

## **Supporting Information for “Perceptions of powerlessness are negatively associated with taking action on climate change: A preregistered replication”**

This Supporting Information document provides additional demographic information about our sample along with some additional information about deviations from the preregistration which we found to be necessary during data analysis. We also report a replication of the regression model reported in Table 5 of Aitken et al. (2011), which we did not report in the main text (as it was not necessary to test our preregistered hypotheses).

### **Demographic Characteristics of Sample**

The main text of our manuscript contains a brief summary of the demographic characteristics of our sample. A more complete descriptions is displayed in SI Table 1.

SI Table 1

#### *Demographic Characteristics of Survey Participants*

Variable	Category	Valid percentage*
Age	0 – 19	11
	20 – 29	51
	30 – 39	24
	40 – 49	7
	50 – 59	5
	60 +	2
Gender	Male	52

	Female	47
	Gender diverse	1
Highest educational qualification	No qualification	1
	High school qualification	30
	Tertiary degree	59
	Tertiary other	10
Individual income (AUD p.a.)	0 - \$25,000	37
	\$25,000 - \$50,000	23
	\$50,001 - \$75,000	20
	\$75,001 +	20

*Note.* \*I.e., the percentage of those participants who responded to each question.

### **Deviations from Preregistration**

#### **Treatment of Missing Data**

For ethical reasons, our Qualtrics survey was constructed such that participants could opt not to answer any item in the survey (albeit with a reminder pop-up checking whether they wished to answer any items they had missed). We also offered an explicit “prefer not to say” option for gender and income. We signalled the option not to respond more explicitly for these items because some participants might feel embarrassed to reveal their income, some might identify as gender diverse but prefer not to state this to avoid risk of identifiability, and some might not identify with any of the gender categories represented. As such, we wished to make it especially clear to participants that it was acceptable not to answer these questions.

As mentioned in the manuscript, two participants left the gender item blank, and three participants described themselves as gender diverse (with no participants selecting the “prefer

not to say” option). In those substantive analyses that used gender as a predictor (the OLS and binary logistic regression models for H4), responses of “gender diverse” were treated as missing data and these three participants were thus excluded from those analyses. 24 participants also responded “prefer not to say” for income. In effect, there were thus 29 missing data points for gender and income in our final dataset.

In addition, question 6 (“How much has climate change been a factor in changing your actions?”) was only presented to participants who responded “yes” to question 5 “Have you changed your actions, at least partly, due to consideration of climate change?” As such, a response to question 6 was missing for the 67 participants who responded “no” to question 5.

In terms of relevant guidance for dealing with missing data, our preregistration stated that our method for dealing with missing data would be “Single (expectation maximisation) imputation for missing responses to items” and that the analyses for hypothesis 4 would include gender as a predictor gender coded as “male or female; cases with other responses excluded from this analysis”. Taken literally, this implies that we would exclude participants who responded with anything other than “male” or “female” to the gender item from the analyses pertaining to hypothesis 4, but impute missing responses to gender, missing responses to income, and income values for those participants who responded “prefer not to say”.

We had initially specified this plan to impute via expectation-maximisation with the responses to the actual rating scale items (i.e., items relating to attitudes, beliefs and behaviours relating to climate change) in mind. Given that we expected these rating scale variables to have fairly substantial interrelations, it was reasonable to assume that we would be able to accurately impute missing responses based on participants’ responses to other items. While these variables also had only discrete response options, our preregistration effectively planned to treat them as quantitative in all planned analyses, meaning that the fact

that expectation-maximisation treats variables as quantitative and produces non-integer imputed values was unproblematic.

However, we unfortunately neglected to fully consider the implications of the possibility of missing data on demographic items when writing the plan for missing data in the preregistration. Utilising expectation-maximisation imputation for gender and income bracket seems hard to justify: These variables are categorical in nature (and were *treated* as categorical in some of our analyses), meaning that imputing non-integer values would be problematic. Perhaps more importantly, there was little reasonable basis to assume we could accurately predict participants' gender and income based on their responses to other items in our survey.

As such, we did not impute participants' gender or income for those participants who missed these items or selected the "prefer not to say" option. Instead, we used listwise deletion in the analyses pertaining to hypothesis 4 (the regression models reported in tables 4 and 5), meaning that 29 participants were excluded from these analyses. Similarly, we did not impute responses to question 6 ("Have you changed your actions, at least partly, due to consideration of climate change?"): It would make little sense to estimate how much importance climate change had in changing the actions of participants who stated that they had *not* changed their actions at all in consideration of climate change. Ideally, we would have made this clearer in our preregistration itself.

Other researchers might wish to specify alternative methods for dealing with the missing data in this study using our open dataset and code.

### **Creation of Risk and Human Influence Composite Variable**

In the plan for hypothesis 4 in our preregistration, we stated that one of the predictors would be "A composite variable comprised of the perceived risk of climate change and the

perceived human influence on climate change (sum of responses to items/questions 3, 4)". Unfortunately, this was an error: Item 2 ("To what extent do you believe human activity is contributing to climate change?") should have been included in this list. This represents an unambiguous error: Items 3 and 4 probe only probe perceived risks of climate change, while item 2 probes perceived human influence, and Aitken et al. (2011) clearly stated that they used all three items when creating this composite variable in the original study. As such, we created the predictor using items 2, 3 and 4, and that is what is reported in the main manuscript (but further below we include the results for the preregistered specification).

### **Treatment of Education Level as Categorical in Logistic Regression Model**

In our preregistration, we also stated that we would treat age bracket and income bracket as categorical variables in our logistic regression model. However, we unfortunately failed to note that education level was clearly a categorical variable, and should likewise be treated as such. Given that this was a clear error, we reported an analysis with education level treated as categorical in the main manuscript.

### **Regression models based on preregistered specifications**

Neither education level nor perceived risk and human played any role in the analyses testing hypotheses 1 to 3, but they are involved in the analyses testing hypothesis 4 (the OLS regression model and binary logistic regression model). In SI Tables 2 and 3, we report the coefficients for these models according to the original preregistered specification (i.e., with a composite formed solely of questions 3 and 4, which we title "perceived risk of climate change" here, and with education treated as quantitative in both models). Hypothesis 4 remains supported in both cases (i.e., in each case it has a positive regression coefficient that

is statistically significant at  $p < .05$ ). As such, adhering to the original preregistered plan would not change our conclusions.

SI Table 2

*OLS Regression with Taking Action on Climate Change as Outcome Variable (Original Preregistered Specification)*

	<u>95% CI for <math>b</math></u>			$\beta$
	$b$	LL	UL	
Intercept	-0.557*	-0.938	-0.176	
Q1 How Informed	0.048*	0.009	0.087	0.121
<b>Perceived risk</b>	<b>0.137*</b>	<b>0.103</b>	<b>0.171</b>	<b>0.418</b>
Option difficulty	0.005	-0.007	0.018	0.040
Option uncertainty (confusion)	-0.003	-0.021	0.016	-0.014
Powerlessness	-0.026*	-0.037	-0.014	-0.253
Perceptions of the commons dilemma	-0.002	-0.015	0.011	-0.019
Q20 Looking foolish	0.018	-0.017	0.053	0.052
Age	-0.015	-0.053	0.022	-0.042
Gender (female = 1)	0.041	-0.031	0.114	0.053
Education	0.033	-0.026	0.092	0.054
Income	0.004	-0.029	0.037	0.011

*Notes.*  $b$  = unstandardised regression coefficient.  $\beta$  = standardised regression coefficient. \*  $p < .05$ .

SI Table 3

*Binary Logistic Regression with Taking Action on Climate Change as Outcome Variable*

	<i>b</i>	Exp( <i>b</i> )	95% CI for Exp( <i>b</i> )	
			LL	UL
Intercept	-7.043*	0.001	0.000	0.029
Q1 How Informed	0.572*	1.772	1.132	2.848
<b>Perceived risk</b>	1.023*	2.781	1.945	4.175
Option difficulty	0.050	1.052	0.917	1.208
Option uncertainty (confusion)	-0.138	0.871	0.698	1.079
Powerlessness	-0.340*	0.711	0.603	0.824
Perceptions of the commons dilemma	-0.014	0.986	0.853	1.137
Q20 Looking foolish	0.042	1.042	0.727	1.525
Age <sup>a</sup> 20-29	-0.322	0.725	0.175	2.717
Age 30-39	-0.185	0.831	0.172	3.819
Age 40-49	0.343	1.409	0.187	12.035
Age 50-59	-2.556*	0.078	0.008	0.694
Age 60+	-0.272	0.762	0.023	24.785
Gender (female = 1)	0.351	1.420	0.631	3.236
<b>Education</b>	0.406	1.501	0.796	2.876
Income <sup>b</sup> : \$25,001 - \$50,000	0.699	2.011	0.701	6.137
Income: \$50,001 - \$75,000	0.303	1.353	0.463	4.151
Income: \$75,001+	0.171	1.187	0.354	4.194

Notes. <sup>a</sup>Reference category: Age = 18-19. <sup>b</sup>Reference category: 0 - \$25,000 p.a. \**p* < .05.

### Replication of Table 5 in Aitken et al.

As well as the analyses discussed in our manuscript, Aitken et al. also reported coefficients for a regression model in which importance placed on climate change as an influence on actions was the outcome variable, with the same eleven predictors used to predict whether or not participants took action on climate change (their Table 4). We did not report a replication of that analysis in our main manuscript because it was not necessary in order to test the hypotheses we preregistered based on Aitken et al's abstract, and appears to have had relatively minor importance in their study. Coefficients for our replication of that regression model are nevertheless reported in SI Table 4 for completeness.

SI Table 4

*OLS Regression with Importance Placed on Climate Change as an Influence on Actions as Outcome Variable*

	$b$	<u>95% CI for <math>b</math></u>		$\beta$
		LL	UL	
Intercept	-0.824	-2.187	0.539	-
Perceived risk and human influence	0.184*	0.095	0.274	0.244
Powerlessness	-0.015	-0.049	0.019	-0.058
Age	0.129*	0.020	0.237	0.137
Option difficulty	0.031	-0.005	0.067	0.098
Perceptions of the commons dilemma	-0.022	-0.060	0.016	-0.083
Q20 Looking foolish	0.048	-0.056	0.152	0.057
Q1 How Informed	0.279*	0.159	0.399	0.283



Education	0.079	-0.094	0.252	0.053
Gender (female = 1)	0.224*	0.020	0.428	0.120
Option uncertainty (confusion)	-0.042	-0.094	0.010	-0.094
Income	0.052	-0.044	0.148	0.064

*Notes.*  $b$  = unstandardised regression coefficient.  $\beta$  = standardised regression coefficient.

Predictors shown in same order as Aitken et al. (who ordered them by size of standardised regression coefficient). \*  $p < .05$ .

### References Cited in Supplementary Information

- Aitken, C., Chapman, R., & McClure, J. (2011). Climate change, powerlessness and the commons dilemma: Assessing New Zealanders' preparedness to act. *Global Environmental Change*, 21(2), 752–760.  
<https://doi.org/10.1016/j.gloenvcha.2011.01.002>

# Perceptions of Powerlessness Are Negatively Associated with Taking Action on Climate Change: A Preregistered Replication

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