	0.026
SRMR[b]	–	0.041	0.042
CFI[c]	–	0.904	0.901

Note. [a]Root Mean Square Error of Approximation, [b]Standardised Root Mean Square Residual, [c]Comparative Fit Index. Indices were not reported for step 1 due to non-convergence. Fit statistics for step 1 using ML estimator: $\chi^2 = 16165.32$, RMSEA = 0.030, SRMR = 0.041, CFI = 0.889. Scaled versions of the RMSEA, SRMR and CFI are population-corrected as lavaan was unable to generate sample-corrected versions for this model (for further information, see Brosseau-Liard et al. (2012) and Brosseau-Liard and Savalei (2014)).

Fit indices at step 2 showed the RMSEA and SRMR were within the preregistered threshold for good fit (Hu & Bentler, 1999); however, the CFI did not meet these criteria, suggesting ambiguous model fit. We then ran the step 1 and step 2 models again using the simpler estimator ML to enable us to compare model fit using a chi-square difference test. This revealed a significant change in model fit, $\Delta\chi^2(108) = 342.22$, $p < .001$, indicating the second model fitted significantly worse than the first. However, very small changes in RMSEA, and to a lesser extent CFI, between model 1 and 2, suggested the fit might not be substantially worse, especially given that these indices take model parsimony into account. We then proceeded to step 3 with the assumption of weak invariance, adequate for testing relationships between variables over time (Van de Schoot et al., 2012).

At step 3, we fitted a strong factorial invariance model, where factor loadings and intercepts were held constant over time. This model also had ambiguous model fit, with the RMSEA and SRMR both within the preregistered threshold, but the CFI not. As before, a chi-square difference test – this time comparing MLR-estimated models with scaled fit statistics, indicated the third model fitted significantly worse that the second $\Delta\chi^2(120) = 249.73$, $p < .001$. However, again, minimal changes in RMSEA and, to a lesser extent, CFI, across steps, suggested model fit might not be significantly worse.

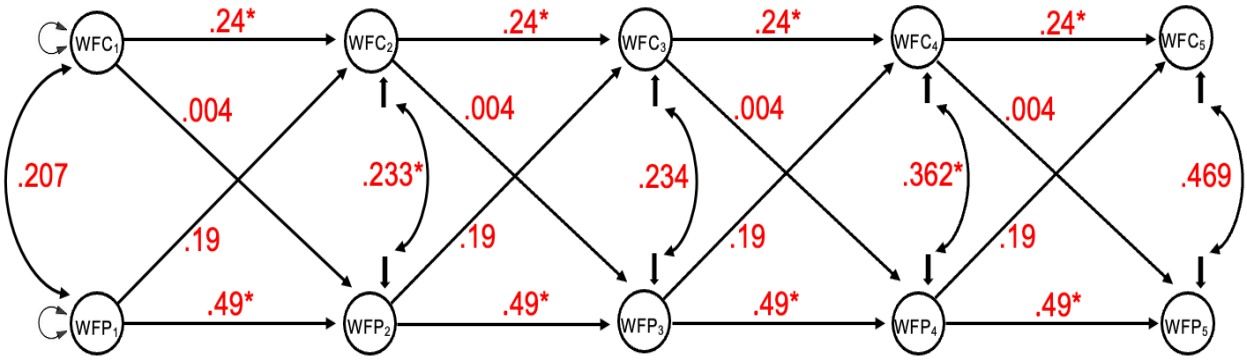
As per our pre-registered analysis plan, we used this step 3 model, the most constrained of the series, to test our hypotheses. There was a significant autoregressive effect for climate anxiety, indicating that increases in climate anxiety predicted further increases in climate anxiety at the next measurement wave (unstandardised coefficient B = .236, *SE* = .092, *p* = .010, 95% confidence interval (CI) = [.06, .42]). Likewise, there was a significant autoregressive effect for pro-environmental behaviour, indicating that increases in pro-

environmental behaviour predicted even further increases in pro-environmental behaviour at the next measurement wave (B = .490, *SE* =.151, *p* = .001, 95% CI = [.19, .79]).

However, no significant cross-lagged effects were found between climate anxiety and pro-environmental behaviour across the various waves. Specifically, climate anxiety at wave t-1 did not predict pro-environmental behaviour at wave t (B = .004, *SE* = .032, *p* = .890, 95% CI = [-.06, .07], hence, H1 was not supported. Likewise, pro-environmental behaviour at wave t-1 did not predict climate anxiety at wave t (B = .188, *SE* = .230, *p* = .414, 95% CI = [-.26, .64]). As such, H2 was not supported. These relationships are depicted in Figure 5. To confirm these results were robust to any alternative specification, these hypotheses were also tested with a single-indicator RI-CLPM. These results, reported in Appendix E: Additional Analyses, confirm the multiple indicator findings that there was no significant evidence of substantial cross-lagged effects.

Figure 5

Simplified Model with Constrained Unstandardised Regression Coefficients



Note. *Statistically significant at $p < 0.05$. WFC = Within factor climate anxiety, WFP = Within factor pro-environmental behaviour. Numbers 1-5 indicate specific waves.

We then looked at the within-person correlations between climate anxiety and pro-environmental behaviour at the same wave. These are interesting in that they indicate how much these two variables correlate within a person at same time after controlling for autoregressive and cross-lagged effects. Results, reported in Table 9, show this correlation was positive at all waves, but only significant at waves 2 and 4. This suggests that, at these two waves only, when someone was feeling more anxious about the climate than typical for them, they were more likely to report pro-environmental behaviour in the same wave. This mixed result is tentative evidence of a within-person correlation.

Table 9

Correlations Between the Within-Person Climate Anxiety and Pro-Environmental Behaviour Factors at Each Wave

Wave	Correlation (*r*)	*p*-value
Wave 1	.207	.129
Wave 2	.233	.041
Wave 3	.234	.142
Wave 4	.362	.014
Wave 5	.469	.072

Finally, we also examined the variances of the within-person factors for each of the latent variables. These were of interest because if they are very small, they could reduce the power to detect significant effects between climate anxiety and pro-environmental behaviour. Results are reported in Table 10. We found little within-person variance. For climate anxiety, values were significant but small, ranging from a low of 0.049 (wave 3) to a high of 0.089

(wave 5). For pro-environmental behaviour, the variances were even smaller and non-significant, ranging from 0.006 (wave 4 and 5) to 0.015 (wave 1). This finding suggests that within-person latent factors for climate anxiety and pro-environmental behaviour did not fluctuate much over time, which may have reduced our statistical power.

Table 10

Within-Person Variances for Climate Anxiety and Pro-Environmental Behaviour at Each Wave

Construct	Wave	Variance Estimate	*p*-value
Climate Anxiety			
	Wave 1	.089	< .001
	Wave 2	.078	< .001
	Wave 3	.049	< .001
	Wave 4	.083	< .001
	Wave 5	.074	< .001
Pro-Environmental Behaviour			
	Wave 1	.015	.155
	Wave 2	.008	.146
	Wave 3	.009	.124
	Wave 4	.006	.226
	Wave 5	.006	.265

Exploratory Analyses

High Impact Pro-Environmental Behaviour

Exploratory analyses were carried out to investigate the relationship between climate anxiety and a group of pro-environmental behaviours known to be especially helpful in mitigating climate change (See Table 5 for included items). We are interested to see how pro-environmental behaviours deemed to have a moderate or high impact on greenhouse gas

emissions related to climate anxiety (Cologna et al., 2022). This is important because it is these behaviours that are most likely to address the cause of the anxiety: climate change. To do this, we ran another RI-CLPM, this time including all CCAS items but only the eight adapted PEBS items deemed to have a higher impact on climate change.

At step 1, we received a warning about convergence. Similar warnings were given at step 2 and 3, hence we switched to the simpler estimator ML. After receiving the same set of warnings with ML we opted instead to use a single indicator model, which can address convergence issues by summarising latent constructs into a single variable, a total score for each climate anxiety and pro-environmental behaviour, but without accounting for measurement error. As with the confirmatory analysis, we employed the 2-step process recommended by Mulder and Hamaker (2021). Fit statistics are presented in Table 11. Despite a significant chi-square statistic at both step 1 ($\chi^2(21) = 43.755$, $p = 0.003$) and step 2 ($\chi^2(50) = 119.768$, $p < .001$), all other model fit indices reported at step 1 and 2 were in the accepted range, suggesting overall good fit.

Table 11

Model Fit Indices at Each Step for the Exploratory Single Indicator RI-CLPM

Model Fit Indices	Step 1	Step 2
Chi-square	43.755	119.768
RMSEA[a]	0.039	0.045
SRMR[b]	0.030	0.042
CFI[c]	0.995	0.984

Note. [a]Root Mean Square Error of Approximation, [b]Standardised Root Mean Square Residual, [c]Comparative Fit Index.

The results indicated significant autoregressive effects for both climate anxiety and high-impact pro-environmental behaviour. Specifically, there was a significant autoregressive effect for climate anxiety across the measurement waves, suggesting that increases in climate anxiety at one time point were predictive of further increases in climate anxiety at the subsequent measurement wave (B = .184, *SE* = .031, *z* = 5.911, *p* <.001, 95% CI = [.13, .24]). Similarly, there was a significant autoregressive effect for high impact pro-environmental behaviour across waves, as indicated by a B of .143, *SE* of .032, and *p*-value less than .001 (*z* = 4.503, 95% CI = [.09, .20]).

However, no significant cross-lagged effects between climate anxiety and high impact pro-environmental behaviour were found across the multiple waves. Specifically, climate anxiety at wave t-1 did not predict pro-environmental behaviour at wave t (B = .017, *SE* = .021, *p* = .404, 95% CI = [-.02, .06]). Likewise, high impact pro-environmental behaviour at the wave t-1 did not serve as a significant predictor of climate anxiety at wave t (B = -.050, *SE* = .036, *p* = .164, 95% CI = [-.12, .02]). The covariance between the random intercepts for climate anxiety and high-impact pro-environmental behaviour was estimated at B = 0.030 (*SE* = 0.006), *z* = 5.188, *p* < .001. This indicates a significant and positive correlation between individuals' overall levels of each of these variables, reflecting a stable association at the between-subjects level.

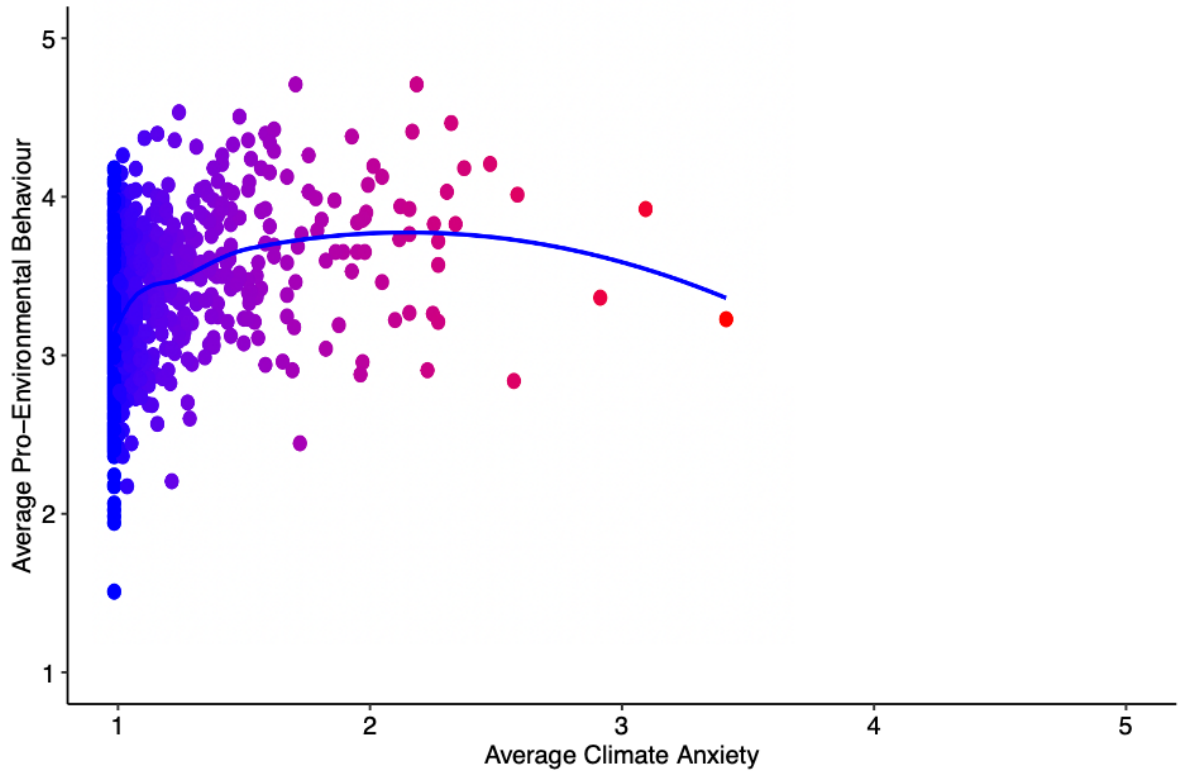
Non Linear Effect of Climate Anxiety on Pro-Environmental Behaviour

Given the absence of a significant relationship in the main analysis, we ran an exploratory analysis to investigate whether the true effect of climate anxiety on pro-environmental behaviour might be non-linear. We wanted to see whether climate anxiety is possibly more adaptive at lower levels (i.e., leads to higher adapted PEBS scores in subsequent waves) than at higher levels (i.e., leads to lower adapted PEBS scores in subsequent waves), as some research suggests (see the Literature Review for the theoretical

background). To test this, we first assessed non-linearity at the between-person level by examining the relationship between average climate anxiety and average pro-environmental behaviour across all time points. We visualised the relationship with a scatterplot (see Figure 6) that employed locally estimated scatterplot smoothing (LOESS). The graphed line exhibits a mildly inverted U-shaped pattern, suggesting that levels of pro-environment behaviour tend to be lower than average for individuals with lower levels of climate anxiety. As climate anxiety increases, these behaviours tend to increase, reaching a peak, but then decline again when anxiety is at its highest. This result indicates a slightly non-linear relationship between these variables.

Figure 6

Between-Persons Linearity Analysis



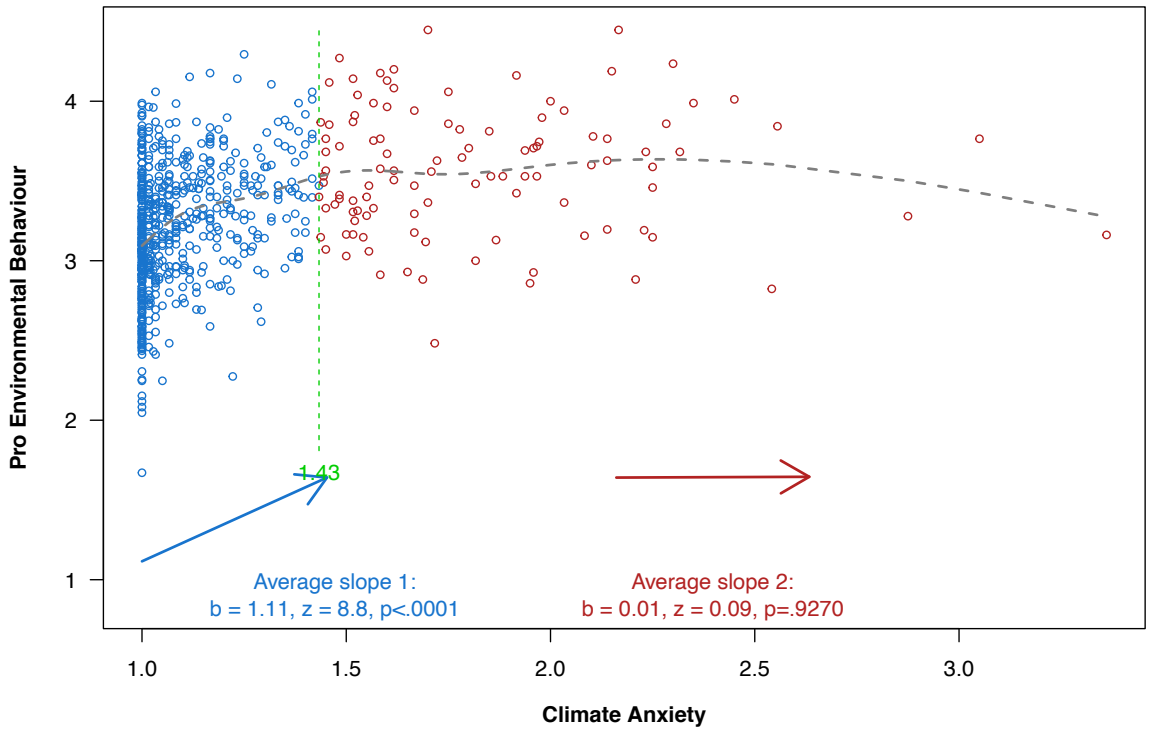
Note. Each point represents an individual's average scores across all time points.

For a more nuanced examination of non-linearity at the between-persons level, we next used the two-lines test (Simonsohn, 2018). This test identifies a breakpoint by systematically splitting the data at potential points where the relationship between the variables might change in strength or direction. It then runs separate regressions for each potential breakpoint, compares the slopes, and finally identifies the breakpoint that offers the most significant difference in slopes, signifying the point of non-linearity. The results, depicted in Figure 7, showed that up to the breakpoint (climate anxiety mean score = 1.43), the pro-environmental behaviour mean score increased quite substantially as climate anxiety mean score increased. After the breakpoint, the pro-environmental behaviour mean score still increased as climate anxiety mean score increased; however, the rate of this increase was much slower and non-significant. The curve is a very slightly inverted U-shape; however, as both slopes are positive and there is no sign change, there is no significant evidence for this U-shaped relationship (Simonsohn, 2018).

In summary, both the detection of a breakpoint and the visual deviation from a straight line depicted in these between-persons analyses collectively suggested that the relationship between climate anxiety and pro-environmental behaviour may be slightly non-linear. However, the absence of strong evidence for a U-shaped pattern suggested the relationship might be monotonic.

Figure 7

Two-lines Test Showing Effect of Climate Anxiety on Pro-Environmental Behaviour

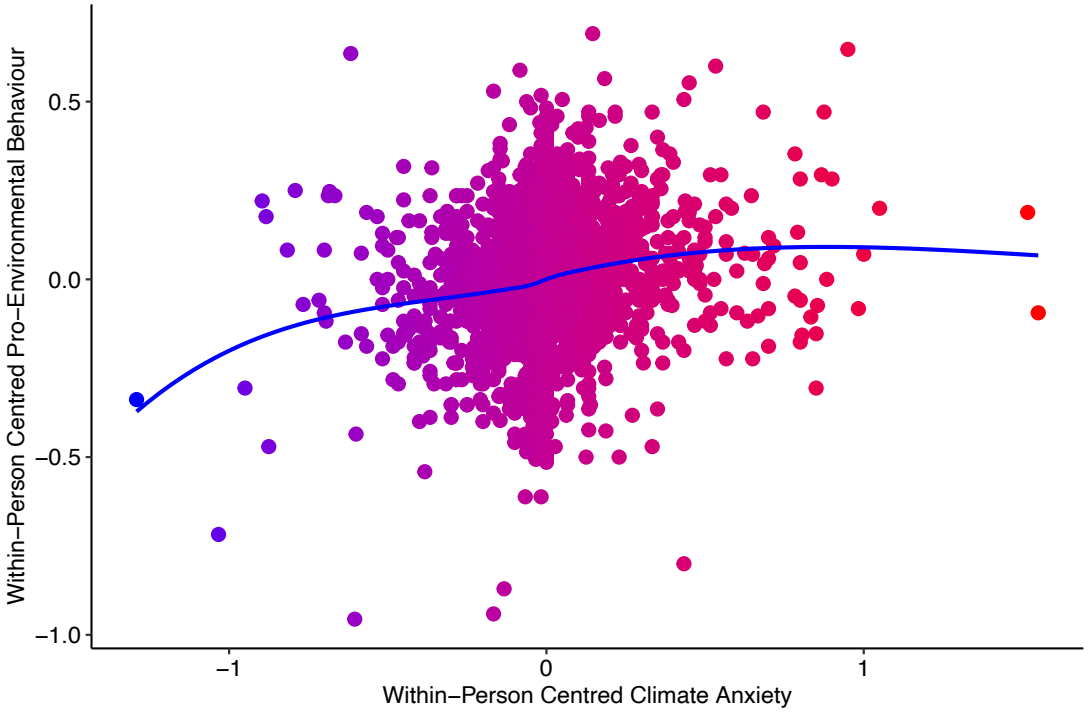


Finally, we assessed non-linearity at the within-person level by plotting the within-person variability of climate anxiety and pro-environmental behaviour over time, after subtracting each individual's mean score. Figure 8 indicates that, within individuals, most fluctuations from personal averages of climate anxiety were modest in relation to pro-environmental behaviour. The smoothed line increased modestly over time, suggesting that as climate anxiety deviations increased from their personal average, there was a general tendency for pro-environmental behaviour deviations to also increase. At the very highest levels of pro-environmental behaviour, climate anxiety deviations increased slightly more than prior, a pattern not observed for higher levels of climate anxiety deviations. It is possible that the relationship between these two variables within people over time might be more linear – although not purely linear – in nature than it is between people. While interpreting

scatterplots in this manner is subjective and is not a formal method of inference, it does appear that overall, there is some evidence the within-person relationship between climate anxiety and pro-environmental behaviour is non-linear and potentially monotonic.

Figure 8

Within-Persons Linearity Analysis with Climate Anxiety as Independent Variable



Discussion

The goal of this study was to examine whether climate anxiety and pro-environmental behaviour affect one another. Prior research has provided some evidence that these two variables are positively correlated but, to date, there have been very few attempts to test whether these relationships represent causal effects. Despite this, there are theories and commonly held beliefs that 1) climate anxiety causes pro-environmental behaviour to increase, and 2) that this behaviour in turn lowers climate anxiety. This study tested these two hypotheses using longitudinal data collected from Australian and New Zealand adults every month over five months. We used an RI-CLPM, an advanced statistical technique that allowed us to control for stable, between-person differences and thereby focus on dynamic within-person changes over time.

Key Findings

We found no evidence of a causal relationship between climate anxiety and pro-environmental behaviour. Contrary to hypothesis 1, higher levels of climate anxiety at one wave were not significantly associated with higher levels of pro-environmental behaviour at the following wave. Likewise, contrary to hypothesis 2, higher levels of pro-environmental behaviour at one wave were not significantly associated with lower levels of climate anxiety at the next wave. Additional findings from exploratory analyses found that there was also no statistically significant effect in either direction when focusing only on those pro-environmental behaviours most likely to mitigate climate change. Furthermore, we found some evidence to suggest the relationship between the variables might be non-linear but monotonic.

Comparison with Existing Literature

These results stand in contrast to much of the academic literature and public narrative which, though varied, generally suggests that climate anxiety motivates people to act to mitigate climate change, thereby reducing their levels of climate anxiety. The claims that climate anxiety increases pro-environmental behaviour (Hypothesis 1) are largely based on a body of correlational research that suggests a positive association (Bingley et al., 2021; Budziszewska & Jonsson, 2021; Cunsolo et al., 2020). However, these studies often infer causation obliquely from correlational results and fail to consider how variables interact over time. As such, they do not adequately account for potential third variables that may influence the observed relationships. Our results also contrast with a few experimental studies employing fear appeals (Gao et al., 2021; van Zomeren et al., 2010) which have shown an increase in pro-environmental behaviour when fear is induced. It is possible that the anxiety induced in these experiments does not influence behaviour in the same way as the chronic, long-term anxiety that our study investigated. Notably, our results also differ from those of Pavani et al. (2023), who found that eco-anxiety positively predicted pro-environmental behaviour over time. This finding suggests that differences in cultural context, measurement tools, or the frequency of measurement may have influenced these outcomes.

Our result, showing no evidence that pro-environmental behaviour affects climate anxiety (hypothesis 2), is at odds with an often-stated assumption in academic literature, clinical opinion and mainstream media that taking action will likely reduce anxiety symptoms. Particularly, the widely recommended action-as-treatment approach (e.g., Cunsolo et al., 2020; Kennedy-Woodard & Kennedy-Williams, 2022) implies that pro-environmental action will reduce climate anxiety. This stance may be intuitive, reflecting a societal tendency to think that doing something can solve problems, especially when both the action and the problem are rooted in climate change. This approach is also helpful, in that it

offers a practical solution to a difficult psychological experience. The scant evidence for this causal effect is mostly drawn from experiments involving environmental volunteers, which suggest that pro-environmentalism may benefit mental health (O'Brien et al., 2010; Pillemer et al., 2010). Yet these studies were not specifically interested in climate anxiety or climate change, and the target population differed from ours. Additionally, a range of qualitative literature (Berglund, 2019; Patrick et al., 2021) suggests certain groups, predominantly environmental activists, believe their behaviour reduces their anxiety, although these findings provide little causal evidence and are based on specific demographics experiencing climate anxiety.

Importantly, our results align with recent research from Contreras et al. (2024), who investigated the temporal relationship between climate anxiety, as measured with the CCAS, as well as climate-related anger and sadness, and pro-environmental behaviour daily for 60 days. This Belgian study found no significant effects of climate anxiety on pro-environment behaviour, or vice-versa. Interestingly, only eco-anger demonstrated a reciprocal relationship with pro-environmental behaviour over time.

Possible Explanations

These findings suggest that climate anxiety and pro-environmental behaviour do not actually have much, if any, effect on one another. There are a few possible explanations for this. Thinking rationally, it might be that individuals understand that behaving pro-environmentally will not mitigate climate change to any appreciable degree. As a result, they may not feel motivated to engage in these behaviours even if they are anxious, and even if they do, they might not experience relief from their anxiety symptoms. That is, if pro-environmental behaviour does not meaningfully reduce or eliminate the source of their anxiety – climate change – their anxiety about this issue may remain unchanged. It is feasible that individuals sense their pro-climate behaviours will make negligible difference to

greenhouse gas emissions given the overwhelming scale and omnipresence of the threat, and the tendency to underestimate the willingness of our fellow citizens to act (Andre et al., 2024). It is also possible that the act of *doing* pro-environmental behaviour may not be enough alone to lower climate anxiety; a person may also require some knowledge of the consequences of that behaviour in order to reduce their anxiety about the crisis. Literature on household power consumption shows people often misperceive their energy use and lack information on the amount of energy that can be conserved by different behaviours (Lesic et al., 2018). However, providing feedback can increase energy conservation (Abrahamse et al., 2007; Aydin et al., 2018). Perhaps understanding the consequences of their behaviour is necessary in order for the behaviour to reduce anxiety about climate change.

Another related explanation is that anxiety, in the context of climate change, may not be an effective motivator of behaviour in general. Indeed, anxiety is often marked by avoidance rather than approach behaviour (Barlow, 2004). There are several select examples from public health, specifically for smoking, skin cancer and HIV/AIDS (e.g., Janz & Becker, 1984; Witte & Allen, 2000), where fear has propelled people to change what they do. However, it is argued that fear only effectively motivates action when an individual's perceived efficacy outweighs the perceived threat (Witte, 1992). It seems feasible that for the huge, slow-moving and deeply complex issue of climate change, people have little confidence that their individual behaviour can reduce emissions. Most of us feel – and really are – pretty helpless.

It might also be that there are more pivotal determinants of both climate anxiety and pro-environmental behaviour that overshadow the impact these variables have on one another. Research suggests that whether or not a person behaves pro-environmentally might be influenced by other psychological factors such as other emotions, self-efficacy, knowledge, values and attitudes towards the particular pro-environmental behaviours (van

Valkengoed et al., 2022), along with practical factors like the cost, availability and convenience of environmentally-friendly choices (Kollmuss & Agyeman, 2002). It is possible these variables added "noise" variation that reduced power and potentially weakened the effect of climate anxiety on behaviour in our findings. Hence, any effect of climate anxiety on pro-environmental behaviour is very small and thus not easily detectable. Likewise, there are other determinants of climate anxiety, such as media exposure, knowledge and understanding of climate science, and direct experience of climate impacts (Kankawale & Niedzwiedz, 2023), which could potentially have a more significant influence on climate anxiety than pro-environmental behaviour. It might even be that the act of thinking about climate change is a powerful determinant of climate anxiety. People who work to mitigate climate change tend to think about the crisis a lot (Kleres & Wettergren, 2017), so it is possible this cognitive effect renders the effects of behaviour on climate anxiety relatively small.

The other important possibility is that climate anxiety and pro-environmental behaviour *do* in fact affect one another, just not in a way that could be detected in this study. There are plausible reasons that this might be the case. Firstly, our study was designed to detect linear relationships, but it is possible that the relationship between these variables is non-linear. Looking specifically at the effect of climate anxiety on pro-environmental behaviour, where we had particular reason to expect an effect, we considered that a certain level of anxiety might be needed to spur people to behave pro-environmentally, and maybe participants in this study were not experiencing the level required to bring about action. Indeed, findings from the exploratory analysis suggest that, at the between-person level, the relationship may be non-linear. There was a more pronounced increase in pro-environmental behaviour at lower levels of climate anxiety, and this rate of increase diminished, especially at the highest levels of climate anxiety. However, the slopes remained positive, hence, there

is no convincing evidence of an inverted U-shaped relationship. The within-person analysis revealed a general trend of increasing pro-environmental behaviour with rising personal deviations in climate anxiety, although this relationship was not strictly linear. These findings broadly align with the few other studies on the topic (Heeren, Mouguiama-Daouda, & Contreras, 2022; Latkin et al., 2022), and suggest that climate anxiety might be associated with pro-environmental behaviour in an inconsistent way that may not have been detected by our linear analysis method.

It is also possible we did not detect a causal relationship because climate anxiety and pro-environmental behaviour could affect individuals differently. Some people with climate anxiety might become motivated to take action while others feel overwhelmed and become inactive (Innocenti et al., 2023). These contrasting responses could lead to an overall null effect across the sample. Similarly, behaving pro-environmentally might make some individuals feel better in themselves in a way that lowers their anxiety symptoms, while others find their actions bring no relief. This explanation aligns with methodological literature showing that psychological processes often exhibit intraindividual variation that may not be fully captured by group-based analyses (Molenaar, 2004).

While the literature is far from clear on the role of individual differences in this relationship, it seems feasible that the anxiety-behaviour link could differ according to an individual's lifestyle, personal circumstances, personality traits and values. For instance, it might be that environmental volunteers and climate activists, with their stronger connection to nature and environmental values, are more motivated to channel their anxiety into behaviour than individuals who are less environmentally focused (de Groot & Steg, 2010). The same might be said of an individual who believes their behaviour is benefiting the environment compared with an individual who feels the action is futile (Kollmuss & Agyeman, 2002). These differences are similar to those seen in people presenting with the

same anxiety disorder, who may meet the same diagnostic criteria but can *look* very different and have very different experiences of anxiety; for instance, over-thinking versus avoidance of thinking (for more on symptom heterogeneity, see Nandi et al. (2009)). Framed thus, whether a person responds with pro-environmental behaviour may depend on that individual's experience of climate anxiety, among other factors.

Strengths and Limitations

The present study has many strengths; in particular its use of a relatively large, well-powered sample that offers some assurances in the reported relationships between climate anxiety and pro-environmental behaviour. All participant data were gathered from a high-quality source (Palan & Schitter, 2018) and our mean retention rate of 84.25%[4] was markedly higher than that usually achieved in longitudinal studies (Teague et al. (2018) report a mean retention rate of 73.5% in their meta-analysis of 143 longitudinal studies). Furthermore, the study was preregistered to create a public record of the methodological and analytical decisions made prior to data collection, allowing others to transparently evaluate the capacity of our research to falsify our hypotheses (Lakens, 2019). Lastly, the use of a RI-CLPM allowed us to partial out the between-person factors and focus only on the within-person elements of interest while accounting for measurement error so as not to bias cross-lagged coefficients. With the exception of Contreras et al. (2024), who demonstrated similar strengths in estimating causal effects using the multilevel vector autoregressive model, to our knowledge, our study is the first to apply the RI-CLPM method using these variables. However, our study also has limitations that must be considered when interpreting the results.

[4] Calculated by averaging the retention rates from Wave 2 to Wave 5.

Causal Inferences

The longitudinal design allowed us to demonstrate covariation between climate anxiety and pro-environmental behaviour, and establish temporal precedence of hypothesised cause before hypothesised effect. Use of random intercepts in our RI-CLPM allowed us to rule out stable confounding variables influencing results. However, our results may be biased by unmeasured time-varying confounding variables that may have hindered our ability to establish causal relationships based on the processes observed (Bollen, 1989). It is theoretically possible that a time-varying confound suppressed the relationship between these variables, even if they truly do affect one another. For instance, a confound that has a negative effect on climate anxiety and a positive effect on pro-environmental behaviour might mask anxiety's positive effect on behaviour. Moreover, for such a confound to significantly bias our estimates, it would need to impact climate anxiety and pro-environmental behaviour at different rates or times, thus introducing additional complexity in detecting and correctly attributing cause and effect relationships (Rohrer & Murayama, 2023). However, this relatively subtle and complex threat to internal validity is unlikely to have compromised the overall validity of our findings. To address the troublesome issue of causal inference, the present study does as Grosz et al. (2020) recommend and explicitly states causal assumptions, such as the absence of time-varying confounding variables, as well our express interest in causal effects.

Temporal Issues

Another limitation worth mentioning is the possibility that the interval between data collection waves may not have been optimal—potentially being either too long or too short—to capture the dynamic effects of these variables on one another. First, consider that the waves may have been too short. For example, climate anxiety might initially lead to inaction, but as people process their emotions and gather information, it could eventually result in

behavioural change (Kleres & Wettergren, 2017). This transformation could be more gradual than our monthly collections allowed. A recent study by Hogg et al. (2024) found that levels of climate anxiety, at least when measured with the Hogg Eco-Anxiety Scale, change very little across a two-week period. In our study, the ICC for the CCAS was 0.67, suggesting that climate anxiety is more trait-like than state-like. This moderate to high reliability indicates that climate anxiety is relatively stable over short periods, implying that longer study durations might be necessary to observe its impact on pro-environmental behaviour. Conversely, it is also possible that the time between waves was too long. Fear appeal research shows that strong negative feelings can lead swiftly to decisions to donate to a charity or sign up for a tree-planting programme (Hine & Gifford, 1991), so it is also conceivable that anxiety measured one month prior is no longer present to the extent that it could influence how that person acts or, alternatively, that any effect of anxiety on behaviour at one wave happens so quickly that its effect is fully captured in the PEBS measurement in the same wave. Likewise, regarding the impact of pro-environmental behaviour on climate anxiety, our wave intervals might again have been too short or too long to capture dynamic effects.

Research indicates that, when studying a phenomenon over varying time periods, researchers often find different lagged effect estimates (Kuiper & Ryan, 2018), although results are likely also influenced by noise or other complexities in time series analyses. Crucially, choosing a time interval that differs from the actual timeframe of causal effects can introduce significant biases in the estimation. For example, Bollen (1989) notes that, if the measurement intervals exceed the actual time intervals in scenarios where one variable impacts another, the relationship might appear as reciprocal causation. However, the one-way nature of the effect would become evident in shorter time lags. This challenge is compounded by limitations in theoretical frameworks, which, as is often the case in psychology (Scholz, 2019), do not provide explicit guidance on the expected duration of effects between variables

such as climate anxiety and pro-environmental behaviour. Consequently, the selection of the time interval between data collection waves becomes somewhat arbitrary, lacking a direct theoretical basis to hypothesise effects of a specific duration.

Limited Within-Person Variance

Study findings may also have been impacted by the limited within-person variance observed for each of our measures. ICCs of 0.67 for climate anxiety and 0.81 for pro-environmental behaviour, together with small within-person variances reported for both scales, indicates that mean scores varied little from wave to wave. This may have reduced the statistical power for detecting cross-lagged effects.

While this limited variance might reflect the highly stable nature of climate anxiety and pro-environmental behaviour, it is possible the addition of a 3-week survey timeframe may also have contributed by potentially reducing occurrences of certain experiences, thereby not capturing fluctuations in scores. This is because in very many cases, participants responded to a CCAS item with the lowest possible option ('*never*'). On the CCAS, many of the symptoms are rare enough (e.g., crying over climate change) that participants might not experience them at all within any given 3-week period. So a person who experienced a symptom only once or twice in their entire life might select *rarely* on the original scale, but experience the symptom *never* in the last 3 weeks. It is possible the same was true for the PEBS, however, the fact that the behaviours probed in the PEBS are more common everyday occurrences (e.g., washing clothes, turning off lights) may have made it less of a driver of the observed high stability. Furthermore, far fewer PEBS responses were *nevers*.

One method to investigate the extent to which statistical power was reduced is via the inspection of confidence intervals for the cross-lagged effects. The interval for the cross-lagged effect of climate anxiety on pro-environmental behaviour, measured with unstandardised coefficients, was relatively narrow [-.06, .07], indicating we can rule out

anything but a small effect with reasonable confidence. However, for the cross-lagged effect of pro-environmental behaviour on climate anxiety, the confidence interval was estimated less precisely [-.26, .64], and so while we can rule out a large positive effect (e.g., > .51) with reasonable confidence, it remain possible there was a smaller but substantial effect that we lacked the statistical power to detect. Furthermore, it should be noted that the ICCs in our study were not that high, at least compared to the value of 0.9 that was assumed in the power analysis, so perhaps these variance issues are not a critical limitation.

Measurement of Climate Anxiety

Beyond the aforementioned problem of limited variance, there were other issues with way climate anxiety was measured that might also have impacted the validity of our findings. In particular, CCAS scores were low in the sample, with an average score across all waves of 1.19 on a 1-5 scale. Just two people reported being more than *sometimes* affected by climate anxiety on average across the study duration (a score of 3 or more). CCAS mean scores are typically quite low. Our scores were similar to the mean of 1.25 reported by Whitmarsh et al. (2022), but somewhat lower than those found by Feather and Williams (2022) (1.47), Schwartz et al. (2022) (1.52) and Lutz et al. (2023) (1.61), and notably lower than the mean of 1.89[5] reported by Clayton and Karazsia (2020). It seems possible that scores on the CCAS are generally low because the scale is capturing only more severe representations of climate anxiety. As others have suggested, the CCAS seems to have difficulty differentiating at the mild to moderate end of the climate anxiety spectrum (Feather & Williams, 2022; Lutz et al., 2023; Wullenkord et al., 2021). We propose that this lack of sensitivity became even more evident in our study where participants were asked to reflect on a specific recent period. If the scale had difficulty picking up more mild climate anxiety experiences among our sample, it

[5] This weighted mean was calculated using the cognitive impairment sub-scale score (1.75) and functional impairment subscale score (2.09) reported in study 1.

may not be sensitive enough to detect any meaningful change in anxiety levels, explaining the failure to identify a causal relationship.

This lack of differentiation is also evident when comparing the low CCAS scores with considerably higher scores on a single item measuring climate change worry. Among our sample, half of respondents (49.9%) reported being either *very* or *extremely worried* about climate change. Of course, it is possible this disparity in results might reflect the distinction Clayton and Karazsia (2020) make between "worry" about climate change and the cognitive, emotional and functional impact that climate anxiety may have on someone's life, which appear to be far less common. So it might be that people are highly concerned about the climate crisis, but not (yet) to the extent that this concern usually affects their daily lives.

These low scores leave questions about the construct validity of the CCAS, particularly concerning what precisely the scale is measuring and whether it effectively captures what climate anxiety is. While relatively well established and validated, some scholars suggest the CCAS might not comprehensively encapsulate the emotional experience of climate anxiety, but could instead represent a collection of various impairments arising from the climate crisis (Wullenkord et al., 2021). The difficulties faced by the scale are likely due, at least in part, to the lack of conceptual clarity around the construct of climate anxiety (Coffey et al., 2021). Identifying and defining constructs is essential in psychology if any experience of the mind is to be studied empirically (Cronbach & Meehl, 1955), and is an essential for the development of accurate mental health measures (Flake & Fried, 2020). Without a clear *conceptual* definition of climate anxiety, it is very difficult to produce a valid *operational* definition, that is a scale, to align it with. Despite our efforts to define climate anxiety clearly in this thesis, the theoretical base is poorly developed, leaving considerable questions about what it is (and is not), and what dimensions it contains. Thus, we cannot rule

out validity and sensitivity issues as explanations for the lack of significant causal effect identified in our study.

Measurement of Pro-Environmental Behaviour

Our self-report measure of pro-environmental behaviour might also have limited the validity and reliability of the findings. While self-reports can be valuable when assessing constructs aimed at defining emotions and behaviour (Haeffel & Howard, 2010), there are concerns that participants lack the ability to assess themselves accurately in psychometric questionnaires (Vazire & Carlson, 2011). Indeed, self-reported pro-environmental behaviour often shows weak relationships with objectively measured pro-environmental behaviour (Kormos & Gifford, 2014; Lange & Dewitte, 2021), which means that the causal inferences drawn from our results come with substantial uncertainty attached. For instance, participants might have had difficulty working out whether certain pro-environmental behaviours were performed in the preceding 3-week period, as the study requests. We sought to limit some of these influences by measuring behaviour rather than the even less reliable intention, clearly naming the time period in each question and randomising the order in which our two scales were presented to participants so as to not systematically prime all respondents with climate anxiety awareness prior to answering behavioural questions.

Our pro-environmental behaviour measure was also adapted specifically for this study; therefore, its validity is unknown. The decision to adapt the PEBS was a necessary compromise that allowed us to use a scale that specifically sought to capture a wider range of behaviours deemed to have a meaningful impact on greenhouse gas emissions. While not ideal, an adapted scale arguably has more validity than yet another custom-made, single-use pro-environmental behaviour scale in an already cluttered psychometric landscape.

Directions for Future Research

While our study found no evidence of causal effects of climate anxiety on pro-environmental behaviour or vice versa, further causally-focused research is needed to confirm this is the case. The simplest first step to test our results would be to conduct a straightforward replication study, using the existing analytic strategy and code. Researchers could recruit from climate-sensitive populations, such as climate activists or younger people, who are likely to score higher on the CCAS, thus increasing the likelihood of capturing changes in anxiety levels and how it relates to pro-environmental behaviour. Replication studies are inherently valuable. They serve not only to verify the original findings but also to bridge existing and new knowledge (Schmidt, 2009), rather than being focused on fixing some deficit in the current study. Another possibility is that researchers explicitly test the hypothesis that there are *no effects*, as we found, by employing equivalence testing (Lakens, Scheel et al., 2018), a robust statistical method that allows for more confident assertions about the absence of meaningful differences. We would also encourage further exploration of the role of individual differences, possibly with the use of a latent profile analysis (Gibson, 1959) or case-based time series design (Borckardt et al., 2008), to help to pinpoint specific subgroups that exhibit unique responses in the way climate anxiety and pro-environmental behaviour affect one another.

Work is also needed to develop more comprehensive, temporally-bound psychological theories to explain how climate anxiety and pro-environmental behaviour might causally relate. As it stands, the theoretical landscape is murky, with many ideas, both overlapping and contradictory, that account for how the two variables might affect each other in different contexts and over different timeframes. In particular, no theories address the speed at which these processes unfold and until they do, capturing causal change involves significant guesswork. To address these unknowns, Hamaker (2023) suggests a focus on

developing stronger temporal understandings about how fast or slow processes in a potential causal relationship are occurring, what patterns characterise them, and when they take place or change. This knowledge can then guide important methodological decisions about the time span of a study, the number of measurements that are needed, and the time intervals between the measurements, that will impact the results obtained. An alternative approach could be to systematically experiment with a range of time lags between data collections to identify the optimal time interval for observing the maximum effects of these variables on one another (Dormann & Griffin, 2015). Such work would give researchers more confidence in results obtained. In particular, it would be important to see whether the low climate anxiety scores obtained in our study persisted under these various time intervals, thereby deepening understanding of how climate anxious the population really is. This investigation would also help clinicians better understand how climate anxiety is experienced temporally, that is, whether it is relatively static or more dynamic and changing over time, which has implications for treatment.

Future research could also improve on the measurement of climate anxiety. This could involve further validation to adapt the CCAS by, for instance, potentially removing items such as those focused on rumination that might not add value to the scale (Feather & Williams, 2022). Such work might reshape the scale to better capture gradations and degrees of severity of climate anxiety (Wullenkord et al., 2021). Alternatively, validating the newly introduced Hogg Climate Anxiety Scale (Hogg et al., 2024) could offer insights into whether it better represents the construct compared to the CCAS. Another potentially more fruitful approach could be to establish a specific theory of climate anxiety, given the substantial uncertainty about its nature and how it is experienced. Such theoretical grounding could inform the development of a new scale unencumbered by the criticisms of generally low scores and questionable face validity of some items, that have been levelled at the CCAS. A

new measure could be more sensitive to allow for more reliable discrimination among those with low to moderate levels of climate anxiety, which in turn may improve the power and precision of data analyses investigating relationships between climate anxiety and other variables. Importantly, replicating the present study with such a measure may provide a more accurate depiction of how climate anxiety impacts pro-environmental behaviour over time, and vice versa. Furthermore, as rates of climate anxiety are expected to rise with the deepening climate crisis, a more sensitive scale could help clinicians and researchers in developing and evaluating clinical interventions to manage climate anxiety.

Work could also be undertaken to adapt and further validate the PEBS or develop a new pro-environmental behaviour scale to include only those behaviours empirically established to help mitigate climate change (Lacroix, 2018), and with content relevant to the lifestyles of respondents (Miller et al., 2022). In doing so, researchers could closely consider what constitutes an individual pro-environmental behaviour. In the present study, we identified a potential conceptual muddle in that these behaviours mostly seemed to be operationalised as actions that directly reduce emissions in everyday life, rather than more public-sphere behaviours such as political activism, lobbying MPs, joining pressure groups and other efforts aimed at social change, that also feasibly constitute an individual pro-environmental behaviour. A scale more targeted at measuring a wide range of high-impact individual pro-environmental behaviours would allow more accurate testing of the behaviour-climate anxiety relationship, as well behaviour's relationship to other potentially more important determinants.

Finally, another related avenue could be to explore whether anxiety is more likely to be affected by pro-environmental behaviour that is deliberately carried out to reduce climate anxiety. Studies to date, including our own, are limited by capturing only what people did (or did not) do, including, crucially, those behaviours almost automatically engaged in simply

because of the way institutions, laws, and social norms work. These require almost no effort or even awareness because society decides for us that we should engage in them. The decision is baked into our environment. In this sense, the behaviour may not be sought out or consciously performed. This raises the question of whether pro-environmental behaviours might reduce climate anxiety only if the person deliberately and consciously engages in the behaviour to alleviate their anxiety. This notion could be explored by comparing climate anxiety levels before and after participants engage in self-chosen versus assigned pro-environmental behaviours, to see whether intentional, self-directed actions more effectively reduce anxiety.

Clinical Implications

Our findings have important implications in terms of the conceptualisation of climate anxiety and the approach to supporting people experiencing this type of distress. Firstly, levels of climate anxiety in our sample were very low. Most people experienced, at most, mild symptoms, and almost a third experienced none at all. While it is possible these low scores represent a measurement problem, it is also feasible that people, or at least those in our sample, are simply not anxious about climate change. For some, it might be that they deny climate change is occurring; however, the rates of some type of denial were relatively low in our study (13% thought climate was caused by natural events, was not occurring, or were unsure). It could also be that individuals may still, on the whole, perceive climate change as temporally, socially, or spatially distant, and hence, do not experience anxiety to the extent that it impacts daily functioning (Trope & Liberman, 2010). It is also possible that accepting the reality of climate change and the potential severity of its consequences conflicts with an individual's existing beliefs or lifestyle, so they may downplay the issue to reduce cognitive dissonance and maintain psychological comfort (Festinger, 1957). Other explanations for low climate anxiety might be the human tendency towards optimism bias in which individuals

believe that negative events are less likely to happen to them personally compared to others (Sharot, 2011), or ego-defence mechanisms, such as rationalisation, which could involve downplaying the importance of individual actions or attributing responsibility to external factors (Vaillant, 1992). Finally, it may even be a form of apathy, where individuals exhibit a general indifference or emotional detachment when faced with the complex and overwhelming nature of climate change (Bickel & Preston, 2023).

Another implication of these low scores is that, if people are not anxious about climate change, it suggests there may not be a need for clinical interventions to treat it. This is at odds with anecdotal evidence in the media (Barry, 2022; Whitcomb, 2021) suggesting an increased demand for therapy to treat climate anxiety. Moreover, even if most people experience very limited symptoms of climate anxiety, this does not preclude the possibility that some people experience clinically significant levels. For example, two study participants scored over the CCAS midpoint of 3 on average across all waves, indicating they experienced climate anxiety-related impairments more than *sometimes* in the three weeks prior to each of the waves. Consequently, it does remain useful to consider how clinicians might respond to the (likely small) number of people who experience clinically significant climate anxiety who are experiencing cognitive, emotional and functional issues at a frequency that might cause distress. Bearing this in mind, we can consider the specific implications of our findings as they relate to our hypotheses.

Firstly, we found no evidence that climate anxiety affects pro-environmental behaviour. The positive association observed between these variables has led to the assumption that anxiety increases these behaviours, giving rise to some concern that efforts to alleviate climate anxiety might inadvertently reduce much-needed pro-climate behaviour (Bingley et al., 2021; Cunsolo et al., 2020; van Valkengoed & Steg, 2023). However, our results found no evidence that climate anxiety has an influence on pro-environmentalism,

therefore there is little reason for concern that treating and subsequently reducing anxiety will have this undesirable consequence.

Secondly, our study challenges the anecdotal belief that behaving pro-environmentally will lower climate anxiety. Of course, this is not to say pro-environmental behaviours should be discouraged. Indeed, there are other important reasons to engage in pro-environmental behaviour, most importantly to mitigate climate change but also to improve physical health, environmental knowledge, nature connectedness and social cohesion (Pothitou et al., 2016; Rosa & Collado, 2020; Whitburn et al., 2020). However, our finding does inform clinicians that, if reducing climate anxiety is the goal, prescribing pro-environmental behaviour might not always be the most effective treatment target. It also raises questions about the effectiveness of numerous interventions (see Baudon & Jachens, 2021), including those offered by clinicians (e.g., (https://www.goodgriefnetwork.org) and promoted in self-help books (Grose, 2020; Ray, 2020), that often include pro-climate behaviours as a cornerstone of a programme to alleviate climate anxiety.

While encouraging climate action as treatment seems unlikely to cause harm, and may bring other positive consequences for the planet and the person, our findings do suggest that for the small subset of people who experience high levels of climate anxiety there is a need to shift focus to new treatment approaches for climate anxiety that are empirically grounded in research. There is a dearth of randomised controlled trials investigating current therapeutic approaches for treatment of climate anxiety. In three recent reviews (Baudon & Jachens, 2021; Bingley et al., 2021; Jarrett et al., 2024), problem-focused action, essentially increasing pro-environmental behaviours, emerged as a key theme among current interventions, although none of these interventions had been well tested. These reviews also identified emotion management, enhancing social connection and building resilience (e.g., Fraser et al., 2013; Gibson et al., 2019; Verlie, 2021) as other key themes in climate anxiety interventions.

One study that explored therapy experiences from the perspective of climate anxious clients found that therapists' knowledge of climate change, their ability to cope with this knowledge, and that use of values and validation of climate-related emotions were the most salient aspects of therapy (Budziszewska & Jonsson, 2022). These insights can inform the development of more effective interventions for individuals experiencing climate anxiety.

Finally, this research has also revealed considerable gaps in the way climate anxiety is defined, conceptualised and measured. In conducting this study, we followed steps outlined by Flake and Fried (2020) to promote transparency in the treatment of psychological constructs. However, it was challenging to clearly define a construct and describe supporting theories in the absence of an established theoretical framework, and then match our newly-established understanding of what climate anxiety is onto an existing measure that itself lacks a theoretical base. Without a clear conceptualisation, it is difficult to establish what climate anxiety actually *is*, that is, what emotions, cognitions, bodily sensations and/or behaviours are involved it its expression, and whether these experiences are accurately captured in current measurement tools. Until these benchmarks are more established, debate will continue as to whether climate anxiety is an inherently psychological "problem" or if, in fact, it is more nuanced as most other types of mental distress are, in that low levels are often not problematic (e.g., intermittent sadness, occasional anxiety, anger in certain situations). Regardless, even with further conceptual development, a natural tension is likely to remain between the importance of recognising climate anxiety as a legitimate and understandable response to the climate crisis and the need to identify when it causes significant distress and impairment in order to be able to offer appropriate support to those who need it.

Conclusion

Our study finds no evidence that climate anxiety and pro-environmental behaviour are causally related. These findings contrast with the existing empirical and theoretical literature

which, while mixed, largely suggests that climate anxiety motivates a person to act pro-environmentally, and that these actions will reduce a person's climate anxiety. Our results may reflect that people recognise their pro-environmental behaviour makes a negligible difference to reducing greenhouse gas emissions given the scale of the threat, and that perhaps anxiety, experienced in the context of climate change, is not an effective motivator. Additionally, it is possible that both climate anxiety and pro-environmental behaviour are influenced by more important determinants than one another. Further longitudinal research, including replication studies using our analytical rationale and code, is needed to confirm our findings. Importantly, advancing our conceptual understanding of climate anxiety and developing theories to clarify the potential causal relationships and their temporal dynamics is essential. Such work will guide methodological decisions, improve measurement tools, and strengthen confidence in these results.

Regarding implications, this research suggests that, while there are many valid and important reasons to encourage people to behave pro-environmentally, there is currently no strong evidence base for clinicians to recommend they do so to reduce climate anxiety. However, it also indicates that clinicians can help clients reduce anxiety symptoms without concerns that this may deter them from taking pro-environmental action. Climate change is regarded as one of the most serious challenges of our time. While we found generally low levels of climate anxiety, as the crisis progresses, and its impacts become increasingly visible worldwide (IPCC, 2022a), we can anticipate rising rates of debilitating climate anxiety and a more urgent need for people to engage pro-environmentally to help mitigate climate change. Therefore, it is critical that we, as researchers and scientist-practitioners, strive to better understand these constructs and how they affect one another as we face this impending crisis.

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Appendices

Appendix A: Survey Materials

This appendix contains two surveys downloaded from the online survey platform, Qualtrics. The first is the wave 1 survey, which includes demographic items and additional questions about climate change. The second is the wave 2 survey which does not contain these additional items. Wave 3-5 surveys are not included here as they are identical to wave 2 in every way except the value of reimbursement offered for survey completion, and the specific text used for the attention check item. For the sake of the completeness, attention check items included in wave 3-5 surveys are replicated at the end of this appendix. Attention check items were presented in the middle of the PEBS items.

Wave 1 Survey

Block: Consent

Branch: New Branch
If
If Having read the information sheet above, do you consent to participate in this study? No Is Selected

EndSurvey: Advanced

Standard: Screening

Branch: New Branch
If
If What is your age? Text Response Is Less Than 18
Or In which country do you currently reside? Other Is Selected

EndSurvey: Advanced

Standard: Demographics
Standard: CCItems

BlockRandomizer: 2 - Evenly Present Elements

Standard: CCAS
Standard: PEBS

Standard: Summary

Start of Block: Consent

Information Sheet

Researcher introduction My name is Tamara McLean; I am a doctoral candidate within the School of Psychology at Massey University in New Zealand. My research is overseen by my primary supervisor, senior lecturer Dr Matt Williams and by my co-supervisors Associate Professors Stephen Hill and Joanne Taylor, all from Massey University.

Project description

This study is designed to investigate the extent to which Australians and New Zealanders experience anxiety in relation to climate change. I am also interested in knowing what types of green 'sustainable' behaviours you engage in, and how often you've done them recently. To be eligible to participate in this study you need to be at least 18 years old, and be living in Australia or New Zealand.

If you complete this survey carefully and attentively, I hope to invite you to complete similar (but shorter) follow-up surveys at one-monthly intervals over the next four months (5 surveys total).

Project procedures

If you choose to participate, you will be asked to indicate the extent to which you experience different symptoms relating to climate anxiety in the past three weeks. You will also be asked whether, and to what extent, you have engaged in a range of green 'sustainable' behaviours over that same period. Some basic demographic questions about yourself are also included. The survey will include 43 closed-ended questions in total, and will take around 5 minutes. If you complete the survey, you will receive GBP0.75 via Prolific.

I do not anticipate that completing this survey will cause you any discomfort or harm. If you do experience distress, you can find contact numbers for free mental health support services in Australia on the Health Direct website, and in New Zealand on the Mental Health Foundation website.

Data management

After I have completed data analysis, the data from this study will be made publicly available on the Open Science Framework and stored indefinitely. This means that other researchers and members of the public will be able to use the data to run analyses that help answer new research questions. Before sharing the data, I will remove any information that might indicate who you are (e.g., your Prolific ID).

Participant rights

You are under no obligation to accept my invitation to take part in this research. If you decide to participate, you have the right to decline to answer any particular question, or to stop answering questions at any time.

Project contacts

If you have any questions about this research, you are welcome to contact me at tamara.mclean.2@uni.massey.ac.nz or M.N.Williams@massey.ac.nz, or by using the Prolific messaging system.

Ethics statement

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researchers

named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researchers, please contact Prof Craig Johnson, Director, Research Ethics at Massey University, telephone +64 6 356 9099 x 85271, email humanethics@massey.ac.nz. (Ethics notification number: 4000026848).

Having read the information sheet above, do you consent to participate in this study?

- ○ Yes
- ○ No

End of Block: Consent

Start of Block: Screening

Please enter your Prolific ID (if it's correctly displayed already, you can move to the next question).

_____

What is your age?

_____

In which country do you currently reside?

- ○ Australia
- ○ New Zealand
- ○ Other

End of Block: Screening

Start of Block: Demographics

Which gender do you identify with?

- ○ Male
- ○ Female
- ○ I identify my gender as _____

Which ethnic group(s) do you identify with?

- ☐ European or Pākehā
- ☐ NZ Māori
- ☐ Asian (including South Asian)
- ☐ Pacific peoples
- ☐ Other _____

Which ethnic group(s) do you identify with?

- ☐ European/ White
- ☐ Asian (including South Asian)
- ☐ Aboriginal or Torres Strait Islander
- ☐ Other _____

What is the highest level of education you have completed?

- ○ Doctoral degree (e.g., PhD, PsyD, MD)
- ○ Postgraduate degree (e.g., Masterate)
- ○ Undergraduate degree (e.g., Bachelor's)
- ○ Other tertiary qualification
- ○ Completed high school
- ○ Some high school (without completing)
- ○ No high school

What is your personal income (before tax) per year in New Zealand dollars? (NZ only)

- ○ Less than $20,000
- ○ $20,000 - $39,999
- ○ $40,000 - $59,999
- ○ $60,000 - $79,999
- ○ $80,000 - $99,999
- ○ $100,000 or more

What is your personal income (before tax) per year in Australian dollars? (AU only)

- ○ Less than $20,000
- ○ $20,000 - $39,999
- ○ $40,000 - $59,999
- ○ $60,000 - $79,999
- ○ $80,000 - $99,999
- ○ $100,000 or more

Which of these best describes your employment status over the last three months?

- ○ Working full-time
- ○ Working part-time
- ○ Unemployed and looking for work
- ○ A homemaker or stay-at-home parent
- ○ Student
- ○ Retired
- ○ Other

What is your current marital status?

- ○ Married
- ○ In a civil union/de facto/partnered relationship
- ○ Widowed
- ○ Divorced/separated
- ○ Single

Which of these best describes the general area where you live?

- ○ Urban
- ○ Suburban
- ○ Rural or remote

End of Block: Demographics

Start of Block: CCItems

Which of the following three statements do you personally believe?

- ○ Climate change is happening now, caused mainly by human activities
- ○ Climate change is happening now, but caused mainly by natural forces
- ○ Climate change is not happening now
- ○ Unsure/don’t have an opinion

Which of the following three statements do you personally believe?

- ○ Climate change is happening now, caused mainly by human activities
- ○ Climate change is happening now, but caused mainly by natural forces
- ○ Climate change is not happening now
- ○ Unsure/don't have an opinion

How worried are you about climate change?

- ○ Not at all worried
- ○ Not very worried
- ○ Somewhat worried
- ○ Very worried
- ○ Extremely worried

End of Block: CCItems

Start of Block: CCAS

The following statements relate to particular climate change experiences. Please rate how often the following statements have been true of you in the past three weeks.

In the past three weeks, thinking about climate change has made it difficult for me to concentrate.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, thinking about climate change has made it difficult for me to sleep.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have had nightmares about climate change.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have found myself crying because of climate change.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have thought, “why can’t I handle climate change better?”

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have gone away by myself and thought about why I feel this way about climate change.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have written down my thoughts about climate change and analysed them.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have thought, “why do I react to climate change this way?”

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my concerns about climate change have made it hard for me to have fun with my family or friends.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my concerns about climate change have interfered with my ability to get work or school assignments done.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my concerns about climate change have undermined my ability to work to my potential.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my friends have said I think about climate change too much.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

End of Block: CCAS

Start of Block: PEBS

The following questions ask you to what extent you have engaged in particular 'sustainable' behaviours in the past 3-week period.

In the past three weeks, how often have you turned off the lights when leaving a room?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you switched off standby modes of appliances or electronic devices?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you cut down on heating or air conditioning to limit energy use?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you turned off the TV when leaving a room?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you limited your time in the shower in order to conserve water?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you waited until you have a full load to use the washing machine or dishwasher?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

Please select “always” for this item if you’re paying attention.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, at which temperature have you washed most of your clothes?

- ○ Hot
- ○ Warm
- ○ Cold

In the past three weeks, have you taken a domestic or international flight?

- ○ Yes
- ○ No

During the past three weeks, have you contributed money to an environmental, conservation, or wildlife protection group?

- ○ Yes
- ○ No

In the past three weeks, how often have you walked or cycled instead of driving?

- ○ Never
- ○ Occasionally
- ○ Frequently

In the past three weeks, how often have you thrown away cooked or uncooked food that could have been eaten?

- ○ Never
- ○ Occasionally
- ○ Frequently

In the past three weeks, how frequently have you watched television programs, movies, or internet videos about environmental issues?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Constantly

In the past three weeks, how often have you talked to others about their environmental behaviour?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Constantly

In the past three weeks, how many servings of beef have you consumed? One serving is 65 grams (the size of a pack of playing cards).

- ○ None
- ○ 1-5 servings
- ○ 6-10 servings
- ○ 11-15 servings
- ○ 16 servings or more

In the past three weeks, how many servings of lamb have you consumed? One serving is 65 grams (the size of a pack of playing cards).

- ○ None
- ○ 1-5 servings
- ○ 6-10 servings
- ○ 11-15 servings
- ○ 16 servings or more

In the past three weeks, how often have you car-pooled?

- ○ Never
- ○ Occasionally
- ○ Frequently

In the past three weeks, how often have you used public transportation?

- ○ Never
- ○ Occasionally
- ○ Frequently

End of Block: PEBS

Start of Block: Summary

Thanks for participating in this survey!

A reminder: You can find contact numbers for free mental health support services in Australia on the Health Direct website, and in New Zealand on the Mental Health Foundation website.

Would you like to receive a **summary of findings** of this study once it is complete? (This will probably be sometime in late 2023).

If you answer "yes", I will send you a summary of findings once it is available, using the Prolific messaging system.

- ○ Yes
- ○ No

Did you experience any problems completing this survey? Please let us know. (Answering this question is optional).

_____

End of Block: Summary

Wave 2 Survey

Block: Consent

Branch: New Branch
If
If Having read the information sheet above, do you consent to participate in this study?
No Is Selected

EndSurvey: Advanced

BlockRandomizer: 2 - Evenly Present Elements

Standard: CCAS
Standard: PEBS

Standard: Summary

Start of Block: Consent

Information Sheet

Researcher introduction My name is Tamara McLean; I am a doctoral candidate within the School of Psychology at Massey University in New Zealand. My research is overseen by my primary supervisor, senior lecturer Dr Matt Williams and by my co-supervisors Associate Professors Stephen Hill and Joanne Taylor, all from Massey University.

Project description

This study is designed to investigate the extent to which Australians and New Zealanders experience anxiety in relation to climate change. I am also interested in knowing what types of green 'sustainable' behaviours you engage in, and how often you've done them recently. To be eligible to participate in this study you need to be at least 18 years old, and be living in Australia or New Zealand.

This survey is a shorter follow-up to a survey you completed a month ago. Thank you for

your involvement! I hope to invite you to complete similar follow-up surveys at one-monthly intervals over the next few months (5 surveys total).

Project procedures

As you might remember from last time, this survey asks you to indicate the extent to which you experienced different symptoms relating to climate anxiety in the past three weeks. You will also be asked whether, and to what extent, you have engaged in a range of green 'sustainable' behaviours over that same period. The survey will include 34 close-ended questions in total, and will take around 4 minutes. If you complete the survey, you will receive GBP0.60 via Prolific.

I do not anticipate that completing this survey will cause you any discomfort or harm. If you do experience distress, you can find contact numbers for free mental health support services in Australia on the Health Direct website, and in New Zealand on the Mental Health Foundation website.

Data management

After I have completed data analysis, the data from this study will be made publicly available on the Open Science Framework and stored indefinitely. This means that other researchers and members of the public will be able to use the data to run analyses that help answer new research questions. Before sharing the data, I will remove any information that might indicate who you are (e.g., your Prolific ID).

Participant rights

You are under no obligation to accept my invitation to take part in this research. If you decide to participate, you have the right to decline to answer any particular question, or to stop answering questions at any time.

Project contacts

If you have any questions about this research, you are welcome to contact me at tamara.mclean.2@uni.massey.ac.nz or M.N.Williams@massey.ac.nz, or by using the Prolific messaging system.

Ethics statement

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researchers named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researchers, please contact Prof Craig Johnson, Director, Research Ethics at Massey University, telephone +64 6 356 9099 x 85271, email humanethics@massey.ac.nz. (Ethics notification number: 4000026848).

Having read the information sheet above, do you consent to participate in this study?

- ○ Yes
- ○ No

End of Block: Consent

Start of Block: Screening

Please enter your Prolific ID (if it's correctly displayed already, you can move to the next question).

_____

End of Block: Screening

Start of Block: CCAS

The following statements relate to particular climate change experiences. Please rate how often the following statements have been true of you in the past three weeks.

In the past three weeks, thinking about climate change has made it difficult for me to concentrate.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, thinking about climate change has made it difficult for me to sleep.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have had nightmares about climate change.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have found myself crying because of climate change.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have thought, “why can’t I handle climate change better?”

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have gone away by myself and thought about why I feel this way about climate change.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have written down my thoughts about climate change and analysed them.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, I have thought, “why do I react to climate change this way?”

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my concerns about climate change have made it hard for me to have fun with my family or friends.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my concerns about climate change have interfered with my ability to get work or school assignments done.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my concerns about climate change have undermined my ability to work to my potential.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

In the past three weeks, my friends have said I think about climate change too much.

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Almost always

End of Block: CCAS

Start of Block: PEBS

The following questions ask you to what extent you have engaged in particular 'sustainable' behaviours in the past 3-week period.

In the past three weeks, how often have you turned off the lights when leaving a room?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you switched off standby modes of appliances or electronic devices?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you cut down on heating or air conditioning to limit energy use?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you turned off the TV when leaving a room?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you limited your time in the shower in order to conserve water?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

In the past three weeks, how often have you waited until you have a full load to use the washing machine or dishwasher?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually
- ○ Always

What day is typically the first day in the working week? This is an attention check. The correct answer is Monday.

- ○ Monday
- ○ Tuesday
- ○ Wednesday
- ○ Thursday
- ○ Friday

In the past three weeks, at which temperature have you washed most of your clothes?

- ○ Hot
- ○ Warm
- ○ Cold

In the past three weeks, have you taken a domestic or international flight?

- ○ Yes
- ○ No

During the past three weeks, have you contributed money to an environmental, conservation, or wildlife protection group?

- ○ Yes
- ○ No

In the past three weeks, how often have you walked or cycled instead of driving?

- ○ Never
- ○ Occasionally
- ○ Frequently

In the past three weeks, how often have you thrown away cooked or uncooked food that could have been eaten?

- ○ Never
- ○ Occasionally
- ○ Frequently

In the past three weeks, how frequently have you watched television programs, movies, or internet videos about environmental issues?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Constantly

In the past three weeks, how often have you talked to others about their environmental behaviour?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Constantly

In the past three weeks, how many servings of beef have you consumed? One serving is 65 grams (the size of a pack of playing cards).

- ○ None
- ○ 1-5 servings
- ○ 6-10 servings
- ○ 11-15 servings
- ○ 16 servings or more

In the past three weeks, how many servings of lamb have you consumed? One serving is 65 grams (the size of a pack of playing cards).

- ○ None
- ○ 1-5 servings
- ○ 6-10 servings
- ○ 11-15 servings
- ○ 16 servings or more

In the past three weeks, how often have you car-pooled?

- ○ Never
- ○ Occasionally
- ○ Frequently

In the past three weeks, how often have you used public transportation?

- ○ Never
- ○ Occasionally
- ○ Frequently

End of Block: PEBS

Start of Block: Summary

Thanks for participating in this survey!

A reminder: You can find contact numbers for free mental health support services in Australia on the Health Direct website, and in New Zealand on the Mental Health Foundation website.

Did you experience any problems completing this survey? Please let us know. (Answering this question is optional).

End of Block: Summary

Attention Check Items for Waves 3–5

Wave 3

What is the usual colour of fresh grass? This is an attention check. The correct answer is Green.

- ○ Red
- ○ Blue
- ○ Green
- ○ Orange
- ○ Purple

Wave 4

I climb Mount Everest to get to work every day.

- ○ Strongly disagree
- ○ Disagree
- ○ Agree
- ○ Strongly agree

Wave 5

The vegetable test you are about to take part in is very simple. When asked to select a vegetable, you must select ‘broccoli’. This is an attention check.

Based on the text above, what vegetable have you been asked to select?

- ○ Pumpkin
- ○ Potato
- ○ Carrot
- ○ Broccoli

Appendix B: Summary of Findings for Participants

Hello!
You completed our survey on climate change anxiety and sustainable behaviours in late 2022 – early 2023 and indicated you would be interested in receiving a summary of our findings. We've attached an outline of the research and results below.

Thanks again for your involvement. We couldn't have done it without you!
Cheers, Tamara

Background: Climate change poses a serious threat to psychological wellbeing. One particular negative emotional response gaining attention is climate anxiety, defined as anxious feelings arising from climate change, even among people not yet personally impacted by this global environmental crisis. Research shows that climate anxiety might be related to pro-environmental behaviour. Some say climate anxiety may motivate people to behave pro-environmentally, spurring them to engage in the very behaviours that, if widely adopted, could mitigate the damage caused by climate change. There is also an assumption that these sustainable behaviours will alleviate climate anxiety, creating a mutually beneficial outcome in which helpful behaviours increase and distressing anxious feelings are eased. However, these ideas are not well supported by empirical and theoretical evidence.
Study aims. Our study aimed to examine whether climate anxiety and pro-environmental behaviour do affect one another. We tested the hypotheses that 1) climate anxiety causes pro-environmental behaviour to increase over time, and 2) pro-environmental behaviour causes climate anxiety to decrease over time.
Method: We recruited a final sample of 700 Australian and New Zealand adults from Prolific and surveyed them every month for five months. The data were analysed using a complex analysis method called random-intercept cross-lagged panel model (RI-CLPM), which allowed us to focus on dynamic changes within a person over time.
Results: We found that higher levels of climate anxiety in one survey were not associated with higher levels of pro-environmental behaviour in the following survey, and that higher levels of pro-environmental behaviour in one survey were not associated with lower levels of climate anxiety in the next survey. Levels of climate anxiety were very low across the sample.
Conclusion: We found no evidence that climate anxiety affects pro-environmental behaviour, or vice-versa. The results also suggest that climate anxiety, experienced at a level that causes clinically significant emotional and cognitive difficulties, is relatively rare. These findings indicate that climate anxiety is unlikely to have the helpful side-effect of increasing an individual's engagement in pro-environmental behaviour, but neither will it deter a person from taking action. Also, it seems that taking action is unlikely to reduce climate anxiety. So, if therapists are working with clients to treat climate anxiety, it may be beneficial to focus on other treatment strategies beyond encouraging pro-environmental action.

Appendix C: Low Risk Ethics Notification

Application Title
From Anxiety to Action? Testing the Relationship Between Climate Anxiety and Pro-Environmental Behaviour

Aim of Project
To investigate whether a person's anxious feelings about climate change influence whether they engage in behaviours to mitigate climate change. Conversely, we are also testing whether engaging in these pro-environmental behaviours can, in turn, help alleviate climate anxiety.

Project Summary
This project will investigate the relationship between climate anxiety and pro-environmental behaviour through a series of online surveys involving 750 adults from Australia and New Zealand. Climate anxiety may increase as climate change advances, potentially causing clinically-significant emotional and cognitive impairment. There is growing interest in the relationship between climate anxiety and pro-environmental behaviours, such as use of energy-efficient transportation and sustainable food choices. Literature suggests climate anxiety may motivate individuals to behave pro-environmentally, and this behaviour may in turn reduce climate anxiety.

This will be investigated using a longitudinal study in which the same cohort of adults aged 18 and over will be surveyed five times over four months. These participants will be recruited from Prolific, a worldwide behavioural research participant recruitment website where respondents are financially compensated for their time. The survey contains 33 items, including 13 which ask about participants' anxiety experiences in relation to climate change, and a further 17 asking to what extent they have engaged in a range of specific sustainable behaviours. The remaining 3 items relate to consent, Prolific ID and an attention check. In the first survey, participants will also be asked nine demographic questions and two screening questions on age and country of residence. The longer first survey will take about 5 minutes to complete, while subsequent surveys will take 4 minutes each. Participants will be paid GBP0.75 and 0.60 respectively for completing each survey, which is in line with the GBP9 per hour rate recommended by Prolific. Survey responses will be analysed using a random-intercept cross-lagged panel model. Findings are expected to help inform psychological interventions for climate anxiety, and policy on climate change mitigation strategies.

Describe the peer review process that has been used to discuss and analyse the ethical issues present in this project
Ethical issues were discussed with primary supervisor Dr Matt Williams (member of MUHEC Northern), and co-supervisors, Associate Professors Stephen Hill and Jo Taylor. It

was agreed by all that this study was suitable as a low risk study. The question requiring most consideration was 4b. Our planned survey does include questions relating to psychological distress (climate anxiety). However, there is no reason to expect that answering these questions will cause discomfort or other types of harm to participants, especially considering that participants' engagement with these items will be limited to ticking particular response options in short scales rather than writing personal narratives or sharing identifiable information.

The researcher (Tamara) also had a cultural consultation session with Associate Professor Natasha Tassell-Matamua on September 29. This meeting discussed whether it was appropriate to collect ethnicity data given that the study was unlikely to be able to empirically examine ethnic differences (as too few Prolific participants identify as being of an Indigenous ethnicity). Dr Tassell-Matamua advised she was comfortable for Tamara to either include or exclude an ethnicity question in this instance, based on what Tamara felt most comfortable with.

This issue was also outlined in the confirmation report and discussed at the confirmation event on October 12. The confirmation panel, which consisted of convenor Associate Professor Ross Flett and independent researchers Dr Ilana Seagar van Dyk and Professor Fiona Alpass, highlighted that some scientific journals only accept research which includes ethnicity data. The decision was made to include an ethnicity question with broad categories, which allow us to describe the ethnic make-up of our participants, and thereby demonstrate why we are unable to examine this data empirically. The confirmation panel did not query or comment on other ethical issues outlined in the confirmation report and presentation.

Summarise the ethical issues considered and explain how each has been addressed

Anonymity
Participants will not be asked for their names or any other directly identifying information. However, we will collect IP addresses and Prolific ID numbers, which might be inadvertently identifying if combined with other data by third parties. Therefore, only Tamara and Dr Williams will view raw data with possible identifying information, and will store this with encryption and password protection.

Participants are informed that de-identified data will be uploaded to an online repository. All identifying information (e.g., Prolific ID, IP address) will be removed.

Informed consent
Informed consent will be established before completing the survey. Participants will be provided with a description and purpose of the study, and informed about compensation and completion time.

It will be made clear that participation is voluntary and participants can decline to respond to any question.

Minimisation of harm
Literature suggests questions on mental health are unlikely to cause participants any discomfort or harm (Labott et al., 2016).

We will mitigate the small possibility of harm by providing links to mental health agencies that provide free phone counselling at the start and end of the survey.
Justice
The financial payment ensures a fair distribution of burden and reward, but is not large enough to comprise an inducement.

Cultural considerations
Although Māori are not a specific focus of this research, it is expected that some participants will be Māori, and ethnicity data will be collected. We recognise the centrality of Te Tiriti o Waitangi to all research conducted in Aotearoa.

Regarding whakapapa, cultural consultation was sought and advice followed.

Regarding manākitanga, we have ensured measures selected are culturally relevant and appropriate.

Regarding tika and mana, we have been realistic about the limited ability of this project to empirically evaluate ethnicity data.

With whom did you peer review your research?
Peer review was carried out with the three thesis supervisors, Dr Matt Williams, and Associate Professors Stephen Hill and Jo Taylor, as well as the three panellists involved in the confirmation process, convenor Associate Professor Ross Flett, and independent researchers Professor Fiona Alpass and Dr Ilana Seager van Dyk.

28/10/2022

Dear: Tamara McLean

Re: Low Risk Notification - 4000026848 - From Anxiety to Action? Testing the Relationship Between Climate Anxiety and Pro-Environmental BehaviourNew Application

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our database for inclusion in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, email humanethics@massey.ac.nz."

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Professor Craig Johnson
Chair, Human Ethics Chairs' Committee and Director (Research Ethics)

Appendix D: OSF Preregistration

For convenience, the preregistration is set out below, exactly replicating the publicly available document at https://osf.io/qrksx/?view_only=428faa9d6dea4e7cb0be22205f1b7a7c.

Study Information

Title
From Anxiety to Action? Testing the Relationship Between Climate Anxiety and Pro-Environmental Behaviour

Contributors
Tamara McLean, Matt Williams, Stephen Hill

Description
Despite strong evidence that climate anxiety and pro-environmental behaviour are positively correlated, there are few longitudinal studies that explore how these phenomena might be causally connected. Understanding the causal relationship is of critical importance. Whether climate anxiety motivates a person towards climate action, or immobilises individuals, has a significant bearing on how humans respond to the climate crisis. Increasing adoption of pro-environmental behaviours of global populations is deemed essential in the fight against climate change (Steg & Vlek, 2009). Without the buy-in to key sustainable behaviours, it is doubtful the climate change calamity can be surmounted (Intergovernmental Panel on Climate Change, 2018).

On the flipside, pro-environmental behaviours are currently widely recommended as a climate anxiety-management strategy across mental health organisations. However, there is limited evidence for these interventions (Hogg et al., 2021)., and even some suggestion they could aggravate distress. Thus, knowing how climate anxiety and pro-environmental behaviours interact may offer psychologists better tools to manage and alleviate climate anxiety, while also offering a possible pathway to increasing sustainable behaviours among our citizens.

The present study will use a longitudinal design to determine the direction of these causal effects and allows for the testing of reciprocal effects. In doing so, this work seeks to examine whether people who are experiencing symptoms of climate anxiety go on to later experience changes in their levels of pro-environmental behaviour, and vice-versa.

Hypotheses

H1: We hypothesise that climate anxiety will have a positive cross-lagged effect on pro-environmental behaviour.
H2: We hypothesise that pro-environmental behaviour will have a negative cross-lagged effect on climate anxiety.

Design Plan

Study type

Observational Study - Data is collected from study subjects that are not randomly assigned to a treatment. This includes surveys, “natural experiments,” and regression discontinuity designs.

Blinding

No blinding is involved in this study. Participants will not be aware of the specific hypotheses of this study, but there will be no blinding per se, as this is not an experimental study.

Study design

This will be a longitudinal observational study. The sample will complete measurements on a monthly basis for 5 waves.

Randomization

None

Sampling Plan

Existing Data

Registration prior to creation of data

Explanation of existing data

Not applicable

Data collection procedures

Data will be collected at 5 timepoints one month apart, over a total of 4 months. Participants will be recruited from survey platform Prolific. Participants must be 18 years or older (Prolific only allows participants aged at least 18 to register on their platform). Pre-screening criterion will be entered to ensure that only participants residing in the New Zealand and Australia are considered for the study. Additionally, participants will need to have completed at least 20 prior studies on Prolific. This criterion is specified to identify participants who have shown a reasonably substantial level of engagement with the platform, and thus might plausibly keep returning for longitudinal study waves. Lastly, participants need to have an approval rate on prior Prolific submissions of 95% (Note: Prolific operationalises the approval rate as the upper limit of the 95% confidence interval based on a participant’s prior submissions).

No other requirements will be specified for age, gender or other demographic thresholds. At the start of the first wave, we will release one advertisement on Prolific targeting Australian and New Zealand Prolific members only. An advertisement will also be released on Prolific for the second and subsequent surveys each month.

This will be screened via a custom allowlist (i.e., a list of Prolific IDs for participants who completed the first wave and passed the attention checks; see Data Exclusions below). Each participant in the first wave will be paid GBP0.75 (approximately NZD1.50) for completing the survey. Participants will be paid a slightly smaller amount of GBP0.60 (approximately NZD1.15) for each of the subsequent surveys (waves 2-5), as these surveys will be shorter.

Sample size

Our target sample size is 700 participants. Given that we expect some attrition over time, we aim to recruit 750 participants at wave 1. Participants surveyed for wave 1 will be invited to repeat the survey at each subsequent wave (waves 2-5).
Sample size rationale

The analyses described below will involve a multiple indicator random intercept cross-lagged panel model (RI-CLPM) (see the Statistical Models section below). To our knowledge, no closed-form formulae for estimating power for this model have been developed in the statistical literature. It is possible to use simulations to estimate power, however, it is not feasible in this instance, given the complexity of the model. As a result, we have instead determined our sample size (in terms of the number of participants and waves) based on recent power analyses using the simpler single-indicator RI-CLPM, which show that larger samples and more observations are needed for more stable attributes (Williams et al., 2022). Our variables, climate anxiety and pro-environmental behaviour, have been shown to vary little over time (Markle, 2013; Whitmarsh et al., 2022). For the sake of being conservative, we assumed these variables had relatively little intra-individual variance and, as such, we assumed a high intraclass correlation coefficient (ICC) of 0.9, where there is a lot of variance between people rather than within people. Williams et al. (2022) determined that assuming an ICC of 0.9, five waves and 700 participants were needed to achieve 80% power to detect a small to moderate effect size (B = .2). This also assumes a small correlation between the random intercepts and within-person residuals at each time point (r = 0.2), and large autoregressive effects (0.7).

The target sample was increased to 750 to help protect against attrition. Similar research undertaken by Williams et al. (2022) on Prolific suggests this study will retain 74% of participants at wave 5. Of course, multiple indicator RI-CLPMs may have somewhat different power characteristics to a single-indicator RI-CLPM, but this power analysis provides some heuristic evidence in favour of a sample of this size.

Stopping rule

The primary mechanism for stopping sampling in each wave will be the target sample size set in Prolific, which will stop data collection when the specified number of participants has entered a submission with a completion code. At wave 1, this may result in a small number of additional survey completions beyond the specified target, since occasionally participants complete surveys but do not enter a completion code (e.g., due to timing out, or a browser page not loading). In addition to this mechanism, we will also leave each survey wave open for one week (7 days).

At some point within this 7-day open period for each survey (likely around day 3-4), we will send messages to all eligible Prolific participants who have not yet responded to that survey to remind them of its availability. In the event that the advertised survey for a wave does not reach its target after the 7 days, it will be manually stopped.

Variables

Manipulated variables

None

Measured variables

The key measured variables, climate anxiety and pro-environmental behaviour, are both predictor and outcome variables.

CLIMATE ANXIETY
Climate anxiety will be measured using the Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020). This 13-item scale assesses the negative cognitive and emotional impacts and functional impairment related to perceptions of climate change. It includes two subscales, cognitive emotional impairment (8 items) and functional impairment (5 items). Items in the cognitive emotional impairment subscale include “I go away by myself and think about why I feel this way about climate change,” while the functional impairment subscale includes items such as “My concerns about climate change interfere with my ability to get work or school assignments done.”

Some changes were made to the original scale. First, the original preamble was adjusted to state: “The following statements relate to particular climate change experiences. Please rate how often the following statements have been true of you in the past three weeks.” Additionally, a response timeframe (“in the past three weeks”) was added to each statement in the scale. This timeframe was designed to capture experiences from one monthly survey wave to the next, minus the one week that the survey remains open, so the response period does not overlap with the previous survey. Finally, one item asking about “concerns about sustainability” was excluded as it appeared to be measuring pro-environmental behaviour more than climate anxiety. The final scale contained 12 items. Responses were reported using a 5-point rating scale, with response options of 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = almost always.

PRO-ENVIRONMENTAL BEHAVIOUR
Pro-environmental behaviour will be measured using the Pro-Environmental Behaviour Scale (PEBS; Markle, 2013). The original contained 19 items across four different dimensions of pro-environmentalism: conservation, environmental citizenship, food, and transportation. The first dimension comprises seven items assessing consumption of water and lighting: time spent in shower, turning off the

light or using standby mode for electronic devices, and the use of washing machines, dishwashers, or air conditioning. Environmental citizenship comprises six items assessing: being a member of an environmental organisation or donating to them, talking with others or watching TV programmes/movies about environmental issues, the consumption of organic fruits, and the fuel efficacy of the principal motor vehicle used. Food comprises three items assessing the reduction in consumption of meat (pork, poultry, and beef). Transportation comprises three items assessing using public or share transport (e.g. car pooling) and ecological alternatives transport (cycling or walking).

Several adjustments were made to the original, as follows. As with the CCAS, a response timeframe ("in the past three weeks") was added to each item so the response period does not overlap with the previous survey. Additionally, as with the CCAS, an introductory line was added to the scale stating: "The following questions ask you to what extent you have engaged in particular 'sustainable' behaviours in the past 3-week period." Two items (membership of any environmental group, and fuel efficiency of the main household vehicle) were excluded on the grounds that participant responses to these questions were unlikely to change in between surveys. A further three items (consumption of organic fruit and vegetables, pork and poultry) were excluded as these dietary choices were deemed not to have a significant bearing on greenhouse gas emissions (Hoolohan et al., 2013). Two new items were added to capture high-impact behaviours not previously included in the scale, reduced aviation use and reduced food waste, both deemed helpful for mitigating climate change (Cologna et al., 2022). A third item was added to capture lamb consumption, which is prevalent in Australasia and carries a substantial carbon footprint (Dougherty et al., 2018).

Finally, the two meat consumption items (beef and lamb) were adjusted to capture quantities consumed rather than decreases in consumption, which participants might have difficulty estimating in a 3-week period. The serving size of 65 grams was selected based on current recommended portion sizes in Australia and New Zealand (Ministry of Health, 2020; National Health and Medical Research Council, 2013). Servings were categorised into five response options by creating an interval measurement where the increments have approximately the same meaning (that is, a one-point increase on the scale equals approximately 3 more servings). Response ranges include a 5-point and 3-point Likert scale, and dichotomous yes/no options. The final 17 items will be coded according to guidelines provided by Markle (2013), with scores on any single item ranging from 1 for the least pro-environmental option, to 5 for the most pro-environmental option.

ADDITIONAL VARIABLES

Screening and demographic information will also be collected to describe the sample. This includes: Prolific ID (numerals) Consent (yes/no) Country of residence (Australia, New Zealand, other) Age (years) Location (urban, suburban, rural) Ethnicity (NZ: European, NZ Māori, Asian, Pacific peoples, other. Australia: European, Asian, Aboriginal or Torres Strait Islander, other) Gender (male, female, I identify my gender as:) Employment (working full-time, working part-time, unemployed and looking for work, homemaker/stay at home parent, student, retired, other) Income (less than $20,000, $20,000 - $39,999, $40,000 - $59,999, $60,000 -

$79,999, $80,000 - $99,999, $100,000 or more) Highest level of education (doctoral degree, postgraduate degree, undergraduate degree, other tertiary qualification, completed high school, some high school (without completing), no high school) Marital status (married, in a civil union/de facto/partnered relationship, widowed, divorced/separated, single) Climate change denial (climate change is happening now, caused mainly by human activities, climate change is happening now, but caused mainly by natural forces, climate change is not happening now, unsure/don't have an opinion) Climate change worry (not very worried to extremely worried).

RANDOMISATION
The CCAS and PEBS measures will be randomised at the block level, so participants may encounter either first. The CCAS will also be randomised within the block, so items will appear in a different order for different participants. The PEBS will not be randomised within the block because items in the scale are grouped into subgroups with matching response formats. Demographic items will not be randomised. The two climate change items (worry and denial) were separated into their own block and randomised.
SURVEY ITEMS
The document attached as "Survey Items Wave 1" lists all items included in wave 1.

- Survey Items Wave 1.docx

Indices

The analyses we describe below will use a multiple indicator RI-CLPM and thus do not require the creation of score variables per se. However, scores/indices will be created for descriptive and exploratory analyses. A CCAS total score will be calculated by adding together individual item responses and dividing this number by 12. Total scores range from 1 to 5, with higher scores indicating higher levels of climate anxiety. No items require reverse coding. CCAS subscale scores may also be calculated. For these, responses to items 1–8 are added and divided by 8 to compute the cognitive-emotional impairment subscale score. The functional impairment subscale score is computed by dividing by 4 the total responses for 9–12.

A PEBS total score will be calculated by adding together individual item scores and dividing this number by 17. Total scores range from 1 to 5, with higher scores indicating more pro-environmental behaviour. No items require reverse coding. A subscale of pro-environmental behaviours deemed most helpful for mitigating climate change will be created by summing scores for four items representing 'high impact' behaviours (walking/cycling, public transport and car-pooling, no flying) and four items representing 'moderate impact' behaviours (no/low beef and lamb consumption, low food waste, low standby power consumption). This total score will be divided by 8 to create a higher impact PEBS scale which can be compared with the summed and divided score for the remaining lower impact behaviour items (lower impact PEBS scale).

Analysis Plan

Statistical models

This study uses an RI-CLPM with multiple indicators (Mulder & Hamaker, 2021) to assess the cross-lagged effects between climate anxiety and pro-environmental behaviours. A single model will be used to test H1 and H2. Use of this model will allow us to disentangle within- from between-person effects. We will use all 5 waves of data to analyse the direction of effects between these two variables, which are treated as both predictor and outcome variables. To examine whether effects are similar across time (e.g., paths from wave 1 to wave 2 are similar to paths from wave 2 to wave 3, and so forth) we will use a model with these paths constrained to be equal across time. Alpha (α) is set at $p < .05$ for analyses. This analysis will be carried out on R.

In our model, we will assume that any within-person factor loadings and intercepts, as well as the cross-lagged and autoregressive parameters, are constant across time points. The within-person components of the latent variables (climate anxiety and pro-environmental behaviour) will be treated as unidimensional, with no correlated error terms in each case. All random intercept terms will be permitted to correlate. The pairs of within-person factors (at wave 1) and their residuals (at wave 2 onwards) will be permitted to correlate at each time point. The decision to treat the latent variables as unidimensional was perhaps unusual, given the original CCAS has two dimensions and PEBS has four. However, our hypotheses pertain to the overarching constructs of climate anxiety and pro-environmental behaviour, not dimensions thereof. Furthermore, the original factor analyses reporting multidimensional models for these scales would have been based mainly on inter-individual differences, not within person variance, so it is not clear what the within-person factor structure would be.

Our model will be estimated using maximum likelihood with Huber-white standard errors and a scaled test statistic (MLR in lavaan). This estimation method prioritises accounting for missing data, which is likely to be a substantial concern given the use of a longitudinal design. It can also account for non-normal data, which will make up a substantial portion of this dataset, given the use of ordinal rating scale data. However, this estimation method is prone to convergence failures when used for RI-CLPMs. In the event that the estimation of a model produces an error message or a warning message about impossible parameter values (e.g., Heywood cases), we will switch estimation methods to full information maximum likelihood (i.e., estimator = “ML”, missing = “ML” in lavaan syntax). This estimator is simpler and is less likely to cause convergence failures than MLR. Like MLR, it also prioritises accounting for missing data, however, it does assume multivariate normal data, an assumption that will be breached in our dataset. MODEL DIAGRAM The diagram attached as “Climate Anxiety RICLPM” is a simplified diagram of our model containing 3 items instead of 12 items for climate anxiety (CCAS), 3 items instead of 17 items for pro-environmental behaviour (PEBS), and three waves instead of five. Error terms for items are not displayed for the sake of brevity.

- Climate Anxiety RICLPM.pptx

Transformations

None

Inference criteria

H1 will be considered to be supported if the within-person effect (cross-lagged path) from climate anxiety to pro-environmental behaviour is positive and significant, with p less than 0.05 (2-tailed). H1 will be considered to be not supported if this effect is negative (with p less than 0.05), or if this effect is positive but not significant. H2 will be considered to be supported if the within-person effect (cross-lagged path) from pro-environmental behaviour to climate anxiety is negative and significant, with p less than 0.05 (2-tailed). H2 will be considered to be not supported if this effect is positive (with p less than 0.05), or if this effect is negative but not significant. The conventional alpha level of 0.05 was selected because the challenges inherent in power analyses for these models limit our capacity to be confident of adequate power for more stringent alpha levels such as 0.005 (see Benjamin et al., 2018).

The following fit statistics will be reported:
• The root mean square error of approximation (RMSEA), and associated confidence intervals. • The standardised root mean square residual (SRMR)
• The comparative fit index (CFI) Model fit will be deemed supported if all the following criteria are met (as similar to Masselink et al. (2018).
• The RMSEA is less than or equal to 0.06
• The SRMR is less than or equal to 0.08
• The CFI is equal to or greater than 0.95
The model will be considered to have a poor fit if none of the above criteria is met. If all of the fit statistics are met, it will be considered to have a good fit. If only some fit statistics are met, then it will be considered ambiguous. However, the fit statistics will not be used to determine if the hypotheses are supported; they are best regarded as reflecting on auxiliary measurement assumptions.

Data exclusion

EXCLUSION AT THE STUDY LEVEL:
Participants that meet any of the criteria below will be completely excluded from the confirmatory analyses:

1. Indicating a country of residence other than Australia or New Zealand (that is, selecting the “other” option in the country of residence item) at wave 1. Such participants will not be invited back for subsequent waves. However, the residence item will not be included in subsequent waves, such that participants who move countries over the course of the longitudinal study will be retained. Participants who fail to answer this question will be retained.

2. Indicating an age of 17 years or younger. Only adults aged 18+ are able to participate in this study. Participants younger than 18 are unlikely as Prolific requires its members to be 18+. Participants who fail to answer this question will be retained.

3. Not providing a correct response to the attention check included in the wave 1 survey. This attention check is an instructional manipulation check, and it states: “Please select ‘always’ for this item if you’re paying attention.” Participants who give any response other than “always”, or who do not respond to this item, will be considered to have failed this attention check. The check is included in the middle of the PEBS scale. In failing this check, participant responses will be excluded, and they will not be invited to subsequent waves. (They may nevertheless still receive payment for wave 1, since we will apply Prolific’s policies on Approvals, Rejections and Returns).

4. Having a study duration (recorded by Qualtrics) of less than the sum of the number of items in the survey at wave 1 (44) multiplied by 2 equalling 88 seconds (see Huang et al., 2012). Such participants will not be invited back for subsequent surveys.

5. Not reaching the end point of the survey at wave 1. Such participants will not be invited back for subsequent surveys.

6. ”Returning” their submission for wave 1 in the Prolific system, indicating that they revoke their consent. Such participants will not be invited back for subsequent surveys.

7. Only reaching the end of the wave 1 survey, but not reaching the end point of any other wave. Such participants effectively provide no relevant information for estimation of within-person parameters, and including them might increase the risk of estimation failures.
Note: Participants who complete wave 1 but then miss a subsequent wave will still continue to be invited to waves following the one they missed.

EXCLUSION AT THE WAVE LEVEL:
When a participant meets any of the criteria below at a given wave, their data from that wave will be excluded (i.e., treated as missing), but their data for the remaining waves will be retained for analysis.

1. Qualtrics status other than 0 (normal response), i.e., removing duplicate, preview and test responses.

2. Not providing a correct response to the attention check included in the wave. We plan to include a different attention check item at each wave. Participants who fail the attention check in a wave will have their data from that wave excluded. As above, participants fail this check if they give the incorrect response, or if they fail to respond to this item.

3. Having a study duration (recorded by Qualtrics) of less than the sum of the number of items in the survey multiplied by 2 (see Huang et al., 2012).

4. ”Returning” their submission in the Prolific system, indicating that they revoke their consent (unless the participant subsequently indicates via the messaging system

that they are willing for their data to be retained contingent on payment being awarded).
5. Duplicate submissions from the same participant to the same wave, as detected via Prolific ID (in which case the most complete response will be retained; if both are fully complete, the most recent will be retained).

Missing data

Missing data will be dealt with by full information maximum likelihood estimation in lavaan (i.e., setting the missing = “ML” argument).

Exploratory analysis

We will report tests of measurement invariance across time for our multiple indicator RI-CLPM using the steps set out in Mulder and Hamaker (2021). These steps are configural invariance, weak factorial invariance (loadings constant across time), and strong factorial invariance (loadings and intercepts constant across time). However, we will use the model we have specified above to test our hypotheses regardless of the findings of these invariance tests. Where there is evidence against measurement invariance we will interpret this as reason to regard the main results as having additional uncertainty attached. Due to space limitations in journal articles, it is likely that these tests of measurement invariance may be reported in supplementary materials.

We are also interested in doing the following exploratory analyses.

1. Investigating whether the true effect of climate anxiety on pro-environmental behaviour might be non-linear. We want to see if climate anxiety is more adaptive at lower levels (i.e., leads to higher PEBS scores in subsequent waves) than at higher levels (i.e, leads to lower PEBS scores in subsequent waves). It might be that too little anxiety reduces motivation to engage while too much leads to disengagement and denial. The analysis would be run using a non-RICLPM (e.g., quadratic) cross-lagged panel model, or possibly just plots.

2. Investigating the relationship between climate anxiety and a group of pro-environmental behaviours known to be especially helpful in mitigating climate change. We are interested to see how pro-environmental behaviours deemed to have a moderate or high impact on reducing greenhouse gas emissions relate to climate anxiety behaviours (Cologna et al., 2022). This is important because it is these behaviours that are most likely to address the cause of anxiety, climate change. To do this, we would create a subscale of “higher impact” behaviours (as detailed in Indices) and analyse these using a RI-CLPM that contains all 12 CCAS items but just eight PEBS items.

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Appendix E: Additional Analyses

Descriptive Analyses of Climate Anxiety and Pro-Environmental Behaviour Means

Additional analyses were conducted to explore the relationships between means for climate anxiety pro-environmental behaviour at wave 1 and various demographic data. Australian participants had a slightly higher mean climate anxiety score (1.24, *SD* = 0.40) compared with participants from New Zealand (1.17, *SD* = 0.30). Similarly, Australians also had a slightly higher pro-environmental behaviour mean score (3.31, *SD* = 0.44), compared to New Zealanders (3.26, *SD* = 0.45). Females reported slightly higher climate anxiety mean score (1.24, *SD* = 0.36) compared to males (1.19, *SD* = 0.40). Likewise, females exhibited higher pro-environmental behaviour (3.36, *SD* = 0.43) compared to males (3.22, *SD* = 0.44). The 11 participants who identified their gender in other ways had the highest scores for both climate anxiety (1.39, *SD* = 0.43) and pro-environmental behaviour (3.48, *SD* = 0.49).

Participants from urban areas reported a slightly higher climate anxiety score (1.27, SD = 0.44) compared to those from suburban areas (1.20, *SD* = 0.35), and those from rural or remote areas (1.23, *SD* = 0.36). In terms of pro-environmental behaviour, urban dwellers scored an average of 3.38 (*SD* = 0.49), which was higher than suburban residents (3.27, *SD* = 0.42), and those living rurally (3.26, *SD* = 0.45). Regarding marital status, people who were in a relationship had a slightly lower climate anxiety mean score(1.24, *SD* = 0.41) compared with those who were not (1.20, *SD* = 0.32), and the relationship group also had lower higher pro-environmental behaviour (3.28, *SD* = 0.45 compared with 3.32, *SD* = 0.43 for those who were widowed, separated, or never married.

In terms of age groups, the youngest participants (18-24) exhibited slightly higher levels of climate anxiety, with a mean score of 1.26 (*SD* = 0.37), compared to other age groups. The 25–34 age group reported a similar level of climate anxiety (*M* = 1.25, *SD* =

0.43). As age increased, a general decline in climate anxiety was observed, with the 65+ age group reporting the lowest anxiety levels (M = 1.05, SD = 0.09). When observing pro-environmental behaviour, the 18–24 age group again reported higher levels (M = 3.41, SD = 0.42). The mean scores for pro-environmental behaviour were relatively consistent across the age groups, ranging from 3.30 (SD = 0.44) in the 25–34 age group to 3.11 (SD = 0.42) in the 65+ age group, with the latter group showing the lowest engagement in pro-environmental behaviours. The 45–54 age group showed slightly elevated levels of pro-environmental behaviour (M = 3.34, SD = 0.43) compared to their adjacent age groups.

There were subtle variations in climate anxiety and pro-environmental behaviour scores by income among Australian participants. Participants earning between $40,000 and $59,999 annually exhibited slightly higher climate anxiety (M = 1.33, SD = 0.47) compared to other income groups. Those earning less than $20,000 and over $100,000 reported marginally lower climate anxiety, with means of 1.17 (SD = 0.25) and 1.18 (SD = 0.37), respectively. Regarding pro-environmental behaviour, Australians with an annual income between $80,000 and $99,999 showed the highest mean score (M = 3.37, SD = 0.45). In contrast, participants earning between $20,000 and $39,999 reported a slightly lower pro-environmental behaviour mean (M = 3.30, SD = 0.43), and those in the $100,000 and above income bracket also reported a lower mean of 3.26 (SD = 0.44). Similarly modest variations in climate anxiety and pro-environmental behaviour scores by income were seen in New Zealand. Those earning less than $20,000 displayed slightly higher climate anxiety (M = 1.20, SD = 0.27) and the highest pro-environmental behaviour scores (M = 3.40, SD = 0.39). The lowest climate anxiety (M = 1.13, SD = 0.21) was noted among those earning $20,000 to $39,999, correlating with lower pro-environmental behaviour scores (M = 3.26, SD = 0.39). Overall, the variations across different income levels in both countries were subtle,

suggesting that income might not be a significant determinant of climate anxiety and pro-environmental behaviours in this study.

Single Indicator RI-CLPM to Check Confirmatory Analysis Results

We ran a single-indicator RI-CLPM to check whether the results found using the multiple indicator version were robust to this alternative specification. As the name suggests, the single indicator includes just one variable, a total score, for each of the latent constructs, climate anxiety and pro-environmental behaviour. We used the two-step process recommended by Mulder and Hamaker (2021), in which we ran a basic model followed by a model with constraints over time. Fit statistics are presented in Table 11. Despite a significant chi-square statistic at both step 1 ($\chi^2 = 33.159$, df = 21, $p = .044$) and step 2 ($\chi^2 = 109.877$, df = 50, $p < .001$), all other model fit indices reported at step 1 and 2 were in the accepted range, suggesting overall good fit.

Table E1

Model Fit Indices at Each Step for the Single Indicator RI-CLPM

Model Fit Indices	Step 1	Step 2
Chi-square	33.159	109.877
RMSEA[a]	0.029	0.041
SRMR[b]	0.028	0.042
CFI[c]	0.998	0.988

Notes. [a]Root Mean Square Error of Approximation, [b]Standardised Root Mean Square Residual, [c]Comparative Fit Index.

Results reported at step 2 showed autoregressive effects for both climate anxiety and pro-environmental behaviour. Specifically, there was a significant autoregressive effect for

climate anxiety across the measurement waves, suggesting that increases in climate anxiety at one time point were predictive of further increases in climate anxiety at the subsequent measurement wave (B = .179, *SE* = .031, *z* = 5.720, *p* <.001, 95% CI = [.12, .24]). Similarly, there was a significant autoregressive effect for pro-environmental behaviour across waves, as indicated by a B of .184, *SE* of .032, and *p*-value less than .001 (*z* = 5.773, 95% CI = [.12, .25]).

Regarding cross-lagged effects, climate anxiety at wave t-1 did not predict pro-environmental behaviour at wave t (B = -0.002, *SE* = .026, *p* = .940, 95% CI = (−.05, .05]). However, pro-environmental behaviour at wave t-1 predicted climate anxiety at wave t (B = 0.065, *SE* = .029, *p* = .026, 95% CI = [.01, .12]). The effect was small, with a borderline significant *p* value. The covariance between the random intercepts for climate anxiety and high-impact pro-environmental behaviour was estimated at B = 0.43 (*SE* = 0.005), *z* = 8.290, *p* < .001. This indicated a significant and positive correlation between individuals' overall levels of each of these variables, reflecting a stable association at the between-subjects level, rather than at the initial (baseline) measurement point. Despite the significant result, the effect was small. Overall, these results reinforced the idea that the data showed no real evidence of substantial effects.

Appendix F: Research Case Study

Massey University
Clinical Psychology

RESEARCH CASE STUDY

Climate Anxiety and Pro-Environmental Behaviour: The Importance of my Doctoral Research for Development of my Clinical Practice during my Internship Year

Candidate : Tamara McLean
Clinical Psychology Programme Massey University
Student ID :
Academic supervisors : Dr Matt Williams, Dr Stephen Hill, A. Prof Joanne Taylor

This research case study represents the research conducted in 2022 and 2023, and reflections on the role as Intern Psychologist at a Te Whatu Ora Adult Community Mental Health Service in Auckland in 2024. This case study is presented in partial fulfilment of the requirements of the qualification of Doctor of Clinical Psychology at Massey University.

Special thanks to my supervisors, the research participants, Massey University for my Doctoral Scholarship, Freemasons for the Post-Graduate Scholarship, and to my whānau.

Clinical Supervisor
Associate Professor Joanne Taylor

Student
Tamara McLean

Date: 18th September 2024

Abstract

This case study was carried out during my clinical psychology internship. It describes my doctoral research, conducted to better understand the relationship between climate anxiety and pro-environmental behaviour in a time of growing climate change concern. The process of designing and conducting this study enhanced my clinical practice in various ways, as I explore in this case study. In addition to the value of engaging in one's own research in developing as a scientist-practitioner, this experience has led me to confront my own climate anxiety, experience first-hand the impact of climate anxiety on clients, and reflect on how, given the complexities and acute presentations often encountered in public health settings, climate anxiety is not frequently a primary focus of treatment for clinical psychologists practising in the public sphere. Together, these elements have fostered both my professional and personal development.

Keywords: Reflexive practice; climate anxiety, pro-environmental behaviour, public health, climate change

Part 1. Overview of Research

Anthropogenic climate change poses a serious threat to human health and psychological wellbeing. One particular negative emotional response gaining scholarly attention is climate anxiety: anxious feelings arising from climate change, even among people not yet personally impacted by this global environmental crisis (Clayton, 2020). Climate anxiety is experienced on a continuum from mild to severe, but people do not generally seek psychological support for it. There is also growing interest in the relationship between climate anxiety and pro-environmental behaviour, defined as behaviours that do as little harm to the environment as possible (Steg & Vlek, 2009). It is widely acknowledged that pro-environmental behaviours must urgently increase if global emissions targets are to be met (IPCC, 2022). As the climate crisis advances, both climate anxiety and pro-environmental behaviours can be expected to rise, hence understanding how these two climate change responses relate to one another is of critical importance. This study aimed to investigate whether climate anxiety and pro-environmental behaviour are causally related using high quality longitudinal data and a methodically robust analytical approach.

Existing Research

Existing research suggests climate anxiety and pro-environmental behaviour are related, but there are few studies using causal identification strategies that allow us to determine which causal effects are responsible for this relationship. The literature was explored from four perspectives.

First I considered evidence that climate anxiety increases pro-environmental behaviour. Literature suggests that climate anxiety may act as a motivator for pro-environmental behaviour, encouraging actions that contribute to climate change mitigation (Bingley et al., 2021; Budziszewska & Jonsson, 2021; Cunsolo et al., 2020). Experimental studies have used fear appeals to examine this phenomenon, demonstrating that fear-induced

emotions can enhance pro-environmental intentions (Gao et al., 2021; Hine & Gifford, 1991; van Zomeren et al., 2010). However, these studies mainly assume that short-term induced anxiety impacts behaviour similarly to chronic anxiety, a concept with limited empirical support. I explored arguments suggesting that climate anxiety could inhibit pro-environmental behaviour. Research indicates that feelings of fear and helplessness can result in eco-paralysis, where individuals feel overwhelmed by ecological damage and become inactive (Albrecht, 2011). This is supported by studies showing that anxiety might reduce the likelihood of engaging in pro-environmental public actions (Geiger et al., 2021). Additionally, catastrophic thinking, a typical symptom of anxiety, may interfere with adaptive responses to environmental challenges (McDonald et al., 2015). A nuanced view suggests that the relationship between anxiety and action might be dose-dependent, with both insufficient and excessive anxiety leading to reduced motivation or complete disengagement (Clayton, 2020).

There is also the perspective that engaging in pro-environmental behaviour could reduce climate anxiety. Community conservation programmes have been studied for their psychological benefits, suggesting that participation can improve mental health and emotional state (Husk et al., 2016; O'Brien et al., 2010). Qualitative research supports this, with environmental activists reporting feelings of relief from active engagement (Ágoston et al., 2022; Berglund, 2019; Budziszewska & Jonsson, 2021; Verlie, 2021). Nonetheless, these findings are not definitive, and the effect of pro-environmentalism on climate anxiety is still considered largely theoretical within academic discussions (Baker et al., 2021; Cunsolo et al., 2020; Lewis, 2018; Sampaio & Sequeira, 2022). Lastly, the idea that pro-environmental behaviour could increase climate anxiety is least supported by empirical research. Few studies have directly measured this relationship, but some qualitative research indicates that environmental activities might evoke distress or feelings of futility, especially when

considering the overall state of the environment (Christie, 2004; Gooch, 2005). Interviews with young activists in New Zealand reveal that, while activism can foster hope, it can also lead to burnout and temporary disengagement due to feelings of despair (Nairn, 2019).

In summary, there is limited empirical and theoretical evidence to suggest climate anxiety and pro-environmental behaviour impact one another. The few longitudinal studies that exist tend to measure constructs that differ somewhat from climate anxiety and pro-environmental behaviour, utilise unvalidated or ad hoc measurement tools, or are not accompanied by a suitable data analysis method that enables credible causal inferences to be made. Consequently, substantial uncertainty remains regarding the relationship between these variables and the potential clinical implications.

Research Hypotheses

This study proposed two hypotheses.

Hypothesis 1

Existing research indicates that people experiencing climate anxiety may increase engagement in pro-environmental behaviour (Ágoston, Csaba, et al., 2022; Gao et al., 2021; van Zomeren et al., 2010). Correlational research showing a moderate positive association between these variables (e.g., Innocenti et al., 2021; Wullenkord et al., 2021) may also support this proposition. Therefore, I hypothesised that when controlling for pro-environmental behaviour at time t-1, higher levels of climate anxiety at time t-1 will be associated with higher levels of pro-environmental behaviour at time t. Hypothesis 1 is consistent with several relevant theories: in particular, that climate anxiety increases pro-environmental behaviour by acting as a motivator (Barlow, 2004), by supporting information-seeking and problem solving (Kurth, 2018), by increasing one's sense of personal responsibility (Bouman et al., 2020), or by reducing cognitive dissonance (Festinger, 1957).

Hypothesis 2

Some existing research indicates that people who engage in pro-environmental behaviour may experience a reduction in climate anxiety (Berglund, 2019; O'Brien et al., 2010; Verlie, 2021). Therefore, I hypothesised that, when controlling for climate anxiety at time t-1, higher levels of pro-environmental behaviour at time t-1 will be associated with lower levels of climate anxiety at time t. Hypothesis 2 is consistent with several relevant theories. In particular, it suggests that pro-environmental behaviour can decrease climate anxiety by enhancing an individual's sense of meaning and purpose (Venhoeven et al., 2020), or by providing education and new knowledge about climate change mitigation possibilities (Khatibi et al., 2021). Furthermore, the popularity of the 'action as treatment' approach and self-help recommendations (e.g., Cunsolo et al., 2020; Kennedy-Woodard & Kennedy-Williams, 2022) that implicitly assume the veracity of this hypothesis make it important to test.

Research Methods

The study was designed as longitudinal, observational research, and carried out by anonymous electronic survey hosted on the survey platform Qualtrics. Data was collected on five occasions over four months between November 2022 and March 2023. The approach and analytic strategy were quantitative. This study was preregistered on the Open Science Framework on 2 November 2022 – see https://osf.io/qrksx. Preregistration enhances accountability and transparency, enabling replication (Flake & Fried, 2020). As required by the preregistration, no data were collected, created, or realised prior to uploading the study design and analysis plan.

Participants

Eligible participants were adults (18+) currently living in New Zealand or Australia. The target sample size of 750 and decision to conduct five waves were based on the stability

of the selected variables, climate anxiety and pro-environmental behaviour, which show little variation over time (Markle, 2013; Whitmarsh et al., 2022). Due to the complexity of the analytical method used (see Analytical Approach), a direct power calculation was not feasible. Therefore, I extrapolated from similar studies that this sample size would provide adequate power to detect such stable attributes, factoring in high intraclass correlation and planned attrition (Williams et al., 2024). Following a complex exclusion process, in which several evidence-based rules were followed to exclude surveys at both wave 1 and subsequent waves, a final sample of 700 participants remained. In order to be retained, participants needed to complete surveys for at least two waves. Demographic data showed participants ranged in age from 18 to 85 years. Most resided in Australia (73.9%), were female (57.3%), lived in a suburban location (65%), had a university undergraduate degree or higher (67%), were employed fulltime (51.4%), and were married or in a de facto relationship (56.3%).

Procedure

Participants were recruited from Prolific, a worldwide behavioural research participant recruitment website where participants are financially compensated for their time (Palan & Schitter, 2018). The survey landing page provided detailed information about the study, and endorsement of the informed consent item was required to initiate the survey. Participants completed the same survey questions relating to climate anxiety and pro-environmental behaviour at every wave, with additional demographic data collected at wave 1. A different attention check item was included at each wave to ensure participants were paying attention to the task. The survey was run monthly, and remained open for one week each time. Data collection at waves 2-5 was only available to participants who had completed the first survey. Participants who missed a subsequent survey wave were still invited to join

the following waves. Participants were paid between 0.50 and 0.90 British pounds sterling (GBP) per survey for their time.

Measures

Climate anxiety was measured with the Climate Change Anxiety Scale (CCAS; Clayton & Karazsia, 2020), a 13-item scale that assesses the negative cognitive and emotional impacts and functional impairment related to perceptions of climate change. The scale is divided into two subscales: cognitive emotional impairment (8 items) and functional impairment (5 items). Items in the cognitive emotional impairment subscale include, "I go away by myself and think about why I feel this way about climate change," while the functional impairment subscale includes items such as, "My concerns about climate change interfere with my ability to get work or school assignments done." Responses were reported using a 5-point Likert scale, with options ranging from 1 = Never to 5 = Almost always, where higher scores indicate higher climate anxiety. Validation studies have shown mixed results; while the scale is praised for its psychometric robustness and its pioneering role in measuring climate anxiety, criticisms include its inability to reliably replicate the proposed two-factor structure and concerns over its focus on severe distress which may overlook milder experiences of climate anxiety (Wullenkord et al., 2021; Feather & Williams, 2022; Lutz et al., 2023). A validation study by Whitmarsh et al. (2022) reported excellent internal consistency reliability for the total scale (Cronbach's alpha of .93). In my study, the Cronbach's alpha coefficient for wave 1 data, was .89, indicating good reliability.

Pro-environmental behaviour was operationalised with an adapted version of the Pro-Environmental Behaviour Scale (PEBS; Markle, 2013), a 19-item scale measuring four different dimensions of pro-environmentalism: conservation, environmental citizenship, food, and transportation. Items covered a broad range of behaviours, including water and light usage, dietary choices and engagement with environmental issues. This scale was selected

because it is relatively recent, a moderate length and, importantly, is one of few pro-environmental psychometrics to include behaviours shown to meaningfully impact climate change outcomes, such as eating less meat and using alternative transport options (Girod et al., 2013). Response ranges include a 5-point and 3-point Likert scale, and dichotomous yes/no options, with higher scores on an item reflecting higher pro-environmentalism. Some adjustments were made to the original scale to make the items more relevant to an Australasian context and suited to monthly re-testing. The original development study shows a satisfactory internal consistency for the scale (Cronbach's alpha = .76) and subscales (Cronbach's alpha ranging from .62 to .74), and strong test-retest correlations (r = .85, p <.01) (Markle, 2013). This paper also reported good convergent, discriminant, and factorial validity across the scales four dimensions.

Analytical Approach

The main analysis employed a random intercept cross-lagged panel model (RI-CLPM) with multiple indicators (Mulder & Hamaker, 2021). This allowed us to test directly whether changes in climate anxiety are associated with subsequent changes in pro-environmental behaviour (and vice versa) within the same person. A single model was used to test H1 and H2. A cross-lagged panel model was deemed most appropriate for this study as it allows researchers to explore the effect of two or more variables on each other over time. More specifically, I used a cross-lagged panel model with a random intercept (the RI-CLPM) because it allows stable "trait-like" between-person components to be separated out from the dynamic "state-like" within-person components that vary over time, hence allowing all stable individual difference confounds to be implicitly controlled for (Hamaker et al., 2015). This model is more appropriate for variables that are to some extent trait-like, such as climate anxiety, and avoids critical limitations of the original cross-lagged panel model (Rogosa,

1980) which cannot discriminate between- and within-person variation, thereby over-estimating causal paths.

My version of the RI-CLPM included multiple indicators for each of the latent constructs, that is, each of the 12 CCAS items and 17 adapted PEBS items that make up the two scales. Specifying multiple indicators increases the reliability of the measurement model by accounting for measurement errors unique to items. The result is a more nuanced, reliable, and valid representation of the underlying multi-faceted latent constructs when compared with the single indicator variant, and one which avoids the assumption that the variables are measured without any error. The main parameters of interest for my hypotheses are the cross-lagged parameters. These indicate at the within-person level whether different-from-usual scores from one variable (e.g., climate anxiety) are associated with different-from-usual scores on the other variable (e.g., pro-environmental behaviour) at the next time point after controlling for the first variable at the first time point (e.g., climate anxiety). The model also allows for testing reciprocal effects and can explicitly model the reciprocal relationship proposed in the hypotheses. All analyses were performed using RStudio and the R programming language version 4.2.0 (R Core Team, 2022).

Results, Explanations and Implications

The study found no evidence of a causal relationship between climate anxiety and pro-environmental behaviour. Regarding hypothesis 1, climate anxiety at wave t-1 did not predict pro-environmental behaviour at wave t (B = .004, *SE* = .032, *p* = .890, 95% CI = [-.06, .07], hence, H1 was not supported. Regarding hypothesis 2, pro-environmental behaviour at wave t-1 did not predict climate anxiety at wave t (B = .188, *SE* = .230, *p* = .414, 95% CI = [-.26, .64]). As such, H2 was also not supported. These results stand in contrast to much of the academic literature and public narrative that, while mixed, largely suggests climate

anxiety motivates people to act to mitigate climate change, and that, by acting, climate anxiety is likely to reduce.

There are many potential explanations for these results. It might be that individuals understand that behaving pro-environmentally will not mitigate climate change to any appreciable degree, leading them to not feel motivated to engage in these behaviours even if they are anxious. Moreover, even if they do engage, it might not relieve their anxiety symptoms, as pro-environmental behaviour does not meaningfully reduce or eliminate the source of their anxiety - climate change. Another potential explanation is that the act of engaging in pro-environmental behaviour alone may not be enough to lower climate anxiety; a person may also require some knowledge of the consequences of that behaviour to reduce their anxiety about the crisis. Literature on household power consumption shows people often misperceive their energy use and lack information on the amount of energy that can be conserved by different behaviours (Lesic et al., 2018). However, providing feedback can increase energy conservation (Abrahamse et al., 2007; Aydin et al., 2018), which might be necessary for the behaviour to reduce anxiety about climate change.

Another related explanation is that anxiety, in the context of climate change, may not be an effective motivator of behaviour in general. Indeed, anxiety is often marked by avoidance rather than approach behaviour (Barlow, 2004). It is argued that fear only effectively motivates action when an individual's perceived efficacy outweighs the perceived threat (Witte, 1992). This might not be the case with the huge, slow-moving, and deeply complex issue of climate change, where most feel helpless. Finally, it might also be that there are more pivotal determinants of both climate anxiety and pro-environmental behaviour that overshadow the impact these variables have on one another. Research suggests that whether or not a person behaves pro-environmentally might be influenced by other psychological factors such as other emotions, self-efficacy, knowledge, values and attitudes towards the

particular pro-environmental behaviours (van Valkengoed et al., 2022), along with practical factors like the cost, availability, and convenience of environmentally-friendly choices (Kollmuss & Agyeman, 2002). Hence, any effect of climate anxiety on pro-environmental behaviour is very small and thus not easily detectable.

Another important possibility is that climate anxiety and pro-environmental behaviour do in fact affect one another, just not in a way that could be detected in this study. There are plausible reasons for this. My study was designed to detect linear relationships, potentially overlooking any non-linear interactions between these variables. Exploratory analysis indicated non-linear patterns at different levels of climate anxiety which weren't adequately captured due to the linear analytical methods used. Additionally, the measurements of both climate anxiety and pro-environmental behaviour might not fully reflect the constructs they aim to measure, with the former potentially overlooking milder forms of anxiety due to its focus on severe symptoms, and the latter suffering from validity issues related to self-reported data (Kormos & Gifford, 2014). The high intraclass correlations suggest stable levels of these traits over time, which could further diminish the ability to detect dynamic interactions. Finally, the interval between survey waves might not have been optimal for capturing the dynamic effects of these variables on each other, potentially affecting the timing and observation of their interactions (Kuiper & Ryan, 2018).

Regarding implications, this research suggests that while there are many valid and important reasons to encourage pro-environmental behaviour, there is currently no substantial evidence base for clinicians to recommend such actions as a strategy to reduce climate anxiety. However, it also indicates that clinicians can help clients reduce anxiety symptoms without concerns that this may deter them from taking pro-environmental action. Climate change is regarded as one of the most serious challenges of our time. Although this study observed generally low levels of climate anxiety, the ongoing progression of the climate

crisis and its increasingly visible impacts worldwide (IPCC, 2022) will likely increase prevalence and severity on climate anxiety over time. This highlights the importance of further research to understand the link between high levels of climate anxiety and pro-environmental behaviour, which could enable clinicians to better support a likely small but significant number of individuals who experience severe symptoms. Thus, even with non-clinical samples, this study provides crucial insights into how climate anxiety might be addressed and managed within clinical settings, pointing to the necessity of developing targeted and empirically-grounded therapeutic approaches for those at the higher end of the anxiety spectrum.

Part 2. Reflexive Observations

My experience as a researcher has been integral to my development as a scientist-practitioner, shaping the reflections shared in this case study. In this section, I discuss my critical approach to research and address the challenge of poorly defined psychological concepts. I also explore how confronting my own climate anxiety has enriched my clinical practice. Furthermore, I discuss my experience of climate anxiety in the internship year and how, given the complexities and acute presentations often encountered in public health settings, climate anxiety is not frequently a primary focus of treatment for clinical psychologists.

Scientist Practitioner Perspective

Reflexivity in relation to this research goes beyond assessing how my personal perspectives or preferences could have introduced bias in the study's design, analysis, or findings. It has provided an unparalleled opportunity for me to repeatedly and vigilantly evaluate the source material I cite, thereby making me more critical of the research that informs my clinical decisions for clients. Certainly, embracing open science as both an advocate and a practitioner has opened my eyes to the many academic articles that lack

stringent control. In particular, I am reminded that, in my previous career as a medical journalist in the mainstream media, myself and colleagues would report on ‘scientific breakthroughs’ based on studies in academic journals that, on reflection, very often fell short of stringent methodological standards. This realisation underscores the importance of scrutinising the rigour of studies before accepting their conclusions. My journey through this research process has therefore not only sharpened my critical thinking but also instilled a deeper commitment to ensuring the reliability and validity of the information I utilise and disseminate in both my current practice and broader communications.

More surprisingly, encountering results that contradicted my expectations underscored the allure of retrospectively altering the focus or objectives of a study to craft a different narrative. Without preregistration, it would be easy to modify inferential standards or to deviate from initially planned analyses. For researchers whose careers and reputations hinge on publishing, especially in journals that demand confirmed predictions, the stakes are indeed high. Committing to methodologically sound, preregistered, open research practices has honed my ability to critically assess information and become a more analytical clinician, capable of selecting evidence-based methods for my clients. This approach has sharpened my skills in identifying methodologically-sound studies and in evaluating the scientific basis of treatments or measures before deciding on their suitability for a particular client. Moreover, I have contemplated the differing role of transparency in research compared with clinical practice. While adherence to a preregistered plan is crucial for maintaining credibility in research outcomes, clinical practice thrives on adaptability and the ongoing revision of strategies in partnership with clients. Thus, while the principles of open science are vital, they serve distinctly different purposes in each context.

Conceptual Issues in Psychology

My doctoral research illuminated the importance of critical scrutiny toward the concepts we utilise in psychology, especially those that are loosely defined or poorly captured by psychometric tools. This experience was particularly relevant in studying climate anxiety, a concept which the CCAS attempts to measure but remains ambiguously defined with varying interpretations among academics (some treat it as a very specific concept and others consider it a catch-all term for negative psychological reactions to environmental threats (Coffey et al., 2021). The frustrating process of trying to establish what climate anxiety is, given the wide array of definitions and operationalisations of the concept, instilled in me a healthy scepticism about other psychological labels used widely in this field. In particular, there is not yet any clear agreement of what actual emotional, cognitive and behavioural experiences make up climate anxiety. This was a confronting process and made me realise that I seek to see psychological concepts as concrete, with some surety of what they 'are' and how they are experienced, when in fact they are constructions firmed up over time by research reasoning and eventual consensus. As a result, I now take a less concrete view of concepts I encounter in practice, whether it be social anxiety or major depression, and tend to put more weight on considering a client's specific symptoms, for understanding client experiences and guiding treatment.

Confronting Climate Change: My Personal Journey

Undertaking this research required me to engage with the issue of climate change in ways I never had before. The process of immersing myself in the statistical data and acknowledging the growing consensus among academics and scientists about the undeniable occurrence and increasing urgency of climate change was deeply uncomfortable for me. I realised that I had been avoidant of climate change as a method of managing my own climate anxiety. Without fully acknowledging it before, I was that person who skimmed past climate

change headlines, shifted conversations away from global warming to lighter topics, and reassured myself that the increasingly wild weather patterns impacting my city of Auckland was mere coincidence. While I wouldn't classify myself as a climate denialist — since deep down, I recognised the reality of the situation — I had certainly been using these avoidance strategies to cope with my anxiety. Through reviewing extensive literature on this topic, I was compelled to face the evidence head-on and read numerous accounts from environmentalists, activists, and scientists who are deeply engaged with the ongoing changes to our planet. The experience was embarrassing and humbling, and made me realise that I had intellectualised my research topic as an academic exercise without actively engaging with it in a personally meaningful way.

I opted to deal with this avoidance using the gold standard approach to anxiety treatment – exposure. As a result, I switched to engaging with the topic more actively than ever—reading challenging articles, initiating discussions with friends, and allowing myself to be with the feeling of anxiety that arose in me when engaging with the content. I completed the CCAS myself, and even found myself looking at distressing photos and videos of climate-affected environments, real top-of-the-fear-hierarchy stuff. Just as in exposure therapy, I found that confronting the content directly led to a decrease in my anxiety, confirming that I could handle this content and be okay.

Another significant insight from engaging with this topic was recognising my own limited involvement in pro-environmental behaviours. Without information on behaviours that mitigated climate change, I made excuses about my lack of pro-environmental action. After undertaking a literature review, I felt informed enough to start making tangible lifestyle changes. At home, my whānau adopted a more plant-based diet and we moved to an electric vehicle. At work, I initiated a sustainability group focused on reducing taxi use and managing food waste. Although these changes might not directly reduce my climate anxiety (as

indicated by my study findings), pro-environmental behaviour carries many other benefits. Increasing my own pro-environmental behaviour significantly enhanced my sense of responsibility and engagement as a citizen, and increased personal fulfilment.

Climate Anxiety Assessment and Therapy

After two years of academic hypothesising about the impact of the climate crisis on mental health, it was a powerful moment when I first came face to face with climate anxiety in the therapy room. Here was first-hand evidence that the impact is real, and can be debilitating. Thanks to my research experience, I was able to quickly identify climate anxiety in clients through mentally checking off items included in the CCAS, such as difficulties concentrating, sleeping or having fun due to anxiety about climate change. Interestingly, despite its conceptual limitations, the CCAS served as a useful informal screener during assessment in my clinical practice. Probably even more poignant was the experience of treating climate anxiety in one client, a young man with generalised anxiety disorder who regularly cried and had nightmares due to climate change. Informed by my research findings, I opted not to focus on engaging him in pro-environmental behaviour, but instead focused on current therapeutic approaches I had canvassed in the academic literature. These included work to validate climate-related emotions, enhance social connections, and build resilience, focuses shown to be effective in treating climate anxiety (e.g., Fraser et al., 2013; Gibson et al., 2019; Verlie, 2021). In the therapy room, these approaches felt both positive and constructive. Probably my most significant therapeutic learning for my development as a clinical psychological was that I could use my recent exploration of my own climate anxiety to help me empathise deeply, discuss climate change knowledgeably, and model coping strategies, all of which are beneficial for supporting climate distressed clients (Budziszewska & Jonsson, 2022).

Climate Anxiety in Adult Community Mental Health

While I did get a chance to work with climate anxiety in clients during internship, these opportunities were few and far between, likely because, while climate anxiety is an important and growing concern, it is relatively rare among clients with multiple acute mental health issues seen in the public mental health system. There were many significant realisations starting my career in mental health at the coalface that is the public health system, one being that my clients were often grappling with urgent and personally impacting concerns such as how to tolerate delusional voices, how to leave the house, and how to pay for their medications. As Maslow (1943) argued in his hierarchy of needs, an individual's fundamental physiological and safety needs must first be satisfied before other needs, including global existential threats like the declining state of the planet, can be addressed. Therapy for climate anxiety therapy may be more feasible in private practice settings, where the lower threshold for accessing care can accommodate such concerns more readily.

Concluding Remarks

Initially, the connection between my doctoral research and my professional development as a clinician may not be immediately apparent. However, as discussed above, I believe it has profoundly influenced both my professional and personal growth. I am deeply appreciative to the 700 participants who took the time to repeatedly engage with my surveys, and grateful for this chance to learn and grow from the experience. Some reflections were challenging yet essential and I believe they have already begun to shape me into a more mindful, curious, tolerant and analytical clinician in the therapy room. I look forward to further developing these insights, and continually improving my capacity for self-reflection and growth as a clinician in the years to come.

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