Adaptive Regulation of Effort: Pro-Environmental Behaviours, Climate Change Hopelessness, and Secondary Control Strategies

by

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Abstract

Climate change hopelessness has been observed across the globe and is a psychological barrier to engagement in pro-environmental behaviours (PEBs). Drawing on the life-span theory of control, the present research investigated whether secondary control strategies could offset the negative effects of climate change hopelessness on environmental engagement. Secondary control refers to cognitive strategies that help individuals accept or accommodate themselves to external situations that are difficult to change. Study 1 recruited 289 Canadian adult respondents from the Prolific online platform. They provided information through a cross-sectional survey regarding their climate change hopelessness, primary control striving, use of secondary control strategies, environmental identity, and both self-reported and performance-based measures of PEBs. In Study 2, 123 undergraduates at the University of Manitoba were randomly assigned to conditions of a 2 × 2 factorial experiment that manipulated participants' feelings of climate change hopelessness and availability of secondary control, before presenting them with a performance-based measure of PEB. The proposed explanatory model, adapted from the life-span theory of control, was not supported. However, several important findings emerged that highlight the adaptive role of secondary control strategies in regulating environmental effort. In Study 1, secondary control strategies appeared to offset the negative influence of climate change hopelessness on routine and citizenship PEBs, either directly or indirectly through the maintenance of environmental identity. Both studies also demonstrated that self-reported and performance-based measures of PEB reflected different aspects of environmental engagement, with the latter primarily capturing momentary persistence in effortful and personally costly environmental decisions.

Across both studies, individuals who more strongly endorsed secondary control strategies, or were experimentally primed with them, were more likely to withdraw effort from performance-based PEBs. Altogether, the findings suggest that secondary control strategies facilitate the adaptive regulation of effort by helping individuals maintain commitment to environmental values while also adaptively disengaging from PEBs that are costly to sustain. In this way, secondary control strategies may help individuals remain engaged with environmental goals and actions through sustainable actions, despite experiences of climate change hopelessness.

Keywords: climate change hopelessness, secondary control, pro-environmental behaviours, identity

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Adaptive Regulation of Effort: Pro-Environmental Behaviours, Climate Change Hopelessness, Secondary Control Strategies

The influence of climate change is getting hard to ignore. Earth's surface temperature increased by 1.1°C from 2011 to 2020, and more than 3.3 billion people live in regions highly vulnerable to climate disasters (Intergovernmental Panel on Climate Change, 2023). Despite the worsening situation, climate change remains a solvable issue, and there are countless opportunities for individuals and groups to act. Take Canada as an example. The two largest sources of greenhouse gas emissions in Canada in 2025 were burning oil and gas (43%) and transportation (28%; Environment and Climate Change Canada, 2025), and many of these emissions can be reduced through actions such as driving less, supporting the transition to renewable energy, or improving household energy efficiency. While no single act can halt the climate crisis, the cumulative impact of behaviours can be profound, particularly when sustained over time.

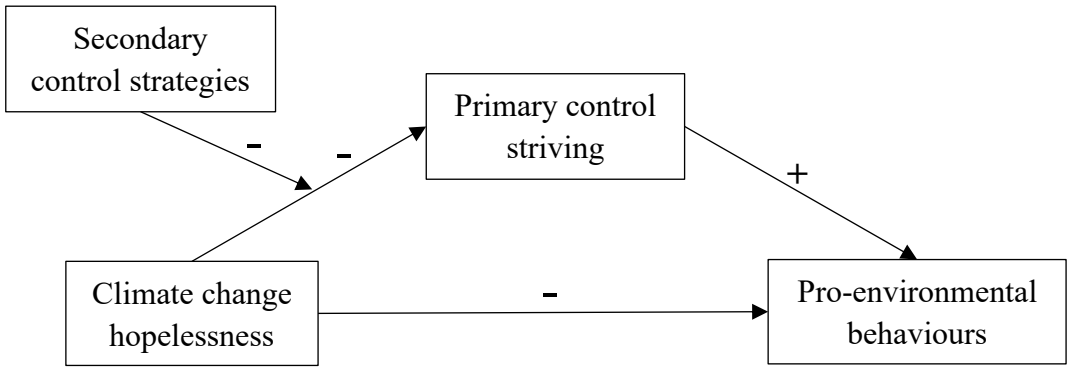
However, many people around the world report feeling hopeless in the face of climate change (Baldwin et al., 2023; Galway & Field, 2023; Hickman et al., 2021; Marlon et al., 2019), even though there are many opportunities for impactful actions. For example, Galway and Field (2023) surveyed a thousand young Canadians, and found that more than half felt sad and powerless about climate change. Approximately three-quarters agreed that climate change makes the future feel frightening and that people are not taking adequate care of the environment. The widespread experience of climate-related hopelessness raises important questions about its implications for environmental engagement. Empirical evidence suggests that hopelessness is associated with reduced participation in climate action (Aitken et al.,

2011; Williams & Jaftha, 2020). Consequently, researchers and practitioners need to identify psychological processes and coping strategies that enable individuals to remain engaged in environmental action despite feelings of hopelessness.

Based on the concepts of primary and secondary control (Rothbaum et al., 1982), the life-span theory of control (Heckhausen & Schulz, 1995) proposes how individuals can deal with frustrations or failures while maintaining their momentum in the goal-seeking process throughout the entire life span. This research aims to use the life-span theory of control to present secondary control strategies as a solution to the prevailing sense of climate change hopelessness and propose a model to sustain environmental engagement (see Figure 1). It proposes that secondary control strategies can maintain individuals' primary control striving in the face of climate change hopelessness, leading to sustained climate actions.

Figure 1

Hypothesized Relationships of Hopelessness with Primary Control Striving, Secondary Control Strategies, and Pro-Environmental Behaviours.



Pro-Environmental Behaviours and Measurements

Pro-environmental behaviours (PEBs) are behaviours that have minimal harm or have benefits to the environment (Steg & Vlek, 2009). Among all ways to measure PEBs, self-reported methods are the most frequently used ones (Lange & Dewitte, 2019). While they are easy to use, one disadvantage of them is that actual behaviour changes are hard to measure with self-reported measures immediately after experimental manipulation (Lange & Dewitte, 2019). To complement this limitation, many performance-based tasks were proposed to try to simulate PEBs, like the Work for Environmental Protection Task (WEPT; Lange & Dewitte, 2022) and the Pro-Environmental Behavior Task (PEBT; Lange et al., 2018). Both WEPT and the PEBT symbolize the central characteristic of PEBs, which is the dilemma between self-interest and collective environmental benefit (Georgiou & Van Lange, 2024; Gifford, 2011; Lange & Dewitte, 2022). In both tasks, participants must sacrifice personal resources, such as time, effort, or comfort, in order to generate environmental benefits. The WEPT presents participants with decisions about whether to invest effort in a series of number-identification tasks in exchange for donations to an environmental organization. PEBT creates a decisional conflict between a more convenient travel option (i.e., a car for less travel time but more environmental harm) and a more environmentally friendly option (i.e., choosing a bike for less environmental harm but longer travel time). The present study will use self-report and WEPT for the first cross-sectional study, and the second experimental study will use PEBT to measure PEBs after experimental manipulations.

Climate Change Hopelessness

In the present study, hopelessness is defined as a multidimensional construct that

encompasses both cognitive and emotional dimensions (Mortreux et al., 2025). From the cognitive perspective, hope can be strengthened or diminished through the appraisal of pathways (the possible routes to a goal) and agency (motivation to reach a goal; Snyder et al., 2002). From the affective perspective, hopelessness is a negative emotion characterized by the feeling that nothing good will happen in the future of climate change (Baumgartner et al., 2008; Geiger et al., 2023). Integrating both perspectives, climate change hopelessness is a negative cognitive and emotional experience, characterized by the perception that people have little influence over the future of climate change and that nothing good will happen.

Considering the collective nature of climate change, climate change hopelessness can be directed toward both one's own actions and the actions of others. First, climate change can emerge from a lack of individual will and way to engage with climate actions (Li & Monroe, 2018), thinking that they cannot contribute meaningfully to climate actions. Second, climate change hopelessness can sprout from the perception that other people are unwilling to take action, leading individuals to feel minimal in their battles to tackle climate change. Such perceptions can be reinforced by pluralistic ignorance, a psychological phenomenon where individuals mistakenly assume that others do not share the same belief or attitude (Miller & McFarland, 1987). Previous studies have shown that participants tended to underestimate the popularity of pro-climate attitudes (Geiger et al., 2025) and other people’s willingness to engage in PEBs (Andre et al., 2024). Overall, past studies have shown that both perceived futility of individual actions and collective inaction were associated with lower engagement in climate action (Aitken et al., 2011; Williams & Jaftha, 2020). These findings highlight that climate change hopelessness may represent a psychological barrier to PEBs. Therefore, in

this research, I hypothesize that individuals who report higher levels of climate change hopelessness, or who are experimentally induced to feel more hopeless about climate change, are expected to engage in lower levels of PEBs.

Hypothesis 1: Higher levels of climate change hopelessness are negatively associated with lower levels of pro-environmental behaviours.

The rest of the model was developed in response to evidence that has cast doubt on the effectiveness of directly increasing hope as a means of promoting environmental engagement. A meta-analysis done by Geiger et al. (2023) found that the effect of experimentally increased hope on environmental engagement was only minimal (Cohen's d = 0.08). Similarly, several attempts to increase climate-related hope have failed to produce meaningful behavioural changes. For example, providing information about the actual prevalence of pro-climate attitudes to reduce pluralistic ignorance did not increase participants' willingness to engage in PEBs (Geiger et al., 2025). Likewise, manipulations that successfully strengthened participants' beliefs that climate change can be addressed through effective action did not significantly increase their motivation to participate in collective climate action (Van Zomeren et al., 2019). Together, these findings suggest that fostering hope alone may be insufficient to sustain environmental engagement. Therefore, rather than focusing on increasing hope directly, the present research examines whether secondary control strategies may help individuals remain engaged in PEBs even when feelings of climate-related hopelessness persist.

Primary and Secondary Control

The concepts of primary and secondary control were built on the concept of perceived

control, which refers to the belief that one is able to achieve desired outcomes through action. Traditionally, it has been conceptualized as being expressed mainly through outward behaviours aimed at influencing the environment and its outcomes. For example, learned helplessness theorists (e.g., Abramson et al., 1978) believed that attempts to change oneself (i.e., inward behaviours) were a result of failures and the perception that the outcome is uncontrollable. The locus of control theorists (e.g., Rotter, 1966) believed that inward behaviours were a sign of an external locus of control, that the outcome is contingent on forces individuals can not control (e.g., luck, chance, or others). In both perspectives, efforts directed toward changing oneself rather than the environment were generally viewed as responses to limited or absent control over external outcomes.

In an important development of these ideas, Rothbaum and his colleagues (1982) distinguished between primary control and secondary control as two distinct processes of control. Primary control refers to attempts to influence the external environment so that it conforms to one's needs and goals, whereas secondary control involves psychological efforts to adjust oneself to existing circumstances. They proposed that changing oneself can also reduce the discrepancy between internal needs and the external environment and thus achieve the purpose of increasing perceived control. The life-span theory of control (Heckhausen & Schulz, 1995) further expanded this framework by integrating secondary control as an adaptive regulatory process that facilitates primary control across life-course development and transitions. Rather than being limited to responding to failure, secondary control strategies help individuals protect motivational resources, adjust goal engagement, and preserve commitment when primary control is constrained (Heckhausen & Schulz, 1995;

Heckhausen et al., 2010). Secondary control is emphasized by its connection to primary control and its function to enhance and minimize the loss of primary control.

There has been debate regarding the conceptualization of secondary control. Rothbaum et al. (1982) originally described secondary control as internally directed processes that facilitate adaptation to situational constraints, often emphasizing fit with external conditions. In contrast, the life-span theory of control (Heckhausen & Schulz, 1995; Heckhausen et al., 2010) conceptualizes secondary control more specifically as control-relevant processes that support the maintenance of motivation and the optimization of primary control, particularly under conditions of constraint. Morling and Evered (2006) further highlighted this distinction, arguing that these perspectives differ in whether secondary control is primarily fit-focused or control-focused. The present research adopts a control-focused view of secondary control consistent with the life-span theory of control. Specifically, secondary control strategies are conceptualized as regulatory processes that help individuals sustain motivational resources for primary-control striving when climate change hopelessness is high.

Mediating Role of Primary Control

In adapting the life-span theory of control to the context of climate action, the present study adapts the principle of primacy of primary control. The life-span theory of control (Heckhausen & Schulz, 1995; Heckhausen et al., 2010) suggests that individuals always strive to exert influence on the external world first when an incongruence between internal needs and the external world appears, and thus, primary control striving possesses primacy over secondary control. For example, a cross-cultural study involving European Canadians,

East Asian Canadians, and the Japanese found that all cultural groups preferred primary control over secondary control (Han et al., 2022). Sawaumi et al.'s (2025) recent cross-cultural survey revealed a similar behaviour pattern, that across all cultural groups, primary control was preferred more than secondary control. Striving for primary control has also been shown to be associated with better physical and mental health outcomes (Haverstock et al., 2020; Haynes et al., 2009; Thompson et al., 1994; Toyama, 2022), and adaptive thriving and goal striving (Hall et al., 2006; Hamm et al., 2013). As primary control enables individuals to actively change the environment to fit internal needs, the life-span theory of control deems it as being functionally superior to secondary control in life-course development (Heckhausen & Schulz, 1995; Heckhausen et al., 2010).

Primary control striving is relevant in the context of environmental engagement, as it has consistently demonstrated a positive relationship with PEBs. A survey conducted among American university students asked participants to report the degree to which they perceived control over climate change and their actions to combat climate change (Ulichney et al., 2021). They found that increased perceived control over climate change was associated with more PEBs. A study conducted among Chinese young adults discovered that one's perceived capacity to shape the external environment was associated with more self-reported PEBs (Li et al., 2020). Another line of research focused on problem-focused coping, referring to attempts to address the issue directly (Ojala, 2012). It has shown a positive relationship with PEBs among Swedish adolescents (Ojala, 2013; Wullenkord & Ojala, 2023; Ojala & Bengtsson, 2019). These findings suggest that people's primary control over climate change might be a crucial source of motivation for environmental engagement. Therefore, higher

primary control should be associated with higher levels of PEBs.

In addition, hope has always been an important antecedent of primary control striving in difficult situations (e.g., Hall et al., 2016; Shao et al., 2000). Makarem et al. (2014) discovered that patients with type-2 diabetes were more likely to adhere to medical advice when they showed high hopes and believed that they were capable of following the doctor's instructions. Being devoid of hope could be associated with less striving for primary control over the situation. In the context of climate change, individuals devoid of hope about climate change are likely to possess a weaker primary control striving. Consequently, this lack of primary control could lead to low engagement with PEBs. In this research, I suggest that people's loss of primary control striving is a channel between feelings of hopelessness regarding climate change and less persistent PEBs.

Hypothesis 2: Primary control striving mediates the relationship between hopelessness and pro-environmental behaviours.

Moderating Role of Secondary Control

While primary control serves as a vital motivational resource to one's active goal-directed behaviours, it is extremely vulnerable to failures and setbacks. Empirical studies have shown that overly relying on primary control striving can lead to undesirable outcomes, especially in low-control situations. For example, an eight-month field study of first-year college students discovered that among unsuccessful students with unsatisfactory performance at the start of their first year, those who relied solely on primary control showed less satisfactory academic performance, less positive affect, and a higher rate of dropping courses at the end, than their peers who adopted a mix of primary and secondary control (Hall

et al., 2006). To complement the vulnerability of primary control and restrain from overreliance on it, the life-span theory of control (Heckhausen et al., 2010; Heckhausen & Schulz, 1993) illustrates that secondary control is an important pillar. Utilizing secondary control strategies plays a salient and positive role in low-control situations. For example, older populations exhibiting low primary control experienced advantages from using downward social comparison of their activity levels, leading to a reduction in hospitalization and mortality rates over two years (Bailis et al., 2005). HIV-positive male patients with diminished beliefs in primary control also benefited from employing secondary control strategies as a supplementary coping approach, resulting in reduced depressive symptoms (Thompson et al., 1994). In a survey conducted in America (Tobin & Raymundo, 2010), participants who reported higher doubt about their ability to explain the causes of events showed more depressive symptoms, but the positive association between causal uncertainty and depressive symptoms became weaker when the use of secondary control strategies was high, suggesting that secondary control strategies buffered the negative effect of causal uncertainty on individuals' emotions. These findings are consistent with the proposed role of secondary control strategies in helping individuals adapt to difficult situations, maintain motivational resources, and regulate their efforts in ways that facilitate positive outcomes.

Within the life-span theory of control, secondary control strategies are theorized to serve both goal-engagement and goal-disengagement functions (Heckhausen et al., 2010; Heckhausen & Schulz, 1993). During goal engagement, secondary control strategies compensate for the loss of primary control and maintain motivational resources when primary control has failed. During goal disengagement, secondary control strategies help individuals

adjust to constraints by reducing commitment to costly and unattainable goals and emphasizing achievable goals, thereby preventing the depletion of psychological resources. It is worth noting that goal disengagement is not conceptualized as failure or complete withdrawal from valued domains. Rather, it is viewed as an adaptive process that enables individuals to conserve resources and redirect effort toward alternative goals. Common secondary control strategies include positive reappraisal, social comparison, and lowering aspiration (Haynes et al., 2009; Wrosch et al., 2000).

Emerging research has shown that secondary control strategies are often associated with greater levels of climate action. For example, individuals who habitually engage in cognitive reappraisal, a strategy used to regulate emotions through reinterpreting a situation, reported higher intentions to act pro-environmentally and more self-reported PEBs (Dong et al., 2023; Panno et al., 2015, 2020). Cognitive reappraisal was shown to promote PEBs by increasing the perceived usefulness of their individual behaviours, indicating that people who habitually engaged in cognitive reappraisal were more likely to believe in the worth of their own actions. Meaning-focused strategies, which refer to finding the silver lining in challenging situations and reframing them to view the circumstances more positively (Ojala, 2012), were associated with more PEBs (Ojala, 2013; Ojala & Bengtsson, 2019; Wullenkord & Ojala, 2023). According to Wullenkord and Ojala (2023), meaning-focused strategies protect people from climate pessimism and foster PEBs by complementing problem-focused coping. Drawing from theories and empirical evidence, I propose that secondary control strategies can offset the negative effects of climate change hopelessness by minimizing the loss of primary control striving in environmental engagement. Consequently, individuals who

experience high levels of climate change hopelessness but make greater use of secondary control strategies are expected to report higher levels of primary control striving than those who make less use of such strategies.

Hypothesis 3: Secondary control strategies moderate the negative association between climate change hopelessness and primary control striving.

Two studies were conducted to examine the proposed theoretical model. Study 1 is a correlational study with all variables measured in a survey. Study 2 was a laboratory experiment in which climate change hopelessness and the availability of secondary control strategies were manipulated. Environmental engagement was assessed using a different performance-based measure that captured real-time environmentally consequential decision-making and effort. Together, the two studies attempt to provide correlational and causal evidence regarding the relationships among climate change hopelessness, the two control processes, and environmental effort.

Study 1

Method

Participants

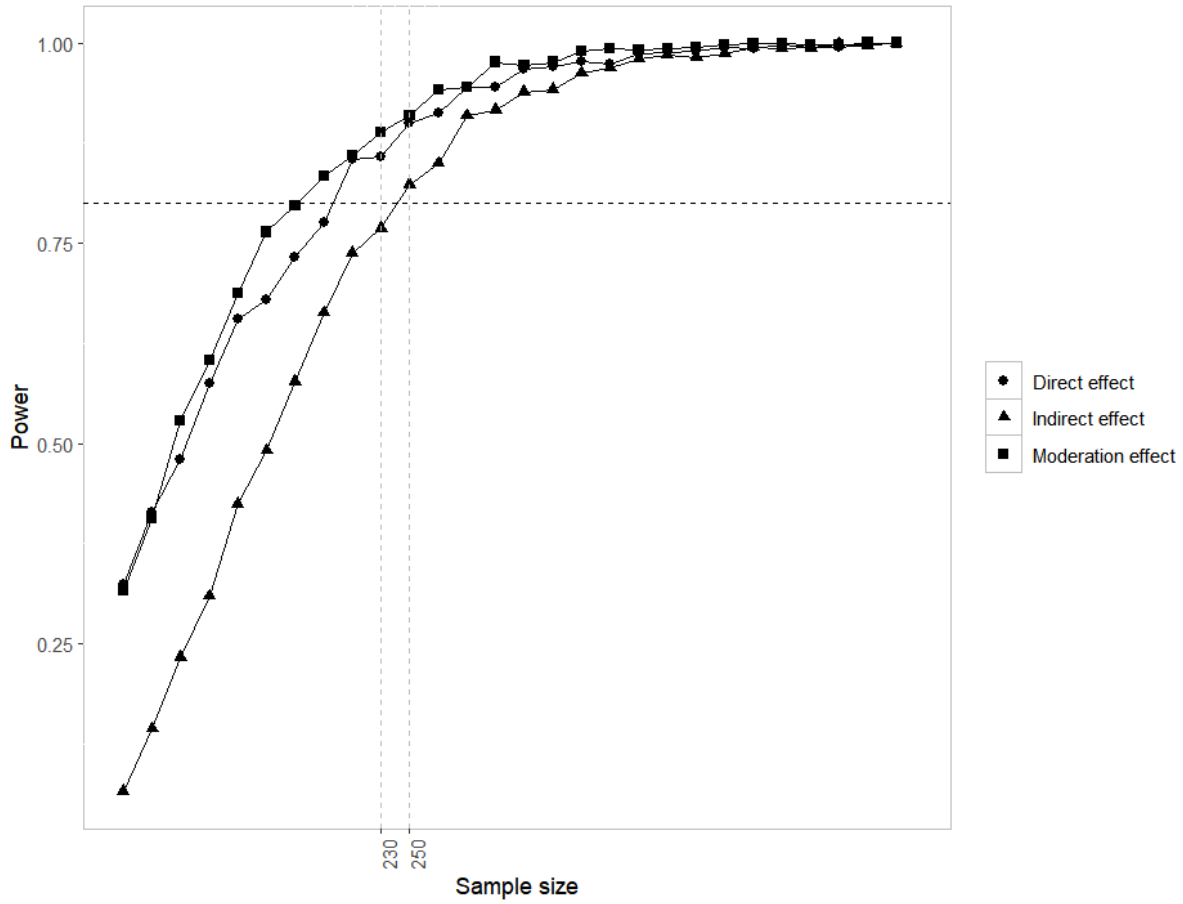
To determine the sample size, a Monte Carlo-based power analysis using simulated data was conducted. The simulation code and methodology are suggested and adapted from Xu et al. (2024). All regression coefficients were set to 0.21. Richard et al. (2003) conducted a quantitative meta-analysis of social psychological studies and found that the average effect size (r) for relationships among social psychological constructs was approximately 0.21. The covariance between the predictor and the moderator was also set at 0.21, and the Type I error

rate (α) was set at .05. The simulation code can be found in Appendix A. Based on the simulation result, a power curve (see Figure 2) is generated to visualize the relationship among sample size, power and different effects (i.e., direct, indirect, and moderation). Figure 2 shows that the smallest sample size to detect all three true effects is around 240. Larger than necessary samples ($N = 316$) were collected to allow for potential incomplete or unusable responses.

Participants across Canada were recruited through Prolific. To meet the eligibility requirements, participants need to be over 18 years old and fluent in English, and they need to reside in Canada and have a 99% or larger approval rate on Prolific. After data collection, data cleaning procedures were conducted to remove participants who (1) completed the survey in less than 4 minutes or more than 1 hour, (2) did not complete the survey, (3) submitted duplicate responses (only the second submission was removed), or (4) answered "No" to one or more attention or commitment questions. A total of 27 responses were excluded, leaving 289 responses for further analysis. Their demographic information is reported in Table 1.

Figure 2

Power Curve from the Power Analysis



Note. The x-axis represents the sample size, and the y-axis is the probability of detecting a significant effect (α = .05) when the effect truly exists. The dashed *horizontal* line represents 0.80 power, and the two dashed *vertical* lines represent sample sizes of 230 and 240.

Table 1

Demographic Characteristics of Participants in Study 1

Characteristic	*n*	%
Gender		
Female	146	50.52
Male	141	48.79
I identity as …	2	0.69
Ethnicity [a]		
African or Black	16	5.18
Indigenous or Inuit/First Nations/Métis	11	3.56
South or Latin American	5	1.62
East Asian	53	17.15
South Asian	14	4.53
Southeast Asian	13	4.21
West Asian, Middle Eastern, or Arab	10	3.24
West Indian	4	1.29
White/European	180	58.25
I identify as …	3	0.97
Highest Education		
Less than high school	0	0
High school graduate	29	10.03
Some college	51	17.65
Two-year degree	21	7.27
Four-year degree	142	49.13
Professional degree	42	14.53
Doctorate	4	1.38
Household income		
≤ 10,000	10	3.48
10,001 – 20,000	7	2.44
20,001 – 30,000	17	5.92
30,001 – 75,000	85	29.62
75,001 – 100,000	74	25.78
≥ 100,001	94	32.75

Note. Participants were on average 38.39 years old (*SD* = 12.51).

[a] Participants can choose more than one ethnicity.

Independent Variables

Climate Change Hopelessness. Two scales were combined to measure climate change hopelessness. The "lack of will and way" subscale in Li and Monroe's (2018) Climate Change Hope scale was used to assess the perceived futility of individual actions. It had three items, and one sample item is "The actions I can take are too small to help solve problems caused by climate change". Perceived collective inaction was measured with the "perceptions of commons dilemma" scale (Aitken et al., 2011). This scale was adjusted to match the format of the "lack of will and way" scale. The adjusted scale has three items, and one sample item is "Other people will not help solve problems caused by climate change even if I do". The six items showed modest internal consistency (Cronbach's $\alpha = .66$). Before answering the questions, participants were provided with a definition of climate change (Li & Monroe, 2018). Then they were asked to rate the six items based on the extent to which they agree or disagree with each statement, using a 5-point Likert scale (1 = *strongly disagree*, 3 = *neutral*, 5 = *strongly agree*). Participants' level of climate change hopelessness was computed by taking the mean of their responses. Full scale and instructions are presented in Appendix B.

Primary Control Striving. Primary control striving was measured with 5 items (Wrosch et al., 2000; Cronbach's $\alpha = .82$). An exam item is "When I encounter problems, I don't give up until I solve them". Participants were asked to identify to what extent they think the items describe them when they encounter difficult problems in life and rate each item on a 4-point scale (1 = *not at all*, 4 = *a lot*). Participants' endorsement of primary control striving was calculated by averaging the sum scores they gave to the items. See the full scale in Appendix C.

Secondary Control Strategies. Three secondary control strategies were measured in Study 1, including social comparison, positive reappraisal, and lowering aspiration. Positive reappraisal and lowering aspiration were measured using the instrument in Wrosch et al.'s (2000) study, including 4 items in positive reappraisal (Cronbach's $\alpha = .81$) and 5 items on lowering aspiration (Cronbach's $\alpha = .61$). An example item of positive reappraisal is "I find I usually learn something meaningful from a difficult situation", and that of lowering aspiration is "When my expectations are not being met, I lower my expectations". The items measuring social comparison were adapted from Haynes et al.'s (2009) research. One item specifically related to aging was removed, and the remaining three items' wordings were slightly adjusted so that each item uses "I" as the pronoun (Cronbach's $\alpha = .79$). An example item is "I tell myself that despite this problem, I am better off than many others". All items were scored on a 4-point scale (1 = *not at all*, 4 = *a lot)*, and participants were asked to indicate how well these items suit them in the face of difficult problems in life. All items measuring secondary control strategies are presented in Appendix C.

The original plan for scoring secondary control strategies was to compute the average of all items, based on the expectation that the three strategies would be moderately correlated with one another (i.e., $r \geq .4$). However, Table 2 indicated that only the correlation between positive reappraisal and social comparison met this criterion. Lowering aspiration was not significantly correlated with positive reappraisal and was only weakly correlated with social comparison. These findings suggested that lowering aspiration did not function similarly to the other two strategies. Therefore, the secondary control strategies score was computed by averaging the positive reappraisal and social comparison subscales only.

Covariates

Environmental Concern. Schultz's (2001) environmental concern scale distinguishes three categories of motivations behind people's environmental concern: egoistic concern (focused on the consequences of climate change for oneself), altruistic concern (focused on the consequences of climate change for other people), and biospheric concern (focused on the consequences of climate change for nature). Participants were presented with a list of 12 different targets, such as "plants" (biospheric concern), "me" (egoistic concern), and "people in my country" (altruistic concern). They were asked to rate each item using a 7-point scale from 1 (*not important)* to 7 (*supreme importance*), based on how concerned participants were about the consequences of climate change on each of the target items. Cronbach's α for egoistic concern was .92, for altruistic concern was .82, and for biospheric concern was .94. The full scale is presented in Appendix D.

Environmental Identity. The Revised Environmental Identity Scale (Clayton et al., 2021) quantifies the extent person identifies as a connected part of the natural environment (Clayton et al., 2021). Each of the 14 items was scored on a 7-point scale (1 = *not at all true of me*, 4 = *neither true nor untrue*, 7 = *completely true of me*). An example item is "An important part of my life would be missing if I was not able to get outside and enjoy nature from time to time". The scale showed high internal consistency (Cronbach's α = .93). The full scale is presented in Appendix E.

Dependent Variables

Pro-Environmental Behaviours. The scale developed by Schultz et al. (2005) was adapted to assess self-reported PEBs. Two items in the original scale related to recycling were

combined into a single item (“Recycled papers, cans, or bottles”). The remaining 11 items were then divided into two separate scales: one measuring routine PEBs (8 items; Cronbach’s $\alpha = .68$), which focused on behaviours that individuals can perform frequently, and another measuring citizenship behaviours (3 items) that are less commonly performed. An example item from the citizenship behaviour scale was “Voted for a candidate who supported environmental issues.” The full scale is presented in Appendix F.

For routine PEBs, participants reported how frequently they engaged in the eight behaviours being asked during the past year using a 5-point Likert scale ranging from *never* to *very often*. A routine PEBs score was calculated by averaging responses across the eight items. For citizenship PEBs, participants indicated whether they had engaged in each behaviour during the past year using “Yes” (1) or “No” (0) responses. Of the participants, 117 reported engaging in none of the behaviours, 132 reported engaging in one behaviour, 33 reported engaging in two behaviours, and 7 reported engaging in all three behaviours. Because approximately 40% of participants scored 0 on the citizenship behaviour scale, and even a single citizenship behaviour may have a substantial environmental impact, the variable was dichotomized for further analysis. A score of 0 indicated that participants had not engaged in any citizenship behaviours in the past year, whereas a score of 1 indicated engagement in one or more citizenship behaviours.

Another assessment of PEBs is a simulation-based procedure named the Work for Environmental Protection Task (WEPT; Lange & Dewitte, 2022). WEPT offers participants the opportunity to exert voluntary effort in exchange for a donation to Tree Canada, a non-profit organization dedicated to tree planting and preservation. Participants were presented

with 15 pages containing 40 two-digit numbers, and they needed to identify all numbers with an even first digit and an odd second digit. Participants were told that for each correctly completed page, the researchers would donate 0.5 CAD to Tree Canada. Thus, participants will have the opportunity to contribute up to 7.5 CAD to Tree Canada depending on their efforts. A successfully completed page is one with at least 90% of the correct numbers identified. Since it is a voluntary task, participants have the option to skip the whole or part of the WEPT task. There is no time restriction to finish the task. See Figure 3 for an example trial. In total, participants successfully completed 2,170 pages, which contributed 1,085 CAD in donations to Tree Canada. The donations have been processed.

The original plan for scoring the WEPT was to compute the number of correctly completed pages, with scores ranging from 0 to 15. However, inspection of the distribution of completed pages (see Figure 4) indicated that the distribution appeared bimodal, with one peak at 1 completed page and another between 12 and 13. Given the pronounced bimodal distribution and clustering at the lower and upper ends of the scale, treating the variable as binary was considered a more interpretable representation of task persistence. The variable was dichotomized using a median split (*Mdn* = 8). WEPT performance of fewer than eight pages was coded as 0, and that of eight or more pages was coded as 1.

In summary, Study 1 included three measures of PEB: self-reported routine PEBs, self-reported citizenship PEBs, and WEPT performance. These measures were expected to assess the same underlying construct of persistent, long-term engagement in PEBs and, therefore, were expected to be positively correlated with one another.

Figure 3

An Example Trial of WEPT

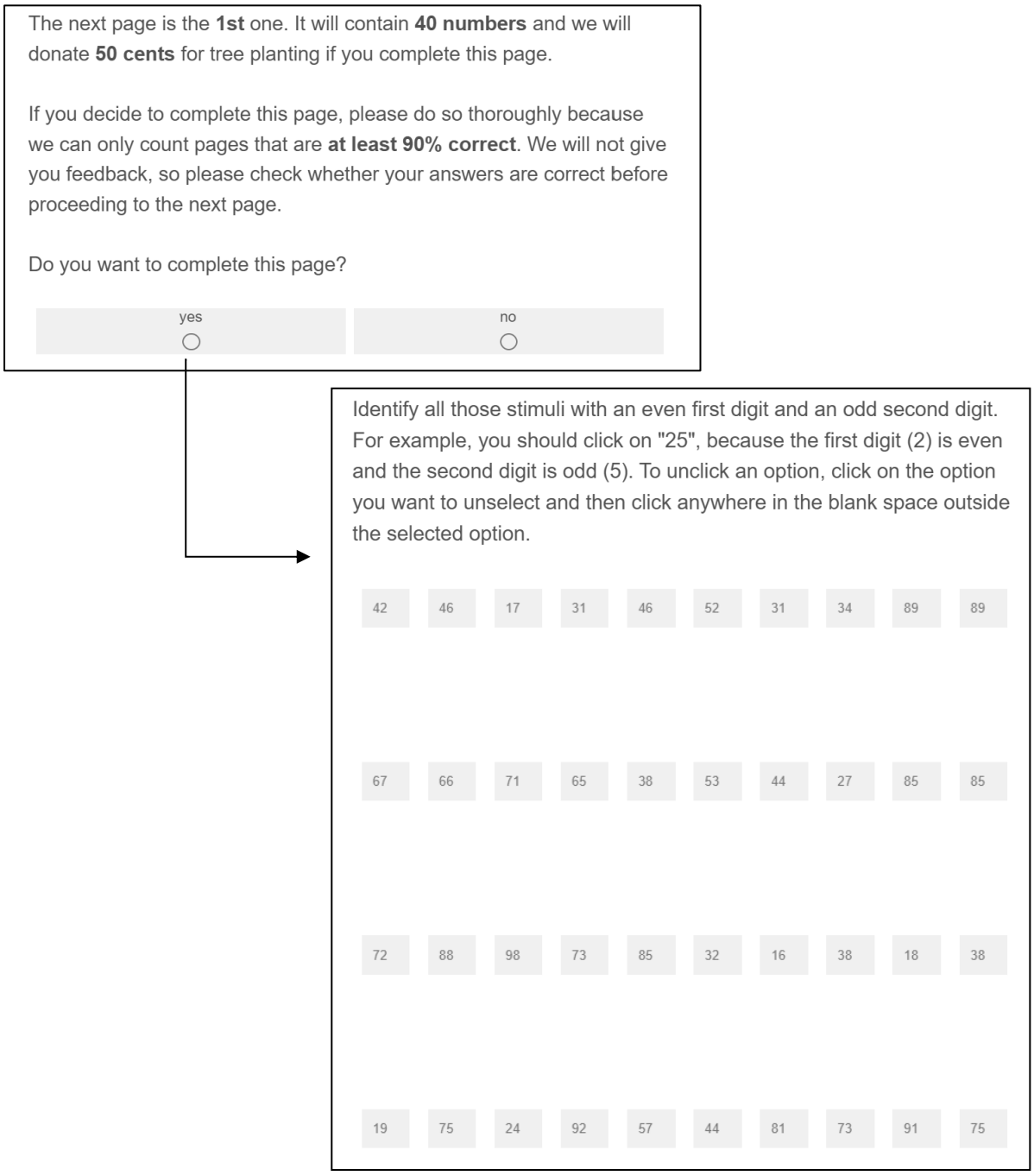


Figure 4

Distribution of Completed Pages in WEPT

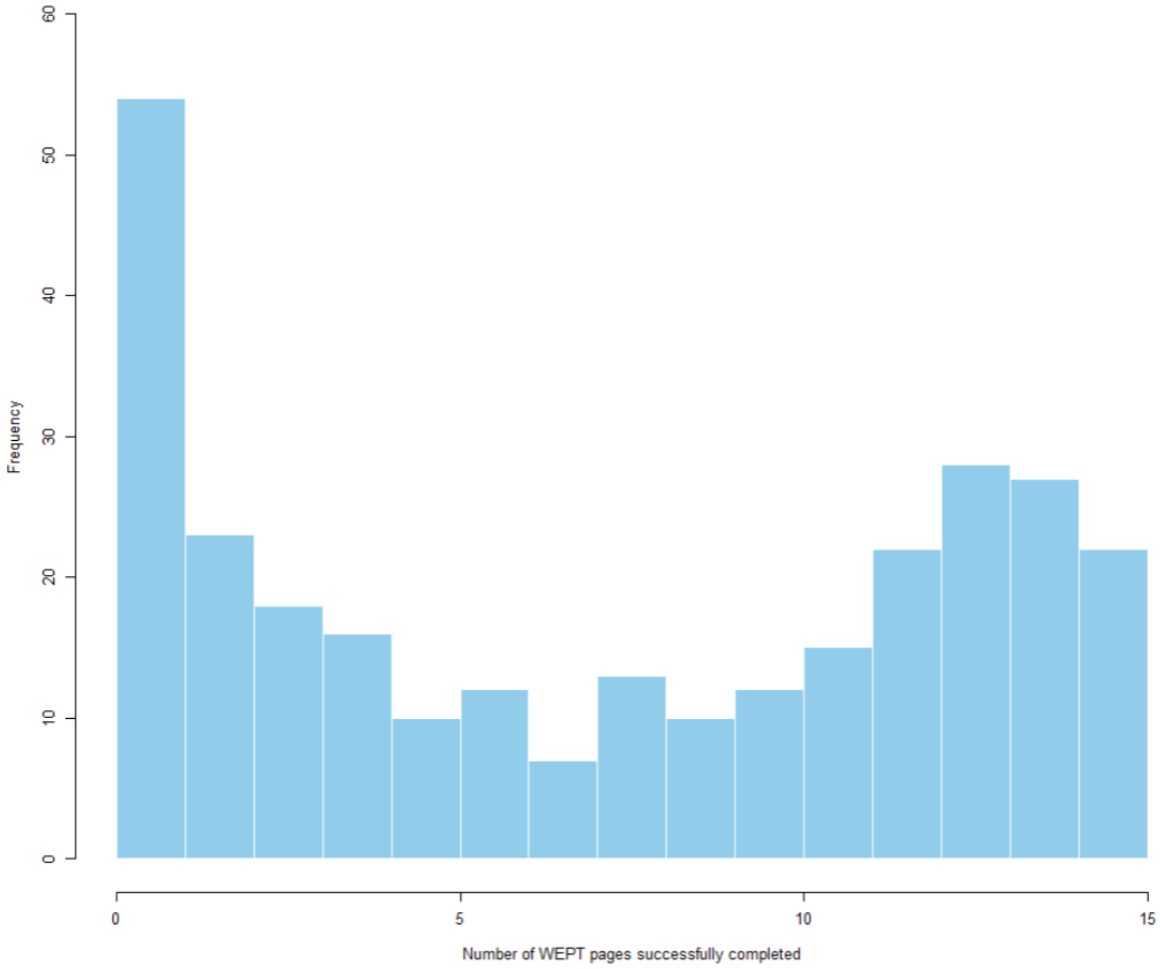


Table 2

Descriptive Statistics and Correlations for Variables in Study 1

	M (*SD*)	1	2	3	4	5	6	7	8	9	10	11	12
1. Climate hopelessness	3.06 (0.65)	—	-.15*	-.14*	-.10	.16	-.30***	-.29***	-.09	-.28***	-.31***	-.17**	-.14*
2. Primary control	2.89 (0.59)	-.16**	—	.60**	.28***	-.26***	.11	.20**	-.00	.27***	.21***	-.01	-.11
3. Positive reappraisal	2.92 (0.60)	-.15*	.62***	—	.40***	-.13*	.07	.20**	.05	.22***	.24***	.02	-.13*
4. Social comparison	2.81 (0.71)	-.08	.31***	.45***	—	.12	.11	.18**	.00	.22***	.20***	.03	-.08
5. Lowering aspiration	2.56 (0.51)	.14*	-.23***	-.09	.15*	—	.01	-.03	.09	-.01	-.06	-.05	.13*
6. Biospheric concern	5.70 (1.26)	-.31***	.12*	.10	.12*	.03	—	.48***	.24***	.59***	.35***	.17**	.14*
7. Altruistic concern	5.76 (1.11)	-.31***	.20***	.24***	.20***	-.00	.50***	—	.51***	.39***	.35***	.22***	.09
8. Egoistic concern	5.19 (1.40)	-.09	-.02	.05	-.03	.08	.24***	.50***	—	.18**	.14*	.00	.06
9. Environmental identity	5.53 (0.10)	-.30***	.28***	.24***	.19**	-.05	.54***	.41***	.18**	—	.49***	.24***	.12*
10. Routine PEBs	3.25 (0.62)	-.31***	.21***	.26***	.20***	-.02	.39***	.36***	.17**	.51***	—	.42***	.10
11. Citizenship PEBs [a]	0.76 (0.75)	-.20***	.01	.02	.01	-.05	.18**	.22***	.03	.27**	.40***	—	.14*
12. WEPT pages [a]	7.51 (5.29)	-.16**	-.12*	-.14*	-.07	.14**	.15**	.12*	.07	.11	.17*	.13*	—

Note. Values below the diagonal are Pearson's correlations, and those above the diagonal are Spearman's correlations.

[a] They are continuous variables in this table. Values for citizenship PEBs ranged from 0 to 3, and values for WEPT pages ranged from 0 to 15.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Results

First, the correlations presented in Table 2 were examined to determine whether the outcome measures were associated with one another. Because citizenship PEBs and WEPT performance were not normally distributed, Spearman's rank-order correlations were interpreted instead. The strongest association was observed between self-reported routine PEBs and citizenship PEBs. The number of pages completed in WEPT was positively associated with citizenship PEBs, but there is no correlation between routine PEBs and WEPT performance. This finding failed to replicate the positive correlation between WEPT performance and self-reported PEBs in the original WEPT study (r_s = .18, p = .004; Lange & Dewitte, 2022). Therefore, the measures were analyzed and interpreted separately in the analyses that follow. Nonetheless, each of the environmental-behaviour measures correlated in consistent ways with motivational measures, such as environmental identity and environmental concern.

As expected, climate change hopelessness was negatively associated with primary control striving. Positive reappraisal and social comparison as secondary control strategies were positively associated with primary control striving, as the life-span theory of control would suggest that secondary control could facilitate primary control striving. Among the outcome measures, however, only routine PEBs showed the expected positive zero-order association with primary control striving. In comparison to primary control, environmental identity stood out in the zero-order correlation table. It was related to climate change hopelessness, positive reappraisal, social comparison, and all three measures of PEBs. It

suggests that environmental identity might play a central role not anticipated by the theoretical model.

To test the proposed explanatory model shown in Figure 1, PROCESS Model 7 (Hayes, 2022) in R (R Core Team, 2026) was used. In separate analyses, the same model predicted routine PEBs, dichotomized citizenship PEBs, and dichotomized WEPT performance, using linear regression for routine PEBs, and logistic regression for the dichotomous measures of citizenship PEBs and WEPT performance. In all models, climate change hopelessness served as the independent variable, primary control striving served as the mediator, and secondary control striving served as a moderator of the relationship between climate change hopelessness and primary control striving. Path coefficients and corresponding inferential statistics are presented in Table 3.

In all models, climate change hopelessness had a significant negative direct effect on all three PEBs measures. Therefore, Hypothesis 1 was supported. Bootstrapped confidence intervals for the indirect effects of climate change hopelessness through primary control all included zero for routine PEBs [−0.04, 0.00], citizenship PEBs [−0.03, 0.06], and WEPT performance [-0.00, 0.12]. Therefore, the mediating effect of primary control striving was not supported, and Hypothesis 2 was rejected. In the model predicting primary control striving, endorsement of secondary control strategies was positively associated with primary control striving as expected. In contrast to the bivariate correlation results, climate change hopelessness was no longer a significant predictor of primary control striving after controlling for secondary control strategies. The interaction between climate change

hopelessness and secondary control striving did not predict primary control striving. Thus, Hypothesis 3 was not supported.

In sum, these tests indicated direct and independent effects of climate change hopelessness and primary control on PEBs, rather than the indirect and interconnected effects proposed by the original model. Climate change hopelessness consistently showed negative associations with PEBs, whereas the effects of primary control striving were mixed. Specifically, higher primary control striving was associated with more frequent routine PEBs. In contrast, primary control striving was negatively associated with WEPT performance. Although secondary control strategies did not exhibit the moderating effects predicted in the original model, the results presented in Table 2 suggested that secondary control strategies remained meaningfully associated with several other variables that the original model may have missed. Further exploratory analyses were conducted to better understand the role of secondary control strategies not captured by the original model.

Table 3

Results of Hypothesis Testing in Study 1

Predictor	M			Routine PEBs			Citizenship PEBs [a]			WEPT [a]		
	b	*SE*	95% CI	*b*	*SE*	95% CI	*b*	*SE*	95% CI	*b*	*SE*	95% CI
Intercept	0.00	0.03	[-0.05, 0.05]	0.00	0.03	[-0.07, 0.07]	0.40	0.12	[0.16, 0.65]	0.07	0.12	[0.17, 0.30]
X	-0.08	0.05	[-0.17, 0.01]	-0.26	0.05	[-0.36, -0.16]	-0.52	0.19	[-0.91, -0.14]	-0.60	0.19	[-0.98, -0.21]
W	0.57	0.05	[0.47, 0.68]	—	—	—	—	—	—	—	—	—
X × W	0.09	0.07	[-0.06, 0.22]	—	—	—	—	—	—	—	—	—
M	—	—	—	0.17	0.06	[0.06, 0.29]	-0.13	0.21	[-0.54, 0.28]	-0.49	0.21	[-0.90, -0.07]

Note. X = climate hopelessness; M = primary control striving; W = secondary control strategies; CI = confidence interval; PEBs = pro-environmental behaviours. All continuous variables were mean centered. Confidence intervals were computed from bootstrapping with 10,000 resamples.

[a] Dichotomous variable, and all estimates are on the scale of log odds.

Exploratory Analysis

In the exploratory analysis, environmental identity replaced primary control striving in the original model, and I expected that secondary control strategies would have an indirect effect on PEBs through environmental identity. The indirect effect makes sense for several reasons. First, environmental identity is a robust predictor of PEBs as shown in many studies (e.g., Schmitt et al., 2019). And according to the correlation observed in Table 2, environmental identity was positively related to all PEB measures and secondary control strategies and negatively correlated with climate change hopelessness. Because this pattern closely mirrored the relationships originally expected for primary control striving, environmental identity emerged as a plausible alternative mechanism through which climate change hopelessness and secondary control strategies may influence environmental engagement. Second, positive reappraisals and social comparison have long been theorized to serve identity maintenance functions. For example, Hui et al. (2025) found that among Chinese pre-service teachers, greater use of cognitive reappraisal was associated with stronger professional identity. Similarly, greater use of cognitive reappraisal predicted more self-perceived positive identity among medical students, and through boosting positive self-perception, cognitive reappraisal was indirectly associated with less psychological pain (Qiang et al., 2025). In terms of downward social comparison, a qualitative study has shown that it helped disabled workers to deal with stigma regarding their disability and strengthen their positive identity as professional workers (Richard & Hennekam, 2021). Not only for self-identity, Turner (1975) also pointed out that people could develop social identity through comparisons between social groups. By evaluating their own group relative to others,

individuals can strengthen their identification with that group and derive a more positive sense of self. Overall, the possibility of the indirect effects of secondary control on environmental behaviours through environmental identity is supported both theoretically and empirically.

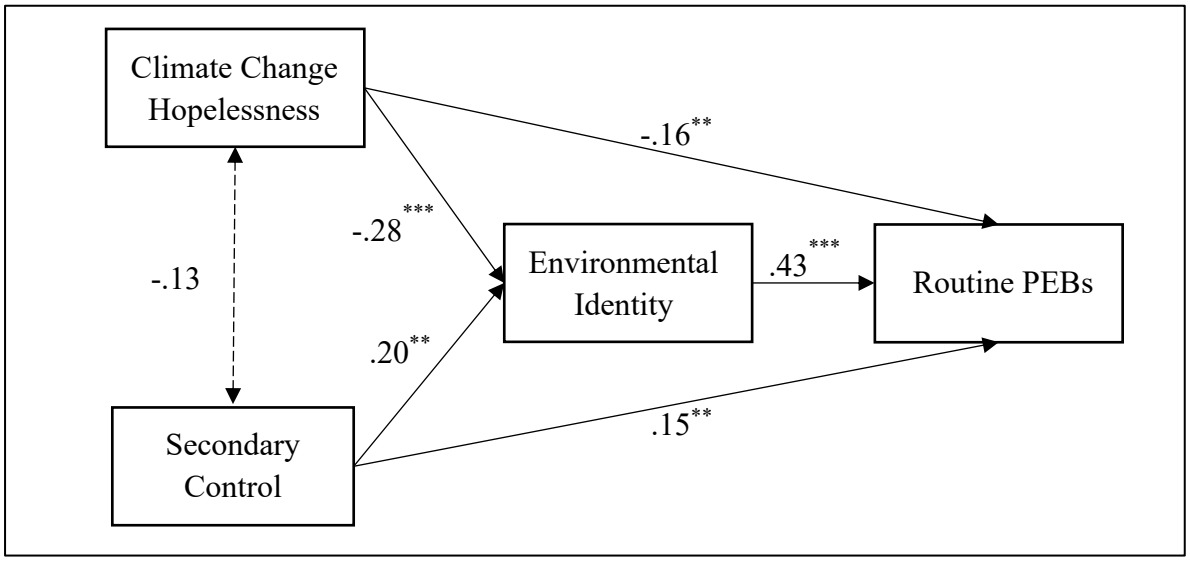
Three path analysis models were tested using the *lavaan* package (Rosseel, 2012) in R (R Core Team, 2026), with each model using one of the three outcome measures as the dependent variable. In each model, environmental identity was a predictor of the outcome measures, whereas climate change hopelessness and secondary control strategies predicted environmental identity. Climate change hopelessness and secondary control strategies were allowed to covary and directly predict the outcome measure. Thus, all models were just-identified, meaning that the number of free parameters is equal to the number of unique data points. Consequently, model fit indices are not reported, and only model parameter estimates are interpreted.

For routine PEBs, a path analysis model was estimated using maximum likelihood estimation with bootstrap confidence intervals based on 5,000 resamples. Standardized path coefficients are presented in Figure 5, and unstandardized path coefficients and confidence intervals are presented in the text. The covariance between climate change hopelessness and secondary control strategies was marginally significant (p = .053). Higher climate change hopelessness was associated with lower environmental identity (b = -.43, 95% bootstrap CI [-.59, -.25]), whereas greater endorsement of secondary control strategies was associated with stronger environmental identity (b = .36, 95% bootstrap CI [.14, .58]). In turn, stronger environmental identity was associated with more frequent routine PEBs (b = .26, 95%

bootstrap CI [.20, .33]). Climate change hopelessness also demonstrated a significant direct effect on routine PEBs (b = -.15, 95% bootstrap CI [-.24, -.05]), and secondary control strategies demonstrated a significant positive direct effect on routine PEBs (b = .17, 95% bootstrap CI [.05, .27]). Bootstrap confidence intervals indicated significant indirect effects through environmental identity for both secondary control strategies and climate change hopelessness. These indirect effects were opposite in direction but similar in magnitude, with secondary control strategies showing a positive indirect effect (b = .10, β = .08, 95% bootstrap CI [.04, .17]) and climate change hopelessness showing a negative indirect effect (b = -.11, β = -.12, 95% bootstrap CI [-.17, -.06]). A similar pattern emerged for the total effects on routine PEBs. Secondary control strategies had a positive total effect (b = .26, β = .23, 95% bootstrap CI [.14, .38]), whereas climate change hopelessness had a negative total effect (b = -.26, β = -.28, 95% bootstrap CI [-.35, -.17]). Their effects were also very comparable in magnitude.

Figure 5

Path Analysis Model Predicting Routine PEBs



Note. All path coefficients are standardized. Concrete lines represent significant paths, while dashed lines represent nonsignificant paths.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

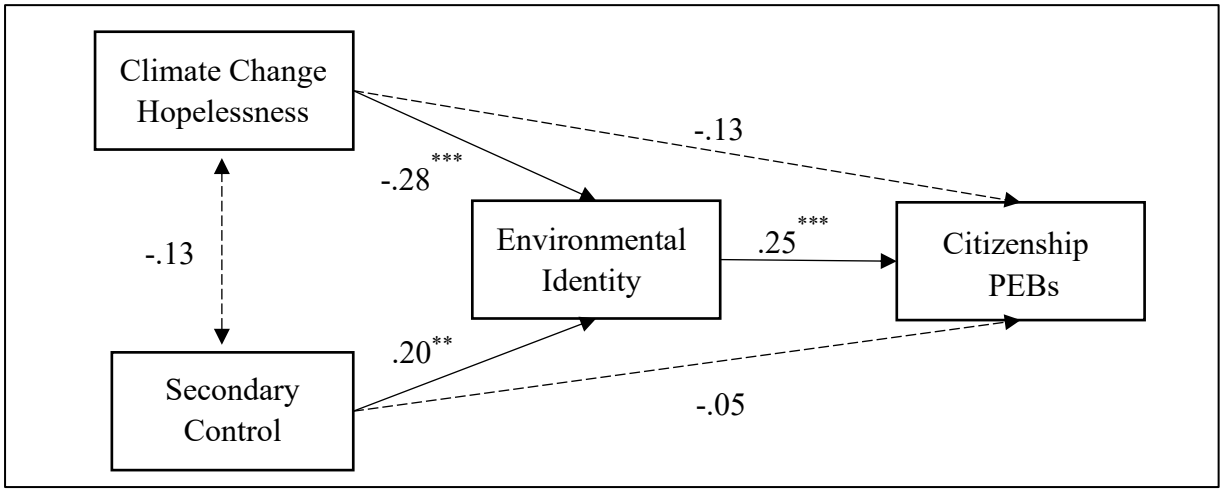
The path analysis models with citizenship PEBs (0 = did zero citizenship PEB, 1 = did one or more citizenship PEBs) and WEPT performance (0 = completed less than 8 pages, 1 = completed 8 or more pages) as dependent measures were estimated with the robust weighted least squares estimator (WLSMV). WLSMV uses a probit link by default when estimating categorical variables, which models the probability of observing a specific categorical response. Inference was based on robust standard errors. The standardized path coefficients of the models predicting citizenship PEBs and WEPT performance are reported in Figures 6 and 7, respectively. The unstandardized path coefficients and standard errors are reported in the text below.

Higher environmental identity was associated with a higher probability of doing one or more citizenship behaviours (b = .25, SE = .07). Neither hopelessness (b = -.20, SE = .12) nor secondary control strategies (b = -.08, SE = .13) had direct effects on citizenship PEBs. The indirect effects through environmental identity were significant for both secondary control (b = .09, β = .05, SE = .03, p < .01) and hopelessness (b = -.11, β = -.07, SE = .04, p < .01). The two indirect effects were opposite in direction but very similar in the magnitude of effects. The total effect of hopelessness on the possibility of doing citizenship PEBs was significant (b = -.31, β = -.20, SE = .11, p < .01), but not for secondary control (b = .01, β = .01, SE = .13, p = .94).

In the WEPT performance model, higher environmental identity was associated with a higher probability of completing 8 or more pages (b = .15, SE = .07. Both secondary control (b = -.37, SE = .13) and climate change hopelessness (b = -.29, SE = .12) had significant and negative direct effects on WEPT performance. Although a similar pattern of indirect effects appeared to hold for WEPT performance as for the other behavioural measures (see Figure 7), these indirect effects through environmental identity were marginally significant for both secondary control strategies (b = .05, β = .03, SE = .03, p = .06) and climate change hopelessness (b = -.06, β = -.04, SE = .03, p = .06). The total effects of secondary control (b = -.32, β = -.18, SE = .13, p < .05) and hopelessness (b = -.35, β = -.23, SE = .11, p < .01) were negative and significant.

Figure 6

Path Analysis Model Predicting Citizenship PEBs

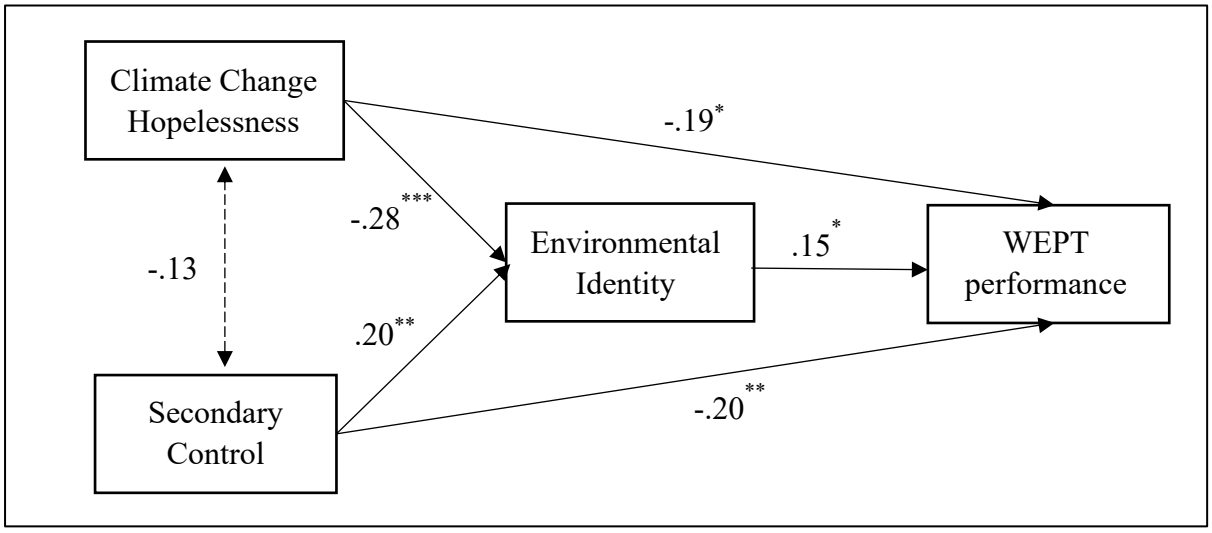


Note. All path coefficients are standardized. Concrete lines represent significant paths, while dashed lines represent nonsignificant paths.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Figure 7

Path Analysis Model Predicting WEPT Performance



Note. All path coefficients are standardized. Concrete lines represent significant paths, while dashed lines represent nonsignificant paths.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Discussion

By means of a cross-sectional survey, Study 1 was designed to examine the psychological mechanisms in climate actions through the lens of the life-span theory of control (Heckhausen & Schulz, 1995). Of the main hypotheses, only the negative association between climate change hopelessness and environmental engagement received support. Primary control striving was positively associated with secondary control strategies, which supports the general function of secondary control strategies in maintaining primary control striving. The negative association between climate change hopelessness and primary control striving in Table 2 was weak but became nonsignificant after accounting for secondary control strategies. Nonetheless, the results showed both primary and secondary control to have meaningful associations with PEBs.

The findings for routine PEBs and citizenship PEBs suggested that primary and secondary control processes may contribute to sustained environmental engagement, albeit through different pathways. Consistent with the proposed model, primary control striving was positively associated with routine PEBs, suggesting that individuals who perceive themselves as capable of influencing outcomes are more likely to engage in everyday environmental behaviours. But primary control striving showed little evidence of promoting citizenship PEBs. Secondary control strategies also showed positive associations with routine PEBs, both directly and indirectly through environmental identity in exploratory analyses. Secondary control strategies also predicted more citizenship PEBs through environmental identity. In contrast, climate change hopelessness was negatively associated with routine PEBs, citizenship PEBs, and environmental identity. Notably, the total effects of climate change

hopelessness and secondary control strategies on routine PEBs were comparable in magnitude but opposite in direction. In addition, the indirect effects of hopelessness and secondary control strategies on citizenship PEBs through environmental identity were also comparable in magnitude. These findings support the goal-engagement function of secondary control strategies, which help individuals minimize the harm to motivational resources caused by setbacks and failures (Heckhausen & Schulz, 1995; Heckhausen et al., 2010). In the context of climate change, environmental identity may represent one pathway through which this motivational function is expressed. Specifically, these findings suggest that secondary control strategies help individuals sustain a sense of connection with nature despite feelings of climate-related hopelessness, which in turn supports continued engagement in routine and citizenship PEBs. This interpretation is inconsistent with previous research linking cognitive reappraisal and downward social comparison to stronger identity-related outcomes (e.g., Hui et al., 2025; Richard & Hennekam, 2021). Overall, the present findings regarding routine and citizenship PEBs suggest that secondary control strategies may partially offset the negative effects of climate change hopelessness through maintaining environmental identity and supporting continued environmental engagement.

A different pattern emerged for WEPT performance. Primary control striving was negatively associated with WEPT performance. Similarly, secondary control strategies showed a significant negative direct association with WEPT performance. This different pattern could be due to the lack of association between WEPT and self-reported PEBs, suggesting that they captured different aspects of PEBs. Self-reported PEBs may capture individuals' actual long-term environmental behaviours, while WEPT captures participants'

momentary persistence when they are asked to complete an environmental task that requires a significant amount of effort. These findings suggest that the psychological processes supporting routine and citizenship PEBs may differ from those underlying more effortful or costly forms of environmental engagement.

With this distinction in mind, these findings regarding WEPT are consistent with the goal-disengagement function of secondary control strategies, where they support adaptive adjustment by reducing investment in goals that are perceived as difficult to attain and excessively costly (Heckhausen & Schulz, 1995; Heckhausen et al., 2010). Participants might perceive that the WEPT requires substantial cognitive effort while providing relatively indirect environmental benefits, although participants' perceptions of the task's effectiveness or impact were not assessed. Under such circumstances, individuals who make greater use of secondary control strategies may be less willing to persist on the task. Importantly, reduced engagement in the WEPT should not be interpreted as complete disengagement from environmental goals. Rather, it may reflect the adaptive regulation of effort emphasized by the life-span theory of control, whereby individuals strategically allocate limited resources across different opportunities for environmental engagement (Heckhausen & Wrosch, 2022; Heckhausen et al., 2010). This interpretation is consistent with the broader pattern of findings, as secondary control strategies were positively associated with routine and citizenship PEBs while being negatively associated with WEPT performance. Together, these results suggest that secondary control strategies can promote sustained involvement in some forms of pro-environmental behaviour while reducing persistence in less attainable goals.

It is important to note several limitations of Study 1. First, lowering aspiration did not

function similarly to the other two assessed secondary control strategies, nor did it have strong relationships to the other variables of interest in this research. Therefore, this study's findings may not be directly comparable with other studies that have included lowering aspirations in the definition and measurement of secondary control. Second, self-reported PEB measures and WEPT performance were not closely related, although both were associated with environmental concern and environmental identity. As discussed above, one possible interpretation of this dissociation is that self-reported PEBs may capture individuals' long-term environmental behaviours, which accumulate despite ups and downs of motivation and persistence. And WEPT may capture participants' momentary persistence when they are asked to complete an environmental task that requires a significant amount of effort. Third, both primary control string and secondary control strategies measures assessed generalized rather than domain-specific beliefs. It is possible that stronger relationships would be observed between control strategies and behaviours if they were measured in the domain of climate change. Fourth, and most importantly, Study 1 relied on a cross-sectional study design to examine a causal theoretical model. Although they did negate premises of some causal relationships in this model, the cross-sectional findings cannot establish whether hypothesized causal relationships exist. Therefore, Study 2 aimed to clarify the effect of secondary control strategies, especially on performance-based measures, using an experimental design in which both climate change hopelessness and availability of secondary control strategies were manipulated independent variables.

Study 2

Study 2 employed a 2 × 2 factorial experimental design manipulating climate change

hopelessness (high vs. low) and endorsement of secondary control strategies (high vs. low). The first manipulation was designed to induce climate-related hopelessness using a Prisoner's Dilemma paradigm involving a fictitious teammate (Miller et al., 1998). Participants completed a cooperative decision-making task in which the outcomes of the task, in the form of donations, depended jointly on their decisions and those of their partner. In this structure, cooperation produces more donations to an environmental organization, whereas non-cooperation reduces them. To manipulate perceived climate change hopelessness, the level of cooperation attributed to the fictitious teammate was systematically varied. Participants in the hopeless condition received feedback indicating lower levels of cooperation from their partner, whereas those in the hopeful condition were informed that their partner cooperated to a similar extent. This manipulation was intended to alter the perceived effectiveness of collective action and participants' own action.

The endorsement of secondary control strategies was manipulated using a recall-based writing task (Petsnik, 2023). Participants were randomly assigned to either a secondary control writing condition or a neutral control writing condition. In the secondary control writing condition, participants were instructed to recall and describe a past difficult situation in which they successfully used strategies including positive reappraisal, social comparison, and lowering aspirations to cope with adversity. In the neutral writing condition, participants instead described a previously challenging situation without guidance on using specific coping strategies. This manipulation was designed to temporarily activate the availability of secondary control strategies, thereby increasing their accessibility during subsequent decision-making.

PEBs in Study 2 were assessed using an adapted version of the Pro-Environmental Behaviour Task (PEBT; Lange et al., 2018). Unlike WEPT, PEBT can only be implemented in laboratory settings. It captures repeated real-time trade-offs between personal cost (time) and environmental benefit (reduced emissions) across multiple decision trials. This design allows for the assessment of environmentally relevant choices under varying levels of effort and cost, while also introducing a more dynamic decision-making structure that may be more sensitive to experimental manipulations of hopelessness and secondary control strategies.

Method

Participants

An a priori power analysis conducted using G*Power (Faul et al., 2007) indicated that a sample size of $N = 158$ would be required to detect a medium effect size in a 2 × 2 factorial design with 80% power at $\alpha = .05$. The original recruitment plan targeted 200 undergraduate students enrolled in Introduction to Psychology at the University of Manitoba during the Winter 2026 term. However, participant enrollment in the experiment was lower than anticipated during the term. To facilitate recruitment, eligibility was expanded to include undergraduate students across the university, and these additional participants, who were not enrolled in Introduction to Psychology, received 20 CAD compensation for participation instead of course credits. Recruitment concluded at the end of March 2026, resulting in 147 recorded observations. After data cleaning, 24 participants were excluded, and 123 observations remained for analysis. Although below the original target, a sensitivity analysis with the same α and β parameters indicated that the obtained sample provided adequate power to detect an effect size of $r = .25$ (or above). Details of the data cleaning procedures

are reported in the following section. A summary of participants' demographic characteristics is presented in Table 4.

Table 4

Demographic Characteristics of Participants in Study 2

Characteristic	*n*	%
Gender		
Female	83	67.48
Male	37	30.08
I identity as …	3	2.44
Ethnicity [a]		
African or Black	20	14.08
Indigenous or Inuit/First Nations/Métis	9	6.34
South or Latin American	2	1.41
East Asian	19	13.38
South Asian	18	12.68
Southeast Asian	11	7.75
West Asian, Middle Eastern, or Arab	7	4.93
West Indian	3	2.11
White/European	49	3.45
I identify as …	4	2.82
Household income		
≤ 10,000	36	29.75
10,001 – 20,000	11	9.09
20,001 – 30,000	5	4.13
30,001 – 75,000	24	19.83
75,001 – 100,000	21	17.36
≥ 100,001	24	19.83

Note. Participants were on average 19.25 years old (*SD* = 2.98).

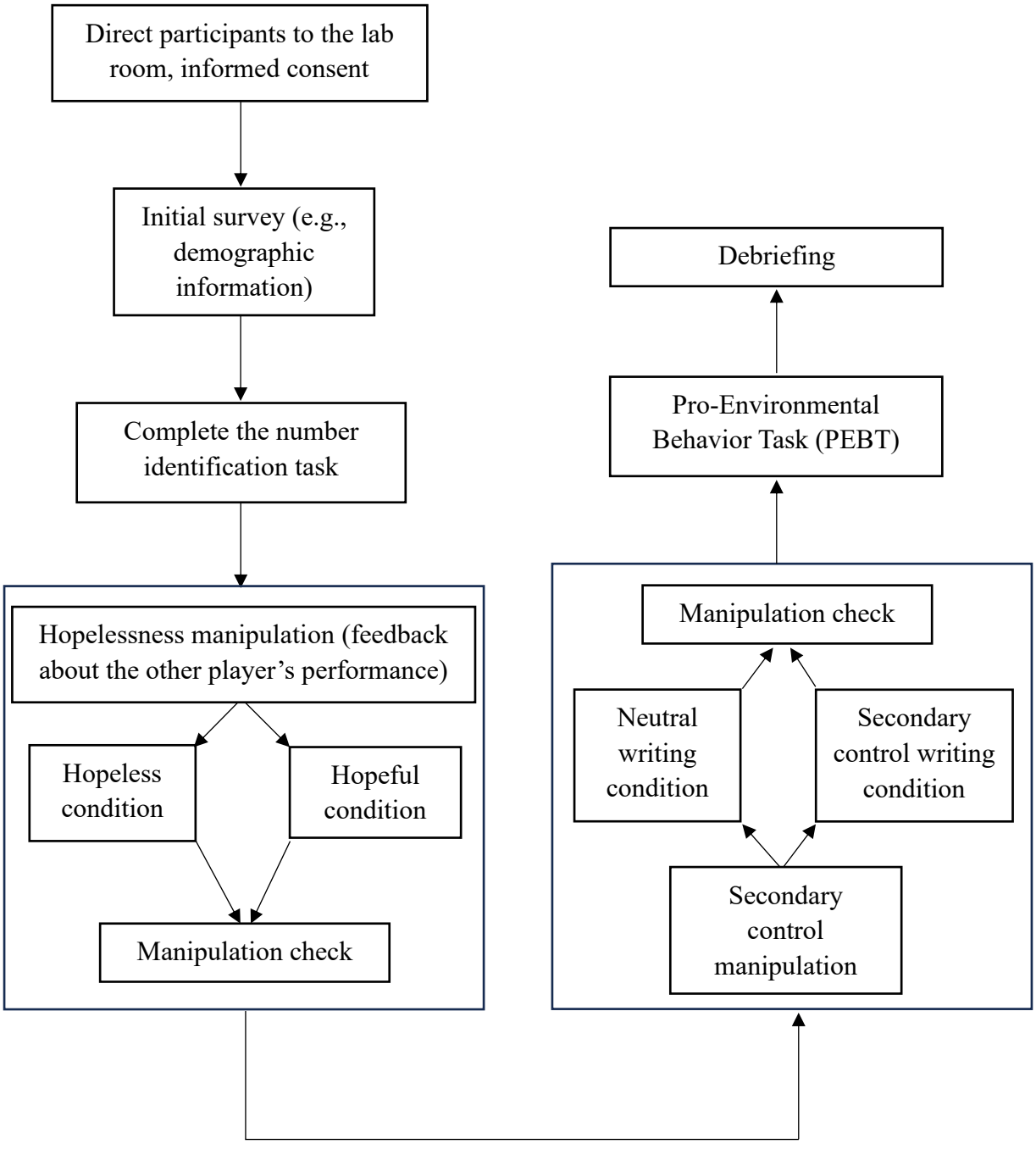
[a] Participants can choose more than one ethnicity.

Procedure and Design

See Figure 8 for the experimental procedure of Study 2. In the recruitment script, participants were informed that the study examined relationships among different working styles, psychological responses, and performance, and that they might be paired with another participant for certain tasks. Upon arrival at the laboratory, participants were led to a lab room with a computer by the experimenter and informed that they had been paired with another participant who had already arrived and was located in a separate laboratory room. Participants were told that the study focused on remote work collaboration, which explained why they would not meet the other participant in person. After providing informed consent, participants completed an initial survey assessing demographic information, environmental identity (Cronbach's $\alpha = .89$), and environmental concern, including biospheric concern (Cronbach's $\alpha = .91$), egoistic concern (Cronbach's $\alpha = .92$), and altruistic concern (Cronbach's $\alpha = .79$). The survey also included two practice trials of the number identification task, which was later used as part of the climate hopelessness manipulation.

Figure 8

Experimental Procedure of Study 2

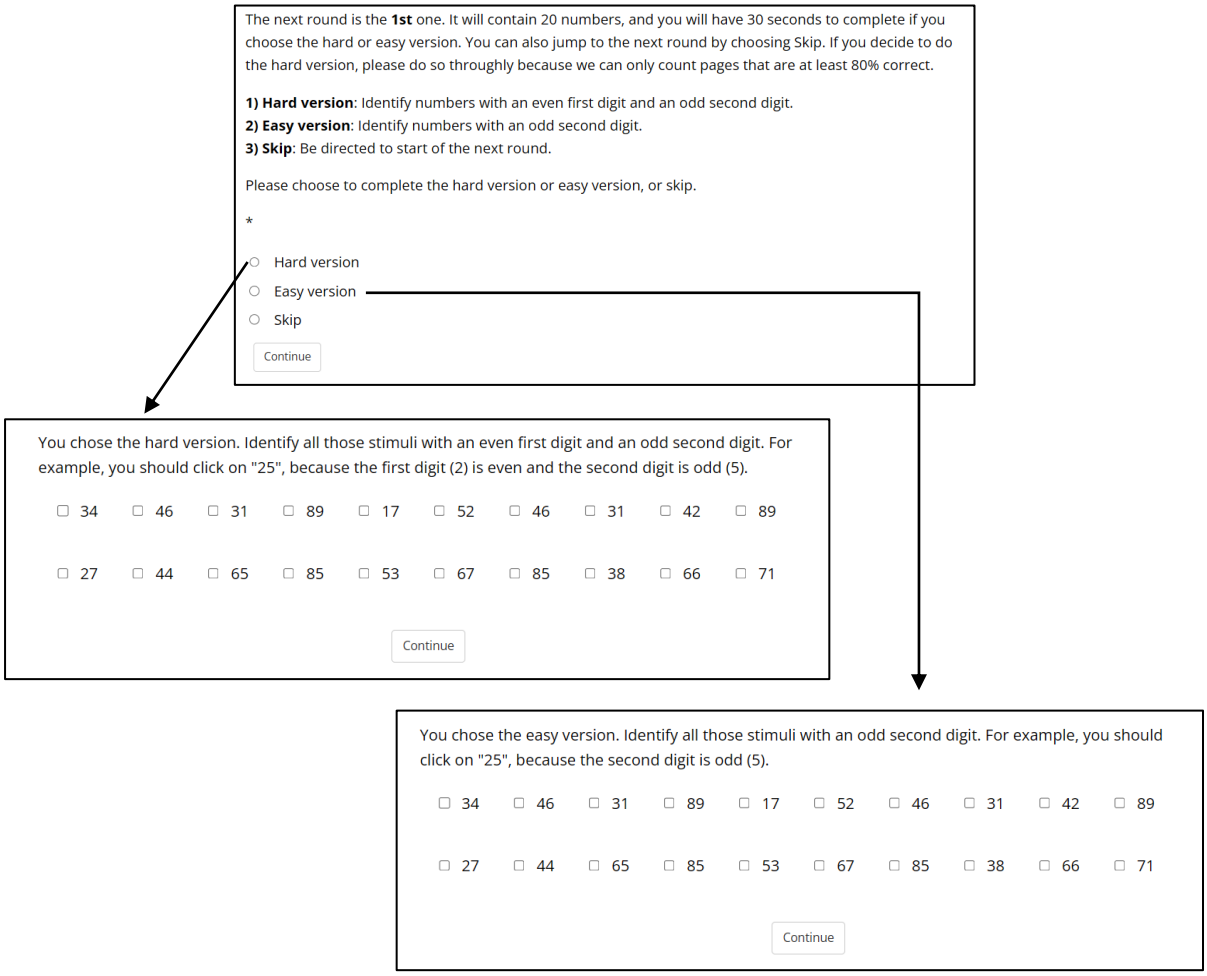


Hopelessness Manipulation. An adapted version of WEPT (Lange & Dewitte, 2022) was used to manipulate climate change hopelessness. Participants were told that they would complete a number-identification task simultaneously with their teammate remotely, and their combined performance would determine the amount of donation to Tree Canada. The task consisted of 10 trials. In each trial, participants were presented with a page containing 20 two-digit numbers. Before beginning each trial, participants chose whether to complete a difficult version, an easy version, or skip the trial entirely. In the difficult version, participants were required to identify numbers with an even first digit and an odd second digit. In the easy version, participants were instructed to identify all odd numbers (i.e., numbers with an odd second digit). Participants were reminded that they had 30 seconds to complete each page. See Figure 9 for an example trial.

Before participants started the task, the experimenter informed them about how the amount of donation would be determined. Similar to a Prisoner's Dilemma structure, maximum environmental benefit could only be achieved through cooperation. If both participants successfully completed the difficult version in one trial, 0.50 CAD would be donated. If in one trial only one participant completed the difficult version while the other selected the easy version or skipped the page, a minimal donation of 0.10 CAD would be made from this trial. No donation would be made when both participants selected the easy version or skipped the page in one trial. Therefore, they can contribute up to 5 CAD through this task, which is equal to the cost of planting one tree through Tree Canada.

Figure 9

An Example Trial of the Number-Identification Task



After participants completed the task, the experimenter assessed how many hard versions the participant successfully completed and provided fabricated feedback regarding the teammate's performance and the resulting donation outcomes. This feedback varied by the experimental condition that was randomly assigned. Participants in the hopelessness condition were told that their teammate completed five fewer difficult trials than they had completed, whereas participants in the hopeful condition were told that their teammate completed the same number of difficult trials as they had completed. This payoff structure required participants to exert effort that would maximize environmental benefit only if their partner also contributed comparable effort, thereby mirroring the collective-action dynamics of climate change mitigation, in which individual efforts alone often produce limited outcomes but coordinated collective action can generate substantial environmental benefits. The total amount of donations generated from this task was 453.1 CAD.

To assess the effectiveness of the hopelessness manipulation, participants completed the same climate change hopelessness measure used in Study 1 (Cronbach's $\alpha = .57$), in which they rated their agreement with each item on a 5-point scale. To capture immediate emotional responses related to hopelessness, participants also rated their agreement with the statement, "I am hopeful about the future of climate change." Results of the manipulation checks are presented in Table 5. Although the two conditions did not differ significantly on the climate change hopelessness measure, participants in the hopelessness condition reported significantly lower levels of emotional hope about the future of climate change than participants in the hopeful condition. Therefore, the manipulation influenced participants' immediate emotional state of hope about the future of climate change, irrespective of their

generalized beliefs about climate change.

A few participants were excluded due to their performance at this stage. One participant was excluded because technical issues prevented the experimenter from assessing task performance. Seventeen participants were excluded because they completed fewer than five difficult trials, making the hopelessness manipulation infeasible. Three participants were excluded because they explicitly reported during debriefing that they did not believe another participant existed.

Table 5

Results of Hopelessness Manipulation Checks

Parameter	Hopeful condition		Hopeless condition		*df*	*t*	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*				
Climate hopelessness	2.71	0.57	2.74	0.57	118.56	0.27	.79	.05
Hopeful emotion	3.41	1.02	3.02	1.09	115.67	2.04	.04	.37

Note. There were 66 participants in the hopeful condition and 57 participants in the hopeless condition.

Secondary Control Manipulation. A recall-based writing task (Petsnik, 2023) was used to induce secondary control. Participants were randomly assigned to either the secondary control writing condition or the neutral writing condition. Participants in the secondary control condition were instructed to recall and describe a difficult situation in which they were able to cope with the adversity by using positive reappraisal, social comparison, or lowering aspiration. In contrast, participants in the neutral writing condition were asked only to recall and describe a previously challenging situation. The full instruction

is presented in Appendix G.

To assess the success of the manipulation, participants completed four manipulation-check items. Participants rated each item based on how they believed they would respond if they encountered a difficult situation at the present moment, using a 4-point scale ranging from 1 (*not at all*) to 4 (*very*). One item assessed primary control ("I would do what I can to change the situation for the better"), one assessed positive reappraisal ("I would find a bright side to the situation"), one assessed social comparison ("I would tell myself that despite this problem, I am better off than many others"), and one assessed lowering aspiration ("I would lower my expectations"). Based on the findings of Study 1, secondary control strategies were scored as the average of positive reappraisal and social comparison only. Three additional items measuring self-affirmation (Cronbach's $\alpha = .65$) were included to examine whether the secondary control manipulation also influenced self-affirmation processes. They were adapted from the Spontaneous Self-Affirmation Measure (Harris et al., 2019) and assessed personal strengths ("I would think about my strengths"), values ("I would think about my values"), and important relationships ("I would think about the people who are important to me").

One participant was excluded due to not providing a response to the secondary control writing task. Results of the manipulation checks are presented in Table 6. Participants in two conditions did not differ significantly on reported primary control striving, lowering aspiration, or self-affirmation. Participants in the secondary control condition reported significantly greater endorsement of secondary control strategies than participants in the neutral condition, with a medium effect size. These findings suggest that the manipulation

had the intended effect of increasing the availability of secondary control strategies.

Table 6

Results of Secondary Control Manipulation Checks

Parameter	Neutral writing		Secondary control writing		*df*	*t*	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*				
Primary control striving	3.43	0.69	3.60	0.53	115.71	1.55	.12	.28
Secondary control strategies	2.67	0.75	3.06	0.65	120.12	3.11	<.01	.56
Lowering aspiration	2.18	0.80	2.29	0.83	118.08	0.75	.46	.14
Self-affirmation	2.88	0.78	2.91	0.68	120.16	0.21	.84	.04

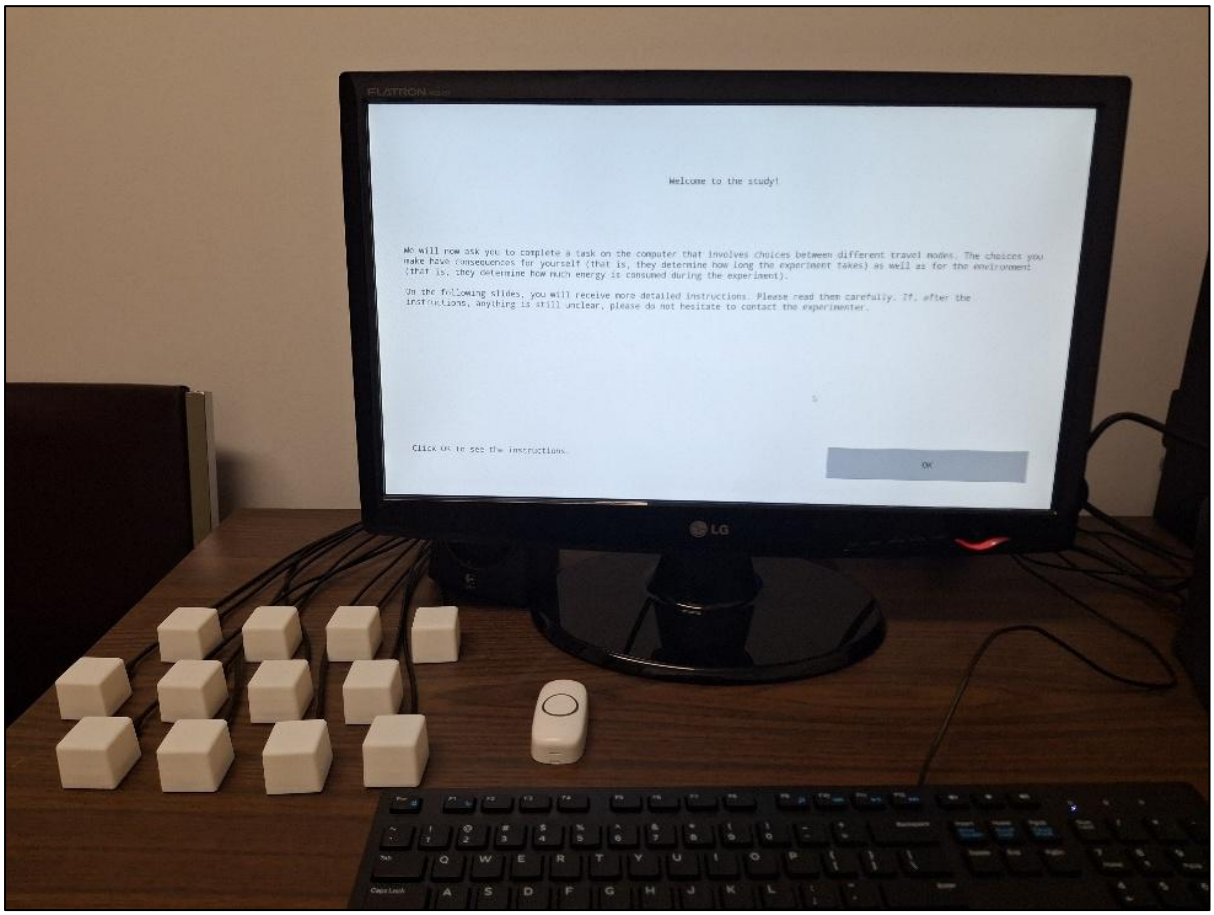
Note. There were 63 participants in the neutral writing condition and 60 participants in the secondary control writing condition.

Pro-Environmental Behavior Task. An adapted version of the Pro-Environmental Behavior Task (PEBT; Lange et al., 2018) was used to measure pro-environmental persistence effort. Originally, the PEBT was incorporated based on the assumption that it would capture the same underlying construct as self-reported long-term PEBs, so a self-reported measure of PEBs was not included as a measure. Whether PEBT and self-reported PEBs are truly related or not can not be tested in Study 2. However, findings from Study 1 indicated that the performance-based measure (WEPT) was not significantly correlated with self-reported PEB measures. Therefore, the construct assessed by the PEBT was interpreted with caution. Specifically, the task may capture momentary persistence in environmentally consequential decision-making rather than stable, long-term PEB tendencies.

The task consisted of 3 blocks of 12 choice trials, resulting in a total of 36 trials. In each trial, participants would choose between two transportation options for an upcoming trip: travelling by car or by bicycle. Information regarding the travel time associated with each transportation mode and the additional travel time associated with choosing the bicycle over the car was presented at every trial. Choosing the bicycle often resulted in a longer travel time than choosing the car, and the travel time corresponded to the amount of time participants were required to wait after making their choice. In addition, 12 USB-powered lightbulbs were connected to the laboratory computer (see Figure 10 for the setup). Participants were informed of the number of lightbulbs that would be illuminated if they chose to travel by car, as well as the corresponding CO_2 emissions generated by the lights. Choosing the car option resulted in illuminated lightbulbs and associated CO_2 emissions, whereas choosing the bicycle resulted in no illuminated lightbulbs and zero CO_2 emissions. Thus, the PEBT simulated the trade-off between personal convenience and environmental benefit that characterizes many everyday decisions. Choosing the bicycle represented a more environmentally friendly but more time-consuming option, whereas choosing the car reduced waiting time at the expense of greater CO_2 emissions.

Figure 10

Setup of PEBT in the Lab Room



The travel time associated with the car option varied across four levels (5 s, 10 s, 15 s, and 20 s), and the additional bicycle travel time varied across three levels (0 s, 10 s, and 20 s), resulting in 12 unique trial combinations. Each combination appeared once within each of the three blocks. The environmental consequences associated with choosing the car also varied across blocks. In each block, choosing the car resulted in either low (4 lights; 3,000 mg/h CO_2), medium (8 lights; 6,000 mg/h CO_2), or high (12 lights; 9,000 mg/h CO_2) emissions. The order of travel-time combinations and emission conditions was counterbalanced across participants.

Two participants were excluded because they did not complete the PEBT. In addition, two participants exhibited extremely low performance on PEBT and their PEBT performance was coded as missing, while their responses on other study variables were retained. The original scoring plan was to compute the proportion of bicycle choices across the 36 trials. However, inspection of the distribution (see Figure 11) revealed a ceiling effect, as well as a gradual increase in bicycle choices across the three blocks. Aggregating responses across blocks into a single proportion score would therefore obscure potentially meaningful within-subject variation and temporal changes in responding. PEBT can also be considered as repeatedly measuring participants' environmentally friendly choices. Accordingly, the PEBT was analyzed using a generalized linear mixed model (GLMM), which is capable of accounting for the skewed distribution of responses and the repeated-measures structure of the task.

Figure 11

Distribution of the Number of Bike Choices in PEBT by Block

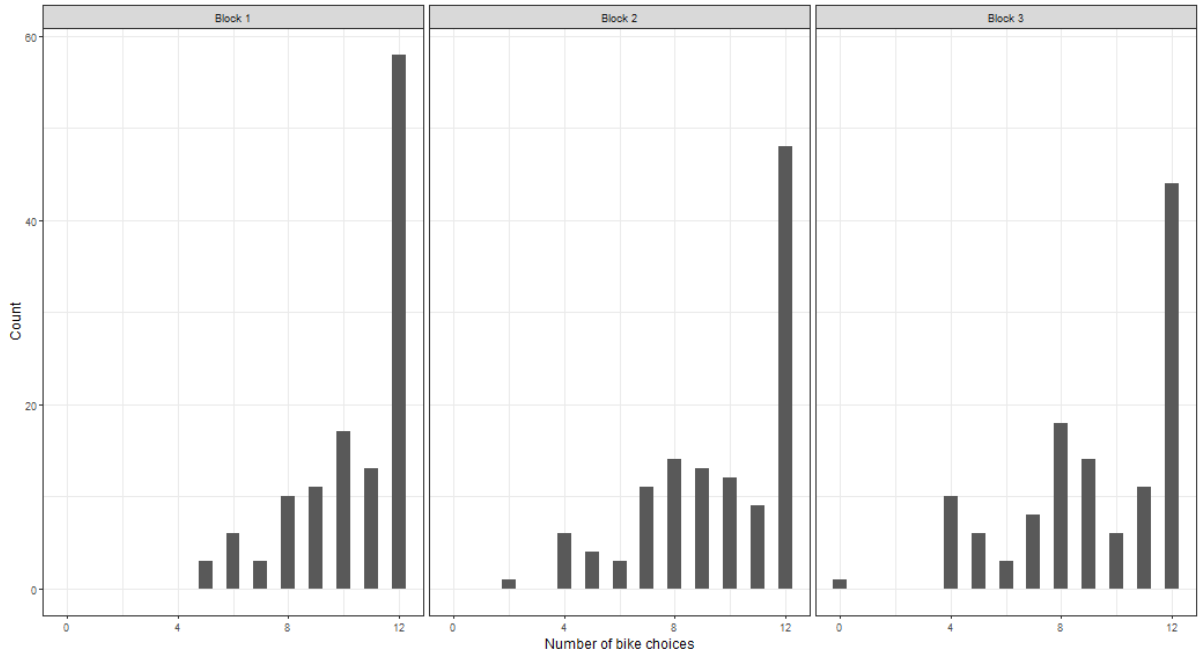


Table 7

Descriptive Statistics and Correlations for Variables in Study 2

	M (*SD*)	1	2	3	4	5	6	7	8	9	10	11
1. Climate hopelessness	2.73 (0.57)	—	-.14	-.20*	-.14	.02	-.18	-.08	-.15	-.04	-.13	-.01
2. Hopeful emotion	3.23 (1.07)	-.13	—	.09	-.04	-.09	.13	.02	.06	.15	.10	-.08
3. Primary control	3.51 (0.62)	-.24**	.07	—	.29**	.05	.39***	.20*	.33***	.20*	.26**	.06
4. Social comparison	2.76 (0.98)	-.16	-.06	.27**	—	.08	.26**	-.06	.03	.07	.07	-.09
5. Lowering aspiration	2.23 (0.81)	.03	-.08	.06	.08	—	.05	-.05	-.04	.08	-.12	-.07
6. Positive reappraisal	2.96 (0.83)	-.18	.12	.37***	.28**	.05	—	-.00	.22*	.26**	.10	-.13
7. Biospheric concern	5.50 (1.41)	-.05	.00	.14	-.09	-.12	.00	—	.41***	.06	.50***	.26**
8. Altruistic concern	5.92 (1.06)	-.16	.02	.28**	.03	-.02	.19*	.32***	—	.47***	.35***	.20*
9. Egoistic concern	5.48 (1.32)	-.06	.11	.16	.03	.09	.22*	-.03	.45***	—	.16	-.20*
10. Environmental identity	5.16 (0.87)	-.16	.10	.25**	.10	-.12	.16	.47***	.30***	.12	—	.15
11. PEBT task	0.82 (0.18)	-.04	-.12	.01	-.13	-.00	-.16	.26**	.13	-.23*	.09	—

Note. Values below the diagonal are Pearson's correlations, and those above the diagonal are Spearman's correlations.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Results

The descriptive statistics and correlations for variables in Study 2 are presented in Table 7. On average, participants chose bikes for 82% of the trials. The overall proportion of bike choices was positively correlated with biospheric concern and altruistic concern and was negatively related to egoistic concern. However, for reasons discussed above, aggregated PEBT performance was not used for data analysis. The *glmmTMB* package (Brooks et al., 2017) in R (R Core Team, 2026) was used to build the GLMM model. GLMMs allow researchers to specify outcome distributions and link functions that better match the characteristics of the data when assumptions of normality and homogeneity of variance are violated. This was particularly important in the present study because PEBT performance was highly skewed and exhibited substantial ceiling effects (see Figure 11). The analysis modelled the count of bike choices relative to car choices using a binomial distribution with a logit link function. This approach treats the outcome as a bounded proportion derived from counts while appropriately accounting for the underlying binomial response structure. The logit link function ensured that predicted probabilities remained bounded between 0 and 1.

Another advantage of GLMMs is that they can accommodate random effects to account for dependency in repeated observations. In Study 2, repeated PEBT performance measurements obtained from the same participant were likely to be more similar to each other than measurements obtained from different participants. Participant ID as a categorical variable was included as a random intercept to account for within-subject correlation and the non-independence of repeated observations. In addition, the model tested the two-way interaction with hopelessness and secondary control manipulation between-subject factors,

while controlling for blocks and the level of CO_2 emissions associated with each block.[1] Statistical parameters were estimated using maximum likelihood estimation.

The GLMM model was evaluated using simulation-based residual diagnostics implemented in *DHARMa* (Hartig, 2026), and the diagnostic plots are presented in Figure 12. Residual diagnostics indicated no evidence of overdispersion ($p = .22$), excessive outliers ($p = .74$), or zero inflation ($p = .70$). Although the result of the Kolmogorov-Smirnov test was significant ($p < .01$), visual inspection of the QQ plot suggested that the simulated residuals generally followed the expected uniform distribution. The residuals-versus-predicted plots showed that there is a minor deviation in the 0.25 quantile line. But the combined quantiles test was not significant ($p = .06$), indicating that the residual distribution was generally consistent with model expectations across the range of predicted values. Taken together, these diagnostics suggested an acceptable model fit and did not indicate any severe violations of model assumptions.

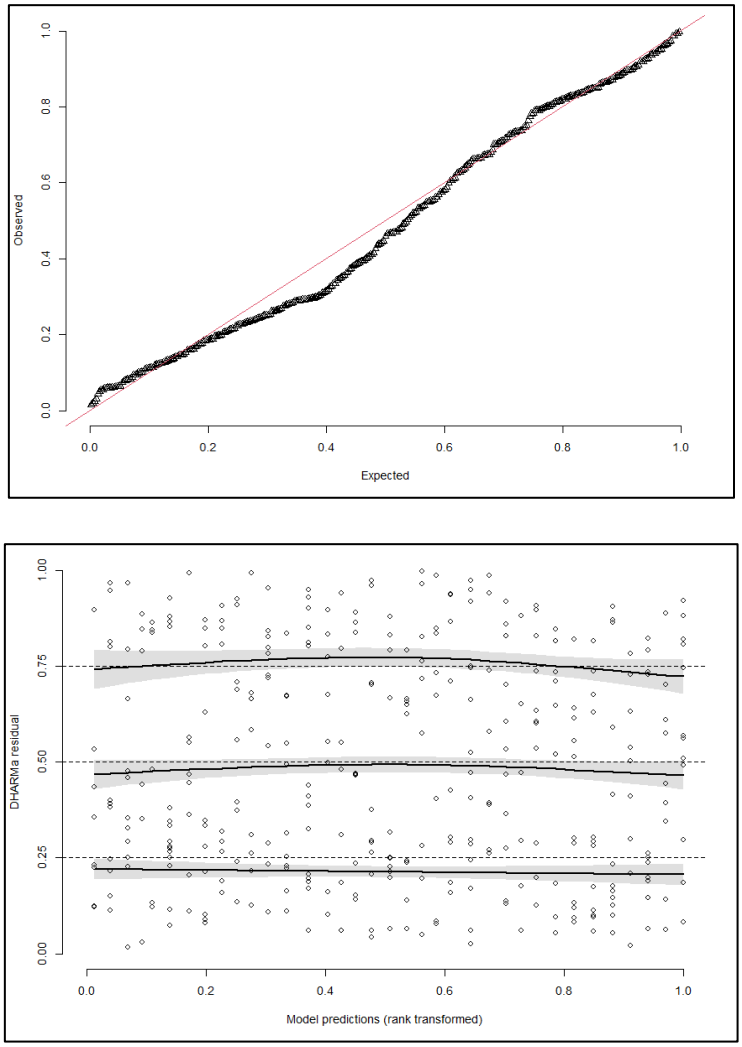
Regarding the random effect, the intraclass correlation coefficient (ICC) was calculated for participant ID included as a random intercept ($\sigma^2 = 2.91$, $SD = 1.71$). The value of ICC reflects the proportion of variance in the outcome variable attributable to the random effect (Bono et al., 2021). The estimated ICC of 0.47 indicated that around 47% of the variance in PEBT performance was explained by between-participant variability at the baseline level. This substantial between-subject variability justified the inclusion of

[1] The model here was obtained after first fitting a model that included the three-way interaction among block, hopelessness manipulation conditions, and writing conditions, while controlling for the level of CO_2 emissions. Because the three-way interaction was not significant, it was removed from the final model. The two-way interaction between hopelessness manipulation conditions and writing conditions was retained because it is theoretically important.

participant ID as a random intercept in the model.

Figure 12

Diagnostic Plots of GLMM



Note. The graph in the top panel is the QQ plot of the *DHARMa* simulated residuals. The graph in the bottom panel displays residuals plotted against model predictions. The three dashed horizontal lines indicate the theoretical 0.25, 0.50, and 0.75 quantiles expected under a correctly specified model, whereas the three solid lines represent the corresponding empirical quantiles estimated from the observed residuals.

Table 8

Summary of Fixed Effects Estimated by GLMM

	Estimate	*SE*	*z*	*p*
Intercept	2.92	0.37	7.86	<.001
Hopeful condition	-0.96	0.49	-1.97	.049
Secondary control writing condition	-1.20	0.51	-2.35	.019
Block 2	-0.62	0.11	-5.46	<.001
Block 3	-0.87	0.11	-7.66	<.001
Level of CO_2 emissions	0.31	0.06	5.51	<.001
Hopeful condition × Secondary control writing condition	1.17	0.69	1.69	.092

Note. Parameter estimates are reported on the log-odds scale from a generalized linear mixed model with a binomial distribution and logit link.

Table 8 presents the fixed-effects parameter estimates. In Table 8, Block 1 was the reference level for block effects. The hopeless condition served as the reference level for the hopelessness manipulation, and the coefficient estimate for the hopeful condition in Table 8 represents the change in the likelihood of choosing the bike option in the hopeful condition relative to the hopeless condition when the writing manipulation is at its reference level (i.e., the neutral writing condition), averaged across blocks. Similarly, the coefficient estimate for the secondary control writing condition represents the change in the likelihood of choosing the bike option in the secondary control writing condition relative to the neutral writing condition when the hopelessness manipulation is at its reference level (i.e., the hopeless condition), averaged across blocks. And the estimate for the interaction term represents the extent to which the effect of hopefulness differs between the secondary control and neutral writing conditions. The intercept in Table 8 represents the estimated log-odds of choosing the bike option in the reference conditions. Because model estimates in Table 8 were initially computed on the log-odds scale, they were later transformed into predicted probabilities to

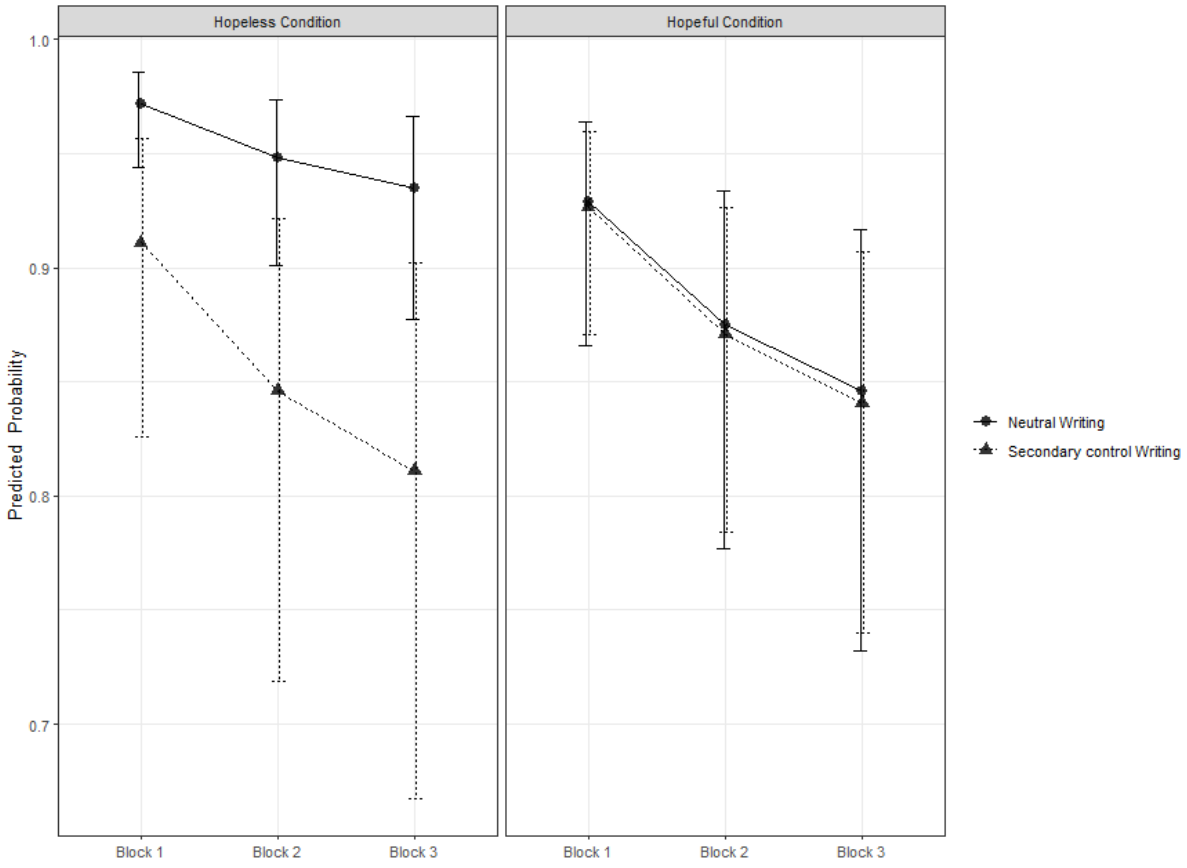
facilitate interpretation. Figure 13 visualizes the predicted probabilities of choosing bike options after transformation. The error bars shown in Figure 13 represent asymptotic 95% confidence intervals.

According to Table 8, bike choices declined significantly across blocks, such that participants chose significantly fewer bike options in Blocks 2 and 3 relative to Block 1. The level of CO_2 emissions was also a significant predictor, indicating that participants were more likely to choose bike options when the car option was associated with higher CO_2 emissions. Within the neutral writing condition, "hopeful" participants who had a cooperative partner in the first part of the experiment were less likely to choose the bike option than "hopeless" participants who had an uncooperative partner. Furthermore, among participants in the hopeless condition, those who did the secondary control writing were significantly less likely to choose the bike option than those who did the neutral writing.

The interaction term between hopeful condition and secondary control manipulation had a probability level below .10, but not below .05, indicating that the effect of the secondary control manipulation did not differ significantly between hopeful and hopeless conditions. However, the size of this effect was nearly equal to the main effect of secondary control, and in the opposite direction. Thus, the significant difference between secondary control and neutral writings, which was found for participants in the hopeless condition, was nearly eliminated for those in the hopeful condition. These trends are illustrated in Figure 13. Thus, secondary control priming was associated with a lower likelihood of choosing the bike option only when participants felt hopeless about the future of climate change, due to having had an uncooperative partner in the first part of the study procedures.

Figure 13

Visualization of Predicted Probability



Discussion

Study 2 achieved its central aim of priming the availability of secondary control strategies. Participants in the secondary control writing condition scored significantly higher than those in the neutral writing condition on reported tendencies to use secondary control strategies. The impact of secondary control priming was also measured on a real-time performance of environmental behaviours using PEBT. The study also successfully manipulated participants' emotional hope about the future of climate change, although the general belief in climate change hopelessness was not manipulated. Participants who were paired with a cooperative partner scored significantly higher than those paired with an uncooperative partner on feeling hopeful about climate change in the future.

Before interpreting the effects of the experimental manipulations, it is important to consider what PEBT actually measures. Unlike self-reported measures of routine and citizenship PEB, PEBT assesses participants' willingness to persist in a repeated environmental action that involves a personal cost. Accordingly, performance on PEBT should not be interpreted simply as indicating a greater or lesser overall level of environmental engagement. For example, participants who were most likely to choose the bike option consistently were those in the hopeless condition and the neutral writing condition. According to Figure 13, the predicted probability of choosing the bike for these participants in Block 1, averaged across levels of CO_2 emissions (i.e., the predicted probability corresponding to the intercept in Table 8), was well over 95%. However, maintaining this high level of performance came at a considerable personal cost. Each bike choice typically required a longer waiting time than the corresponding car choice.

Consequently, the cumulative waiting time associated with repeated bike choices made sustained environmental engagement increasingly costly. Consistent with this interpretation, the negative effects of Block 2 and Block 3 in Table 8 indicate that the likelihood of choosing the bike declined significantly across blocks. At the same time, participants were not given alternative ways to use their time or the option to terminate the task early, which is very different from many real-world PEBs. Consequently, PEBT should be interpreted primarily as a measure of persistence in a repeated, personally costly course of environmental action. The effects of climate change hopelessness and secondary control priming should therefore be understood in relation to participants' willingness to persist in this costly form of environmental engagement.

The first main finding of Study 2 was that participants who felt more hopeful about the future of climate change subsequently were less likely to choose bike choices in PEBT, which was contrary to Hypothesis 1. However, it suggests that participants who were first made to feel hopeful about climate change then found it easier to withdraw from PEBT. Given the way in which hope was manipulated in the study, participants in the hopeful condition may have felt that their efforts had already produced meaningful environmental benefits, due to the amount of donations their efforts contributed to. This might bring up moral licensing (Merritt et al., 2010; Monin & Miller, 2001) and reduce their motivation to exert additional effort on PEBT. In contrast, participants in the hopeless condition may have perceived that insufficient environmental benefit had been achieved, leading them to persist in choosing the more environmentally friendly options on the subsequent task. Therefore, this result should not be interpreted as evidence that climate change hopelessness promotes

environmental action, as the manipulation was not successful in altering the general belief in climate change hopelessness.

Another main finding of Study 2 was that participants in the secondary control writing condition were less likely to choose bike options than participants in the neutral writing condition. The finding was contrary to Hypothesis 3. However, it aligns with Study 1's findings in the WEPT task and suggests that participants who were first primed with secondary control strategies also found it easier to withdraw from the PEBT task. More generally, this experimental finding supports the goal-disengagement function of secondary control described in the life-span theory of control (Heckhausen & Wrosch, 2022; Heckhausen et al., 2010), in which secondary control strategies can facilitate adjustment by reducing effort in goals that are perceived as too costly and unrealistic. From this perspective, withdrawing effort from the PEBT could reflect an adaptive reallocation of motivational resources away from a costly immediate action and toward other more sustainable goals or opportunities for environmental engagement.

Study 2 has several limitations that should be considered. First, due to recruitment challenges and participant attrition, the study did not achieve its planned sample size. Second, PEBT showed evidence of a ceiling effect, with participants choosing the environmentally friendly option on the majority of trials. Although the use of a generalized linear mixed model allowed the repeated-measures structure of the task to be retained, the restricted range of responses may have reduced variability and limited the measure's sensitivity to detect experimental effects. Future research can incorporate more difficult decision trials, such as larger waiting-time differences between the car and bike options (Lange et al., 2018), to

increase variability in responding. Third, because self-reported measures of PEBs were not included in this study, it was not possible to examine their association with PEBT performance. Future research should include both self-report and performance-based measures of PEBs to better understand the extent to which these measures capture similar or distinct aspects of environmental engagement. Lastly, the hopelessness manipulation altered participants' momentary feelings but not their generalized beliefs about climate change hopelessness. Future research would need to include a stronger intervention to change these beliefs, in order to test the causal relationship between generalized climate change hopelessness and PEBs.

General Discussion

The present research examined the roles of climate change hopelessness and secondary control strategies in environmental engagement from the perspective of the life-span theory of control (Heckhausen & Schulz, 1995; Heckhausen et al., 2010). Across two studies, a theoretical model was tested in which secondary control strategies were proposed to offset the negative effects of climate change hopelessness by maintaining primary control striving and, consequently, supporting PEBs. Although the results did not support the proposed explanatory model, the studies nevertheless provided important insights into the adaptive regulation of effort in environmental engagement, by means of secondary control.

The initial theoretical model was not supported because it had two weaknesses. First, the model conceptualized the adaptive role of secondary control strategies only as supporting primary control striving. However, the findings demonstrate that secondary control strategies may influence environmental engagement through multiple pathways. In Study 1, secondary

control strategies showed direct associations with PEBs and indirect associations through environmental identity, suggesting that they may help individuals maintain a sense of connection with nature even when experiencing climate change hopelessness. In Study 2, experimentally increasing the availability of secondary control strategies showed its benefit in reducing persistence on a personally costly environmental task. Together, these findings suggest the adaptive value of secondary control strategies. Second, the initial model assumed that performance-based measures and self-reported measures reflected the same underlying construct of environmental engagement. However, the findings from both studies suggest that these measures capture different aspects of PEBs, as they show low correlations with each other and show different correlations with secondary control strategies. Self-reported measures of routine and citizenship PEB might reflect broader, longer-term patterns of environmental engagement, whereas the WEPT and PEBT measure momentary persistence in costly and effortful environmental actions. Therefore, the initial model overlooked the differences in the ratio of effort versus perceived value associated with specific PEBs.

Despite the lack of support for initial model predictions, the picture of secondary control strategies that emerged from this research closely resembles their portrayal in the original life-span theory of control. The research provided evidence for the goal-engagement and goal-disengagement functions of secondary control strategies. In Study 1, secondary control strategies showed positive associations with self-reported routine PEBs and citizenship PEBs, which served to offset the negative contributions of climate change hopelessness to predictions of routine and citizenship PEBs. In Study 2, secondary control priming led participants to withdraw effort by making fewer bike choices in PEBT, but this

effect was specific to participants in the hopeless condition. Taken together, the findings suggest that secondary control strategies can help individuals regulate their effort flexibly according to situational demands. And as secondary control strategies were positively associated with routine and citizenship PEBs, it is theoretically possible that these effects are connected to one another: i.e., people who succeed more often with the long-term routine and citizenship PEBs are those who have better conserved their motivational resources by adaptively withdrawing effort from excessively costly environmental tasks. This interpretation is generally consistent with the life-span theory of control, which suggests that adaptive disengagement can conserve motivational resources and support effective goal pursuit over time (Heckhausen et al., 2010).

However, the present research did not provide direct evidence that individuals who disengage from costly environmental actions in the present moment subsequently invest greater effort in other environmental behaviours. This resource reallocation process was not directly measured in either study. Therefore, the interpretation that secondary control strategies promote long-term environmental engagement by redirecting effort remains tentative. Future experimental and longitudinal research is needed to examine whether reductions in effort on one environmental task are followed by increased engagement in other environmental behaviours over time, thereby establishing the net effect of secondary control strategies in shaping environmental engagement across contexts and time scales.

Future research is also needed to support the present interpretation of self-reported and performance-based measures of PEBs. In the present studies, routine and citizenship PEBs appeared to reflect long-term patterns of environmental engagement, whereas WEPT

and PEBT appeared to capture momentary persistence in effortful and costly environmental choices. But these interpretations should be made cautiously. First, self-reported measures are susceptible to recall errors and social desirability bias. Second, both WEPT and PEBT tasks were adapted to fit the objectives and the constraints of the present research. In the original reports, both WEPT (Lange & Dewitte, 2022) and PEBT (Lange et al., 2018) showed small or medium correlations with self-reported PEBs, environmental concern, and environmental identity. Moreover, participants' responses to these tasks can be influenced by key design features. For example, WEPT performance is affected by the donation amount associated with each completed page and the amount of numbers presented per page, and PEBT performance is influenced by the waiting-time difference between bike and car options. The adaptations made in the present research may have changed how participants reacted to these tasks and therefore altered the relationship between the performance-based and self-reported measures. Future research should further examine the convergent validity of performance-based and self-reported measures of PEB under different task designs, and researchers should be cautious when performance-based measures are used alone.

Despite these limitations, the present research can inform the development of intervention strategies for promoting environmental engagement. More specifically, the results suggest that the type of intervention should depend on the type of behaviours being targeted. In Study 2, participants were less likely to choose the less environmentally friendly option (i.e., the car) when it was associated with greater CO_2 emissions. It suggests that making the environmental consequences of alternative choices very salient may be an effective way to promote pro-environmental decision-making, especially in situations where

the desired PEBs involve substantial personal costs or trade-offs. Secondary control strategies are unlikely to be helpful in these situations, but may be of important consideration for promoting long-term PEBs, such as recycling, volunteering, and pro-environmental consumption.

More broadly, secondary control strategies such as positive reappraisal and lowering aspiration may provide a useful alternative to dichotomous or catastrophic thinking about environmental action. Previous research has shown that individuals who view environmental engagement in all-or-nothing terms (e.g., believing that they must consistently make the most environmentally beneficial choice or that their efforts are wasted) tend to engage in much fewer PEBs (Greene & Egan, 2025; He, 2016). Secondary control strategies may help individuals adopt a more flexible perspective by recognizing that environmental engagement can take many forms and meaningful contributions can occur over time, despite occasional setbacks or lapses. Such flexibility may help individuals maintain commitment to environmental actions while adapting to practical constraints.

In conclusion, the present research illustrates the potential of secondary control strategies to interrupt the cycle between climate change hopelessness and environmental disengagement. By flexibly adjusting effort based on situational demands, secondary control strategies may help individuals remain engaged in climate action over the long term despite experiences of climate change hopelessness, and withdraw effort from effortful environmental choices. More research is needed to examine these potential pathways more directly, particularly whether secondary control strategies help individuals maintain environmental identity, conserve effort by disengaging from unsustainable environmental

actions, and subsequently reinvest that effort in more sustainable forms of environmental engagement, such as routine and citizenship pro-environmental behaviours. Understanding these adaptive processes may help identify effective ways to support persistent environmental engagement despite experiences of climate change hopelessness.

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Appendix A

Study 1 Simulation Code

```
install.packages("WebPower")
library(WebPower)
library (ggplot2)

#get power at a sequence of sample sizes
set.seed(2121)
res <- sapply(n <- seq(50, 1500, 20),
            function(x) wp.modmed.m7(n = x,
                                a1 = 0.21,
                                cp = 0.21,
                                b1 = 0.21,
                                c1 = 0.21,
                                c2 = 0.21,
                                sigx_w = 0.21,
                                nrep= 1000,
                                alpha = 0.05,
                                simulation_method = "MC",
                                power_method = "product",
                                b = 1000,
                                sige12 = 1,
                                sige22 = 1))

ind.eff <- sapply(c(1:73), function(x) res[,x]$power1)
dir.eff <- sapply(c(1:73), function(x) res[,x]$power2)
mod.eff <- sapply(c(1:73), function(x) res[,x]$power3)

ind.df <- data.frame("power" = ind.eff,
                  "n" = seq(50, 1500, 20), "effect" = "Indirect effect")
dir.df <- cbind ("power" = dir.eff,
              "n" = seq(50, 1500, 20), "effect" = "Direct effect")
mod.df <- cbind ("power" = mod.eff,
              "n" = seq(50, 1500, 20), "effect" = "Moderation effect")
sim <- rbind(ind.df,dir.df,mod.df)

ggplot (data = sim,aes(x = as.numeric(n),
                   y = as.numeric(power), group = effect)) +
  geom_line () +
  geom_point(aes(shape = effect), size = 2)+
  xlab("n") +
  ylab("power") +
```

```
geom_hline(yintercept = 0.8,
          linetype ="dashed", color = "black") +
geom_vline(xintercept = 230, linetype = "dashed", color = "gray") +
geom_vline(xintercept = 250, linetype = "dashed", color = "gray") +
scale_x_continuous(breaks = c(230,250),
                limits = c(50, 600))+
theme(panel.background = element_rect(fill = "white", colour = "gray"),
     axis.text.x = element_text(angle = 90, hjust = 1))+
theme(legend.title = element_blank())+ #hide legend title
xlab("Sample size")+
ylab("Power")
```

Appendix B

Climate Change Hopelessness Scale

Strongly disagree		Neutral		Strongly agree
1	2	3	4	5

Definition: Climate change refers to changes in the Earth's climate including changes in temperature, precipitation, and wind patterns over a period of several decades or longer, primarily due to the emission of greenhouse gases from burning fossil fuels and land-use change. It may cause problems such as changes in sea level, more extreme heat events, fires and drought, more extreme storms, and floods. Scientists project that the problems caused by climate change could affect, for example, forest health, agriculture, freshwater supplies, coastlines, human health, economy, wildlife habitat, and human migration.

Lack of Will and Way

1. Climate change is beyond my control, so I won't even bother trying to solve problems caused by climate change.
2. The actions I can take are too small to help solve problems caused by climate change.
3. Climate change is so complex we will not be able to solve problems that it causes.

Perceptions of Collective Inaction

1. Other people will not help solve problems caused by climate change even if I do.
2. I bear the cost of solving problems caused by climate change whilst others do not.
3. Other countries or people are not taking equivalent actions to solve problems caused by climate change currently.

Appendix C

Control Strategies Scale

Not at all			A lot
1	2	3	4

Primary Control Striving

1. When things don't go according to my plans, my motto is, "Where there's a will, there's a way".
2. When faced with a bad situation, I do what I can do to change it for better.
3. Even when I feel I have too much to do, I find a way to get it all done.
4. When I encounter problems, I don't give up until I solve them.
5. I rarely give up on something I am doing, even when things get tough.

Secondary Control

Social Comparison

1. I tell myself that despite this problem, I am better off than many others
2. I think of how many problems other people have, compared to myself
3. I tell myself that others have worse problems

Positive Reappraisal

1. I find I usually learn something meaningful from a difficult situation.
2. When I am faced with a bad situation, it helps to find a different way of looking at things.
3. Even when everything seems to be going wrong, I can usually find a bright side to the situation.
4. I can find something positive, even in the worst situations.

Lowering Aspirations

1. When my expectations are not being met, I lower my expectations.
2. To avoid disappointments, I don't set my goals too high.
3. I feel relieved when I let go of some of my responsibilities.
4. I often remind myself that I can't do everything.
5. When I can't get what I want, I assume my goals must be unrealistic.

Appendix D

Environment Concern Scale

People around the world are generally concerned about environmental problems because of the consequences that result from harming nature. However, people differ in the consequences that concern them the most. Please rate each of the following items from 1 (not important) to 7 (supreme importance) in response to the question: I am concerned about environmental problems because of the consequences for __.

1. Biospheric concerns: Animals, Plants, Marine life, Birds.
2. Egoistic concerns: Me, My lifestyle, My health, My future.
3. Altruistic concerns: People in my country, Humanity, Children, Future generation.

Appendix E

Revised Environmental Identity Scale

Not at all true of me			Neither true nor untrue			Completely true of me
1	2	3	4	5	6	7

1. I like to spend time outdoors in natural settings (such as woods, mountains, rivers, fields, local parks, lake or beach, or a leafy yard or garden)

2. I think of myself as a part of nature, not separate from it.

3. If I had enough resources such as time or money, I would spend some of them to protect the natural environment.

4. When I am upset or stressed, I can feel better by spending some time outdoors surrounded by nature.

5. I feel that I have a lot in common with wild animals.

6. Behaving responsibly toward nature – living a sustainable lifestyle – is important to who I am.

7. Learning about the natural world should be part of everyone's upbringing.

8. If I could choose, I would prefer to live where I can have a view of the natural environment, such as trees or fields.

9. An important part of my life would be missing if I was not able to get outside and enjoy nature from time to time.

10. I think elements of the natural world are more beautiful than any work of art.

11. I feel refreshed when I spend time in nature.

12. I consider myself a steward of our natural resources.

13. I feel comfortable out in nature.

14. I enjoy encountering elements of nature, like trees or grass, even when I am in a city setting.

Appendix F

Self-reported Pro-Environmental Behaviours Scale

Routine Behaviours

Not at all	Seldom	Occasionally	Often	Very Often
1	2	3	4	5

1. Looked for ways to reuse things.
2. Recycled papers, cans, or bottles.
3. Encouraged friends or family to recycle.
4. Purchased products in reusable containers.
5. Picked up litter that was not your own.
6. Composted food scraps.
7. Conserved gasoline by walking or bicycling.
8. Volunteered time to help an environmental group.

Citizenship Behaviours (0 = No, 1 = Yes)

1. Wrote a letter supporting an environmental issue.
2. Voted for a candidate who supported environmental issues.
3. Donated money to an environmental group.

Appendix G

Secondary Control Strategies Priming Task

Secondary Control Writing Condition Instructions

Everyone faces personal challenges that can impact their lives and the environment around them. We would like to explore a broader aspect of how individuals respond to challenges and difficulties in their lives.

Please recall and describe a past experience from your life, in which something unpleasant and challenging happened, and you were able to find a positive side of the situation, and/or adjust your expectation about it, and/or compare yourself with others who have worse problems.

Neutral Writing Condition Instructions

Everyone faces personal challenges that can impact their lives and the environment around them. We would like to explore a broader aspect of how individuals respond to challenges and difficulties in their lives.

Please recall a past experience from your life in which something unpleasant and challenging happened and describe what happened and how you felt in this situation.