Warm Glow in a Warming World: How is Warm Glow Felt Across Individual and Collective Climate Actions?

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Abstract

The scale and severity of climate change are well established; its environmental, physical, social, economic, and psychological effects are already being observed globally, with these consequences expected to worsen over time. Although actions must be taken on a large scale to mitigate these effects, current levels of engagement are insufficient. Encouraging greater participation in pro-environmental behaviours is therefore essential, with positive emotions increasingly recognised as an effective driver. The aim of this research is to explore how warm glow, a positive emotion derived from behaving in environmentally friendly ways, is experienced across collective and individual climate actions. To examine this aim, a quasi-experimental, online survey was conducted among an Australian and New Zealand sample. Participants in the individual and collective climate action conditions completed an autobiographical writing task about a past climate-friendly behaviour, designed to elicit feelings of warm glow. It was hypothesised that participants in both the individual and collective climate action conditions would report higher levels of warm glow relative to the control condition, and that those in the collective condition would report higher levels of warm glow compared to the individual condition. Results showed that warm glow scores were higher for both climate action conditions relative to the control group. However, pairwise comparisons revealed that significant differences were only observed between the collective climate action and control conditions. Exploratory analyses found both efficacy beliefs and extraversion to be strongly correlated with warm glow scores. This study demonstrates that reflecting on past collective climate actions elicits feelings of warm glow, with broader research suggesting that this emotion may motivate future participation and sustain engagement in the movement. Understanding the emotional rewards of climate action may therefore help to encourage participation in the collective behaviours needed to address the climate crisis, while supporting positive psychological, social, and emotional outcomes.

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Surely it is better to not only create a world more conducive to human thriving, but also to create human thriving as we go*?*

Niki Harré, *Psychology for a Better World*

Introduction

I want you to remember a time when you behaved in a way that was good for the climate or helped to protect the natural world. How did you feel afterwards about yourself, your action, or your role within society? Experiencing a warm glow is a common response to such behaviours, and by understanding this positive emotional experience, we may be able to encourage greater engagement with these environmentally friendly actions.

As climate change is not a future problem, the need for such engagement is essential. Driven by anthropogenic greenhouse gas emissions, changes to the climate are already being witnessed on a global scale. Widespread environmental damage is adversely affecting ecosystems, health outcomes, human wellbeing, water availability, food production, and the prevalence of extreme weather events. To alter the trajectory and intensity of climate change, climate action is needed at all levels (Intergovernmental Panel on Climate Change [IPCC], 2023a).

Simply knowing the climate is changing is not enough to motivate action (Colombo et al., 2023). To effectively address such a complex problem, psychological research needs to explore the mechanisms that motivate, inhibit, and sustain climate action. One promising mechanism that warrants further investigation is the role of emotions. As emotions shape how we evaluate information, make decisions, and act (Brosch, 2021), it is unsurprising that there has been an increasing interest in how they influence climate-related decision making and behaviours (Schneider et al., 2021). Among these, positive emotions may be especially useful in supporting long-term engagement in climate actions (Harré, 2011).

Warm glow has emerged across the literature as one such positive emotion. In this research, warm glow is understood as an emotion characterised by feelings of satisfaction and pleasure arising from the appraisal of behaviours that benefit society or the environment (Hartmann et al., 2017, p. 45). In contrast to extrinsic incentives, which often reverse positive behavioural changes once they are removed, warm glow offers a valuable intrinsic driver of pro-environmental behaviours (van der Linden, 2015). Consistent with this, longitudinal research has shown that anticipating warm glow feelings predicted a broad range of pro-environmental behaviours four weeks later (van der Linden, 2018), reinforcing the idea that this emotion may be an effective mechanism to sustain engagement in the climate movement. However, little is known about how warm glow is felt across different approaches to climate action.

Two such approaches that warrant further investigation are climate-friendly behaviours which are performed with others (collective climate actions) and those which are performed alone (individual climate actions). Collective climate actions not only reduce greenhouse gas emissions, they can also increase positive emotions, build activist movements, advance climate policies, and grow the green job market (Ardoin & Bowers, 2025). Furthermore, it has been argued that such large-scale environmental challenges, such as climate change, require action to be taken by the collective (Schneider et al., 2021). Despite these valuable outcomes, the responsibility for addressing climate change has increasingly shifted onto individuals (Klöckner et al., 2024). Rather than perpetuating an emphasis on individual psychological barriers to climate action (Adams, 2021), this study aims to foreground social contexts, move beyond what inhibits action to what sustains it, and highlight the role of interpersonal relationships within the climate movement.

This study examines how warm glow is experienced across individual and collective approaches to climate action, and aims to contribute to the understanding of how these two

promising, yet under-researched, factors influence one another. To address this, a quasi-experimental, survey-based study was conducted. Participants from Australia and New Zealand were randomly allocated to one of three conditions: individual climate action, collective climate action, and the control group. Those in the climate action conditions undertook a brief autobiographical writing task designed to elicit feelings of warm glow, while participants in the control condition wrote about a neutrally affective, everyday task. Measures capturing warm glow, efficacy beliefs, and demographic information were included within the survey.

This thesis begins by reviewing the existing literature and identifies a gap in the current understanding of how warm glow is felt across individual and collective climate actions. Next, the materials and method of this study are outlined. The results of registered, exploratory, and topic analyses are presented. Finally, the results of this research are compared against the literature, possible explanations are proposed, and the practical applications of these findings are considered. Across this thesis, interdisciplinary literature is drawn upon, participation in a broad range of climate actions is advocated for, and positive psychology is centred within the climate movement.

Literature Review

The following literature review aims to explore how performing, or remembering, individual and collective climate actions is associated with feelings of warm glow. To begin, the impacts of climate change will briefly be summarised, and psychology positioned as instrumental in addressing both its causes and consequences. The second section will explore why climate action is needed across multiple levels and why current rates of engagement are insufficient. The third section will examine how people approach climate action, with this review specifically focusing on individual and collective behaviours. Emotional responses to climate actions will then be discussed, with warm glow identified as a particularly adaptive response for motivating pro-environmental behaviours and promoting wellbeing. The final section introduces the current study, with three hypotheses proposed to guide this research.

The Impacts of Climate Change

Although the Earth's climate has shifted dramatically throughout its history, the speed at which it has changed over the past century is unprecedented (NASA, n.d.-a). Since the 1750s, human and industrial activities have increased carbon dioxide levels by almost 50% (Friedlingstein et al., 2022), primarily through the burning of fossil fuels and deforestation (NASA, n.d.-b).

A recurring theme across the literature is how diverse the consequences of climate change are. Adversely affecting economies, reshaping the social structures of communities, damaging the environment, and threatening the health and existence of species across the globe (IPCC, 2023a), this complex issue carries profound psychological consequences, leading to a raft of behavioural and emotional responses (see Table 1). While the impacts of climate change are diverse and well documented, the psychological and personal significance of climate change may not be best represented through academic or grey research. Wang et

Table 1

Environmental, Physical, Social, and Psychological Impacts of Climate Change

Domain	Sub-category	Impacts
Environmental	Globally	• Global warming, irreversible species losses, extreme weather events, permafrost thaw, sea level rise, increases in ocean acidity, damage to ecosystems, and loss of biodiversity (IPCC, 2023a).
	Australia	• Extreme droughts, 2019-2020 Black Summer fires (Cresswell et al., 2021), coral bleaching of the Great Barrier Reef, and the climate whiplash between extreme weather events (Rice et al., 2026).
	New Zealand	• Rainfall events have degraded land, glacier ice volumes have decreased by 35% between 1978 and 2020, biodiversity and ecosystems face mounting pressure, and extreme weather events have intensified (Ministry for the Environment & Stats NZ, 2025).
Physical	Food systems	• Climate change will likely have adverse effects on the quantity, nutritional quality, and affordability of food systems (Haines & Ebi, 2019). • Climate-related changes to food systems are expected to result in an additional 140 deaths per year in New Zealand by 2050 (Royal Society, 2017).
	Water availability	• Indigenous communities across Australia are disproportionately affected by reduced access to water (Cresswell et al., 2021). • In New Zealand, annual rainfalls have increased across many sites in the lower South Island, while rainfalls have decreased across much of the upper North Island (Ministry for the Environment & Stats NZ, 2025).
	Health consequences	• Climate change is widely considered the most serious threat to global health in the 21st century (Australian Psychological Society, 2020). • Extreme weather events, increased transmission of infectious diseases, disruption of health services, increased exposure to air pollutants, and microbial contamination of waterways all adversely impact health outcomes (Royal Society, 2017). • Health impacts will be unevenly distributed, with existing health gaps projected to widen (Royal Society, 2017). • Children, Māori communities, older populations, those with disabilities or chronic diseases, low-income groups (Royal Society (2017), Aboriginal populations, and Torres Strait Islander communities will be particularly vulnerable to climate-related health impacts (Standen et al., 2022).
	Local economic stability	• The economic effects of droughts are especially prevalent in Australian communities; with financial constraints, decreased agricultural outputs, unemployment, the migration away from these communities, and a reduction in community resources, social structures, and services all contribute to community-level hardship. These economic disruptions carry significant psychological consequences, especially for those whose livelihoods are tied to climate-sensitive industries (Vins et al., 2015). • In New Zealand, primary industries are at risk of droughts, floods, the depletion of natural resources, marine heatwaves, and the suitability of land to grow crops (Ministry for the Environment & Stats NZ, 2025). • The tourism industry is also at risk from disruptions to the landscapes and natural environments upon which it depends (Ministry for the Environment & Stats NZ, 2025).

Social	Aggressive and criminal behaviour	• Higher average temperatures are expected to increase aggressive and criminal behaviours (Palinkas & Wong, 2020). • Already, hotter temperatures have been linked with higher rates of crime and violence (Choi et al., 2024), potentially as a result of heat-induced discomfort or increased alcohol consumption leading to heightened aggression (Cianconi et al., 2020).
	Local displacement	• Local displacement from sea level rise or coastal retreat results in the loss of strong social ties, the disruption of communities, and resettlement challenges (Royal Society, 2017).
	Socioeconomic inequalities	• Existing inequalities, both between and within nations, are expected to deepen as climate change intensifies (IPCC, 2023a). • Just-transition frameworks must go beyond simply protecting jobs to address the root causes of socioeconomic inequality and promote social justice (Velicu & Barca, 2020).
	Indigenous wellbeing	• In Australia, Indigenous peoples' wellbeing is inseparable from Country. Changes in the climate disproportionately affect Indigenous communities through seasonal changes, rising temperatures, reduced access to Country, and the ability to engage in cultural practices (Cresswell et al., 2021). • In New Zealand, changes in the environment are disrupting cultural practices such as mahinga kai (traditional food gathering), rongoā rākau (plant medicine), and traditional ways of monitoring the environment. Since many culturally significant sites, such as marae and kainga (settlements), are at risk of damage from extreme weather events, the mātauranga Māori (knowledge) connected to these places can also be affected (Ministry for the Environment & Stats NZ, 2025).
Psychological	Overview	• Climate change affects mental health by activating emotional distress responses (Fritze et al., 2008). • Large portions of the population have already reported their mental health as impacted by climate change (Cianconi et al., 2020). • At an existential level, climate change threatens to disrupt key human needs such as control, feelings of certainty, and personal survival (Stollberg & Jonas, 2021). • Psychological consequences are contingent upon how climate change is experienced (Palinkas & Wong, 2020).
	Extreme weather events	• Events that occur over a shorter duration, such as hurricanes, wildfires, and floods, can result in higher rates of anxiety, stress, and post-traumatic stress disorders (Palinkas & Wong, 2020). • Between 25% to 50% of people who experience an acute extreme weather event will suffer adverse mental health outcomes, most of which will subside over time (Palinkas & Wong, 2020).
	Subacute events (i.e., lasting for months or years)	• In the United States, a 1°C rise in average temperatures over a five year period was linked with a 2% increase in mental health issues (Obradovich et al., 2018). As these figures were based on reported mental health difficulties, it is likely that this estimate is conservative. • A review primarily focused on Australian populations found that the financial hardships induced by droughts were linked to adverse psychological outcomes such as anxiety, shame, stress, depression, and suicide (Vins et al., 2015).
	Long-lasting environmental damage	• Damage to the environment (e.g., higher temperatures, sea level rise) from current and past emissions is expected to persist for generations to come (IPCC, 2023a). These long-lasting changes can culminate in psychological distress and an existential anxiety about the future (Palinkas & Wong, 2020). • Strong emotional responses about what climate change means for the future of the planet (e.g., worry, despair, and hopelessness) have given rise to a distinct cluster of climate related psychological phenomena, including ecoanxiety, ecoparalysis, and solastalgia (Palinkas & Wong, 2020).

al. (2018) argued that "to care about climate change is paradoxically not about climate change itself, but about the things that it will harm or take away from us" (p. 26). These objects of care vary across people, but may include one's values, close others, places, identities, future generations, or the environment (Wang et al., 2018).

The Role of Psychology in Addressing Climate Change

As climate change is the culmination of billions of people's daily decisions, it is inherently a psychological problem (Weir, 2018). The IPCC (2023) reinforced this idea when it concluded that "human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming" (p. 42). As psychologists possess the necessary scientific knowledge, skills, and resources to support both mitigation and adaptation efforts (Australian Psychological Society, 2020), they are uniquely positioned to shape pro-environmental behavioural responses (Weir, 2018). Psychological research can also help to identify the human-led drivers of climate change, examine how people appraise and understand climate risks, and support adaptive coping responses (Australian Psychological Society, 2020).

With respect to climate mitigation, the New Zealand Psychological Society (n.d.) stated that "fundamental changes in our behaviour, our attitudes and values are required if we are to avoid catastrophic future scenarios[1]. We are beginning to experience extreme environmental changes and yet responding to this reality is still resisted" (para. 1). Overcoming this resistance is essential, as the window of opportunity to reduce emissions and secure a liveable future is rapidly shrinking, with the probability of irreversible changes to the climate escalating if emissions continue to rise (IPCC, 2023a). Psychologists can help shift individual and community behaviours towards more environmentally friendly practices, advocate for urgent climate action by governments and organisations, design pro-

[1] See The Case for Climate Action section for climate mitigation and adaptation definitions.

environmental campaigns and policies, and address barriers to climate action (Australian Psychological Society, 2020).

Psychology will play an increasingly valuable role in climate adaptation. Even if net zero emissions were achieved today, the effects of past greenhouse gas emissions would persist for centuries, if not millennia (IPCC, 2023a). The mental toll of these consequences underscores the need for ongoing psychological support (Australian Psychological Society, 2020). Psychologists can support climate adaptation efforts by aiding preparations for climate-related events, fostering adaptive coping with emotional responses to climate change, helping to address the psychosocial impacts of climate change, and developing effective climate adaptation education (Australian Psychological Society, 2020).

It is reasonable to suggest that climate change has also direct implications for psychologists' professional obligations. As the New Zealand Code of Ethics includes principles of responsible caring, social justice, and responsibility to society (New Zealand Psychological Society et al., 2008), I would argue that psychologists not only have a moral responsibility to address climate change (Australian Psychological Society, 2020), but a professional obligation as well. This includes centring equity, fairness, and justice for marginalised and vulnerable groups within climate responses (Australian Psychological Society, 2020). These obligations also extend to how mental health professionals frame what caring for children looks like, as they will experience a larger burden of negative climate effects across their lifetimes (Burke et al., 2018). Prenatal exposure to stressful environments, experiencing extreme weather events during childhood (Burke et al., 2018), and repeated stressors have all been associated with adverse psychological or mental health outcomes (Faravelli et al., 2012). In light of these effects, Burke et al. (2018) argued that psychologists should reconceptualise what it means to care for children in the context of climate change,

supporting both broader mitigation efforts and the development of children's resilience and adaptive capacities.

Psychological research also has the potential to reframe climate responses through a positive lens, rather than only focusing on the barriers to engagement. Research could develop initiatives that create a better world through sustainable action, invite environmentalists to imagine a viable alternative to the status quo (Harré, 2011), or examine the rewarding emotional experiences which sustain participation.

The Case for Climate Action

To effectively address climate change and its impacts, a range of actions must be taken by large numbers of people at all levels. Climate action is a broad term used to describe the collective efforts to reduce greenhouse gas emissions or prepare for climate-related changes (Almeida et al., 2024). In the context of climate change, mitigation refers to human interventions that reduce emissions or enhance greenhouse gas sinks (IPCC, 2023a). These activities are diverse, ranging from developing low emissions technologies and transitioning to renewable energies (IPCC, 2023a), to living car free, reducing meat consumption, volunteering, and protesting (Hampton & Whitmarsh, 2023). For academics and policymakers, mitigation activities are geared towards limiting global warming to no more than 1.5°C by 2030 (Almeida et al., 2024), as in line with the Paris Agreement (United Nations Framework Convention on Climate Change, 2015). Adaptation refers to the process of adjusting to the actual, or anticipated, effects of climate change with the aim of reducing harm, taking advantage of emerging opportunities, or building resilience (IPCC, 2023a). Renovating homes to be more energy efficient and resilient, reviewing insurance coverage, connecting with local communities, sharing knowledge, or starting a climate-related community group all support climate adaptation efforts at the individual and community levels (NSW Department of Planning and Environment, n.d.).

Climate action was initially situated at the government level and focused on measures that reduced national greenhouse gas emissions (Tosun, 2022). However, its scope has since expanded, with the *Climate Action* journal defining it as "all activities and behavior of individuals, groups, and organizations at various levels of spatial, temporal and institutional scale deliberately directed at preventing or reducing climate-related damages to society through mitigation and adaption actions" (Tosun, 2022, p. 1). To examine the social, emotional, and psychological processes of these climate-friendly behaviours, this thesis primarily focused on actions taken at the individual and collective levels. These levels of action are instrumental in driving bottom-up changes which, when widely adopted, can pressure governments to prioritise and enact top-down climate policy change (Vlasceanu et al., 2024).

Pro-environmental behaviours also share significant conceptual overlap with climate action. While climate actions tend to focus on behaviours which specifically reduce greenhouse gas emissions (Tosun, 2022), pro-environmental behaviours have a broader scope and encompass actions which protect the natural environment, or cause as little harm as possible (Steg & Vlek, 2009). Pro-environmental behaviours can be characterised as a type of pro-social behaviour (Venhoeven et al., 2013), motivated by emotions, identity, norms, efficacy beliefs (Fritsche et al., 2018), morals, and contextual factors (Steg & Vlek, 2009). Given this overlap, this review draws upon pro-environmental behavioural research where relevant to provide a more comprehensive evidence base for understanding climate action.

The Importance of Climate Action

Climate action is essential to alter the trajectory and intensity of climate change (IPCC, 2023a). From an environmental perspective, the severity of climate impacts is inextricably linked to current and future human activities; if emissions continue to rise, so too will climate extremes and their damaging effects (NASA, n.d.-c). On the other hand, if

emissions reduce, it may be possible to circumvent the worst of these impacts (NASA, n.d.-c). Climate mitigation and adaptation behaviours not only support positive environmental outcomes, but are also essential in protecting human health (Haines & Ebi, 2019; Royal Society, 2017), outweigh the financial costs of climate inaction (Romanello et al., 2024), and build community resilience (Almeida et al., 2024).

Furthermore, while climate change has adverse consequences on mental health outcomes (see Table 1), participating in climate action may improve mental health. However, these findings are mixed across the literature. Schwartz et al.'s (2023) mixed methods study found that collective climate action buffered the relationship between climate change anxiety and depressive symptoms, whereas individual action did not. In contrast, Curll et al.'s (2022) research using survey data collected after an extreme Australian bushfire season demonstrated that individual climate actions were associated with lower psychological distress, while collective actions were associated with increased psychological distress. These mixed findings highlight the need for more research on how different approaches to climate action affect psychological and emotional outcomes.

Engaging in environmentally friendly actions also has important implications for psychological wellbeing. These climate actions are an important coping strategy for managing climate-related distress (The Australian Psychological Society et al., n.d.), can provide psychological protection, and strengthen feelings of resiliency, hope, and wellbeing (Sanson & Burke, 2020). Supporting this, a meta-analysis found a significant, positive association between pro-environmental behaviours and subjective wellbeing, with this relationship robust across different samples and research designs (Zawadzki et al., 2020).

However, climate action does not always translate into improved wellbeing. If we consider climate actions in the context of hedonic wellbeing, whereby the goal is to maximise the amount of pleasure experienced, performing climate actions may reduce hedonic

wellbeing and feelings of pleasure experienced in the short term (Venhoeven et al., 2013). In practice, climate actions may be more difficult than their less-sustainable counterparts, their impact can be less certain, and they often involve lower consumption, all of which can diminish hedonic wellbeing (Venhoeven et al., 2013).

In contrast, when climate action is understood through eudaimonic wellbeing, sustainable practices are regarded as meaningful and fulfilling because they reflect a commitment to living in accordance with one's values (Venhoeven et al., 2013). Supporting this, Prinzing et al. (2024) found that pro-environmental behaviours were more consistently associated with eudaimonic than with hedonic wellbeing, concluding that people generally perceive these actions as valuable, meaningful, and worthwhile, even if they were not particularly enjoyable. This framing may overlap with spiritual dimensions of meaning making, which similarly centres purpose, the protection of the natural world, and the creation of a sustainable future for generations to come (Bellehumeur et al., 2022).

Although climate action is needed on a global scale, as both Australia and New Zealand contribute relatively high emissions per capita compared to many other nations (Emissions Database for Global Atmospheric Research, n.d.), research on climate action in these countries may have an outsized influence on reducing emissions. The current study, conducted among an Australian and New Zealand sample, is well positioned to address this need.

The Necessity of Climate Action Across Multiple Levels

Urgent behavioural changes are required to mitigate, and adapt to, the impacts of climate change (IPCC, 2022). However, there is no single strategy that will address the multitude of challenges brought about by climate change (Nielsen et al., 2021). As such, effective responses require action across multiple levels, locally tailored approaches, and multidisciplinary knowledge and solutions (United Nations Environment Programme, 2022).

Psychology is one such discipline that meaningfully contributes to this effort, providing valuable insights into the human dimensions of climate action. Table 2 summarises climate actions at different levels and highlights how psychologists can support these efforts.

Although any environmentally friendly action which reduces emissions should be supported, those taken by individuals and collectives are of particular importance to psychological research. Constructs such as emotions, interpersonal relationships, identity, motivations, and efficacy beliefs are relevant in shaping both individual and collective climate action engagement, warranting further examination (Fritsche et al., 2018).

Barriers to Performing Climate Actions

Despite widespread recognition that climate change is caused by human activities, many individuals remain disengaged from the actions that are needed to reduce emissions (Gifford, 2011). Low levels of engagement have important ramifications; without the public pressure to develop strong adaptation and mitigation policies, many environmental policy decisions have been deferred (van der Linden et al., 2015).

There are a number of reasons why people fail to take action. At the individual level, Gifford (2011) grouped psychological barriers to behaviour change into seven categories: limited cognition (e.g., uncertainty), ideologies (e.g., worldviews), comparisons with others (e.g., social norms), sunk costs (e.g., conflicting values and goals), discordance (e.g., denial), perceived risks (e.g., social risks of changing behaviours), and limited engagement (e.g., performing easier, lower-impact climate actions). The psychological distance of climate change, from both a temporal and spatial perspective, also makes it challenging for people to perceive it as a personal risk that requires their attention and action (van der Linden et al., 2015).

However, Schmitt et al. (2020) criticised the practice of explaining climate inaction through psychological barriers. The authors argued that such a focus on these barriers

Table 2

Climate Actions Across Multiple Levels and How Psychologists Can Support These Efforts

Level	Examples of climate actions	Psychological support
Governmental	• Drive international climate cooperation, resulting in agreements such as the Kyoto Protocol (Tosun, 2022). • Develop policies that reduce emissions, set strong renewable targets, support climate research, or remove fossil fuel subsidies (United Nations Environment Programme, 2022).	• Support climate-related disaster preparations, provide information for decision makers to guide climate policies, and advocate for urgent and widespread climate action (Australian Psychological Society, 2020). • Advise governments on how to motivate, lead, and navigate the shift towards a lower carbon future (New Zealand Psychological Society, n.d.).
Organisational	• Advocate for ambitious climate targets from governments and international bodies, develop low-emission technologies, design sharing economy business models, or act as choice architects by setting low carbon defaults (Hampton et al., 2025). • Mitigate their environmental footprint by designing long lived products, decarbonising their own organisations, or creating a circular supply chain (United Nations Environment Programme, 2022).	• Apply evidence-based insights to improve sustainability outcomes, support leaders' green behaviours, advance organisational sustainability goals, and inform environmental policies and interventions (Kühner et al., 2025).
Community	• Actions at this level can span across political, public health, community, ecological, and funding scopes (Salvador Costa et al., 2022). • Community climate actions may include policies that protect residents from climate change effects, social movements, collaborative projects, or the sharing of relevant climate information (Salvador Costa et al., 2022).	• Psychological first aid and resilience programs can mitigate the escalation of family violence, community aggression, conflict, and substance abuse often seen after disasters (Australian Psychological Society, 2020). • Psychology interventions can also promote citizen participation in climate action, support the establishment of community-led networks, and encourage collaborations between individuals, communities, businesses, and councils (New Zealand Psychological Society, n.d.).
Individual	• Drive demand-side emissions reductions through changes in consumption, transportation behaviours, and dietary preferences (Sabherwal & Sparkman, 2025). • Push for supply-side reductions (Sabherwal & Sparkman, 2025). • Facilitate change at the civic level by pressuring policymakers to adopt and implement more ambitious climate policies (Tosun, 2022) through voting and lobbying (United Nations Environment Programme, 2022).	• Research provides critical insights into psychological factors such as risk perception, threat appraisals, coping strategies, efficacy beliefs, and social norms to understand how individuals feel and act in response to climate change (Australian Psychological Society, 2020).

minimises the role of collective climate action and assigns equal responsibility to all in addressing climate change, irrespective of their position, ability, or power in society. This framing implies that humans collectively are not doing enough, and the efforts of many people and groups are obscured (Schmitt et al., 2020). Instead, Schmitt et al. (2020) emphasised the need for situating climate responses within a social and structural context to challenge existing power relations and drive transformative change.

Zooming out to the structural level, it is important to recognise the systemic barriers that perpetuate unequal participation in climate action. For example, financial, political, and social constraints inhibit many in the Global South from acting in pro-environmental ways, irrespective of their attitudes towards, or concerns about, climate change (Ogunbode et al., 2022). More broadly, Kukowski et al. (2026) suggested that the structural barriers constraining climate action are different for the social roles individuals hold. These could include legal risks for marginalised groups engaging in climate activism, small institutional budgets limiting workplace climate initiatives, or limited low-carbon options for investors to choose from (Kukowski et al., 2026).

Even among those engaged in the movement, their participation in climate action can also change over time. For many activists, extensive workloads, feelings of responsibility or anger, and the physical stress of engagement can compound over time, leading to withdrawal or disengagement (Hamann et al., 2025). To build resilient climate movements, Hamann et al. (2025) suggested that groups should celebrate successes, actively cultivate fun experiences, and encourage members to share how they are feeling, strategies that all highlight the role of positive emotional experiences in sustaining long-term engagement.

Collectively, the evidence indicates that sustainable actions performed across society and a wide range of contexts are essential to mitigate the impacts of climate change. However, engagement in these actions is insufficient compared to what is required (IPCC,

2023b). Although the literature has extensively explored barriers to climate action, further research is needed to better understand the drivers of these behaviours and how they vary across individual and collective approaches to climate action.

Types of Climate Action

Climate actions are diverse, ranging from governmental to individual levels. This section will explore how people perform climate actions on their own and with others, before discussing how these forms of engagement relate to one another. Following this, the role of social norms and identity in shaping climate action engagement is considered.

Throughout this section, it is important to recognise that comparisons between individual and collective climate actions are not intended to privilege one approach over the other. Debating the merits of collective versus individual behaviours acts as a distraction from the behavioural and systemic changes that are urgently needed. Instead, this review will examine how to encourage greater climate engagement more widely and lay the groundwork for understanding how warm glow may manifest across these two approaches.

Individual Climate Actions

Individuals fulfil many roles when it comes to climate action, all of which can meaningfully address climate change. In a personal capacity, they act as voters, consumers, citizens, leaders (United Nations Environment Programme, 2022), and investors (Nielsen et al., 2021). Some of the most impactful changes to reduce personal emissions are living car free, using active or public transport, using renewable electricity at home, reducing long-haul flights, eating a vegan diet, using appliances with better energy efficiency, or shifting to an electric vehicle (United Nations Environment Programme, 2020; Wynes & Nicholas, 2017). Within the professional sphere, individuals exert influence by making decisions that affect the emissions of their organisation, clients, projects, or investments (United Nations Environment Programme, 2022). Individuals can also act in a collective capacity, by joining a

group, charity, movement, or by acting as a role model in shaping pro-environmental norms (Nielsen et al., 2021; United Nations Environment Programme, 2022).

People choose to engage in these behaviours for a number of reasons. Motivators may include emotional responses, the perception of climate change as a threat (Brosch & Steg, 2021; Fritsche et al., 2018), the appraisal of these risks in relation to one's objects of care, and conceptions of morality, all of which shape how individuals come to feel about climate change and consequently, how they respond to it (Wang et al., 2018).

Although climate action is required across multiple fronts, the blame and responsibility for mitigating climate change are predominantly framed at the individual level (Supran & Oreskes, 2021; Kent, 2015). Illustrating this point, ExxonMobil's public messaging has normalised fossil fuel dominance as both natural and inevitable, shifting the responsibility away from the company as a supplier of fossil fuel, and onto individual consumers (Supran & Oreskes, 2021). Such narratives not only validate individual level behaviours, but deprioritise systemic and collective responses. From an academic perspective, the prevalence of research on individual consumer behaviour across the climate psychology literature (Schmitt et al., 2020) reduces climate change to the culmination of personal decisions (Schulte et al., 2021). This focus is limiting, as it provides an incomplete picture of climate actions, their motivators, and the power dynamics that shape these. By ignoring collective behaviours, inequality, and the role of power, mainstream psychological research perpetuates a reductive emphasis on individual behaviour change within existing social structures, rather than envisioning a new structure altogether (Schmitt et al., 2020). Addressing these limitations requires climate action to be reframed away from the individualisation of responsibility and towards collective and systemic approaches that challenge unsustainable production and consumption systems (Schulte et al., 2021).

The Value of Collective Climate Action

Brick and van der Linden (2018) described climate change as "the largest social dilemma in history" (para. 6). The cumulative effects of individual behaviours contribute to unintended, adverse collective outcomes; yet these same behaviours are perceived as being too insignificant to make a meaningful difference to climate change (Hormio, 2023). Effectively addressing this complex and multifaceted issue requires the coordination of billions of people across the globe (Jia & van der Linden, 2020), significant cooperation (Schneider et al., 2021), partnerships, and collective efforts (IPCC, 2022).

The social nature of collective climate actions can be understood in a number of ways. Ardoin and Bowers (2025) defined collective action as "people working together to achieve a common goal" (p. 1). Building on this, Masson and Fritsche (2021) conceptualised collective climate actions as behaviours performed by group members, as a representative of the group, and in support of the group's shared environmental goals. These actions could be private or public in nature, with the authors emphasising that it is how individuals position their actions within a collective context, rather than the social nature of the behaviours themselves, that defines collective action. At a broader level, Sabherwal and Sparkman (2025) asserted that when individuals engage in climate actions, these are not done in isolation; rather, their observations, relations, and behaviours are embedded within broader collective contexts, including social groups, workplaces, and political communities. To examine the social benefits of collective behaviours on positive emotional responses, this research adapts Tosun's (2022) definition of climate action to conceptualise collective climate action as behaviours performed with others that aim to prevent or reduce climate change and its effects.

Collective climate actions can result in wide ranging and meaningful outcomes. In their review, Ardoin and Bowers (2025) grouped the positive outcomes of collective action

into six categories: physical and environmental changes, emotional and psychological outcomes, behavioural and social impacts, technological innovation, policy and regulatory changes, and economic outcomes. With respect to physical and environmental changes, Ardoin and Bowers (2025) concluded that collective climate action can reduce emissions and create carbon sinks. For example, a local group in New South Wales established a community solar farm, which saves an estimated 5,500 tons of carbon each year (Flow Power, n.d.).

Considering emotional and psychological outcomes**,** collective engagement also shapes how individuals think and feel about climate action. Focusing first on psychological processes, thinking in terms of the collective can help people overcome the fear of others free riding, alleviate feelings of individual helplessness, and motivate actions that support collective climate goals (Masson & Fritsche, 2021). As the majority of people underestimate others' support for climate mitigation policies and their concern about climate change (Sparkman et al., 2022), working as a collective and directly observing others' genuine concern about climate change and their commitment to environmentally friendly behaviours may help reverse this misperception. From a mental health perspective, Schwartz et al. (2023) found that engaging in collective climate-friendly behaviours was associated with reduced mental health symptoms, buffering the relationship between the cognitive-emotional impairment of climate anxiety and major depressive disorder symptoms. Beyond clinical outcomes, social climate actions, such as carpooling or discussing environmental issues with others, were also found to have a strong positive relationship with wellbeing (Prinzing et al., 2024).

Turning to emotional outcomes, Ardoin and Bowers (2025) concluded that collective climate action increases positive emotions, reduces negative emotions towards climate change, and improves mental health outcomes and wellbeing. In a donation behaviour study, Proulx et al. (2023) found that participants who collaborated with others when deciding how

much to donate reported higher levels of enjoyment, suggesting that collaborative tasks may derive greater intrinsic enjoyment than individual activities. Relatedly, the pleasure derived from an initial pro-environmental action was found to mediate positive behavioural spillover, increasing participants' willingness to engage in further climate-friendly behaviours (Ye et al., 2022). Proulx et al.'s (2023) findings also align with the central theme of Harré's (2011) *Psychology for a Better World*, in that sustainability activities should be enjoyable, satisfying, rewarding, fun, and engaging. It is possible that since many collective actions are performed alongside familiar others, or those with whom relationships develop over time, these close interpersonal connections may amplify generosity, enjoyment, and engagement in pro-environmental behaviours. What is less researched, is the emotional outcomes of different approaches to climate action, such as behaviours which are performed individually or with others.

Examining the behavioural and social outcomes of collective climate action, engaging in these behaviours can provide meaningful psychological support, build solidarity among the group, and encourage future participation (Almeida et al., 2024). This was demonstrated among parents engaged in collective climate activist spaces, where the mutual support generated from these activities fostered hope, empowerment, and solidarity (Howard, 2022).

Finally, collective climate action has the potential to bring about policy and regulatory changes (Ardoin & Bowers, 2025). Almeida et al. (2024) suggested that collective climate action by noninstitutional actors can advance local environmental justice efforts to higher political levels, where concerns are more likely to be taken seriously and acted upon. Relatedly, collective action was also found to be a key determinant of proposed project outcomes; for environmentally sensitive energy projects where community mobilisation occurred, projects were significantly less likely to be approved and implemented compared to

those where no mobilisation took place, highlighting the power of collective opposition (McAdam & Boudet, 2012).

These outcomes demonstrate the potential for collective climate action to create meaningful shifts in the environmental, behavioural, emotional, social, and policy domains. These actions also provide support for those involved, encourage long-term participation in the movement, and increase positive emotions. Despite substantial research demonstrating the benefits of collective climate action, knowledge of the mechanisms and motivations that underpin these behaviours is still limited relative to individual behaviours (Schneider, 2025).

The Relationship Between Individual and Collective Climate Actions

How people choose to engage in climate-friendly behaviours can depend on both the action itself and the social context in which it is performed. Stanley et al. (2021) found that participants engaged in individual behaviours relatively frequently ($M = 65.8$, $SD = 18.8$), while collective climate actions were rarely performed ($M = 25.8$, $SD = 23.8$)[2]. Given that public and collective actions can drive large-scale governmental action (Doherty & Webler, 2016), this disparity highlights the need for more research on how to motivate collective climate engagement.

Notably, individual climate actions may serve as a catalyst for broader collective engagement. Koger et al. (2011) suggested that there may be a positive feedback loop, whereby individual and household climate actions expand into collective forms of engagement, such as community participation or broader advocacy behaviours. This 'foot in the door' phenomenon (Freedman & Fraser, 1966) arises when an individual takes a small, climate-friendly action, thereby building feelings of efficacy, which in turn motivates further or larger behaviours (Koger et al., 2011). Supporting the notion that individual and collective

[2] Participants were asked to report how often in the past year they had performed a range of individual and collective action behaviours from 0 (*never*) to 100 (*at every opportunity*; Stanley et al., 2021).

actions are related, higher levels of individual climate action were significantly correlated with greater engagement in climate activism (Schwartz et al., 2023), suggesting that participating in one form of climate action may reinforce the other.

These spillover effects, in which performing one action influences the likelihood of engaging in other related actions, may also help individuals engage in different types of climate actions and across contexts (Sabherwal & Sparkman, 2025). One such mechanism is through social interactions, which encourage people to perform additional or different types of climate behaviours, such as voting, making sustainable lifestyle changes, or attending a climate protest (Fine, 2022). Spillover effects can also occur when an individual engages in new climate actions as part of their role at work (Sabherwal & Sparkman, 2025). Over time, such behaviours can become internalised as part of their environmental identity, spilling over into other voluntary climate actions, both within and beyond the original workplace context (Sabherwal & Sparkman, 2025), with similar processes potentially occurring between individual and collective climate actions. Despite growing evidence of positive spillover effects across climate behaviours, a meta-analysis found that effects tend to be small and are not consistently observed across different behaviours (Maki et al., 2019).

It is important to recognise that existing research on pro-environmental behaviours often groups actions together in a single measure (Prinzing et al., 2024). This aggregation fails to account for the actions' perceived costs, social norms, impacts, and whether they are performed in a social context or alone. Prinzing et al. (2024) argued that this methodological limitation may obscure significant variation between specific actions and wellbeing outcomes, highlighting the need to examine characteristics of different climate actions and their effects on psychological, emotional, and behavioural outcomes. This limitation is directly relevant to the present research, which examines whether the social nature of climate

actions shapes emotional responses in different ways. As existing studies rarely make this distinction, further research that explicitly accounts for such factors is needed.

The Role of Social Norms and Identity in Climate Action

Human behaviours do not exist in a silo; they are largely influenced by the social groups we belong to (Brosch, 2025; Renger & Reese, 2017). As such, climate actions are shaped by our social circles through norms and identities (Masson & Fritsche, 2021).

External influences, such as social norms, shape how we engage in climate actions with others and on our own. Social norms are the rules and standards that guide social behaviours, are collectively negotiated and understood by group members (Cialdini & Trost, 1998), and are particularly relevant given the uncertain nature of climate change (Perry et al., 2021). Injunctive norms, or the perception of which behaviours the people close to you would approve or disapprove of in a given situation (Ogunbode et al., 2022), help to determine which behaviours ought to be performed (Cialdini et al., 1990). For instance, adopting a vegetarian diet because your family disapproves of eating meat, or attending a climate protest because your friends approve of civic participation, could both be considered behaviours that are shaped by injunctive norms.

While injunctive norms focus on approval, descriptive norms, or the perception of what others would do in a specific situation (Ogunbode et al., 2022), can provide cues that guide behaviours to align with what others are doing (Cialdini et al., 1990). In a study on Californians' energy conservation behaviours, Nolan et al. (2008) found that descriptive norms had the strongest influence on participants' behaviours compared to other motivational factors, despite participants believing they would have the least. In the context of the current study, if a person recycles at home because their colleagues always recycle at work, or if they choose to volunteer at a local tree planting event because their neighbours are also attending, these behaviours have been influenced by descriptive norms. Notably, the influence of social

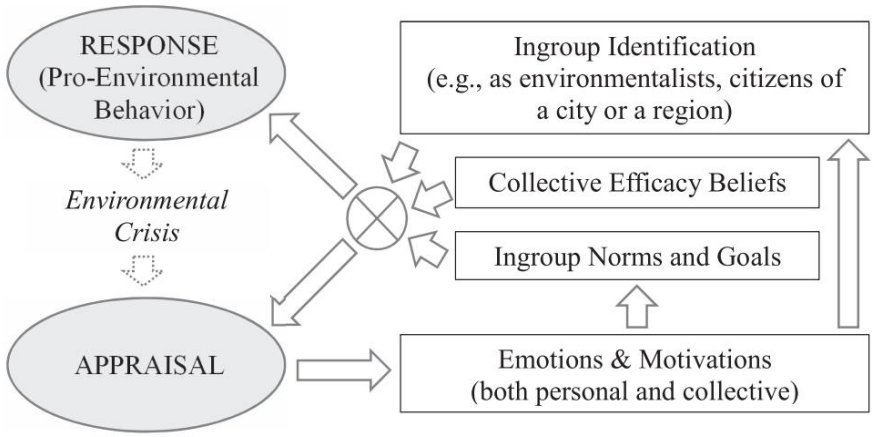
norms on environmentally friendly behaviours extends beyond motivating action; Bissing-Olson et al. (2016) demonstrated that social norms moderated the relationship between pride and future pro-environmental behaviours, suggesting that emotional experiences of acting in line with what others are doing may strengthen engagement. Together, these findings demonstrate that although many climate actions are performed individually, they are still shaped by social influences such as perceived norms.

Shifting to internal influences, social identities can drive climate engagement by shaping how individuals define themselves in relation both to the environment and their social groups. Social identities relate to an individual's self-concept derived from the specific social groups to which they belong (Tajfel & Turner, 1986). These identities are important in the context of climate action, with a meta-analysis revealing social identity as the most influential predictor of pro-environmental behavioural intentions (Schulte et al., 2021). In New Zealand, nearly 90% of participants reported a clean-and-green attitude as central to the national identity, with this identity associated with both individual and collective pro-environmental tendencies (Milfont et al., 2020). Taken together, these studies demonstrate that social identities shape whether, and how, people engage in different types of climate action.

Fritsche et al.'s (2018) Social Identity Model of Pro-Environmental Action (SIMPEA) explained the drivers of climate action through social identity processes (see Figure 1). The authors suggested that environmental action stems from the appraisal of an environmental challenge (e.g., climate change) and when these appraisals are evaluated as relevant to the individual or their ingroup, emotions and motivations arise at both the personal and collective level. These emotions and motivations drive ingroup identification, collective efficacy beliefs (i.e., perceptions that the group is capable of achieving its goals), and ingroup norms and goals, which in turn shape how environmental threats are appraised and responded to.

Figure 1

Social Identity Model of Pro-Environmental Action



Note. From "A Social Identity Model of Pro-Environmental Action (SIMPEA)" by Fritsche et al., 2018, *Psychological Review*, *125*(2), p. 246. Copyright 2017 by American Psychological Association. Reproduced with permission.

The SIMPEA model is particularly versatile, accounting for both private and public environmentally friendly behaviours (Fritsche et al., 2018). Although these behaviours do not perfectly align with individual and collective climate actions, they broadly map onto these approaches, as many private actions relate to personal or household behaviours, while public actions often entail citizenship behaviours such as joining an environmental group (Stern, 2000). The model can also be applied to any ingroup, not just those that are focused on climate or environmental issues (Fritsche et al., 2018). For example, members of a sports team may engage in climate-friendly behaviours when pro-environmental norms are salient within the group, even though the team does not primarily function as an environmental group.

Although the present research primarily focuses on how emotions arise from climate engagement, rather than emotion as drivers of action, the SIMPEA model provides a useful framework to understand the social mechanisms shape the interaction between actions and

emotions. Social norms can shape both individual and collective climate actions to align with group expectations, while social identities align behaviours with how individuals see themselves and wish to be perceived by others.

This section has demonstrated that both individual and collective behaviours are needed to effectively respond to climate change. Although the responsibility for addressing climate change has been shifted onto individuals and actions are often taken at this level, collective behaviours lead to a range of meaningful outcomes. These two forms of action are shaped by social processes such as norms and identities, suggesting that even behaviours performed alone reflect a collective dimension.

Emotions and Their Relation to Climate Action

One of the most challenging policy research questions is how to sustain positive behaviour changes over time (van der Linden, 2015). Adding to this, education alone is insufficient to drive these changes in the first place, suggesting that alternative approaches are necessary (Brick & van der Linden, 2018). Emotions may offer a more promising pathway in both motivating initial engagement and sustaining climate-friendly behaviours over time.

Broadly speaking, emotions are short-lived responses, biologically based, elicited by the appraisal of stimuli, and motivate action (Niedenthal & Ric, 2017)[3]. Emotions can be triggered by a specific target (e.g., a heatwave) or a group of objects (e.g., climate change; Mosquera & Jylhä, 2022). As adaptive responses to a crisis or threat, they serve as valuable sources of information (Mosquera & Jylhä, 2022) that can shape subsequent behaviours (Brosch, 2021). In the context of climate action, emotions can also be experienced both in anticipation, or as a consequence, of engaging in these behaviours (Brosch, 2021).

[3] This review conceptualises warm glow as an emotional construct. While feelings (the subjective experience of an emotion; Mosquera & Jylhä, 2022) and affect (a general, undifferentiated feeling state that is shaped by valence, arousal, and motivations; Harth, 2021) are related concepts, a detailed examination of these states is beyond the scope of this thesis.

Emotional Responses Towards Climate Change

Research indicates that people experience a wide range of emotions towards climate change (see Table 3 for a summary of common emotional responses). A raft of new emotions related to climate change have been identified, such as climate change anxiety, eco-anger, solastalgia, and eco-grief.

It is important to recognise that many of these emotions are experienced in tandem, and can be conflicting in nature (Kovács et al., 2024). For example, hot summer days can evoke feelings of happiness (for the warmer weather), worry (considering the cause of these warmer temperatures), and guilt (for enjoying the sunshine), a conflict Mosquera and Jylhä (2022) described as a climate affective dilemma. However, emotional interactions can also have positive outcomes, with Ojala (2023) suggesting that the combination of hope and worry about the future can help to sustain activists' climate engagement.

Behavioural responses can also shape how people feel about climate change. For people who are actively engaged in the climate movement, their perceptions of climate change and psychological closeness to the issue may lead to deeper, more nuanced emotional responses compared with other groups (Wang et al., 2018). For example, climate scientists expressed a greater frequency and wider range of emotional reactions to climate change compared to students and the general population (Wang et al., 2018).

The Role of Emotions in Motivating Climate Action

Emotional responses to climate change are one of the most significant drivers of pro-environmental decision making and behaviour (Kovács et al., 2024; Brosch & Steg, 2021). They direct our attention to important issues, motivate action, shape our interpretation of the world (Kovács et al., 2024), and encourage responsiveness, all of which are necessary to address climate change (Schneider et al., 2021). As emotions are intertwined with the cognitive and behavioural processes underpinning responses to climate change (Davidson &

Table 3

Overview of Common Emotional Responses to Climate Change

Emotion	Examples and impacts
Fear	• Fear can be experienced in response to dangerous or threatening situations (Mosquera & Jylhä, 2022), such as the reality, impacts, future risks, and existential threats of climate change (Australian Psychological Society et al., n.d.). • Fear facilitates the behaviours necessary to deal with the danger, such as communicating with others and seeking assistance (Brosch, 2025).
Guilt	• A self-directed, negative emotion arising from immoral behaviours (e.g., engaging in harmful actions, or failing to perform good behaviours; Erlandsson et al., 2016). • Guilt demonstrates that people want to do the right thing, and are motivated to act in pro-social and pro-environmental ways (Mosquera & Jylhä, 2022).
Climate anxiety	• Climate-related anxieties can be elicited by extreme weather events and existential threats, resulting in negative cognitive, emotional, and behavioural responses (Schwartz et al., 2023). • Ogunbode et al. (2022) demonstrated the cross-cultural reach of these effects, finding that climate anxiety had a significant inverse relationship with mental wellbeing in 31 out of 32 countries examined.
Eco-anger	• Eco-anger can arise from perceptions that inadequate action is being taken to address climate change, feelings of injustice, or frustration that climate actions are ineffective. More broadly, the effects of climate change can also drive this emotional response (Stanley et al., 2025). • This emotional response can be directed towards governments, industries, organisations, other people, or oneself (Stanley et al., 2025).
Solastalgia	• A form of place-based distress which arises from profound changes in the environments where people continue to reside (Albrecht et al., 2007).
Ecological grief	• A deep sense of grief in response to the anticipated and experienced degradation of the natural world (Cunsolo & Ellis, 2018). • This includes the loss of meaningful species, ecosystems, environmental knowledge, identities, ways of life, and landscapes (Cunsolo & Ellis, 2018).
Hope	• An appraisal-based emotion, dependent on the potential for change, which makes it conceptually distinct from optimism (Ojala, 2023). • Hope can appear contradictory; while it can support wellbeing and drive climate action, it appears less appropriate when rationality is considered (Mosquera & Jylhä, 2022). The literature remains divided on whether hope leads to engagement, or wishful thinking and disengagement (Ojala, 2023). • Constructive hope is based on a positive reappraisal, trust in different societal sources, and perceptions of self-efficacy. It predicted higher levels of climate policy support and intentions to engage in climate-related political behaviours (Marlon et al., 2019). • Passive hope mitigates the need for active involvement (Geiger et al., 2023). • False hope is built upon hope as an emotion, encompasses the denial of reality (Ojala, 2023), and predicted lower political, climate-related behavioural intentions (Marlon et al., 2019).

Kecinski, 2022), understanding how they relate to climate action is therefore essential. Theoretical frameworks, such as the SIMPEA model, highlight how emotions motivate pro-environmental behaviours through social processes such as ingroup identification, collective efficacy beliefs, and ingroup norms and goals (Fritsche et al., 2018).

Ogunbode et al. (2022) drew on data from 32 countries and found that climate anxiety was positively associated with pro-environmental behaviour in 24 countries and environmental activism (e.g., protesting) in 12 countries. In contrast, among an Australian sample, Stanley et al. (2021) found that eco-anxiety was associated with lower levels of collective action engagement, while anger and depression about climate change predicted greater participation in collective actions. While negative emotions can drive climate action, it is important to consider the negative impact they have on an individual's wellbeing (Brosch & Steg, 2021). Although eco-depression was linked to higher reported collective climate engagement, it was also associated with lower wellbeing in an Australian sample (Stanley et al., 2021). Additionally, eco-anxiety was found to predict lower collective engagement and wellbeing (Stanley et al., 2021) and was shown to interfere with education, career, and family goals, eroding feelings of meaning and purpose (Schwartz et al., 2023).

Although negative emotions can drive climate action, the adverse impact they have on wellbeing demonstrates the need for more adaptive approaches. Positive emotions may offer a valuable alternative. It is important to recognise that a focus on positive emotions does not minimise the difficulties of addressing climate change, nor does it assume negative emotions are avoidable; rather, it offers a complementary approach (Harré, 2011). Fredrickson's (2001) broaden-and-build theory proposes that positive emotions broaden an individual's thinking and behaviour, which can build lasting personal resources. Positive emotions can broaden one's mindset, with interest driving exploration, contentment motivating individuals to savour and integrate their circumstances, and joy encouraging playfulness, creativity, and

connection with others. In the context of climate action, this theory was supported by Spence and Burge (2026), who found that feelings of hope increased creativity in sustainable behaviours. Over time, individuals with broadened mindsets can also accumulate valuable resources, including social relationships, psychological resilience, and adaptive skills, all of which can be drawn upon when needed (Fredrickson, 2001). Applying the broaden-and-build theory to climate action, positive emotional experiences may provide individuals with the cognitive, social, and psychological resources needed to meaningfully engage with climate-friendly behaviours over time.

Despite widespread recognition that emotions are powerful motivators of climate action, the climate literature centres adaptation and mitigation activities within economic, financial, policy, governance, engineering, and technological solutions (Davidson & Kecinski, 2022). Therefore, it is essential that research continues to investigate how emotions, especially positive affect, are experienced when participating in these climate-friendly actions and how they motivate and sustain engagement.

Emotional Responses Arising from Climate Action

Emotions not only emerge in anticipation of climate actions but also as a consequence of engaging in these behaviours. Generally, people feel positively about the climate actions they engage in, and negatively when they fail to act (Steg, 2023).

First examining the emotional responses from engaging in climate-friendly actions, Bechtel and Corral-Verdugo (2013) found that students who reported higher engagement in conservationist behaviours also reported higher levels of happiness. The authors attributed this association to the overlap between pro-ecological behaviours and the kind of actions which increase feelings of happiness, such as altruism, problem solving, and connecting with others (Bechtel & Corral-Verdugo, 2013). Similarly, in an experimental study, participants reported higher levels of positive emotions when they learned products they had consumed

contained sustainable ingredients (Yang et al., 2020). Capturing in real time how people felt about acting in environmentally friendly ways, an experience sampling study also demonstrated that engaging in pro-environmental behaviours was positively associated with feelings of pride and negatively related to feelings of guilt (Bissing-Olson et al., 2016). Finally, across multiple experimental studies, pro-environmental behaviours were significantly associated with higher levels of warm glow (Zhou et al., 2026). Taken together, these findings consistently demonstrate that participating in climate-friendly actions generates positive emotional responses.

Conversely, failing to behave in environmentally friendly ways can elicit negative emotional responses such as guilt, sadness, or shame (Steg, 2023). Guilt can emerge when people engage in behaviours that are morally wrong, or when they fail to engage in actions that are morally right (Erlandsson et al., 2016; Nielsen et al., 2024). In an interview-based study, Nielsen et al. (2024) found that among participants who reported high levels of environmental concern, eco-guilt was the predominant emotion they felt, arising from unsustainable choices, environmentally harmful actions, or failing to behave in line with their principles. In contrast, eco-shame can be experienced when behaviours may be perceived as socially damaging (Nielsen et al., 2024). For participants who exhibited lower levels of environmental concern, higher levels of eco-shame were experienced, driven by fears of social exclusion, being seen as behaving unsustainably, or being judged by others (Nielsen et al., 2024). Although positive emotional responses can arise from engaging in climate actions, these studies collectively demonstrate that failing to participate in environmentally friendly behaviours can elicit also strong negative emotions.

Emotional responses can be experienced both while engaging in climate-friendly actions and when reflecting on these behaviours. This process, known as episodic remembering, is a form of mental time travel that allows people to re-experience an event and

the emotions associated with it (Perrin & Michaelian, 2017). From a continuist perspective, remembering is the same cognitive process as imagining future events (Perrin & Michaelian, 2017), which may help motivate further actions. Recalling the positive emotions experienced during environmentally friendly behaviours, such as warm glow, can shape expectations about how one would feel when acting in similar ways in the future, motivating further engagement (Rowe et al., 2019).

The Warm Glow of Climate Action

Humans regularly act in pro-social ways. Donating to charitable causes, helping others, and volunteering all contribute to the wellbeing of others and society (Dovidio et al., 2006); yet, these behaviours often incur personal costs such as time, money, and effort (Prinzing et al., 2024). To understand this paradox, researchers have suggested that these behaviours may be motivated by the positive feelings they generate, including pleasure, satisfaction, and happiness (Hartmann et al., 2017). This phenomenon, known as warm glow, refers to these positive affective responses and has been shown to motivate both pro-social and pro-environmental behaviours (Hartmann et al., 2017).

The concept of a warm glow was first introduced by Isen (1970), who observed when people experienced success on a task, they subsequently demonstrated greater generosity and helpfulness, suggesting that when people feel good, they are more likely to help others (Hartmann et al., 2017). The idea that pro-social behaviours are motivated by positive emotional experiences was further advanced within behavioural economics (Andreoni, 1990; Hartmann et al., 2017). Andreoni (1990) used warm glow to explain why charitable donations diverge from what classical economic theories would predict, proposing that these pro-social behaviours are motivated by feelings of moral satisfaction, rather than the actual benefit to the public good. Supporting this, Kahneman and Knetsch (1992) established that an individual's willingness to donate was reflective of their willingness to pay for the moral

satisfaction derived from contributing to public goods, rather than being driven by the economic benefits to the good itself. These studies built on Isen's (1970) theory, pointing to warm glow as an intrinsic motivator for behaving in a pro-social way.

In the context of climate action, warm glow broadly describes the positive feelings people experience from acting in environmentally friendly ways (Taufik et al., 2015). Warm glow is an apt description for this emotion, as the pleasure people derived from pro-social behaviours is positively associated with warm bodily feelings, such as feeling energetic, smiling, and warmth in the chest or heart (Bianchi et al., 2023). In a novel experiment, Taufik et al. (2015) found that acting in environmentally friendly ways elicits not only a psychological warm glow, but a literal one. As affective states can influence thermal perception, people who were told they had acted in a pro-environmental manner perceived temperatures as higher than those who believed they had acted in environmentally damaging ways. To ensure conceptual clarity, the current research adopts Hartmann et al.'s (2017) definition of warm glow as "an emotional construct of feelings of pleasure and satisfaction derived from the cognitive appraisal of contributing to the wellbeing of society, and, specifically, to environmental protection" (p. 45).

Abatista and Cova (2023) demonstrated that the phenomenological experience of positive emotions can be understood through three emotional dimensions: epistemic, hedonic, and social states. As a positive emotion, warm glow can be better understood through this framework. Epistemic states include feelings of being in the presence of something novel, interesting, or bigger than oneself (e.g., awe, wonder, and interest). Hedonic states involve emotions that are related to personal wellbeing and the fulfilment of self-interests (e.g., amusement, happiness, contentment, and pride). Social states encompass emotions that relate to social connection, the wellbeing of others, and social values (e.g., compassion, love, and being moved). Research which examined how these three states are related to warm glow

indicated that each plays a distinct role. Across recall and experimental studies, Bianchi et al. (2023) found that hedonic states were the strongest predictors of pleasure across both studies. Social states, most commonly described in terms of warm feelings, were the only emotion category to significantly predict future donations. In contrast, epistemic states were correlated with participants keeping the money for themselves in the second study, rather than donating it. Together, these results suggest that the pleasure people experience when acting in pro-social ways is primarily driven by hedonic emotions, while motivation to engage in future pro-social actions is mainly derived from social emotional states. Bianchi et al. (2023) concluded that, while people experience both social and hedonic emotions when they behave in pro-social ways, hedonic emotions are the main source of warm glow feelings.

Warm glow is a concept distinct from altruism. Although both have been shown to drive pro-environmental behaviours, warm glow motivates action through the expectation of psychological benefits, while altruism encourages action through personal value systems (Hartmann et al., 2017). Warm glow was shown to have a stronger effect on pro-environmental behavioural intentions compared to altruistic personality traits, demonstrating the significance of intrinsic, emotional rewards in driving climate-friendly actions (Hartmann et al., 2017). Supporting these results, the positive emotions people experienced when acting in environmentally friendly ways (i.e., green warm glow) predicted conservation behaviours, whereas the feelings people derive when helping others (i.e., altruistic warm glow) did not (Jia & van der Linden, 2020). Reinforcing this idea, across three survey-based studies, de Groot and Steg (2008) reported that while biospheric and altruistic values were positively correlated, they are conceptually and empirically distinct constructs. Taken together, these findings suggest that climate actions are driven by warm glow feelings specifically tied to helping the planet, rather than by the broader prospect of helping others. As warm glow is sufficient in motivating environmentally friendly behaviours, this may help to explain why

individuals who score lower in altruism still perform actions that are good for others and the planet (Hartmann et al., 2017).

Given the ongoing nature of the climate crisis, positive emotions may also help sustain engagement over time. Intrinsic motivators rely on internal processes and, when activated, may be more effective in sustaining positive changes over time (van der Linden et al., 2015), making them particularly useful in addressing ongoing environmental challenges. van der Linden (2015) argued that the psychological rewards, such as warm glow, may be one such intrinsic motivator. In contrast, extrinsic motivators can be costly to enact, the outcomes are not guaranteed to be effective, and positive behaviour changes can disappear when incentives are removed (Jia & van der Linden, 2020; van der Linden, 2015). Supporting the value of intrinsic motivation, Løvoll et al. (2017) found a positive bidirectional relationship between intrinsic motivation and positive emotions more broadly, with both factors influencing subsequent decision making. Collectively, intrinsic motivators, such as the psychological rewards of warm glow, may be an effective, low-cost mechanism for encouraging and sustaining climate engagement.

These sustained effects were demonstrated in O'Brien and Kassirer's (2019) experiment on hedonic adaptation. The authors found that happiness significantly declined among participants who repeatedly received money to spend on themselves. In contrast, among participants who were instructed to give this money away to others, happiness either did not decline at all, or declined at a significantly slower rate. O'Brien and Kassirer (2019) suggested that these patterns may serve a functional social purpose; as pro-social behaviours signal an individual's contribution to the group and need to be repeatedly performed to maintain one's social standing, the happiness people feel from these behaviours may adapt at a slower rate, supporting sustained engagement. This is consistent with research showing that people more readily remember those who perform pro-social behaviours than those who

engage in non-pro-social behaviours (Urban Levy et al., 2023). If positive emotions derived from pro-social behaviours persist (O'Brien & Kassirer, 2019), climate-friendly behaviours may also generate a similarly sustaining source of positive emotions. Consistent with this idea, Harré (2011) argues for embedding positive strategies, such as feeling good, having fun, being inspired, and enjoying the company of others, within sustainability efforts to encourage broader participation in climate action and maintain meaningful long-term engagement within the movement.

Warm Glow and Individual Climate Actions

Warm glow can be experienced when people engage, or reflect on, individual climate actions, with diverse mechanisms underlying this relationship (Bianchi et al., 2023). Moral satisfaction and a sense of meaning are likely processes which elicit warm glow from individual climate actions. Furthermore, Bianchi et al. (2023) offered complementary and additive explanations for what drove the warm glow feelings in their individual donation task, including an agent-centred perspective, outcome-centred perspective, and a feeling of connection with others.

First, Bianchi et al. (2023) identified a sense of belonging to something greater than oneself as a psychological mechanism underlying their warm glow results. In their donation task, this sense significantly predicted participants' positive affective states. To align this explanation with the current research, if an individual purchased locally grown produce, this choice may have fostered a sense of closeness with others in the community, amplifying warm glow feelings.

As climate change is not just an environmental, political or scientific issue, it can also be understood as a moral concern, involving considerations of fairness, responsibility, protecting the environment, and minimising harm (Böhm et al., 2023; Hartmann et al., 2017). One mechanism through which individual climate actions may elicit warm glow is moral

satisfaction, with environmentally friendly actions widely considered morally good behaviours (Venhoeven et al., 2020). Engaging in climate actions at the personal level can reflect an individual's moral integrity, demonstrating a congruence between their political environmental commitments and personal behaviours (Hourdequin, 2010). In this way, when people perform actions that align with their values, feelings of moral satisfaction and warm glow can arise (Hartmann et al., 2017).

Venhoeven et al. (2020) argued that acting in climate-friendly ways is seen as the moral choice, and consequently meaningful, which can amplify positive emotions. In an implicit association study, when individual sustainable actions (e.g., recycling or energy saving) were meaningful to participants, they experienced more positive emotions than when behaviours were less relevant (Venhoeven et al., 2020). In a review of coping strategies with negative climate emotions in the Global North, Kirkhus and Nicholas (2023) found that meaning-focused approaches draw on belief systems, values, and existential goals to elicit positive emotions. Meaning-focused strategies were the only strategy in this review which increased both emotional wellbeing and pro-environmental behaviour, making them particularly well suited to coping with challenges like climate change that cannot be immediately solved (Kirkhus & Nicholas, 2023). Together, these findings suggest that integrating values and personal meaning into emotional and behavioural responses may offer a uniquely effective pathway that supports both positive emotional experiences and climate actions.

Another mechanism for explaining feelings of warm glow from individual climate actions involves a cognitive, self-signalling process. Behaving in climate-friendly ways fulfils a self-signalling function; performing behaviours that help others or the planet, even when such actions are costly, voluntary, and do not result in a direct benefit for the individual, reinforces one's self-concept as a moral person (Venhoeven et al., 2013). For example,

Taufik et al. (2015) explained their physical warm glow results through a self-signalling mechanism; as affect is associated with temperature perceptions, when participants believed that they had behaved in environmentally friendly ways, they saw themselves as a good person and perceived higher temperatures. The role of climate-friendly behaviours as a self-signal underlying warm glow was further supported by Welsch et al. (2021), who found that a green self-image was associated with life satisfaction through the cognitive channel (i.e., how people evaluate and judge their lives), rather than through affective means (i.e., the individual's mood or emotional state). Bianchi et al. (2023) also identified an agent-centred mechanism in their research, whereby engaging in pro-social behaviours allowed individuals to see themselves positively, which predicted positive emotions in their recall study.

The last mechanism proposed by Bianchi et al. (2023) centred on the action outcome (i.e., appraisals of how impactful an action was on others, the environment, or society), which predicted positive affect across both studies. In the context of this research, if an individual chose to take public transport to work rather than drive themselves, and felt this action made a difference, this appraisal may elicit feelings of warm glow. This is consistent with Bischoff and Krauskopf's (2015) finding that while individual donations elicited feelings of warm glow, donations made collectively by a group did not. The authors suggested that difference may have been driven by participants having less control over the outcome. However, this mechanism contradicts behavioural economic theories, which frame warm glow as feelings of moral satisfaction arising from environmentally friendly behaviours, rather than the outcome of these actions (Andreoni, 1990; Kahneman & Knetsch, 1992). Surprisingly, while outcome-centred appraisals consistently predicted positive affect across both studies in Bianchi et al.'s (2023) research, agent-centred and oneness mechanisms were only significant in one context, suggesting that their effectiveness may depend on the context in which warm glow is experienced.

In summary, warm glow arising from engaging in individual, climate-friendly actions may operate through multiple pathways, including moral satisfaction, a sense of meaning and connection, self-signalling processes, and action outcomes. Across all mechanisms discussed in this section, these explanations suggest that warm glow arises not from the pro-social behaviours themselves, but from how people appraise their actions (Bianchi et al., 2023).

Warm Glow and Collective Climate Actions

The pathways of warm glow from individual climate actions likely also apply to collective actions. While moral satisfaction and self-signalling mechanisms are central to warm glow in individual climate actions, they are not exclusive to behaviours performed alone. Collective climate actions likely preserve these benefits, while introducing additional social processes shaped by shared experiences and group dynamics. Supporting this, Brosch (2025) argues that because climate change is caused by, affects, and must be addressed by the collective, emotions towards the problem are inherently social, and should therefore be evaluated through a group-based framework. This section adopts a collective lens to examine how environmentally friendly behaviours performed with others can generate warm glow through multiple social pathways.

The first collective mechanism that may drive warm glow feelings is social relatedness. When people take part in collective climate actions, they act alongside others and develop a sense of connection, which can result in positive affective states. People who engage in collective climate actions often report higher feelings of hope, as they feel supported by others in the movement and recognise they are not alone in trying to address climate change (Ojala, 2023). Using a mix of diary entries and interviews, Howard's (2022) qualitative study found that parents in the United Kingdom channelled their feelings of responsibility and fear about climate change into a wide range of collective action spaces, including protests, workplaces, parental groups, and local climate action groups. Importantly,

these collective spaces fostered and circulated positive emotions through the close personal relationships formed within them. Although Ojala (2023) and Howard (2022) examined different positive affective states, social relatedness may similarly generate feelings of warm glow. For example, if an individual volunteers at a community tree planting event, they may feel supported in their efforts to address climate change, hopeful that others are also working towards the same environmental goals, and connected to like-minded people, thereby eliciting feelings of warm glow.

Taking part in climate-friendly behaviours which align with one's social identity can also generate positive affective states, including feelings of warm glow. Generally, people are driven to appraise their experiences in ways that align with their beliefs and identity (Brosch, 2025). Therefore, when a social identity is salient, people are motivated to act on behalf of their group, rather than as individuals (Fritsche & Masson, 2021). For example, Milfont et al. (2020) found that the perception of New Zealanders having a strong environmental identity was associated with individual environmentally friendly tendencies and collective climate actions. Behaving in ways that align with social identities may elicit positive emotions through self-concept processes (Tajfel & Turner, 1986) or identity-behaviour congruence. Furthermore, collective actions may be particularly valuable for reaffirming one's social identity, as acting visibly alongside others may lead group members to reflect an individual's moral identity back to them. When an individual's moral identity aligns with how others perceive them, they will experience positive emotions (Stets & McCaffree, 2019). Returning to the tree planting example, volunteering alongside others is a visible demonstration of one's environmental identity, and having that identity recognised and affirmed by the group may lead to warm glow feelings.

Collective climate actions not only shape social identities and relatedness but also influence how people experience emotions. While this review has predominantly examined

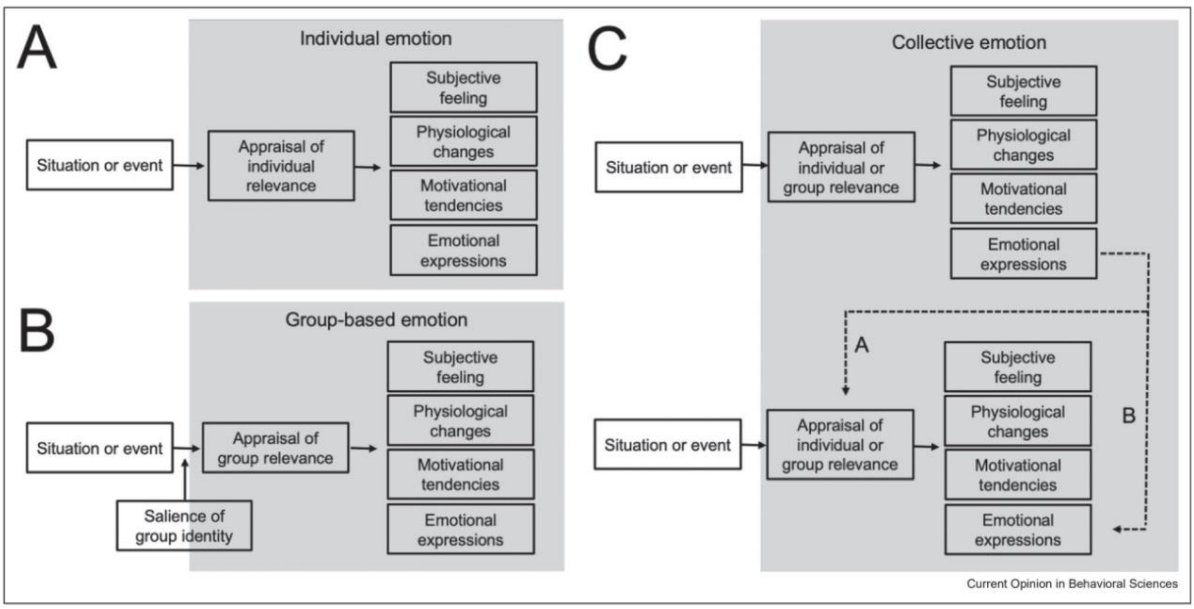
emotions as an individual-level phenomenon, they can also be experienced at the group or collective levels. When group membership is salient, individuals will evaluate the relevance of objects or events in terms of what it means for the group, rather than for themselves (Brosch, 2025). The emotions that arise from this appraisal are known as group-based emotions, whereby emotions are experienced by the individual, but are based on what the event or object means for the group (Brosch, 2025). This appraisal will then drive how the individual feels, how they express these emotions, and their motivation to act (see Figure 2; Brosch, 2025). Extending the earlier example, an individual volunteering at a community tree planting event may experience feelings of warm glow when they recognise the collective impact the group has achieved together, rather than solely focusing on their individual contribution. Group-based emotions may be particularly relevant to climate action, as they can help individuals overcome the perceived imbalance between individual costs and collective benefits by shifting the focus to what is gained by the group (Groenendyk, 2011). Although the SIMPEA model positions group-based emotions as an influence on pro-environmental behaviours (Fritsche et al., 2018), this relationship may be bi-directional where engaging in climate actions may generate group-based emotions such as warm glow.

Engaging in climate actions with others may also elicit collective emotions, including warm glow. Collective emotions are those that emerge when multiple people feel and express emotions together (Brosch, 2025). Figure 2 demonstrates how these individually experienced emotions interact and influence one another through processes such as emotional contagion (i.e., the automatic mimicking of others' responses leading to emotional synchronisation) and social appraisal (i.e., evaluating the emotional responses of others to inform their own emotional response to a situation; Brosch, 2025). However, existing scholarship has faced methodological challenges in simultaneously and continuously measuring collective emotions, with field studies remaining scarce (Brosch, 2025). That said, collective

behaviours, such as social gatherings, demonstrations, community celebrations, rituals, and ceremonies, have been found to elicit collective feelings of effervescence (Pizarro et al., 2022). While these collective experiences differ from climate actions in important ways, they may involve similar positive affective processes, suggesting that collective climate actions may generate comparable feelings of warm glow among group members. To revisit the tree planting example, volunteers may express positive emotions, such as pride, accomplishment, or joy, after completing the day's work. Witnessing and sharing in these positive affective states can elevate an individual member's warm glow, which in turn may amplify the warm glow felt across the group.

Figure 2

Mechanisms of Individual, Group-Based, and Collective Emotion Elicitation



Note. Collective emotions can occur through social appraisal (dashed arrow A) or emotional contagion (dashed arrow B). From "From individual to collective climate emotions and actions: A review" by T. Brosch, 2025, *Current Opinion in Behavioral Sciences*, *61*(Article 101466), p. 2. CC. BY 4.0.

It is worth noting that the social processes discussed in this section predominantly apply to collective climate actions, but not exclusively. People who take part in individual climate actions may still experience group-based emotions when their social identity is salient (Masson & Fritsche, 2021); for example, if a person is a member of a climate collective and reduces their food waste at home, they may perceive this individual action as contributing to the group's goal of mitigating climate change, eliciting group-based feelings of warm glow. Furthermore, as the values underlying climate actions often extend beyond the individual, it is important to recognise that individual climate actions are often driven by collective moral considerations. Hourdequin (2010) contended that humans are deeply connected to others and their communities; therefore, moral decisions driving climate actions cannot be understood at the individual level alone.

Taken together, several, complementary, socially driven mechanisms may foster feelings of warm glow from collective climate engagement. Collective actions offer support to members, cultivate a sense of connection, strengthen and reinforce social identities, and allow group-based and collective emotions to emerge, all of which may elicit warm glow.

The Positive Affective Feedback Loop of Climate Action

As previously discussed, emotions can arise from participating in climate-friendly behaviours, or in anticipation of engaging in these actions. Warm glow can also be experienced both in anticipation, and as a consequence, of acting in pro-environmental, pro-social, moral ways (Erlandsson et al., 2016).

Regarding the former, anticipating positive emotions from acting sustainably led to greater pro-environmental behavioural intentions compared to anticipating negative emotions from failing to act (Schneider et al., 2017). These emotional effects persist, with longitudinal studies demonstrating that anticipated warm glow predicts pro-environmental behaviour four

weeks later, even when behavioural intentions were controlled for (Jia & van der Linden, 2020; van der Linden, 2018).

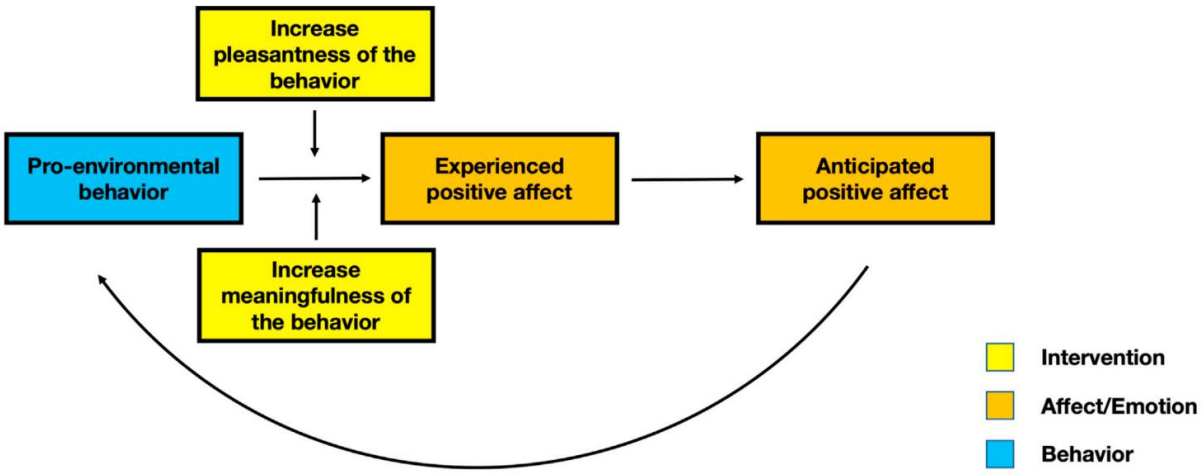
Beyond anticipation, warm glow can also emerge as a consequence of performing climate-friendly behaviours (Taufik & Venhoeven, 2018). Broadly, Schneider et al. (2021) concluded that performing climate-friendly behaviours improves wellbeing, increases an individual's life satisfaction, facilitates a positive self-image, and elicits warm glow. Specifically examining collective behaviours, engaging in collective action groups led to positive emotions such as hope and solidarity for parent climate activists (Howard, 2022), while collective climate actions similarly provided a source of hope for young Australian activists (Hockey, 2025).

As warm glow can act as both an antecedent for, and a consequence of, climate actions, researchers have suggested that it may operate as a reinforcing mechanism (Hartmann et al., 2017; Schneider et al., 2021). If people experience warm glow feelings after performing sustainable behaviours, they will anticipate feeling similar positive emotions if they choose to engage in these actions again (Brosch & Steg, 2021). This anticipation of positive emotions then motivates future climate actions, reinforcing warm glow feelings (see Figure 3; Brosch & Steg, 2021).

To illustrate, Odou and Schill (2020) reported that anticipated positive emotions of pro-environmental behaviours had a stronger effect on behavioural intentions among those already engaged in climate-friendly actions than among less engaged or non-engaged individuals. This supports the existence of a positive affective feedback loop, whereby individuals who regularly perform pro-environmental actions are more motivated to engage in future behaviours because they anticipate experiencing these positive emotions (Odou & Schill, 2020; Brosch & Steg, 2021). Further evidence for this virtuous cycle can be drawn from Hartmann et al.'s (2017) study, which demonstrated that previous pro-environmental

Figure 3

The Positive Feedback Cycle of Warm Glow



Note. From "Leveraging emotion for sustainable action" by T. Brosch and L. Steg, 2021, *One Earth*, *4*(12), p. 1695. CC. BY 4.0.

behaviours predicted positive feelings of warm glow. Notably, the influence of these warm glow emotions was significant enough to mediate the effect of prior climate-friendly behaviours on future pro-environmental intentions. Supporting this, Zhou et al. (2026) demonstrated across multiple experimental studies that behaving in environmentally friendly ways elicited higher levels of warm glow, with these positive emotions strengthening behavioural intentions. This self-reinforcing spiral may be particularly useful for sustaining long-term climate engagement, as the warm glow elicited from prior behaviours may motivate future actions (Schneider et al., 2021). To trigger a warm glow feedback loop, interventions might focus on amplifying the positive emotions associated with sustainable behaviours, or engaging a person's values to deepen the sense of meaning and satisfaction derived from such actions (Brosch & Steg, 2021; see Figure 3).

Given all of this, there is a need for research that investigates the emotional responses, particularly those of positive valence, arising from climate actions, and whether these are

experienced differently across individual and collective behaviours. This is supported by guidance from the Australian Psychological Society et al. (n.d.), who suggested that adaptive coping strategies, such as taking action, cultivating positive and fun climate-related experiences, seeking social support, generating hope, expressing emotions, and honouring climate-related feelings, are needed to help individuals manage climate-related distress. Such strategies are also valuable in helping people not become overwhelmed by their emotions, maintain engagement with climate change and pro-environmental behaviours, continue positive functioning in everyday life, and reduce the risk of burnout (Australian Psychological Society et al., n.d.).

The Current Study

This review has established that climate change is one of the most pressing challenges we face globally, with widespread and profound consequences (IPCC, 2023a). To circumvent the worst of these effects, urgent action is needed at a large scale, by many people, and at all levels. However, current engagement is insufficient to effectively meet these challenges (IPCC, 2023b). While psychological research can support mitigation and adaptation efforts at all levels (see Table 2), this study focuses on actions taken by collectives and individuals. Collective climate actions can reduce emissions, drive systemic changes, and foster better emotional, social, and psychological outcomes (Almeida et al., 2024; Ardoin & Bowers, 2025). Although a comprehensive critique of the individualisation of responsibility for addressing climate change is beyond the scope of this research, individuals can, and do, have a meaningful impact in supporting these efforts (Kent, 2015).

This review has also demonstrated that a range of emotions are experienced towards climate change, with emotional responses consistently found to be among the strongest predictors of pro-environmental behaviours (Brosch, 2021; Kovács et al., 2024). Warm glow may be uniquely positioned to motivate climate action, as it is intrinsic (van der Linden,

2015), has been shown to predict both pro-environmental behaviours (Jia & van der Linden, 2020) and intentions (Hartmann et al., 2017), and appears resistant to hedonic adaptation (O'Brien & Kassirer, 2019). Furthermore, as warm glow can be experienced both in anticipation and as a consequence of engaging in climate-friendly activities, Brosch and Steg (2021) suggested that a positive affective feedback loop may exist, sustaining engagement over time. Despite the established relationship between warm glow and environmentally friendly behaviours across the literature, to the best of my knowledge, no research has examined how this emotion is experienced when reflecting on individual and collective climate actions. As both approaches are essential in addressing climate change, understanding what motivates and sustains participation in these behaviours should be a priority for research.

This research would address the gaps above by examining how warm glow is experienced across individual and collective approaches to climate action. The ability to repeatedly experience these emotions when reflecting on past behaviours may be particularly useful in sustaining engagement. While emotions such as warm glow can be felt during climate-friendly behaviours, they are bound to this experience and only occur once (either during or immediately after the action), with responses tied to the specific behavioural episode. In contrast, reflecting on past actions may allow these emotional responses to be re-experienced beyond the original engagement (Mills & D'Mello, 2014), potentially offering a more accessible and repeatable pathway to warm glow.

Research Question and Hypotheses

This study asks: how does reflecting on past engagement in individual and collective climate actions influence warm glow? Drawing on positive psychology frameworks, this research examines climate action through a motivational lens, rather than focusing on the psychological barriers to engagement. In doing so, this study contributes to the current

understanding of how positive emotions are experienced across different approaches to climate-friendly behaviours, which may help to motivate greater participation, sustain long-term involvement, and foster better social, emotional, and mental health outcomes. To guide the direction of this research, three hypotheses were developed.

Hypothesis one was informed by research consistently linking pro-environmental actions with positive emotional responses. Methodologically similar to the current research, feelings of pride were elicited when participants reflected on past, sustainable behaviours (Rowe et al., 2019). With respect to individual behaviours, an experimental study demonstrated that participants experienced a literal warm glow, manifested as a perception of higher temperatures when learning they had behaved in an environmentally friendly way (Taufik et al., 2015). Supporting this, participants who made donations individually experienced feelings of warm glow (Bischoff & Krauskopf, 2015). Taken together, I anticipate that when reflecting on past, climate-friendly behaviours that were performed alone, participants would experience stronger feelings of warm glow.

H1: participants in the individual climate action condition would report higher levels of warm glow relative to the control condition.

This relationship was also expected to extend to collective climate actions. Closely aligned to the current research, Jerit et al. (2024) elicited feelings of warm glow by asking participants to write about their past, environmentally friendly behaviours; however, this study did not differentiate between individual and collective actions. Focusing specifically on collective actions, support for hypothesis two comes from Ardoin and Bowers' (2025) review, which concluded that collective actions increase positive emotional responses such as hope, optimism, and a feeling of empowerment. An experimental study also demonstrated that engaging in collective action was associated with more self-directed positive affect, such as feeling proud, satisfied, or happy (Becker et al., 2011). Although neither Ardoin and Bowers

(2025) nor Becker et al. (2011) specifically examined warm glow, the consistent link between collective behaviours and positive emotions indicates that reflecting on such actions will likely elicit feelings of warm glow.

H2: participants in the collective climate action condition will report higher levels of warm glow relative to the control condition.

Evidence on whether individual or collective climate actions elicit stronger positive emotions remains underexplored across the literature. However, the social and emotional benefits of collective climate action beyond those provided by individual behaviours supported the rationale of hypothesis three. Socially driven processes arising from collective action, such as collective emotions, social identities, psychological support, and social relatedness, may amplify warm glow feelings relative to individual climate actions (see the Warm Glow and Collective Climate Actions section for an in-depth discussion of potential mechanisms).

H3: Participants in the collective climate action condition will report higher levels of warm glow relative to the individual climate action condition.

Materials and Method

Design

This research examined how reflecting on different types of climate action influenced warm glow. Participants in the climate action conditions completed an experimental manipulation designed to elicit warm glow feelings. The dependent variable in this study was participants' warm glow scores, while the experimental condition was the independent variable. To examine a potential causal relationship in this sample, a quasi-experimental design was employed. Data were collected via an online survey designed in Qualtrics (Provo, UT).

Through Qualtrics' block randomisation function, participants were randomly assigned to one of three conditions: individual climate action (ICA), collective climate action (CCA), or the control group. This between-subjects design examined how the social context of climate action, specifically whether climate actions which are performed individually or collectively, affects warm glow, rather than investigating the individual differences between people who engage in different types of action.

Across all conditions, participants were required to complete a short, autobiographical writing task (see Appendix A for full survey instructions). The ICA condition listed eight climate actions that would be performed individually, with participants instructed to describe their experience with one of these behaviours. The CCA condition featured the same writing task but presented eight climate actions performed with others instead. The writing task for the control condition featured eight common activities that were unrelated to climate change and were not expected to evoke a strong emotional response.

This study was pre-registered through the Open Science Framework. To view the preregistration, visit https://osf.io/3mrhk.

Participants

To recruit a large dataset of survey respondents who were fairly compensated for their time and contributions, participants were enlisted through Prolific (2026). Prolific is an online platform that connects participants with paid research studies. As Prolific requires all users to be at least 18 years old, this experiment also adopted the same minimum age parameter. Participants had to reside in Australia or New Zealand.

To implement a between-subjects design, participants had to report engagement with at least one individual climate action and one collective climate action to be eligible to take part in this research. This screening criterion ensured that participants could be randomly assigned to any of the three study conditions. Therefore, the results and implications of this study relate to participants who had engaged in both individual and collective climate action, and may not be generalisable to the broader population. Participants who met these screening criteria and completed the full survey were compensated £1.50 for their time and engagement. Participants who had not performed at least one individual climate action and one collective climate action were screened out of the survey and compensated £0.50 for their time. Demographic information and average climate engagement for this group can be found in Appendix B.

Additional screeners were applied in Prolific to ensure that the data were of a high quality. To avoid a gender-skewed sample, an equal distribution of male and female participants was targeted. Since Prolific does not capture gender identifiers beyond male and female, more granular data regarding participants' gender identification was limited. Respondents also needed an approval rate of 95% or higher on Prolific to be eligible to take part in this study. Finally, respondents who failed to correctly answer the survey's attention check were excluded from the study. As per the exclusion criteria outlined in the preregistration, five participants' responses were removed from the analysis.

Of the remaining 205 participants, the sample was evenly split between male (n = 102) and female (n = 103) respondents. Participants' ages ranged from 18 to 79 years (M = 37.9, SD = 12.9). Full participant demographics are presented below in Table 4. The demographic characteristics of participants were similar across the three conditions (see Appendix C for details).

Sample Size Determination

To estimate the required sample size for this study, a priori power analysis was conducted using G*Power. Given the methodological similarities between the present experiment and Hartmann et al.'s (2017) study, this power analysis was based on the results reported in their second study (control condition: M = 3.4, SD = 1.1; warm glow condition: M = 4.2, SD = 0.7). Using these results, a sample of 34 participants per condition was calculated to achieve 95% power. It was unlikely the observed difference for the present research would be this large; therefore, the target sample size was doubled to 70 participants per condition (N = 210). Increasing the sample size also provided a buffer to account for any data exclusions.

Using this sampling plan, the study would be sufficiently powered to detect an effect of d = 0.62 at 95% power, and d = 0.48 at 80% power. While Cohen's (1988) conventions consider d = 0.5 as a medium effect size, Lovakov and Agadullina (2021) argued that effect sizes in social psychology effects are typically smaller, and an empirically-based medium effect would be lower than Cohen's original benchmark. Taken together, selecting a target effect size of d = 0.48 was judged to be conservative relative to Hartmann et al.'s (2017) findings, yet still practically meaningful.

Table 4

Sample Demographics of the Current Study

Demographic ($N = 205$)	Characteristic	Frequency	Percentage
Gender	Female	102	49.8%
	Male	103	50.2%
Age	18-24	26	12.7%
	25-34	70	34.1%
	35-44	58	28.3%
	45-54	26	12.7%
	55-64	16	7.8%
	65 or older	9	4.4%
Country of residence	Australia	154	73.3%
	New Zealand	56	26.7%
Ethnicity	African	7	3.4%
	Asian	27	13.2%
	Australian	93	45.4%
	Australian Aboriginal	2	1.0%
	European	19	9.3%
	Māori	2	1.0%
	Middle Eastern	3	1.5%
	North American	4	2.0%
	Pacific Peoples	6	2.9%
	Pākehā/New Zealand European	28	13.7%
	Southeast Asian	7	3.4%
	Other	7	3.4%
Highest level of completed education	Doctoral degree (e.g. PhD, PsyD, MD)	10	4.9%
	Postgraduate degree (e.g. Masterate)	35	17.2%
	Undergraduate degree (e.g. Bachelors)	101	49.5%
	Other tertiary qualification	23	11.3%
	Completed high school	34	16.7%
	Some high school (without completing)	1	0.5%
Political orientation	Liberal/left wing	104	51.0%
	Moderate	71	34.8%
	Conservative/right wing	16	7.8%
	Other	8	3.9%
	Prefer not to answer	6	2.9%
Personal income (before tax and per annum)	Less than $20,000	25	12.3%
	$20,000 - $39,999	28	13.7%
	$40,000 - $59,999	23	11.3%
	$60,000 - $79,999	33	16.2%
	$80,000 - $99,999	36	17.6%
	$100,000 or more	60	29.4%

Materials and Measures

Climate Actions

Participants were presented with a list of 16 climate actions and asked to report whether they had engaged in each one within the last three years (see Appendix A for survey instructions). This measure contained eight actions that would be performed alone and eight actions that would be performed with others. Only participants who had engaged in at least one individual and one collective climate action were eligible to continue.

Climate action items were selected and adapted from measures used in previous research and behaviours recommended by leading climate organisations (e.g., Bostrom et al., 2019; Curll et al., 2022; Doherty & Webler, 2016; Garfin et al., 2024; Hampton et al., 2025; Ivanova et al., 2020; Jerit et al., 2024; Klöckner et al., 2024; Lacroix, 2018; McDonnell & Gupta, 2024; Salvador Costa et al., 2022; United Nations Environment Programme, 2020, 2022; van der Linden, 2018; Wynes et al., 2020). This broad, multidisciplinary review enabled a comprehensive range of climate actions to be identified and informed a deeper understanding of how these behaviours are discussed across the literature.

As the climate crisis is driven by global human activities and requires joint efforts to address it, individual climate behaviours can still be understood within a collective context (Brosch, 2025; Fritsche & Masson, 2021). Nevertheless, for this research, individual actions are defined as behaviours that are performed alone, while collective actions involve social interaction and are group-based (Huber et al., 2021).

Many of the actions included in this measure are performed infrequently (e.g., *shifted to an e-bike, electric, hybrid, or more fuel efficient vehicle, or lived car free*). To capture participants' engagement in these actions, an extended timeframe was required. At the same time, participants needed to reliably remember which actions they had taken and how they felt when performing them. Bianchi et al. (2023) reported that their warm glow effects

became nonsignificant when participants recalled donations that were made more than three years ago. To preserve data reliability, this three-year timeframe was adopted for the present study.

Research has also indicated a mixed relationship between the perceived cost of climate actions and feelings of warm glow. Low-cost climate behaviours were shown to have a moderate effect on experienced warm glow, while high-cost actions had a large effect (Jerit et al., 2024). Conversely, anticipated warm glow from pro-environmental behaviours drove low-cost climate actions (e.g., switching off lights), while anticipated warm glow was a weaker predictor of higher-cost climate actions (e.g., purchasing green energy; Brick & van der Linden, 2018). To control for the possibility that the time, effort, or financial cost of climate actions may influence warm glow, a mix of lower-cost and higher-cost behaviours was included across both of the climate action conditions. Although many existing climate action measures have differentiated between the cost of behaviours (e.g., van der Linden, 2018; Jerit et al., 2024; Klöckner et al., 2024), these measures generally only contained individual actions, making them unsuitable for direct use in the present research. To ensure the cost of behaviours was similar across the collective and individual climate action conditions, each behaviour was reviewed and categorised as lower or higher-cost (see Appendix D).

Warm Glow Manipulation

To induce feelings of warm glow in the climate action conditions, participants were asked to write about a climate action they had previously performed, which made them feel good afterwards. Autobiographical Emotional Memory Tasks (AEMT) are a widely used method which instructs participants to write in detail about a specific memory that is associated with a targeted emotion (Mills & D'Mello, 2014). This task is designed to help participants relive their experience, increasing the likelihood that the same emotions will be

felt again (Mills & D'Mello, 2014). For example, writing about a happy experience has been shown to elicit feelings of happiness (Köbrich Leon & Schobin, 2023; Mills & D'Mello, 2014). Autobiographical writing tasks have also been used to induce warm glow feelings within climate action research. Jerit et al. (2024) tested four methods of inducing warm glow within their research and found that the self-reflective writing task was the only condition to have a statistically significant effect on eliciting warm glow feelings ($p = .043$). This approach was therefore selected for the current research. Across all conditions, participants were required to write at least 50 characters to ensure meaningful engagement with the task.

Participants in the ICA condition were asked to select one individual climate action they had performed and that made them feel good afterwards. Respondents were instructed to describe their experience of this action in a few sentences (see Appendix A for full procedure instructions). Participants in the CCA condition were shown a similar prompt but asked to describe a collective climate action instead.

To ensure that differences in warm glow scores could be attributed to the experimental manipulation, rather than participants' engagement in the writing task, the demands of memory recall, or the effort required to complete the survey, a similar writing task was employed for the control condition. Participants in the control condition were presented with a list of eight neutral everyday events, adapted from Earles et al.'s (2016) study. While it has been argued that neutral affect is a felt experience rather than an absence of emotion (Gasper et al., 2019), these activities were expected to be of low emotional arousal (Earles et al., 2016) and unrelated to climate change, minimising the likelihood of warm glow being experienced by this group. Participants were asked to select one activity from this list and describe their experience in a few sentences (see Appendix A for the full survey instructions and items).

Warm Glow Measure

The dependent variable in this research was participants' warm glow scores. This measure was made up of seven items, which were rated on a five-point Likert scale. Unless otherwise specified, references to warm glow scores refer to the mean of these items, calculated at either the participant or condition level.

Hartmann et al. (2017) developed a four-item measure to capture warm glow feelings and address the shortfalls of existing assessments. As an example, although the Positive and Negative Affect Schedule (Watson et al., 1988) is often used in the climate emotion literature (e.g., Lange & Dewitte, 2020; Wong-Parodi & Feygina, 2021), this measure assesses an individual's general emotional state. To capture warm glow specifically, Hartmann et al.'s (2017) measure assesses the positive affective reward that an individual derives from appraising their environmentally friendly behaviour as beneficial to the common good. Given its high reliability (Cronbach's $\alpha = .97$), Hartmann et al.'s (2017) measure was employed in the present study.

As this research was designed to examine how climate actions of differing social natures affect warm glow, this measure also needed to capture warm glow associated with the collective dimensions of participation. An additional three items were developed to capture the social aspects of collective action, such as working towards common goals, feeling connected to others, and adopting collective identities. To assess the reliability of the extended measure, the internal consistency for the overall warm glow measure (i.e. all seven warm glow items), the individual warm glow subscale (i.e., Hartmann et al.'s (2017) warm glow measure), and the collective warm glow subscale (i.e., the three additional warm glow items) were calculated and reported in the results section.

Perceived Efficacy

Perceptions of how capable individuals and groups are of taking action, as well as how effective these actions are regarded to be, are associated with both climate engagement and emotional states (Fritsche et al., 2018; Landmann & Rohmann, 2020). For example, higher levels of self-efficacy, personal response efficacy, and collective response efficacy beliefs led to greater climate action (Doherty & Webler, 2016)[4]. Efficacy beliefs are also linked to emotional responses, as perceptions of low efficacy can lead people to feeling powerless (van der Linden et al., 2015). Furthermore, Landmann and Rohmann (2020) demonstrated that experiencing feelings of being moved served as a mediator between collective efficacy beliefs and intentions to engage in collective action. Taken together, these findings suggest that efficacy beliefs are associated with climate actions and emotional responses; therefore, differences in efficacy beliefs may shape the results of the current study, highlighting the importance of measuring efficacy perceptions.

Efficacy beliefs were measured using six items. Three items, developed by Klöckner et al. (2024), measured participants' perceptions that they were capable of taking climate action. A further three items, also developed by Klöckner et al. (2024), measured participants' perceptions of the collective's capacity to implement climate actions. Participants were asked to rate their agreement or disagreement with these individual and collective efficacy statements on a five-point Likert scale. Both the individual efficacy (α = .77) and collective efficacy (α = .74) subscales demonstrated high scale reliability in Klöckner et al.'s (2024) research.

One item was developed to capture how effective participants believed the climate action they wrote about had been in helping to reduce the impacts of climate change. This

[4] Self-efficacy refers to a belief that the individual is capable of taking action. Personal response efficacy relates to a belief that an individual's behaviour will lead to specific outcomes. Collective response efficacy can be understood as a belief that a group's behaviour will lead to a specific outcome (Doherty & Webler, 2016).

item was adapted from Garfin et al.'s (2024) and Doherty and Webler's (2016) response efficacy measures and was assessed on a seven-point Likert scale. As this item was related specifically to the climate action each participant wrote about, those in the control condition were not presented with this question.

Extraversion

As people may be drawn towards, or away from, collective climate engagement due to its social nature, introverts and extroverts may derive greater warm glow from different approaches to climate action. To examine for how people feel in social situations, participants were asked to rate their agreement with four statements measuring extraversion on a seven-point Likert scale. The short-form personality measure used was developed by Donnellan et al. (2006) and validated in the New Zealand context by Sibley et al. (2011).

Attention Check

One item was included in the survey to ensure participants were paying attention and that responses came from real people. All participants in this study passed the attention check.

Demographics

Demographic information, including ethnicity, the highest level of completed education, political orientation, and personal income, was collected through the survey. Additional demographic information, including age, sex, country of residence, and employment status, was supplied by Prolific.

Survey Design

To ensure that the survey was set up correctly, data were collected through a phased approach. First, I completed the survey several times to review its usability, test the survey logic, and ensure that the language was understandable. Next, a small test group of family,

friends, and the research supervisor completed the survey and provided feedback[5]. Minor changes were made to the item language before the survey was set live to a pilot group of 20 participants in Prolific. Final adjustments were made to the survey logic before the study was published on Prolific.

Ethics Approval

This research was assessed as low risk and reviewed by the Massey University Human Ethics Committee. Ethical approval was granted on 5 November 2025 (see Appendix E for the approval letter).

Procedure

All participants were required to read a brief information sheet outlining the nature of the research and to give their consent before participating (see Appendix F). Participants who did not provide consent, were not interested in taking part, or did not agree to the study's terms were redirected to the Prolific homepage.

The online survey presented participants with a list of 16 climate actions and asked them to report whether they had engaged in each within the last three years. If participants had not performed at least one individual climate action and one collective climate action, they did not progress further in the survey, were compensated for their time, and debriefed on the nature of the experiment.

Participants who met this screening criterion were randomly assigned to one of the three experimental conditions, with equal numbers targeted for each condition. Participants in each condition were presented with a list of eight actions, asked to select one they had participated in, and were required to complete a brief, self-reflective writing task. Participants rated items regarding warm glow, efficacy, and extraversion, before completing demographic

[5] Survey responses from this group were not included in the research analyses, as they were completed on a test basis and may not reflect genuine responses.

questions. Although the order of the questions was fixed, the order of items within each measure was randomised to minimise order effects. The full survey took a median of 6:23 minutes to finish[6]. Once the survey was completed, participants were thanked for their time, compensated, and provided with a debrief sheet outlining the nature of the study.

Data Analysis and Preprocessing

The primary objective of this analysis was to investigate differences in warm glow scores across the three experimental conditions. Quantitative analyses were performed using jamovi (The jamovi project, 2025; version 2.6.44). The conventional level of significance ($p < .05$) was adopted for all statistical tests. All effect sizes throughout this research were interpreted according to Cohen's (1988) conventions.

As this study employed an experimental design, observed differences in warm glow specifically reflect emotional responses elicited by the writing task. As such, references to warm glow within this section should be interpreted as an affective response induced by the experimental manipulation, rather than a general emotional experience from engaging in climate-friendly behaviours.

To ensure robustness, every analysis of variance (ANOVA) and analysis of covariance (ANCOVA) tests were first checked for the assumption of homogeneity of variance. All Levene's tests returned non-significant results; therefore, equal variances were assumed and standard (Fisher) calculations were applied.

A pilot study of 20 participants was conducted on Prolific prior to the main data collection. The pilot demonstrated high internal reliability for the warm glow measure ($\alpha = .95$), as well as the individual ($\alpha = .91$) and collective warm glow subscales ($\alpha = .88$). An ANOVA showed non-significant variation in reported warm glow across the three conditions,

[6] As one participant took considerably longer to complete the survey compared to the rest of the sample, the median survey response time is reported here, as the mean completion time would be inflated by this outlier.

$F(2, 17) = 2.94$, $p = .080$, $= 0.26$. While these preliminary results trended in the expected direction, the pilot's sample size lacked the statistical power to confirm these findings, and a larger study was needed to establish significance.

As per the exclusion criteria outlined in the OSF preregistration, five participants' responses were excluded from the analysis for failing to meaningfully engage with the writing task, or in accordance with the survey instructions. One participant wrote a short response which failed to describe their experience and included gibberish padding to bypass the minimum character requirement. A second participant provided a non-substantive response, while a third briefly wrote about an action that was not listed in the survey. A fourth participant wrote about a CCA but performed this action alone. The last participant excluded from the analysis wrote about watching others perform a CCA, but did not engage in this behaviour themselves. Accounting for these exclusions, the final sample consisted of 205 participants.

To maintain data integrity, written responses were cross checked against participants' selected climate actions, and data were recoded when discrepancies were identified. For example, one participant wrote about using public transport but incorrectly selected the climate item, *reduced your home's energy consumption*. Five participants' responses were recoded to align with the correct climate action. All discrepancies were congruent within the participant's assigned condition. While this process was not specified in the preregistration, preprocessing the data in this way ensured participants' responses were categorised to the correct action and data were accurate.

Results

Registered Analyses

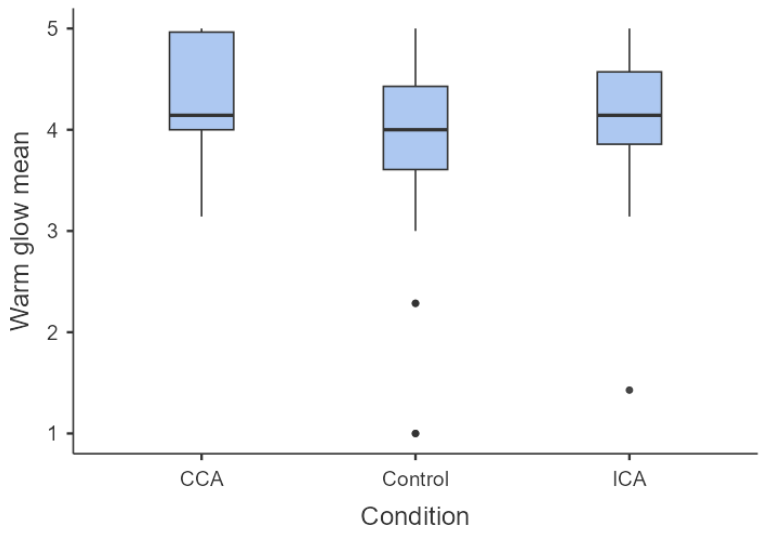
To determine whether warm glow scores varied across conditions, a number of analyses were conducted.

Prior to these, the internal consistency of the warm glow measure was examined. The seven warm glow items demonstrated strong internal consistency (α = .94), suggesting that these items are closely related to one another. The individual (α = .90) and collective (α = .87) warm glow subscales also demonstrated strong internal consistency.

As a first step, the average warm glow of each condition was calculated (see Figure 4). Warm glow scores were higher for both the CCA (n = 58, M = 4.3, SD = 0.5) and ICA conditions (n = 73, M = 4.2, SD = 0.6), compared with the control condition (n = 74, M = 4.0, SD = 0.8).

Figure 4

Box Plot of Mean Warm Glow Scores Across Experimental Conditions



Note. Dots represent outlier data.

To examine the effect that the experimental conditions had on warm glow scores, an ANOVA was then conducted. Results showed that this effect was statistically significant, $F(2, 202) = 3.72$, $p = .026$, $\eta_p^2 = .04$, with warm glow scores differing significantly across conditions.

To test the research hypotheses, pairwise comparisons were performed using Tukey's post-hoc test (see Table 5). Pairwise comparisons between the ICA and control conditions revealed that hypothesis one was not supported ($p = .326$), suggesting that the ICA and control conditions were statistically indistinguishable in this sample. A small effect size was observed between the control and ICA conditions ($d = 0.24$).

Pairwise comparisons between the CCA and control conditions revealed that differences in reported warm glow were statistically significant ($p = .019$), providing support for hypothesis two (see Table 5). This medium effect ($d = 0.48$) demonstrates that asking participants to reflect on how they felt when performing collective climate actions meaningfully influenced their warm glow scores relative to the control condition.

Finally, pairwise comparisons revealed that differences in warm glow between the ICA and CCA conditions were not statistically significant ($p = .358$), indicating that hypothesis three was not supported (see Table 5). A small effect size was observed between the CCA and ICA conditions ($d = 0.24$).

Table 5

Tukey's Pairwise Post-Hoc Comparison of Mean Warm Glow Scores Across Experimental Conditions

Condition 1	Condition 2	M_{diff}	*SE*	*t*	*p*	Cohen's *d*
Control	ICA	-0.2	0.11	-1.43	.326	-0.24
CCA	Control	0.3	0.12	2.72	.019	0.48
	ICA	0.2	0.12	1.37	.358	0.24

Note. *M*diff refers to the mean difference of warm glow scores between condition 1 and condition 2. *df* = 202 across all comparisons.

Exploratory Analyses

To add descriptive richness, explore whether other factors influenced the registered analyses, and contextualise the findings, the control variables outlined in the Materials and Measures section were examined in the following analyses. While exploratory analyses were outlined in the preregistration, the specific analyses were determined following data collection.

Warm Glow Subscales

Comparing the individual and collective warm glow subscales, a paired samples t-test revealed a small, significant effect, $t(204) = 2.97$, $p = .003$, $d = 0.20$. Descriptive analyses demonstrated that the difference in mean scores between the individual ($M = 4.2$, $SD = 0.7$) and collective warm glow ($M = 4.1$, $SD = 0.7$) subscales was not practically significant.

Efficacy Beliefs

The six items which made up the efficacy beliefs measure demonstrated strong internal consistency (α = .85), suggesting that items were aligned[7]. Both the individual (α = .79) and collective efficacy subscales (α = .74) also displayed strong internal consistency. Participants' efficacy scores are presented below in Table 6. Although individual and collective efficacy scores were similar (*M* = 4.0 across both subscales), response efficacy beliefs were scored much lower on average (*M* = 2.6).

Table 6

Mean Efficacy Belief Scores Across Experimental Conditions

Condition	Overall efficacy	Individual efficacy	Collective efficacy	Response efficacy
ICA	4.0 (0.6)	4.1 (0.7)	4.0 (0.6)	2.6 (0.9)
CCA	4.1 (0.6)	4.1 (0.7)	4.1 (0.6)	2.5 (1.0)
Control	3.8 (0.6)	3.9 (0.7)	3.8 (0.7)	N/A
Total	4.0 (0.6)	4.0 (0.7)	4.0 (0.7)	2.6 (1.0)

Note. Overall efficacy beliefs encompass individual and collective efficacy beliefs. As participants in the control condition did not write about their engagement with a specific climate action during the experimental manipulation, they could not complete the response efficacy item. Values represent mean scores, with standard deviations displayed in parentheses.

As efficacy data were collected after the writing task, it was unclear whether these scores were influenced by the experimental manipulation. The initial plan was to conduct an ANCOVA (using condition as the between-subjects factor and efficacy as a covariate) to

[7] This reliability analysis only examined the individual and collective efficacy items, as these were rated on a five-point Likert scale. As the response efficacy measure used a seven-point Likert scale, it could not be included in this reliability analysis.

better understand how condition affects warm glow when controlling for efficacy beliefs. However, an interaction between condition and efficacy violated the assumption of homogeneity of regression slopes, $F(2, 198) = 8.02$, $p < .001$. This analysis indicates that the relationship between efficacy beliefs and warm glow varied by condition. Consequently, this measure could not be considered independent of the experimental condition, and findings that pertain to efficacy should be interpreted with this limitation in mind. As such, an ANCOVA was not an appropriate method for this analysis.

Instead of examining efficacy beliefs as a covariate, a correlation was used to examine the relationship between warm glow scores and efficacy beliefs (see Figure 5). Overall, this analysis revealed a large, positive correlation between efficacy beliefs and warm glow scores ($r = .77$, $p < .001$), and for each of the three conditions (see Figure 5 and Table 7). However, this analysis does not establish whether warm glow drives efficacy beliefs, efficacy beliefs drive warm glow, or a third variable is responsible for this correlation.

Figure 5

Scatterplot of Participants' Warm Glow Scores and Their Efficacy Beliefs by Condition

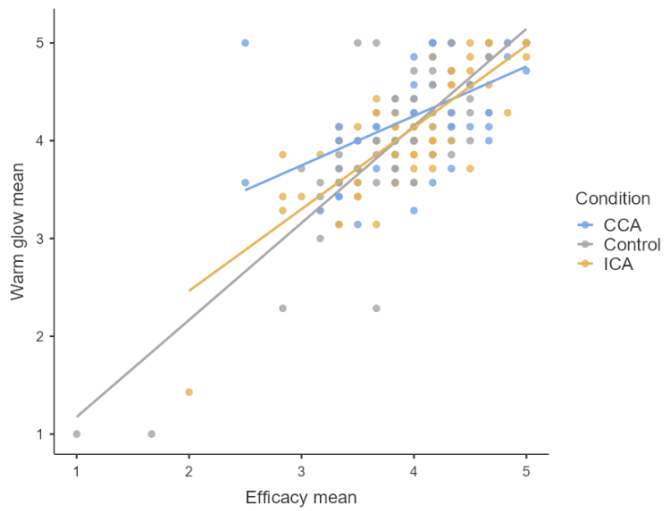


Table 7

Correlation Between Warm Glow Scores and Efficacy Beliefs, Overall and Across Conditions

Condition	Overall	ICA	CCA	Control
Pearson's *r*	.77	.82	.55	.83
df	202	71	55	72
95% CI Upper	.82	.89	.71	.89
95% CI Lower	.70	.73	.33	.74

Note. $p < .001$ for all conditions and the overall sample.

To determine whether these correlations were statistically different from one another, three z-test analyses were conducted[8]. The correlation between warm glow scores and efficacy beliefs was similar for the ICA ($r = .82$) and control ($r = .83$) conditions (see Table 7), with no significant difference between these correlations ($z = -0.18$, $p = .427$). One interpretation of this analysis is that the relationship between efficacy beliefs and warm glow scores was not influenced by reflecting on individual climate actions.

The correlation between warm glow scores and efficacy beliefs was significantly weaker ($z = -3.10$, $p < .001$) in the CCA condition ($r = .55$) relative to the control condition ($r = .83$; see Table 7). Continuing on with the earlier line of reasoning, this result suggests that recalling collective climate actions may weaken the influence of efficacy beliefs in predicting warm glow feelings.

Finally, the correlation between warm glow scores and efficacy beliefs was significantly stronger ($z = 2.92$, $p = .002$) in the ICA ($r = .82$) compared to the CCA condition ($r = .55$; see Table 7). Interpreting this finding in the same way, and given that the control and ICA conditions demonstrated similar correlations, this difference appears to be driven by the

[8] As this study employed a between-subjects design, the *comparisons of correlations from independent samples* calculator was used (Lenhard & Lenhard, 2014).

CCA condition. Specifically, it may reflect the weaker association between warm glow and efficacy beliefs observed in the CCA condition, rather than the ICA condition amplifying that relationship. As with all correlational analyses, caution must be taken when interpreting these results, as the causal relationships between efficacy beliefs, experimental conditions, and warm glow scores remain unclear.

Considering response efficacy, a correlation showed a small, significant relationship between warm glow and response efficacy beliefs, $r(129) = 0.22$, $p = .012$. A linear regression found that response efficacy beliefs significantly predicted warm glow scores, $\beta = 0.22$, $SE = .05$, $t = 2.54$, $p = .012$. The model accounted for 5% of the variance in warm glow scores, $R^2 = 0.05$. However, as only one item made up the response efficacy measure, these results should again be interpreted with caution.

Participant Engagement in Climate Actions

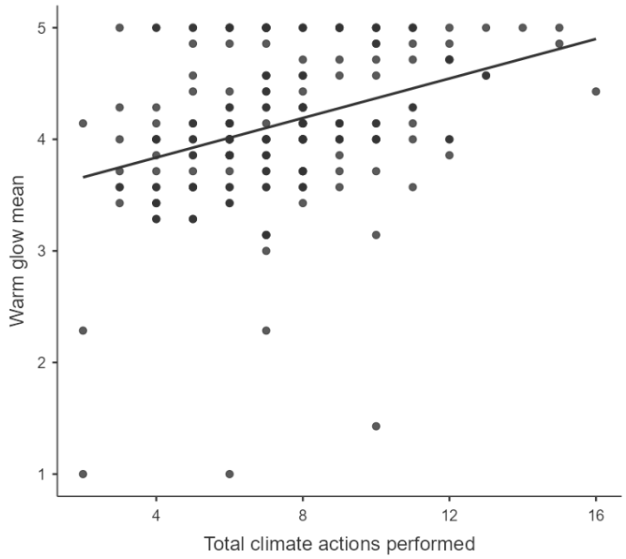
To examine how often participants engaged in climate actions across different social contexts, exploratory analyses were performed. Participants completed an average of 5.2 individual climate actions ($SD = 1.6$), while collective actions were performed far less frequently ($M = 2.2$, $SD = 1.6$). A paired samples t-test revealed that this difference was statistically significant, $t(204) = 23.4$, $p < .001$, $d = 1.64$.

To investigate the relationship between participants' warm glow and the number of climate actions they had engaged in, correlations were calculated. The total number of climate actions performed by participants had a medium positive correlation with warm glow scores, $r = .34$, $p < .001$ (see Figure 6). This finding suggests that more frequent climate action engagement may be associated with higher levels of warm glow. Both total individual climate actions ($r = .30$, $p < .001$) and total collective climate actions ($r = .26$, $p < .001$) also

demonstrated positive correlations with warm glow scores, suggesting that the relationship is not driven by either type of behaviour alone.

Figure 6

Scatterplot of Warm Glow Scores and Their Correlation with the Total Number of Climate Actions Performed by the Participant



Costs of Climate Actions

Participants performed a mean of 4.3 lower-cost actions (*SD* = 1.5) and 3.1 higher-cost actions (*SD* = 1.5). A paired samples t-test revealed that this difference was statistically significant, $t(204) = 10.6$, $p < .001$, $d = 0.74$. An interaction between the cost type and experimental condition demonstrated non-significant results ($F(2, 202) = 0.46$, $p = .634$, $\eta_p^2 = .005$) indicating that the number of high-cost and low-cost climate actions performed by participants did not differ across conditions.

Granular Analysis of Specific Climate Actions

To investigate whether reflecting on, and writing about, different climate action items influenced warm glow scores, descriptive analyses were conducted (see Appendix D). For specific individual climate actions, the mean warm glow reported ranged from 3.9 (*SD* = 0.8)

to 4.9 (*SD* = 0.2). Examining how positively participants felt after reflecting on specific collective climate actions, the mean warm glow scores ranged from 4.1 to 5.0.

Across both climate action conditions, these average warm glow scores corresponded to responses between '*agree*' and '*strongly agree*' with the warm glow items. As average warm glow scores were similar across the climate action items, it is unlikely that the specific climate action a participant wrote about during the experimental manipulation significantly influenced their warm glow ratings beyond condition. However, the number of participants who wrote about each action was often very small, so caution should be taken when interpreting these findings.

Extraversion

To assess warm glow scores across the different experimental conditions while controlling for extraversion, an ANCOVA was conducted. The homogeneity of regression slopes assumption was met prior to analysis ($F(2, 199) = 1.89$, $p = .154$), confirming that ANCOVA was the appropriate analysis to use.

Participants in the control condition reported lower extraversion scores ($M = 3.5$, $SD = 1.4$) compared to those in the ICA ($M = 3.9$, $SD = 1.5$) and CCA ($M = 3.9$, $SD = 1.6$) conditions.

When controlling for extraversion, the experimental condition did not have a statistically significant effect on warm glow, $F(2, 201) = 2.83$, $p = .061$, $\eta_p^2 = .03$. These results suggest that the experimental condition did not meaningfully explain differences in warm glow once extraversion is accounted for. Independent of condition, extraversion demonstrated a statistically significant effect on warm glow scores, $F(1, 201) = 12.44$, $p < .001$, $\eta_p^2 = .06$.

To determine whether these effects varied across different dimensions of warm glow, separate ANCOVA were conducted for each of the two warm glow subscales. As people who

report higher levels of extraversion are generally more socially oriented (Lucas & Fujita, 2000), extraverted participants may have experienced stronger warm glow from the social impact of their climate actions, rather than from the moral or self-signalling elements of these behaviours.

Before the relationship between condition, extraversion, and the collective warm glow subscale was examined, the homogeneity of regression slopes assumption was confirmed, $F(2, 199) = 1.98$, $p = .140$. When controlling for extraversion, the experimental condition had a statistically significant effect on collective warm glow, $F(2, 201) = 3.24$, $p = .041$, $\eta_p^2 = .03$. Tukey's post-hoc pairwise comparisons revealed that the CCA and control condition differed significantly ($p = .032$, $d = .45$), while pairwise comparisons between the CCA and ICA conditions ($p = .264$, $d = .28$), and between the control and ICA conditions ($p = .552$, $d = -.17$) were not statistically significant. Extraversion also demonstrated a statistically significant effect on collective warm glow scores, $F(1, 201) = 11.56$, $p < .001$, $\eta_p^2 = .05$.

Shifting focus to the individual warm glow subscale, an interaction between condition and extraversion demonstrated non-significant results, $F(2, 199) = 1.59$, $p = .206$, confirming that an ANCOVA was appropriate. When controlling for extraversion, the experimental condition did not have a statistically significant effect on individual warm glow, $F(2, 201) = 2.13$, $p = .122$, $\eta_p^2 = .02$. These results suggest that the condition did not meaningfully explain differences in individual warm glow when extraversion is accounted for. Extraversion also demonstrated a statistically significant effect on individual warm glow scores, $F(1, 201) = 11.30$, $p < .001$, $\eta_p^2 = .05$.

Taken together, these findings suggest that extraversion meaningfully predicts warm glow scores across the overall measure and each subscale. When controlling for extraversion, the experimental condition statistically predicted collective warm glow, with differences

observed between the CCA and control conditions. However, this effect was not observed for warm glow scores overall, or for the individual warm glow subscale.

Topic Analyses

Validating the effectiveness of the warm glow manipulation was the primary goal of the topic analysis. Structural Topic Modelling (STM) was used in the current research for its ability to identify broad themes within written responses and estimate how prevalent these themes are across participants' responses (Weston et al., 2023). Data were analysed separately for each of the three experimental conditions in RStudio (Posit, 2025; version 2026.01.1+403). The procedure employed in this research was guided by Weston et al.'s (2023) tutorial.

Data were preprocessed to remove special characters, stop words, numbers, and words which appeared infrequently across each condition's written responses. To identify the set of solutions to evaluate (K), a series of fit statistics were analysed across each condition[9]. For the ICA condition, three solutions were explored (K = 4, 6, 8). Two solutions were examined for the CCA condition (K = 4, 8), while the control condition evaluated three (K = 5, 9, 11). For further details on the STM procedure, see Appendix G.

Labelling topics can help to clarify topic content and inform the interpretation of topic models (Weston et al., 2023). To achieve this, words that were frequently found and exclusive (FREX) within each topic were calculated. These terms were then cross-referenced against the most representative participant responses, which provided further context for interpreting each topic. Some of the labels appeared across multiple topics, indicating that these topics were robust (Weston et al., 2023).

[9] Topics are a probabilistic distribution over terms (i.e., clusters of keywords that sit together under a model; Banks et al., 2018). Models are the algorithms that identify topics (i.e., they determine how words cluster into topics across participants' responses; Banks et al., 2018). The fewer topics there are, the more likely the analysis will merge unrelated keywords together, forcing themes to fit within this specified number of topics (Weston et al., 2023).

Topic labels for the ICA condition are presented below in Table 8. Recurring topics such as *positive emotions from climate action* and *warm glow from climate action* provide evidence for the effectiveness of the warm glow manipulation. Other recurring topics, such as *transport use*, illustrated that participants' written responses aligned with the climate actions listed within the survey instructions. Using Model 4 as an example, emotion-based language was present across all topics, alongside many positive valence words (see Figure G2), providing further evidence that the manipulation was effective.

Table 8

Topic Labels Across Three Primary Solutions Within the ICA Condition

Topic number	4 Topic Solution	6 Topic Solution	8 Topic Solution
1	Perceived ability to make a change, consumption habits	Transport use	Investing in lower-carbon technologies e.g., EVs
2	Positive emotions from climate action	Positive emotions from climate action	Energy use at home
3	Climate actions providing health benefits or aligning with one's values	Warm glow from climate action	Warm glow from climate action
4	Transport use	Actions that reduce personal environmental impact	Feelings from climate action engagement
5		Consumption habits	Active transport
6		Climate actions providing health benefits or aligning with one's values	Perceived ability to make a change
7			Public transport
8			Helping to mitigate climate change

Topic labels for the CCA condition are presented below in Table 9. The label, *positive emotions from climate action*, emerged across both models, indicating thematic consistency and lending support that the AEMT was effective. Drawing on the FREX terms in model 4 as an example, words with strong affective sentiments were observed across three of the four topics (e.g., *feel*, *felt*), positively valenced language appeared in each topic (e.g., *good*, *better*), and collective nouns (e.g., *community*, *kids*, *people*, *group* etc.) were prevalent across

all topics (see Figure G3). These findings provide further support that the experimental manipulation functioned as expected.

Table 9

Topic Labels Across Two Primary Solutions Within the CCA Condition

Topic number	4 Topic Solution	8 Topic Solution
1	Junk topic	Feelings from climate action
2	Feelings from collective, pro-environmental action	Feelings from discussing climate change with others
3	Emotions from collective climate action	Climate conversations
4	Positive emotions from climate action	Positive emotions from climate action
5		Emotions from collective climate action
6		Collective climate action
7		Local/community tree planning events
8		Feeling good from climate actions and being involved in the community

Topic labels for the control condition (see Table 10) closely aligned with the everyday activities listed in the survey. For example, *peeling and eating a banana*, *climbing stairs*, and *brushing teeth* were identified as topic labels across all topic-model solutions, and were reflective of the emotionally neutral activities listed in the control condition. Importantly, no topic labels were related to climate actions or warm glow for this group.

Table 10

Topic Labels Across Three Primary Solutions Within the Control Condition

Topic no.	5 Topic Solution	9 Topic Solution	11 Topic Solution
1	Peeling and eating a banana	Routine activities	Routine of brushing teeth
2	Brushing teeth	Climbing stairs	Climbing stairs
3	Climbing stairs	Junk topic	Tying shoes
4	Tying shoes	Loading groceries into the car	Neutral emotional responses towards teeth brushing
5	Doing the dishes	How people feel when performing the activity	How people feel when performing the activity
6		Brushing teeth	Feeling clean and fresh from teeth brushing
7		Doing the dishes	Doing the dishes
8		Junk topic	Brushing teeth
9		Peeling and eating a banana	Felt good about the activity
10			Peeling and eating a banana
11			Loading groceries into the car

STM analyses across the three conditions indicated that the experimental manipulation was effective in producing condition-specific language and content in participants' written responses. In the ICA and CCA conditions, participants wrote about their emotions, environmentally friendly actions, and climate change more broadly, while also using positive affective language. For the CCA condition, language relating to others was often observed in FREX terms across topic-model solutions. As expected, STM analyses

indicated that participants in the control condition wrote about the everyday activities listed and did not discuss climate change or climate actions.

Summary

These results did not provide support for hypotheses one and three, with no significant differences in warm glow scores observed between the control and ICA conditions, or between the ICA and CCA conditions. Pairwise comparisons revealed that differences in reported warm glow between the CCA and control conditions were statistically significant, providing support for hypothesis two. Exploratory analyses revealed a large, positive correlation between how effective participants perceived their individual and collective efforts were in addressing climate change and their warm glow scores. Extraversion also demonstrated a statistically significant effect on warm glow scores. Finally, STM analyses suggested that the warm glow manipulation functioned as intended.

Discussion

Summary of Main Findings

The goal of this research was to explore whether people experience different levels of warm glow when they reflect on past collective and individual climate actions. The first hypothesis, that participants in the ICA condition would report higher levels of warm glow relative to the control condition, was not supported. Hypothesis two, that participants in the CCA condition would report higher levels of warm glow relative to the control condition, met statistical significance. The third hypothesis, that participants in the CCA condition would report higher levels of warm glow relative to the ICA condition, was not supported. In summary, this study found that reflecting on social, climate-friendly experiences elicited stronger feelings of warm glow compared to those in the control condition. No such relationship was found between participants who recalled collective and individual climate actions, or between those who reflected on an individual climate action or a neutrally affective, everyday activity.

Several exploratory analyses were conducted as part of this research. First, results demonstrated a large, positive correlation between efficacy beliefs and participants' warm glow scores. Second, participants performed significantly more individual climate actions compared with collective behaviours. Third, the total number of climate actions performed exhibited a medium, positive correlation with warm glow scores. Fourth, participants reported significantly higher engagement with lower-cost climate actions compared with higher-cost actions. Fifth, an ANCOVA showed that when controlling for extraversion, condition did not have a statistically significant effect on participants' levels of warm glow. Lastly, extraversion significantly predicted warm glow scores, suggesting that this emotion may also be influenced by participants' personality traits.

Topic analyses indicated that the experimental manipulation functioned as intended. Across the ICA and CCA conditions, participants wrote about their experiences in these activities, described how they felt engaging in these, and reported positive emotional responses. Participants in the CCA condition often wrote about the people who they performed these actions with. As participants in the control condition wrote about their experiences with everyday behaviours, their emotional responses as described in their written accounts were generally neutral, and participants rarely referenced environmental factors in their reflections.

Comparison with Other Literature

Registered Analyses

This experiment aligns with existing literature in that reflecting on a positive, climate-friendly experience can elicit positive affective states. As hypothesised, participants in the CCA condition reported significantly higher warm glow scores compared to those in the control condition. The experimental procedure of this research was inspired by Jerit et al.'s (2024) study, in which participants were asked to describe an experience where they did something good for the environment and felt positively about it. For participants in this condition, Jerit et al. (2024) found higher feelings of warm glow relative to those in the control condition, indicating a small effect size, $b = 0.20$, $SE = 0.10$, $p < .05$. Methodologically similar to the present research, Rowe et al. (2019) asked participants to write about their experience with a past sustainable behaviour, with the aim of evoking specific emotions. Participants who recalled a positive sustainable behaviour reported higher levels of pride compared to those who remembered a negative sustainable behaviour and those in the control condition. Taken together, these studies demonstrate that reflecting on past, positive, climate-friendly behaviours can induce positive affective states, which may explain the warm glow scores in the CCA condition being significantly higher than the

control condition. However, neither Jerit et al. (2024) nor Rowe et al. (2019) differentiated between individual and collective climate actions in their analyses so these results are not directly comparable.

Differences in warm glow scores between participants in the ICA and CCA conditions were not statistically significant; therefore, hypothesis three was not supported. How people feel after remembering individual and collective climate actions remains underexplored in the literature, with even less research specifically examining positive emotions. As such, there is limited evidence regarding how warm glow, or even positive emotions, are experienced across actions performed individually versus collectively. Although Prinzing et al. (2024) did not include separate individual and collective climate action indices within their research, the authors examined the relationship between specific pro-environmental behaviours and different elements of wellbeing. Overall, their pro-environmental behaviour measure was not significantly associated with positive emotions. However, when examined at the item level, positive emotions varied substantially across specific behaviours. In the current research, certain collective and individual climate actions were also associated with higher warm glow scores (see Appendix D for descriptive analyses). This variation in how positively participants in Prinzing et al.'s (2024) study felt about specific actions may have concealed any overall relationship between the pro-environmental behavioural index and pleasant emotions. In the present research, the non-significant difference between the ICA and CCA conditions may similarly reflect variability in warm glow across specific actions, rather than no differences in positive emotions arising from these approaches. These findings suggest that some individual and collective climate actions may be more closely associated than others to positive emotional states. Further research exploring warm glow across a broader range of climate actions may help to clarify whether meaningful differences exist between these approaches, or whether differences exist at the item level.

Although the current study hypothesised that reflecting on collective climate actions would elicit higher warm glow compared to those who recalled an individual behaviour, no significant difference between these conditions was observed. In contrast to these results, an experimental donation study reported that individual donations elicited warm glow feelings, while donations made collectively did not (Bischoff & Krauskopf, 2015). These mixed findings demonstrate that the relationship between pro-social or pro-environmental behaviours, the social nature of these actions, and warm glow is not always straightforward, helping to explain why no statistically significant difference in warm glow scores was observed between participants in the ICA and CCA conditions.

It is again worth noting that most research examining positive emotional responses to climate-friendly actions does not differentiate between individual and collective behaviours. This makes it difficult to interpret the null finding for hypothesis one without undermining the research which supports hypothesis two, as most studies do not distinguish between these approaches.

Although the literature indicates warm glow can be elicited by reflecting on past, environmentally friendly behaviours (e.g., Jerit et al., 2024; Rowe et al., 2019), these results reveal a complex relationship between climate actions and warm glow that extends beyond the social nature of these behaviours.

Exploratory Analyses

Exploratory analyses of the current study revealed that participants had engaged in far fewer collective climate actions, compared to those which were performed individually. These results are consistent with Schwartz et al.'s (2023) finding that engagement in climate activist behaviours (e.g., *took part in a protest/rally about an environmental issue*) was significantly lower than individual climate actions (e.g., *I recycle*). However, these results are not directly comparable to the present research, as the items within the climate activism

measure were not strictly collective in nature (e.g., *educated myself about environmental issues*; *financially supported an environmental cause*)[10]. Supporting this pattern, qualitative analyses of participants' open-ended responses revealed that collective actions were described far less frequently compared to individual behaviours (Schwartz et al., 2023). Schwartz et al. (2023) noted that some written responses reflected participants' perceptions that their individual actions were insignificant when considering the scale of climate change. Other responses suggested that while participants were motivated to take action towards climate change, they typically focused on the individual actions they could take, rather than participating in meaningful collective action (Schwartz et al., 2023). Across both the present study and Schwartz et al.'s (2023) research, the disparity between these approaches is concerning, as both individual behavioural changes and collective structural changes are required to effectively address the challenges presented by climate change. These findings also reiterate the value of research which examines collective climate actions and the factors that motivate engagement.

In addition to these analyses, efficacy beliefs emerged as a noteworthy finding in the current research. Efficacy beliefs have been found to predict pro-environmental behaviours (Bradley et al., 2020; Doherty & Webler, 2016) and may shape the appraisal of environmental challenges (Fritsche et al., 2018). Within the present research, efficacy beliefs varied across experimental conditions, with those in the climate action conditions reporting higher efficacy scores compared to those in the control condition. These results suggest that reflecting upon one's engagement in climate-friendly behaviours may have strengthened perceptions of how capable individuals and groups are of taking meaningful and effective action. Alternatively, completing the response efficacy item prior to the individual and

[10] Supplementary materials regarding the specific items used by Schwartz et al. (2023) were not available. Therefore, these examples have been sourced from Alisat and Riemer's (2015) Environmental Actions Scale, which Schwartz et al. (2023) adapted in their research.

collective efficacy measures may have primed participants in the climate action conditions to reflect on their efficacy beliefs in general, shaping subsequent responses.

The results of the current study also demonstrated that extraversion had a significant effect on overall warm glow scores and both warm glow subscales. These results suggest that personality characteristics may partly account for variability in warm glow scores beyond what can be explained by the experimental manipulation. It has been suggested that extraverts experience more intense and frequent positive emotions (Watson & Clark, 1997; Lucas & Fujita, 2000), with a meta-analysis revealing strong associations between extraversion and positive affect (Anglim et al., 2020). Lucas et al. (2008) indicated that this association appears to reflect a dispositional tendency in extraverts, rather than being explained by how socially engaged they are or how they react to social situations. If participants who scored higher in extraversion were more likely to experience more positive emotions in general, their disposition may explain the relationship between extraversion and warm glow scores.

These exploratory analyses reinforce the idea that the association between warm glow and climate actions of different social natures is nuanced, with both efficacy beliefs and extraversion influencing this relationship.

Possible Explanations

It is evident that the social nature of climate actions played a meaningful role in eliciting warm glow among this sample. What is less certain, is why this difference in scores was not observed between the ICA and control conditions, or between the ICA and CCA conditions.

There are a number of reasons why reflecting on collective climate actions would be associated with higher warm glow scores relative to the control condition. As outlined in the Warm Glow and Collective Climate Actions section, several relational mechanisms, such as social relatedness, moral identity, close personal relationships, feelings of hope, and

collective emotions, may have contributed to these results. As the specific mechanisms underlying this emotion were not explored in the present study, it is unclear which of these possible explanations best accounts for these results. Therefore, future research should test which of these mechanisms most strongly predicts warm glow arising from collective climate actions.

The social nature of collective climate actions, and the relationships between those engaged in these behaviours, may also shape warm glow feelings. The value people place on positive memories extends beyond how pleasant the experience was, with Speer and Delgado (2020) demonstrating that who it was shared with also shapes how memories are valued. After controlling for the positivity of a memory, the authors found that participants were willing to pay 1.5 times more to re-experience a positive memory that included close others, compared to positive memories that were shared with acquaintances or those that were experienced alone. Participants in this study also chose to reminisce about positive memories with close others more often than those involving acquaintances or experienced by oneself, even after controlling for the positivity of the memory. These findings suggest that memories are not only cherished for how pleasant the experience was, but also for who the experience was shared with. Speer and Delgado (2020) attributed these results to the human fundamental need to belong (Baumeister & Leary, 2007) and suggested that these social memories remind us of our connection to others. This explanation may be particularly relevant to hypothesis three, which anticipated that collective climate actions would elicit stronger feelings of warm glow compared to individual climate actions. Should the value of a memory depend on the closeness of the relationships between those involved, rather than the social nature of the experience itself, this may help to explain the non-significant difference in warm glow scores between the ICA and CCA conditions. However, the present research did not differentiate between collective actions performed with close others and those performed with

acquaintances; therefore, variability in relationship closeness within the CCA condition may have obscured potential differences in warm glow scores.

Another possible explanation for the results between the ICA and CCA conditions is that the specific climate action a participant wrote about was responsible for eliciting feelings of warm glow, rather than being attributable to the behaviour's social nature. As an example, a climate-concerned individual who enjoys being active and prefers being in the outdoors would likely experience stronger feelings of warm glow when they cycle to work, compared to discussing sustainability initiatives with colleagues. Alternatively, if a participant attended a climate protest with a group of friends on a sunny day, they may have felt more positively about their involvement in this action, compared to independently researching and switching their superannuation to a fossil-free fund. Prinzing et al. (2024) emphasised that grouping pro-environmental behaviours into a single index may hide significant variability in the relationship between specific actions and wellbeing. This limitation likely applies to the current research; by examining climate actions at the individual or collective level, rather than focusing on the specific behaviours themselves, differences in warm glow scores may have been obscured.

Specific sample characteristics may also explain why hypotheses one and three were not supported. Participants who did not meet the eligibility criteria of both collective and individual climate action engagement were screened out of the survey. As the sample of the present study likely overrepresents individuals who engage in a wide range of climate-friendly behaviours, this group may experience higher levels of warm glow in relation to these behaviours compared to the general population. A meta-analysis revealed a significant, positive relationship between pro-environmental behaviours and subjective wellbeing (r = .24), with warm glow showing a particularly strong correlation (r = .41; Zawadzki et al.,

2020)[11]. These results suggest that people who engage in climate-friendly behaviours may experience higher levels of warm glow compared to other indicators of wellbeing, such as hedonic or evaluative happiness. This finding is particularly relevant for the current study, as participants performed more climate actions ($M = 7.4$) than those who were screened out ($M = 3.7$) (see Table B2). The sample of the current study may have demonstrated higher levels of positive emotions arising from environmentally friendly behaviours, potentially obscuring any differences between experimental conditions. Consistent with this, the current research found a medium positive correlation between the total number of climate actions a participant had performed and their warm glow scores ($r = .34$, $p < .001$), supporting the idea that higher climate action engagement may be associated with stronger feelings of warm glow. To summarise, as the sample of the present research generally performed more climate actions than those who were screened out, they may have held more positive emotions towards their behaviours, resulting in warm glow scores that were not representative of the general population.

Efficacy Beliefs

Although there is a substantial amount of literature examining the association between efficacy beliefs and climate actions, less research has explored the relationship between positive emotional states, such as warm glow, and efficacy. It may be that when people feel their behaviours are impactful, or that they are capable of enacting change, they feel more positively about their actions. Outside of the environmental literature, Salanova et al. (2011) showed that efficacy beliefs and activity engagement are reciprocal, demonstrating that efficacy beliefs indirectly influenced engagement through positive affect. In other words, when people felt confident in their ability to effectively complete a task, they felt more

[11] In this study, subjective wellbeing was conceptualised as positive emotional experiences and how positively participants evaluated their lives (Zawadzki et al., 2020).

positively about their efforts. This, in turn, increased motivation to engage, further strengthening efficacy beliefs. Although this longitudinal research examined the work engagement of secondary school teachers through self-reported questionnaires, and the task engagement of university students in a laboratory setting, the findings may also extend to climate actions. In the current study, if participants felt capable of driving positive change on climate-related issues, they may have felt more positively about their environmentally friendly actions. In doing so, these positive feelings may have motivated further engagement in climate actions, and subsequently reinforced their sense of efficacy.

Considering efficacy within a social context, Sabherwal and Sparkman (2025) suggested that social interactions with friends, family, colleagues, neighbours, or members of other social groups can strengthen psychological mechanisms that drive pro-environmental behavioural spillover, such as positive affective states and feelings of efficacy. The authors proposed that social interactions in the context of climate action can foster collective engagement and motivate participation. As an example, imagine an individual is working with a group of colleagues to set an ambitious carbon reduction target for their organisation. The process of collaboratively developing this goal, liaising with other teams to implement the necessary changes, and discussing the project with others may make the individual feel positively about their efforts, strengthen their beliefs that they can make a change, and potentially motivate further climate actions beyond this project. However, as efficacy scores in the present study were similar across the ICA ($M = 4.0$, $SD = 0.6$) and CCA conditions ($M = 4.1$, $SD = 0.6$), it remains unclear whether this process manifests in practice.

The present study found a large, positive correlation between efficacy beliefs and warm glow scores, regardless of experimental condition, consistent with research identifying positive affect and efficacy as key psychological processes in driving climate engagement (Sabherwal & Sparkman, 2025). Although strong correlations were observed across all three

experimental conditions, these effects were particularly strong among the ICA (r = .82) and control (r = .83) groups relative to the CCA (r = .55) condition. Surprisingly, the correlation between warm glow and efficacy beliefs was nearly identical across the ICA and control conditions, despite the former following a similar procedure as the CCA group (i.e., both conditions reflecting on their engagement with climate actions). However, it is possible that these results are attributable to the CCA condition inducing higher levels of warm glow. As a result, the influence of efficacy beliefs on warm glow scores may have been attenuated in this condition. This restriction of range may have contributed to the lower correlation of the CCA group, rather than the ICA and control conditions exhibiting a particularly strong relation.

Overall, these findings suggest that a sense of efficacy may shape how positively people feel about their climate-friendly behaviours. However, the direction of this relationship requires further investigation.

Theoretical Implications

The findings of this research provide partial support for both the SIMPEA model and a positive reinforcement loop. During the writing task, participants in the ICA condition primarily wrote about their experiences with the listed climate actions. Although these behaviours would have been performed alone, participants in this condition often mentioned other people in their written responses. One participant described how their family discussed ways to address global warming and collectively decided to reduce their air conditioning usage. Another participant wrote that she spent more time with her family after deciding to live car free. A third participant shared that she felt good about teaching her children that small behavioural changes can make a difference to the climate. More broadly, several participants discussed the community or global benefits of their climate-friendly actions, even though these behaviours were performed individually. Together, these responses suggest that even when individuals perform climate actions by themselves, their motivations and

appraisals are often shaped by collective considerations. This finding aligns with the SIMPEA model, in that social identity processes, such as ingroup norms or identification, can influence both private and collective pro-environmental behaviours (Masson & Fritsche, 2021).

Although this research did not capture participants' behavioural intentions or their future actions, results provide support for one component of a positive reinforcement loop, specifically the relationship between engaging in climate-friendly behaviours and positive affect. As the model in Figure 3 illustrates, performing pro-environmental behaviours results in positive affective states (Brosch & Steg, 2021). In the current study, the higher warm glow scores of the CCA condition relative to the control condition was consistent with this process. The experience of these positive affective states elicits anticipatory positive emotions when an individual considers performing future pro-environmental behaviours, which then motivates further engagement in climate-friendly actions (Brosch & Steg, 2021). One explanation for this process is that performing such behaviours may activate a self-identity that encompasses sustainable actions and values (Carrico, 2021). Consistent with this, participants in the current study described feeling proud of themselves or that they were living in line with their values, suggesting their climate actions reflected their sense of self. This idea is supported by Venhoeven et al.'s (2020) argument that behaving in environmentally friendly ways is often seen as the morally right thing to do and is therefore meaningful, resulting in higher levels of positive emotions when engaging in these. In the present study, several participants wrote about how they felt their behaviour was the moral, or right, thing to do, demonstrating that this argument is relevant not only when people perform climate-friendly behaviours, but when they reflect on them too. Taken together, these findings suggest that reflecting on collective climate action engagement can elicit feelings of

warm glow, potentially through the reinforcement of green self-concepts or a sense of moral meaning, which may in turn motivate future pro-environmental behaviours.

Practical Applications

Memory and Warm Glow

This research raises interesting questions about the role of memory in eliciting warm glow feelings. While episodic remembering allows people to re-experience an event and the emotions associated with it (Perrin & Michaelian, 2017), it is worth acknowledging that memory is reconstructive (Roediger & DeSoto, 2015), and elicited emotions may not be a faithful representation of how people felt at the time of the event. Miron-Shatz et al. (2009) found that how participants recalled feeling during daily activities differed from how they actually felt during that experience, with both pleasant and unpleasant emotions remembered as more intense than what was reported at the time. Therefore, how participants in the present study experienced warm glow as a result of the experimental manipulation is unlikely to be an accurate depiction of how they felt when performing their described climate actions.

However, if warm glow can be elicited by the memory of engaging in climate-friendly activities, the accuracy of the memory may be of little consequence if the emotional response remains the same. In the present study, participants who reflected on their collective climate actions reported higher warm glow scores, suggesting that remembering these experiences can elicit meaningful emotional responses, irrespective of how faithful these recollections were. Therefore, the (in)accuracy of how a pro-environmental behaviour is recalled may matter less if the psychological outcomes (e.g., warm glow feelings elicited, green self-image strengthened) continue to drive climate-friendly actions.

It is also possible that collective climate actions may be recalled and shared by the same group who performed them. Shared memories are held individually by members of a social group and pertain to their collective identity (Orianne & Eustache, 2023). In the

context of the present research, these could include memories of volunteering at a tree planting event with members of the local community or attending a climate protest with friends, where the memories reflect how the individual sees themselves as a member of a group. By acting in ways that are consistent with one's social identity, these behaviours may amplify positive emotions, such as warm glow. While shared memories relate to how people see themselves as part of a group, collaborative memories position individuals as active participants in social experiences (Orianne & Eustache, 2023). To extend the earlier example, collaborative memories could arise when the group who attended the climate protest discussed the event a month later, with each person's recollection of the event being shaped by the memories of those around them. Collective emotions may also emerge through these conversations (Brosch, 2025), with the shared recollection of positive experiences potentially amplifying warm glow among the group. When events are remembered and discussed with others, the accuracy of these shared and collaborative memories is likely less important than the social goals of this process, such as facilitating social bonds, teaching others, or helping to regulate one's emotional responses (Harris et al., 2008). Therefore, if members of a social group reminisced together about their past collective climate actions, warm glow may be elicited through the shared retelling of the experience. This process may also provide feedback on how members see themselves; van der Werff et al. (2014) found that receiving feedback about how past sustainable behaviours relate to one's identity influenced environmental self-identity more strongly than simply reminding people about their sustainable actions. In practice, this could look like a friend noting that acting in climate-conscious ways is an important part of who you are while reminiscing about a protest you both attended. This reinforcement of an environmental self-identity may further strengthen warm glow when these collective actions are recalled together. Although collaborative

remembering goes beyond the scope of this research, this process may amplify warm glow responses and represents an important direction for future research.

Warm Glow as a Motivator for Climate Action Engagement

If reflecting on collective climate actions elicits feelings of warm glow, this in turn may motivate engagement in future pro-environmental behaviours. The warm glow derived from acting in environmentally friendly ways has been found to predict future engagement in conservation behaviours (Jia & van der Linden, 2020). Furthermore, this effect appears to have a stronger influence on pro-environmental intentions compared with altruistic personality traits and values, suggesting that intrinsic emotional rewards can be a powerful driver of climate action, even among individuals who score lower on altruism (Hartmann et al., 2017). At this late stage of the climate crisis, any strategies that make the actor feel good, motivate pro-environmental behaviours, or spillover into other forms of engagement should be encouraged. Practically, designing experiences that elicit warm glow feelings could be a valuable mechanism to promote sustained climate engagement. Specifically, Brosch and Steg (2021) suggested that initiatives which increase the positive emotions a person feels from performing climate-friendly actions, or strategies that connect personal values to behaviours, may strengthen the behaviour-warm glow positive feedback loop (see Figure 3). The potential for warm glow to motivate climate action is especially important given the limitations of extrinsic incentives, where positive behavioural changes often reverse once rewards disappear. In contrast, as an intrinsic motivator, warm glow psychologically rewards people for acting in environmentally friendly ways, sustaining engagement in these behavioural changes over time (van der Linden, 2015). Taken together, warm glow may act as a powerful driver of climate action engagement, with the current findings suggesting that remembering past, collective behaviours may be one useful tool in eliciting this emotion.

At the same time, caution should be taken when interventions explicitly aim to elicit or amplify warm glow feelings. Even within the present research, participants often described experiencing other emotions during their climate actions, some of which were negatively valenced. For example, one participant expressed their anger at corporations for shifting environmental responsibility onto individuals, while another wrote about interpersonal disagreements with others in the movement regarding the right way to tackle climate change. Other participants' responses detailed their frustrations about barriers in implementing sustainable practices at work, disappointment towards superannuation funds greenwashing their investments, and feelings of disillusionment after volunteering without seeing the physical impacts of their efforts. Together, these examples demonstrate that even when participants were specifically asked to reflect on climate actions they had felt positively about, their emotional responses did not always include, and often extended beyond, warm glow feelings. This variability in emotional responses may be explained by Brosch and Steg's (2021) argument that emotional responses, and their subsequent role in shaping pro-environmental behaviours, are influenced by both contextual factors and individual differences. As such, "emotions do not continuously affect our behaviour all the time, do not affect everyone's behaviour the same way, and do not affect behaviour each time the same way" (Brosch & Steg, 2021, p. 1698). Therefore, emotions should not be seen as a lever that can simply motivate specific behaviours (Chapman et al., 2017). This inconsistency in eliciting intended emotions and behaviours, alongside the ethical considerations of deliberately engineering emotional responses (Chapman et al., 2017), warrants caution among researchers and policymakers who are seeking to apply these strategies within the context of climate change.

Reflexive Account and Personal Significance of this Research

The value of taking a collective approach and fostering positive emotions within climate action was something I experienced throughout this research. For those who are actively engaged in the climate movement, long-term stressors can result in burnout, negatively impacting their ability to remain engaged and leading to periods of disengagement (Hamann et al., 2025). As continued engagement is required to bring about meaningful change, burnout puts these efforts at risk (Bird et al., 2024).

While undertaking this research, I felt many of the emotions I had written about in the Emotional Responses Towards Climate Change section. In January 2026, I experienced multiple days exceeding 40°C in Melbourne (Bureau of Meteorology, 2026). These extreme heats contributed to mass mortality events of flying fox colonies across Australia (Stock, 2026), triggering feelings of despair about the scale of these ecological losses and injustice at the suffering of species who have played no part in the climate crisis. By 16 February 2026, more severe weather-related states of emergencies had been issued in New Zealand compared to the annual declarations in 21 of the past 24 years (Ball, 2026), eliciting strong feelings of hopelessness. When researching the specific impacts of climate change for this thesis, I felt fearful of what the future might look like. Examining the actions (or lack thereof) being taken to mitigate these effects often left me feeling angry at governments, organisations, and systems for perpetuating the status quo. The cumulative effect of these events, alongside geopolitical, environmental, and policy developments felt overwhelming at the best of times. Furthermore, many of these emotional states were not discretely experienced, but rather overlapped and compounded upon one another.

However, engaging in climate actions, particularly those of a collective nature, helped to counteract many of these feelings. During my thesis, I joined a climate collective, volunteered at regeneration events, and participated in the Yarra City Council's Climate

Voices advocacy program. Being around like-minded others who were working towards the same goals fostered a sense of support, hope, and belonging, and made me feel that my efforts to do something about climate change were a part of something bigger than myself. Putting the lessons of this research into practice, I made a conscious effort to cultivate positive emotions when thinking about, and acting towards, climate change. These efforts not only helped to sustain my own engagement, but also often rubbed off on others. On one occasion, when discussing climate change with a group of friends, the conversation veered towards the deteriorating state of ecological systems and frustration at the inaction of governments and organisations. By redirecting the conversation towards what others were already doing, what community groups have recently achieved, and how we can personally act on climate at the individual, collective, civic, and organisational levels, the discussion grew more hopeful, local, and solutions based. While eliciting warm glow feelings is not going to solve the climate crisis alone, my personal experience has shown me that it is certainly a good place to start.

Limitations and Directions for Future Research

Sampling

As previously discussed, the central limitation of this experiment relates to the quasi-experimental design. The eligibility criteria meant that the sample was not representative of the wider population, as reflected by the higher number of climate actions performed by participants compared to those who were screened out (see Participant Engagement in Climate Actions and Table B2). Future studies could investigate whether people who have only performed climate actions alone, with others, or not at all experience warm glow feelings after imagining doing so. It would also be valuable to sample the general population to see whether the findings from the present research generalise more broadly.

As the study was conducted across Australia and New Zealand, results may not be generalisable to other countries. Furthermore, although this research collected information regarding participants' ethnicities, the sample may not be diverse enough to extrapolate the findings of this study across different cultural contexts. As an example of cross-cultural variation in emotional responses to climate action, the affective predictors of participating in environmental protests differed across countries, even among those located in Europe (Brosch, 2025). In Switzerland, protest enjoyment was the strongest predictor of university students having previously attended a strike, as well as their future intentions to participate (Cologna et al., 2021). Research in Germany found that feelings of being moved mediated the relationship between collective efficacy beliefs and collective action intentions (Landmann & Rohmann, 2020). Among Norwegian students, both collective guilt and the perception of environmental threats were indirectly associated with protest intentions (Haugestad et al., 2021). Taken together, these studies demonstrate the diversity of emotional responses which motivate climate action across cultures, reinforcing the need to exercise caution when generalising the results of the present study. Future research could explore how different countries experience, and express, warm glow in relation to climate engagement and the role that social norms play across these different contexts.

In a similar vein, it would be interesting to explore whether engagement in individual and collective climate actions, and the emotions experienced afterwards, differ across cultures that are more individualistic or collectivist in nature. Regarding cultural differences in climate actions, Xiang et al. (2019) demonstrated that individualistic Chinese students reported lower participation in climate actions compared with collectivistically oriented students, as well as stronger beliefs that climate change cannot be effectively solved through individual action. This study suggests that the relationship between participation in climate-friendly behaviours, and beliefs about their efficacy, may differ across cultural orientations.

Method

As most data converged towards the upper limit of the warm glow measure, ceiling effects may have obscured differences between groups (Chyung et al., 2020). As the average warm glow score for the control condition ($M = 4.0$, $SD = 0.8$) was relatively high on the five-point Likert scale, it is possible that all participants felt positively about engaging in climate actions, even when they were not tasked with specifically reflecting on a past, environmentally friendly behaviour. This explanation may be particularly pertinent for this sample, where all eligible participants reported engagement with a range of climate actions, and higher engagement overall compared to those who were screened out. Hartmann et al. (2017), whose warm glow measure was adapted for the current research, found that green electricity customers reported higher warm glow scores ($M = 4.2$) than customers of standard electricity ($M = 3.4$), reinforcing the idea that the elevated warm glow scores in the present study were reflective of the sample and their climate engagement, rather than a ceiling effect of the measure. Given that average warm glow scores across specific climate actions only ranged from 3.9 to 5.0 (see Appendix D), these effects may have also masked differences in warm glow between specific climate actions. However, as the number of participants who wrote about each behaviour was often quite small ($n = 1$ to 24), findings at the item level should be interpreted with caution.

Critically evaluating the methodology of this research, it is likely that all participants were primed to reflect on their experiences in a range of climate actions, not just those in the ICA and CCA conditions. As all participants reported their engagement with 16 climate-friendly behaviours, this task may have primed participants in the control condition to reflect on their engagement in these activities, potentially activating green self-concepts and influencing affective responses. While environmental self-identity is relatively stable, it can be strengthened by reminding people about their past sustainable behaviours (van der Werff

et al., 2014). These environmentally friendly self-concepts can signal to individuals that they are a good person, which can lead to a literal warm glow in the form of higher perceived temperatures (Taufik et al., 2015) or, in this case, higher warm glow scores. Similarly, the information sheet of the current research may have also acted as a primer, as it informed participants that the survey was examining how people engage in climate actions. This disclosure may have elicited social desirability or demand characteristics, leading participants to respond in ways that portrayed them as environmentally conscientious individuals. However, meta-analyses of environmental behaviour, intention, and attitude measures reported a small correlation with social desirability (Vesely & Klöckner, 2020), suggesting that participants in the current study were unlikely to have been substantially influenced by this bias.

While all participants were asked to recall a past event, only those in the climate action conditions were instructed to remember an activity that they had "participated in and felt good afterwards". Participants in the control condition instead recalled a neutral everyday activity. Although this approach was designed to minimise the introduction of external factors for the control condition (e.g., the social element of a memory, recalling prosocial or altruistic activities, high physiological arousal), it is likely that these instructions resulted in memories that differed in emotional valence across conditions. As a result, differences in warm glow between conditions may be attributable to positive emotions elicited by the recalled memory, rather than the social nature of the climate action itself. Future research could address this limitation by asking all conditions to recall a positive autobiographical memory. By keeping the valence of memories constant across conditions, conclusions regarding the relationship between the social nature of climate action and warm glow could be drawn with greater confidence.

The warm glow scores reported in this study reflect warm glow feelings elicited by the experimental manipulation, rather than a general emotional state. The experimental elicitation of warm glow in this research is clearly different from how this emotion would naturally emerge when engaging in climate actions. Moreover, the process of reflecting on these actions is unlikely to be replicated in such a structured way; while people often discuss pro-environmental behaviours with others, or reflect on these actions by themselves, it is far less likely that people would write about these experiences, especially for more common, everyday climate actions (e.g., catching the bus to work). Furthermore, they would be less likely to write about how they felt during their experience, nor would they be prompted to focus specifically on positive emotions. Beyond AEMT experiments, Zhou et al. (2026) demonstrated that behaving in environmentally friendly ways in an experimental setting was associated with higher levels of warm glow, while Bissing-Olson et al. (2016) captured feelings of pride from pro-environmental behaviours across the day. Together, these studies provide an empirical foundation for future research to examine warm glow responses as they naturally occur in a real world setting.

Another methodological limitation is that the present research only assessed one emotional state. While the AEMT procedure aims to induce a specific emotion, it has been shown to elicit other incidental emotions at the same time (Mills & D'Mello, 2014). This was observed in participants' written responses in the climate action conditions, which included feelings of pride, passion, enjoyment, and hope, despite none of these emotions being referenced in the survey items, suggesting that broader positive emotions may have been captured in the warm glow measure.

Results demonstrated that the efficacy beliefs measure was not fully independent of the experimental condition. As individual and collective efficacy beliefs were measured after the experimental manipulation and response efficacy measure, it is possible that recalling a

past climate action, writing about their experience, rating warm glow items, and reflecting on their response efficacy shaped participants' subsequent efficacy beliefs. Future research could measure efficacy prior to any manipulations or measures capturing emotional responses towards climate-friendly behaviours; however, measuring efficacy first may have the unintended consequence of efficacy beliefs influencing warm glow scores.

Future longitudinal research could also offer valuable insight into whether warm glow feelings are sustained over time, and whether this emotion continues to motivate climate-friendly intentions and behaviours. As existing longitudinal research demonstrates anticipated warm glow predicts pro-environmental behaviours four weeks later (van der Linden, 2018; Jia & van der Linden, 2020), it is plausible that reflecting on past climate actions would have a similar effect. Such studies could also provide evidence of a positive feedback loop, helping to guide interventions in eliciting and maintaining these positive emotional and behavioural cycles.

Extending Hartmann et al.'s (2017) warm glow measure to encompass collective elements of climate action could have compromised its reliability. However, strong internal consistency was observed for the measure overall in the present study, as well as across both the individual and collective subscales. Since internal consistency does not guarantee that the additional items capture the collective elements of warm glow they were designed to measure, future research should independently test their content and criterion validity. Replication of the current internal consistency results would also strengthen confidence in the measure's reliability across contexts.

Finally, as with any research design involving a survey methodology, results and interpretations relied on self-reported data. Whether participants' responses accurately reflected their warm glow feelings remains uncertain.

Contextual Limitations

It is not clear from this research how the scale used to measure warm glow maps out onto the real world. Although the difference in warm glow scores between participants in the collective climate action and control conditions was statistically significant, these results do not help us understand if this difference ($M_{diff} = 0.3$) is practically significant. Future research could determine a threshold for what constitutes a meaningful difference in warm glow scores, or how these levels correspond with behavioural intentions and outcomes.

As with any behaviour, the climate actions listed in this study are shaped by many other factors beyond their social nature. For example, participants who wrote about eating a vegan or vegetarian diet often described animal rights as a motivator of their dietary choice, rather than solely viewing this behaviour through an environmental lens. Similarly, the health and financial benefits of walking, cycling, or using public transport were frequently noted by participants. These examples barely scratch the surface in illustrating the breadth of motivations behind why people choose to perform climate-friendly behaviours. As such, it is methodologically challenging to isolate the exact relationship between warm glow feelings and the social nature of climate actions. An interesting avenue for future research could be to explore how the quality of social interactions within collective climate actions influences feelings of warm glow and future engagement. As the social context of a memory (e.g., shared with close others, acquaintances, or experienced alone) affects how the memory is valued (Speer & Delgado, 2020), who we perform climate actions with likely shapes our emotional responses to the experience. Many collective climate actions are performed alongside people we care about, such as participating in a tree planting event with one's family or regularly seeing other members of a community-based climate action group. The closeness of these relationships may influence how positively people feel when reflecting on such actions, including feelings of warm glow.

Despite these limitations, the present research advanced our understanding of how warm glow is experienced when reflecting on individual and collective climate actions and identified promising directions for future research.

Conclusion

The effects of climate change are far reaching and profound, damaging the environment, endangering the existence of species (IPCC, 2023a), and threatening to harm our objects of care (Wang et al., 2018). To mitigate these effects, action must be taken on a wide scale at all levels (IPCC, 2023a). It is therefore imperative that research examines how to encourage these behaviours and sustain engagement over time. As positive emotions appear to be an effective mechanism in driving environmentally friendly behaviours (Brosch & Steg, 2021), this research examined how warm glow is experienced across collective and individual climate actions.

The present study observed that participants in the CCA condition reported higher warm glow scores than those in the control condition. No statistically significant difference was observed between participants in the ICA and control conditions, or between the ICA and CCA conditions. Exploratory analyses demonstrated a large correlation between efficacy beliefs and warm glow scores, suggesting that stronger beliefs in one's capacity to address climate change were associated with stronger positive emotions. Furthermore, in line with existing research (Schwartz et al., 2023), participants engaged in far more climate actions by themselves, compared to collective actions. As collective climate action is essential in driving systemic changes, more research is needed to encourage participation in these behaviours. Extraversion was also shown to significantly predict participants' warm glow scores, suggesting that personality traits may shape how positively people feel when reflecting on climate-friendly actions. Finally, participants who performed greater numbers of climate actions also reported higher levels of warm glow.

Broadly, research that examines emotional responses arising from environmentally friendly behaviours demonstrates people feel positively about these actions (e.g., Taufik &

Venhoeven, 2018; Zhou et al., 2026). However, literature on how people feel about climate actions of different social natures remains limited. To the best of my knowledge, this is the first research which specifically examines how warm glow is experienced when people reflect on individual and collective climate actions. The results of the current study suggest that collective climate action may have a particularly strong relationship with warm glow, potentially driven by a sense of support, feelings of connection, group-based emotions, and social identities. Although these social and emotional mechanisms were not examined in the present study, further research investigating these processes would help to expand our understanding of why these results were observed, which could be used to encourage greater or more sustained engagement.

Reflecting on past collective climate actions appears to be particularly useful in eliciting feelings of warm glow, allowing the emotions felt during the activity to be re-experienced beyond the original behaviour (Mills & D'Mello, 2014), and potentially offering a more accessible pathway to amplifying these feelings. Furthermore, this focus on warm glow may also encourage long term participation in the climate movement through intrinsic motivation and a positive feedback loop (Brosch & Steg, 2021; van der Linden, 2015). In practice, interventions could elicit these feelings by asking participants to reflect on their past collective climate actions. More broadly, amplifying the positive emotions associated with environmentally friendly behaviours, engaging a person's values (Brosch & Steg, 2021), or building a sense of connection with others may further support long term engagement (Ardoin & Bowers, 2025).

As the sample for this research had engaged in both individual and collective climate actions, future research could examine how warm glow is felt across the general population, including those who demonstrate low engagement. One approach would be to ask participants to imagine engaging in behaviours that they have not previously performed to

examine whether similar results occur and how these might shape future pro-environmental intentions. Similarly, measuring warm glow across different research designs (e.g., reflecting on behaviours, imagining actions, and engaging in environmentally friendly activities) may help to better understand the mechanisms underlying this emotion. The relationship between efficacy and warm glow also warrants further investigation, particularly the direction of this relationship and how the two may interact to motivate action.

Despite the results of this study, I want to reiterate that this research did not intend to privilege one form of climate action over the other. It is clear that there is no single solution that will be sufficient in mitigating and adapting to climate change; rather, it requires a wide range of actions to be taken by many people across all levels. Rather than prioritising one type of action over the other, a shift towards both individual and collective behaviours is necessary (Kirkhus & Nicholas, 2023). Warm glow may a promising route to generally encourage these efforts, with reflecting on collective engagement a particularly effective method for eliciting this emotion. By encouraging behaviours that connect us with others, strengthen a sense of purpose, and make us feel good, climate actions can create a better world while fostering positive emotional, social, and psychological outcomes (Ardoin & Bowers, 2025; Harré, 2011).

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AI Use Statement

Claude was used to supplement my literature searches in Google Scholar and Massey's Discover database. All literature suggestions were reviewed for their quality, currency, credibility, and relevance to my research question. Claude was also used to challenge my work, provide critical feedback, and review the structure of my arguments.

Gemini was employed to support my STM, review the code for this analysis, and check that my understanding of the outputs was correct.

ChatGPT, Gemini, and Claude were occasionally used to check that my interpretation and understanding of academic research was correct. Responses were fact checked against the original research.

These tools, alongside Grammarly, were also used to identify grammar or vocabulary errors in my writing. Grammarly AI writing functions were not used in this research.

List of Appendices

Appendix A: Study Questionnaire

1. Screening questions

Age:

Country of residence:

- New Zealand
- Australia
- Other

What is your Prolific ID? (*Please note that this response should auto-fill with the correct ID.)*

2. Climate actions

Have you engaged in any of the below climate actions below within the last three years? (*Y/N*)

- Adopted energy saving behaviours (e.g. setting lower temperatures, using warm clothes, switching off lights, using high efficiency light bulbs etc.)
- Walked, cycled, or took public transport regularly
- Voted for political parties or candidates that aimed to implement strong climate policies
- Divested from fossil fuel companies, invested in ESG funds, or donated to environmental organisations
- Shifted to an e-bike, electric, hybrid, or more fuel efficient vehicle, or lived car free
- Reduced your home's energy consumption (e.g. purchased energy efficient appliances, switched to renewable energy, renovated your home to be more energy efficient, installed renewables etc.)
- Ate a vegan or vegetarian diet
- Consistently consumed fewer products (e.g. reduced overall consumption, purchased goods with higher longevity, repaired items etc.)

- Attended a climate protest, demonstration, or march
- Volunteered at a local climate initiative (e.g. regeneration, circular economy, or tree planting events etc.)
- Discussed climate solutions, risks, or actions with people within or beyond your immediate social circle
- Engaged in one-off political climate actions with others (e.g. contacted elected officials to demand climate protection measures, participated in a public consultation etc.)
- Participated in political, community-led climate activism (e.g. lobbied for climate friendly policies, joined a citizen panel, group, party, or assembly etc.)
- Developed grassroots climate initiatives within your community (e.g. established a local environmental project, set up a community fundraiser, advocated for climate adaptation and protection plans)
- Worked with colleagues to reduce emissions within your organisation (e.g. helped to set environmental policies and targets; supported training or climate capacity building; planned and implemented zero-emissions transformations; developed long-lived products; created circular supply chains; promoted green incentives etc.)
- Created strong, long-term partnerships within your community, organisation, charity, or local council to help drive climate action

3. Experimental manipulation (participants were presented with one of the three prompts based on their condition)

3.1. ICA condition

Studies show that taking actions to protect the environment, even small things, gives people a feeling of satisfaction. In the last question, you selected that you had participated in a range of pro-environmental actions. Please select one of the activities from below that you have participated in and **felt good** afterwards.

- Adopted energy saving behaviours (e.g. setting lower temperatures, using warm clothes, switching off lights, using high efficiency light bulbs etc.)
- Walked, cycled, or took public transport regularly
- Voted for political parties or candidates that aimed to implement strong climate policies
- Divested from fossil fuel companies, invested in ESG funds, or donated to environmental organisations
- Shifted to an e-bike, electric, hybrid, or more fuel efficient vehicle, or lived car free
- Reduced your home's energy consumption (e.g. purchased energy efficient appliances, switched to renewable energy, renovated your home to be more energy efficient, installed renewables etc.)
- Ate a vegan or vegetarian diet
- Consistently consumed fewer products (e.g. reduced overall consumption, purchased goods with higher longevity, repaired items etc.)
- None of the above

Thinking about the action you just selected, please describe your experience and **how you felt** in a few sentences. We are interested in learning about your experience, so please be as specific as possible and **refrain from using AI**.

3.2. CCA condition

Studies show that taking actions to protect the environment, even small things, gives people a feeling of satisfaction. In the last question, you selected that you had participated in a range of pro-environmental actions. Please select one of the activities from below that you have participated in and **felt good** afterwards.

- Attended a climate protest, demonstration, or march
- Volunteered at a local climate initiative (e.g. regeneration, circular economy, or tree planting events etc.)
- Discussed climate solutions, risks, or actions with people within or beyond your immediate social circle
- Engaged in one-off political climate actions with others (e.g. contacted elected officials to demand climate protection measures, participated in a public consultation etc.)
- Participated in political, community-led climate activism (e.g. lobbied for climate friendly policies, joined a citizen panel, group, party, or assembly etc.)
- Developed grassroots climate initiatives within your community (e.g. established a local environmental project, set up a community fundraiser, advocated for climate adaptation and protection plans)
- Worked with colleagues to reduce emissions within your organisation (e.g. helped to set environmental policies and targets; supported training or climate capacity building; planned and implemented zero-emissions transformations; developed long-lived products; created circular supply chains; promoted green incentives etc.)
- Created strong, long-term partnerships within your community, organisation, charity, or local council to help drive climate action
- None of the above

Thinking about the action you just selected, please describe your experience and **how you felt** in a few sentences. We are interested in learning about your experience, so please be as specific as possible and **refrain from using AI**.

3.3. Control condition

Please select one of the activities from below that you have done sometime in the last three years.

- Tying your shoes
- Doing dishes
- Brushing teeth
- Setting a clock
- Climbing stairs
- Loading groceries into a car
- Measuring a line
- Peeling a banana
- None of the above

Thinking about the action you just selected, please describe your experience and **how you felt** in a few sentences. We are interested in learning about your experience, so please be as specific as possible and **refrain from using AI**.

4. Warm glow measure

We are interested in understanding how contributing to reducing global warming and climate change makes you feel. Please rate your agreement or disagreement with the below statements (*strongly disagree* = 1 to *strongly agree* = 5).

1. Doing something about climate change gives me a pleasant feeling of personal satisfaction.

2. Reducing carbon emissions, I feel happy contributing to human wellbeing and the quality of the natural environment.
3. Helping to prevent climate change, I feel pleased to be doing something good for our planet.
4. Participating in climate protection makes me feel satisfied, giving something back to society and the environment.
5. I feel good when making climate friendly choices, knowing that my actions are contributing to something bigger than myself.
6. Engaging in climate actions makes me feel positive about working towards shared environmental goals.
7. Taking climate friendly actions gives me a warm feeling of connection with others who also care about protecting the planet.

5. Response efficacy beliefs (only presented to ICA and CCA conditions)

Considering your action selected above, how effective do you think this has been to help reduce the impacts of climate change? (*not effective*, *somewhat effective*, *not sure*, *very effective*, *extremely effective*)

6. Efficacy beliefs

Please rate your agreement or disagreement with the below statements (*strongly disagree* = 1 to *strongly agree* = 5).

- I am certain that I personally will find ways to be climate friendly
- I trust that I personally can contribute to a climate neutral society
- I think I personally can manage to permanently lower my own CO_2-emissions
- I can contribute to permanently lower CO_2-emissions together with other people in my community

- I am capable of making a small but important contribution towards a climate neutral society together with other people
- My participation is an important contribution so that we in my community together find ways to be climate friendly

7. Extraversion

Please select the number that best represents how accurately each statement describes you (*very inaccurate* = 1 to *very accurate* = 7).

1. Am the life of the party
2. Don't talk a lot
3. Keep in the background
4. Talk to a lot of different people at parties

8. Attention check

To verify that you are a real person, please select *strongly agree* = 5 and move onto the next question.

9. Demographic information

Ethnicity (*NB: the item order was different depending on where the participant resided*)

- Australian
- Australian Aboriginal
- Torres Strait Islander
- Pākehā/New Zealand European
- Māori
- Pacific Peoples
- Asian
- Southeast Asian
- Middle Eastern

- European
- North American
- Latin American
- South American
- African
- Other

Highest level of completed education

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

Political orientation

- Liberal/left wing
- Moderate
- Conservative/right wing
- Other
- Prefer not to answer

Personal income before tax per annum

- Less than $20,000
- $20,000 - $39,999
- $40,000 - $59,999
- $60,000 - $79,999

- $80,000 - $99,999
- $100,000 or more

10. Pilot feedback (only participants in the pilot were presented with this item)

This study is in its pilot phase and we're still refining it. We'd love your feedback on how easy it was to complete, how clear the questions were, how long it took, or any other suggestions for improvement.

Appendix B: Profile of Participants Screened out of the Study

Table B1

Demographic Information of Participants Who Were Screened Out of the Study

Demographic ($N = 205$)	Characteristic	*n*	Percentage
Gender	Female	89	43.4%
	Male	116	56.6%
Country of residence	Australia	162	79.0%
	New Zealand	43	21.0%

Table B2

Climate Action Engagement by Participants Who Were Screened Out of the Study

Total climate actions performed	*M*	*SD*
Overall	3.7	1.7
Lower-cost actions	2.1	1.0
Higher-cost actions	1.6	1.1

Note. Participants were predominantly screened out of the survey because they had only engaged in individual climate actions. However, a couple of participants had engaged in both approaches but were screened out of the study due to a logic error in the survey. Therefore, the average number of individual and collective climate actions performed by these participants is not reported here.

Appendix C: Demographic Characteristics of Participants Across Conditions

Demographic	Category	Condition (N = 205)		
		Control (n = 74)	ICA (n = 73)	CCA (n = 58)
Sex	Female	36	35	31
	Male	38	38	27
Age	18-24	9	8	9
	25-34	26	23	21
	35-44	24	24	11
	45-54	8	6	11
	55-64	4	7	5
	65 or older	3	5	1
Country of residence	Australia	55	57	38
	New Zealand	19	16	20
Ethnicity	African	5	2	0
	Asian	11	8	8
	Australian	36	33	24
	Australian Aboriginal	1	1	0
	European	3	7	9
	Māori	1	1	0
	Middle Eastern	2	0	1
	North American	0	3	1
	Pacific Peoples	2	2	2
	Pākehā/New Zealand European	11	10	7
	Southeast Asian	1	4	2
	Other	1	2	4
Highest level of completed education	Doctoral degree (e.g. PhD, PsyD, MD)	4	4	2
	Postgraduate degree (e.g. Masterate)	12	14	9
	Undergraduate degree (e.g. Bachelors)	38	35	28
	Other tertiary qualification	10	9	4
	Completed high school	10	10	14
	Some high school (without completing)	0	1	0
Political orientation	Liberal/left wing	32	42	30
	Moderate	30	27	14
	Conservative/right wing	6	3	7
	Other	2	1	5
	Prefer not to answer	4	0	2
Personal income (before tax and per annum)	Less than $20,000	9	8	8
	$20,000 - $39,999	12	10	6
	$40,000 - $59,999	7	7	9
	$60,000 - $79,999	10	13	10
	$80,000 - $99,999	14	10	12
	$100,000 or more	22	25	13

Appendix D: Descriptive Analyses of Warm Glow Scores Across Climate Action Items

Table D1

Descriptive Analyses of Warm Glow Scores Across ICA Items

ICAs that participants wrote about	*n*	*M*	*SD*
Adopted energy saving behaviours (e.g. setting lower temperatures, using warm clothes, switching off lights, using high efficiency light bulbs etc.)	9	4.2	0.7
Ate a vegan or vegetarian diet*	5	4.4	0.5
Consistently consumed fewer products (e.g. reduced overall consumption, purchased goods with higher longevity, repaired items etc.)*	9	4.1	0.6
Divested from fossil fuel companies, invested in ESG funds, or donated to environmental organisations	2	4.9	0.2
Reduced your home's energy consumption (e.g. purchased energy efficient appliances, switched to renewable energy, renovated your home to be more energy efficient, installed renewables etc.)*	11	4.4	0.5
Shifted to an e-bike, electric, hybrid, or more fuel efficient vehicle, or lived car free*	11	3.9	0.6
Voted for political parties or candidates that aimed to implement strong climate policies	9	4.3	0.6
Walked, cycled, or took public transport regularly	17	3.9	0.8

Note. Items marked with an asterisk (*) were categorised as higher-cost climate actions.

Unmarked items were categorised as lower-cost climate actions.

Table D2

Descriptive Analyses of Warm Glow Scores Across CCA Items

CCAs that participants wrote about	*n*	*M*	*SD*
Attended a climate protest, demonstration, or march	7	4.2	0.7
Created strong, long-term partnerships within your community, organisation, charity, or local council to help drive climate action*	3	4.6	0.4
Discussed climate solutions, risks, or actions with people within or beyond your immediate social circle	24	4.3	0.6
Engaged in one-off political climate actions with others (e.g. contacted elected officials to demand climate protection measures, participated in a public consultation etc.)	3	4.3	0.6
Participated in political, community-led climate activism (e.g. lobbied for climate friendly policies, joined a citizen panel, group, party, or assembly etc.)*	1	4.1	-
Developed grassroots climate initiatives within your community (e.g. established a local environmental project, set up a community fundraiser, advocated for climate adaptation and protection plans)*	1	5.0	-
Worked with colleagues to reduce emissions within your organisation (e.g. helped to set environmental policies and targets; supported training or climate capacity building; planned and implemented zero-emissions transformations; developed long-lived products; created circular supply chains; promoted green incentives etc.)*	10	4.4	0.5
Volunteered at a local climate initiative (e.g. regeneration, circular economy, or tree planting events etc.)	9	4.3	0.5

Note. Items marked with an asterisk (*) were categorised as higher-cost climate actions.

Unmarked items were categorised as lower-cost climate actions.

Appendix E: Ethics Approval Letter

TE KUNENGA KI PŪREHUROA | MASSEY UNIVERSITY
UNIVERSITY OF NEW ZEALAND

5/11/2025

Dear: Devon Swift

Re: Low Risk Approval - 4000031519 - How do individual and collective climate actions affect warm glow?

Thank you for submitting a low risk application for your research/teaching/evaluation.

This email is to acknowledge receipt of the low risk application which has been approved. The details of your project will be included in the annual reports to the Health Research Council Ethics Committee (HRCEC) and the Massey University Research Committee (URC).

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

Please notify me if changes occur which cause you to reconsider your initial ethical analysis or project as outlined in the low risk application.

Please include the following statement on all public documents (e.g., information sheet, consent form) related to your project:

> ***This project has been evaluated by peer review and judged to be low risk. Following review by a Massey University Ethics Advisor and Chair of the Ethics Chairs' Committee, the project has been approved. The researcher(s) named above are responsible for the ethical conduct of this research.***
>
> ***If you have any concerns about the ethical conduct of this research that you want to raise with someone other than the researcher(s), please contact Massey University Human Ethics by email: humanethics@massey.ac.nz.***

I wish you all the best in your research, teaching or evaluation activities and appreciate your thoughtful consideration of ethical principles and practices.

Ngā mihi nui,

Professor Tracy Riley
Acting Chair, Research Ethics Chair's Committee

Research Ethics, Graduate Research School and Ethics
Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand
E humanethics@massey.ac.nz; animalethics@massey.ac.nz
www.massey.ac.nz/research/ethics

Appendix F: Study Information Sheet for Participants

Welcome!

Understanding How People Engage in Climate Actions

Researcher introduction

My name is Devon Swift; I am a Masters student at the School of Psychology at Massey University in New Zealand. Dr Stephen Hill, an Associate Professor at the School of Psychology at Massey University, is supervising this project.

Project description

In this study, you will be asked to indicate whether you have engaged in a range of climate actions within the last three years. The study aims to understand how people approach climate friendly behaviours across New Zealand and Australia. To be eligible to participate in this study you need to be at least 18 years old and be living in New Zealand or Australia.

Project procedures

If you choose to participate, you will be asked to indicate if you have participated in a range of activities, your agreement with a range of statements, and some basic demographic questions about yourself. You will also be asked to complete a brief writing task. As we are interested in learning about your personal experiences, please refrain from using AI throughout this survey.

The survey will include approximately 14 questions in total, one brief writing task, and take around nine minutes to complete. If you complete the survey, you will receive GBP1.50, paid via Prolific. I do not anticipate that completing this survey will cause you any discomfort or harm.

Data management

After we have completed our data analyses, the responses you provide to this survey will be stored indefinitely and may be made publicly available. Before sharing the data, however, we

will remove any information that might indicate who you are (e.g., your Prolific ID). The data may be shared on the Open Science Framework for other researchers and members of the public to access. This means that it may be used for other data analyses not forming part of this study.

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 devone.swift@gmail.com or by using the Prolific messaging system.

Ethics statement

This project has been evaluated by peer review and judged to be low risk. Following review by a Massey University Ethics Advisor and Chair of the Ethics Chairs' Committee, the project has been approved. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the ethical conduct of this research that you want to raise with someone other than the researcher(s), please contact Massey University Human Ethics by email: humanethics@massey.ac.nz.

- o I consent to take part in this research study.
- o I DO NOT consent to take part in this research study.

Appendix G: Supplementary Information on Structural Topic Modelling Preprocessing

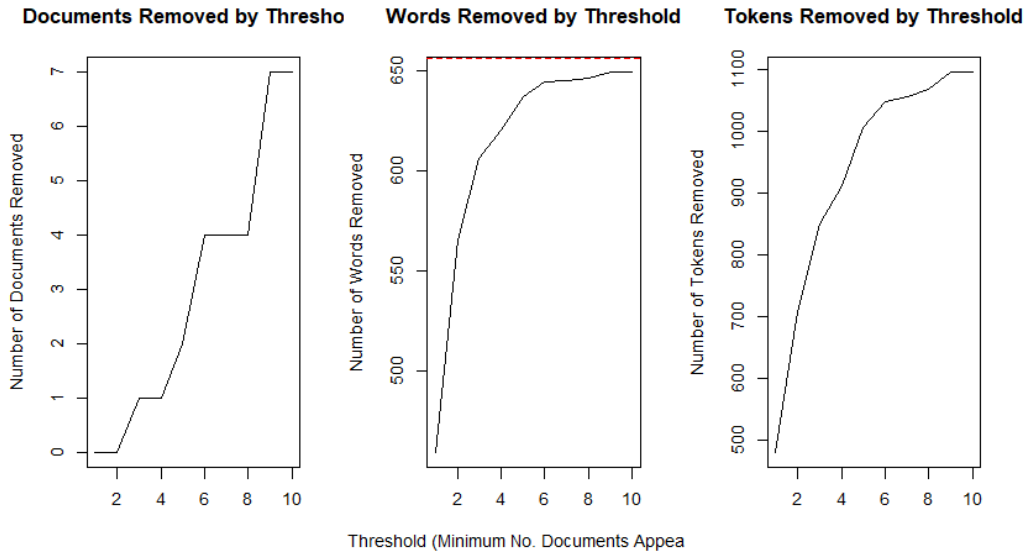
Following Weston et al.'s (2023) tutorial on structural topic modelling, data cleaning across all three models removed numbers, special characters, and stop words (e.g. articles, conjunctions, prepositions, pronouns) from participants' responses.

To remove words which appeared very infrequently across the set of participants' responses (the corpus), the lower bound thresholds were assessed separately for each condition[12]. Given the relatively small volume of text within each corpus, a high proportion of words were infrequently used within participants' responses. However, setting a lower threshold was necessary to minimise noise and prevent the model from overfitting infrequently used terms which did not have enough statistical weight to support a full topic. Through exploratory analysis, various lower thresholds were analysed for the topic models, across each of the three experimental conditions (see Figure G1 for an example of how these were evaluated). Through this analysis, I determined the optimal threshold and set the lower bound at 2 for all conditions' analyses. This lower bound allowed the topic models to ignore a lot of rare words which were creating background noise. This lower bound removed 545/665 terms in the ICA condition, 565/656 terms in the CCA condition, and 557/670 terms in the control condition.

[12] The variational lower bound is a metric which determines the convergence of a specific solution (Weston et al., 2023).

Figure G1

Exploratory Analyses to Determine the Lower Bound Threshold for the CCA Condition



Model Selection and Comparison

Weston et al. (2023) argued "that there is no single correct number of topics for any corpus, but, rather, several good options" (p. 2). Consequently, model selection is a subjective process, informed by the results and research questions (Weston et al., 2023). To ensure computational replicability of the STM, a fixed seed was set for each condition's analysis.

To identify which candidate topic-model solutions should be further examined, a series of fit metrics were compared. As Weston et al. (2023) recommended that ideal solutions have lower residuals and higher exclusivity, variational lower bound, and semantic coherence statistics, this instruction was applied when comparing candidate topic-model solutions. The number of topics evaluated for the ICA condition was K = 4, 6, 8. For the CCA condition, K = 4 , 8. For the control condition, K = 5, 9, 11.

To evaluate and compare candidate models, the congruence between topic solutions was calculated using their beta matrices. The comparison of these matrices enabled quick

identification of topics across different models that showed semantic overlap with one another. Analysing similar FREX terms within these overlapping topics also supported the identification of key themes across candidate models (Weston et al., 2023).

For the ICA condition, Model 4 (Topic 2) and Model 6 (Topic 3) demonstrated high congruence (.87), indicating thematic robustness across both models. FREX words across these solutions included *feel* and *good*. Model 6 (Topic 2) and Model 8 (Topic 4) also demonstrated high correlation (.89), with FREX terms including *felt* and *decision*.

Within the CCA condition, Model 4 (Topic 4) and Model 8 (Topic 8) reflected strong thematic alignment (.76). Both topics shared *community* as a key FREX term, while *felt*, *feel*, and *people* also had a high probability of appearing across participant's responses within these topics.

Topics within the control condition aligned closely with the everyday survey items participants were asked to write about. Model 5 (Topic 2) and Model 9 (Topic 6) demonstrated high congruence (.97), with *toothbrush*, *brushing*, *teeth*, *fresh*, *mouth*, and *daily* appearing as FREX terms across both topics. Model 9 (Topic 2) and Model 11 (Topic 2) showed substantial overlap (.92), with FREX words including *stairs*, *climbing*, *activity*, and *healthy*.

Topic Labelling

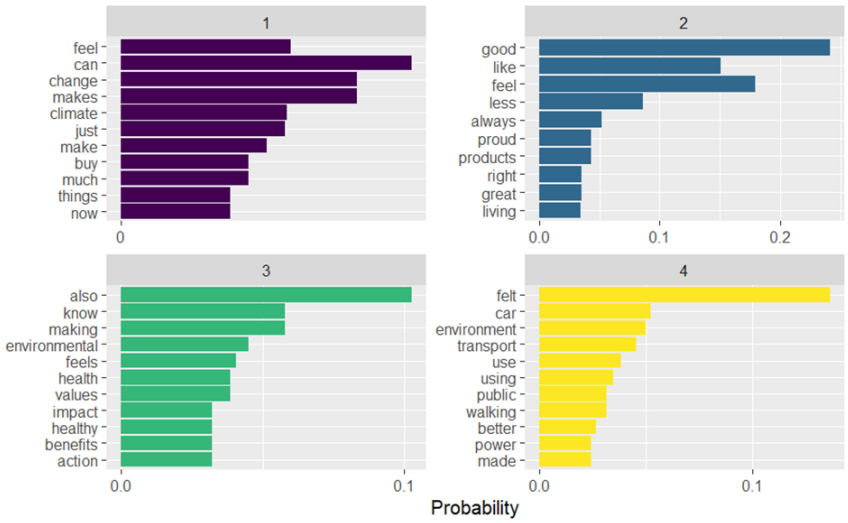
Topic labelling supports the interpretation of a topic model (Weston et al., 2023). To help to explain the flavour of each topic, FREX words were first displayed graphically. These terms were then cross-referenced against the most representative participant responses for each topic. Doing so provided context and validated topic labels as accurately reflective of FREX data.

To label topics within the ICA condition, FREX terms were calculated for each topic. To illustrate, the graphs displaying FREX words for Model 4 (see Figure G2) suggest the

warm glow manipulation was effective, with emotion-based language present across all topics (e.g., feel, feels, felt), alongside many positive valenced words (e.g., good, proud, values). These terms were cross-referenced against the most representative participant responses for each topic. For example, a representative response in Model 4 (Topic 4), "*transitioned to a hybrid vehicle, uses a lot less petrol which is better for the environment and for my wallet"*, confirmed that the topic label *transport use* was appropriate.

Figure G2

Frequent and Exclusive Words Within Topics for the ICA Condition's Model 4

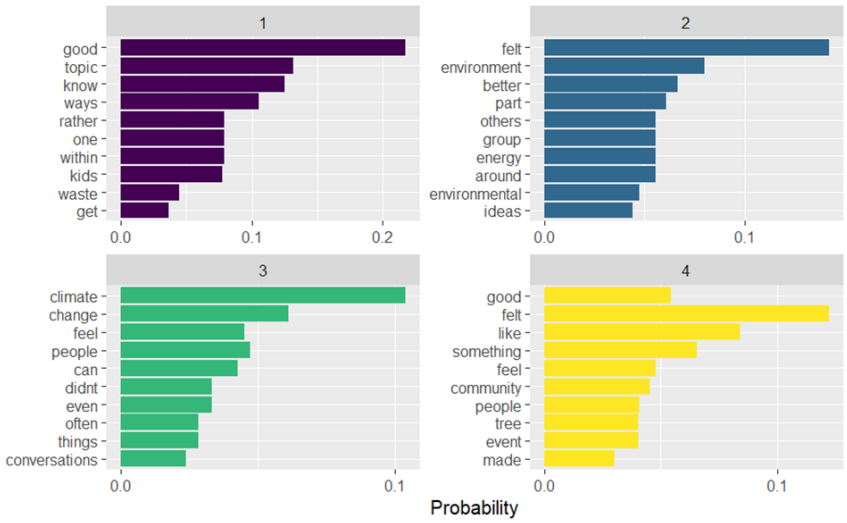


For the CCA condition, FREX terms found within each topic were also calculated. As an example, the graphs created for Model 4 (see Figure G3) suggest that the warm glow manipulation was effective. Words with strong affective sentiments (e.g., *felt*, *feel*) and positively charged terms (e.g., *good*, *better*) were present across three of the four topics, while collective nouns were present across all topics in this model (e.g., *kids*, *others*, *group*, *people*, *community*). Cross-referencing these terms against the most representative participant responses for each topic confirmed the topic labels. For instance, one such response, "*it felt good to be part of something much bigger than myself. It felt good to be with like-minded people. And doing something that better the world both now and for the future felt great*",

demonstrated that the topic label, *positive emotions from climate action*, for Model 8 (Topic 4) was representative of the FREX data.

Figure G3

Frequent and Exclusive Words Within Topics for the CCA Condition's Model 4



Finally, to label the topics of the control condition, FREX terms were analysed. As an example, the FREX words across topics in Model 5 (see Figure G4) contained affective language (e.g., *felt*, *feeling*) across all topics. This was to be expected, as participants were asked to describe how they felt when engaging in everyday actions. However, as there was only one mention of a positive affective term (*good*) across these topics, these graphs suggest that the control condition predominantly elicited neutral emotional responses. Furthermore, no topics referenced climate change, confirming that participants in the control condition generally did not discuss climate change in their responses.

Figure G4

Frequent and Exclusive Words Within topics for the Control Condition's Model 5