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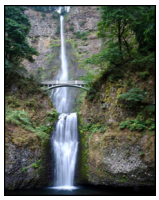

Predicting climate change risk perception and willingness to act

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ABSTRACT

We extended a recent model of climate change risk perception (van der Linden, 2015) to predict the risk perception of Australians and their willingness to engage in mitigation behaviours (N = 921). Affect, mitigation response inefficacy, and descriptive norms were the most important predictors of risk perception, highlighting the influence of affective, cognitive, and socio-cultural factors. Affect and mitigation response inefficacy were also important predictors of behavioural willingness, but socio-cultural influences (free-market ideology, prescriptive norms, and biospheric values) played a relatively larger role in explaining the variance of behavioural willingness. Structural equation modelling provided further evidence that risk perception and behavioural willingness are separable constructs, as some factors in the model had direct effects on willingness independent of risk perception. We discuss the need for future research to develop a comprehensive model of behavioural willingness, and the need for public communication to combat mitigation response inefficacy.

1. Introduction

Like many other industrialised nations, Australia is currently experiencing adverse effects of climate change while failing to mitigate its impact (Head, Adams, McGregor, & Toole, 2014). Just as a carbon pricing scheme designed to reduce Australia's greenhouse gas emissions succeeded and then fell out of political favour, the general public's perceptions about the risk of climate change has been similarly tumultuous and politically polarised (Akter & Bennett, 2011; Tranter, 2013). In 2006, the Lowy Institute found that 68% of Australians perceived global warming as a 'serious and pressing problem … requiring taking steps now even if this involves significant costs'. By 2012, this had almost halved to 36%, but by 2016 had risen again to 53% (The Lowy Institute, 2018).

Climate change risk perception does not only vary over time, but also between countries (Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015; (Reser et al., 2012)) and between people in the same country (Leiserowitz, Maibach, Roser-Renouf, & Smith, 2011; Tranter, 2013). Therefore, much work has sought to identify the *predictors* of risk perception. Although extensive, this literature suffers from inconsistency in the predictor and outcome variables used, and the absence of an integrated framework linking the multiple important predictor variables with risk perception. van der Linden (2015) sought to provide such a framework, proposing four key theoretical dimensions that underlie risk perception; "socio-demographic", "cognitive", "experiential", and "socio-cultural" factors. These dimensions are not necessarily assumed to be independent: for example, cognitive and affective factors can interact dynamically to shape climate change risk perception (van der Linden, 2014). Measures of each of these factors were included in van der Linden's (2015) Climate Change Risk Perception Model (CCRPM). In a representative sample of the UK population, the CCRPM accounted for 68% of variance in risk perceptions of climate change—a value greater than any previously published study, and one that may represent a ceiling value of true variance that can be explained (Sjöberg, 2002).

Although the CCRPM is comprehensive, we expand van der Linden (2015)'s work in three ways. First, we replicated the national survey in a different Western democracy, assessing the extent to which van der Linden (2015)'s findings from a UK population in 2012 generalise to an Australian population in 2016. Although some of the variables specified in the CCRPM have already been investigated with an Australian sample (for example, Leviston, Greenhil, & Walker, 2015 examined social norms, while Reser et al., 2012 looked at the role of negative affect), these findings have not yet been integrated to form a holistic model of Australians' risk perceptions.

Second, we examine two additional predictors of risk perception: (1) free-market ideology and (2) beliefs about the efficacy of climate change mitigation action. These variables were not included in the CCRPM, but we believe they warrant investigation, given theoretical and empirical evidence that they influence climate change risk

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perceptions (Fielding & Head, 2012; Heath & Gifford, 2006; Reser et al., 2012).

Our third, most substantial, innovation is to use these predictors to explain not only risk perception, but also willingness to mitigate climate change. Increased perceived risk is often linked to greater willingness to take mitigation action (e.g., O'Connor, Bard, & Fisher, 1999; Spence, Poortinga, Butler, & Pidgeon, 2011; van der Linden, 2015). While acknowledging this relationship, we believe it is also useful to examine the *direct* predictors of behavioural willingness, which may differ from those that predict risk perception. In what follows, we: (1) provide a brief overview of van der Linden's (2015) CCRPM, (2) discuss research that links free-market ideology and beliefs about the efficacy of mitigation with climate change risk perception, and (3) examine the cases in which risk perception predicts behavioural willingness, and other cases where the two constructs diverge.

1.1. The Climate Change Risk Perception Model (CCRPM)

In line with van der Linden's (2015) integrated model of risk perception, the CCRPM organises predictors into four variable sets: socio-demographic, cognitive, experiential, and socio-cultural factors. van der Linden (2015) provides a thorough justification for including each of the following predictors, therefore only a brief summary of his results is given below. See Appendix A for all items used in the current questionnaire.

The socio-demographic characteristics of interest are gender, party affiliation, income, and level of education. van der Linden (2015) found that the socio-demographic dimension accounted for the least amount of variance in risk perception (6%) of all four variable sets. This is consistent with most previous research finding socio-demographic variables to be relatively unimportant in predicting risk perception (e.g., Brody, Zahran, Vedlitz, & Grover, 2008; Sundblad, Biel, & Gärling, 2007).

Cognitive factors measure the extent to which individuals know about the *causes*, *impacts*, and effective *responses* to climate change. van der Linden (2015) included these knowledge variables because merely knowing about climate change is a prerequisite to reasoning about the risk of climate change. Past research has indeed identified that accurate climate change knowledge is a significant predictor of climate change risk perception (e.g., Hornsey, Harris, Bain, & Fielding, 2016; Kaiser & Fuhrer, 2003; Milfont, 2012). van der Linden (2015) found that correctly identifying the causes of climate change (e.g., "driving a car" is a cause, while "the hole in the ozone layer" is not), its impacts (e.g., "increasing global sea level" is a likely impact, while "acid rain" is not), and effective responses (e.g., "switching from fossil fuels to renewable energy", and not "purchasing only organic products") was associated with greater risk perception.

Experiential processes include *affect* and *personal experience* with extreme weather events. In the CCRPM, affect is the extent to which participants view climate change as unpleasant, unfavourable, and negative. van der Linden (2015) specifies that affect here is distinguished from emotion, and instead should be thought of as an evaluative heuristic that influences information processing (Zajonc, 1980). Personal experience is a dichotomous measure of whether or not a participant had experienced any extreme weather event in their local area within the last five years. Personal experience is thought to influence risk perception through its ability to elicit vivid emotions that strongly influence judgements of risk perception (Loewenstein, Weber, Hsee, & Welch, 2001; McDonald, Chai, & Newell, 2015; van der Linden, 2015). van der Linden (2015) found that those who had experienced an extreme weather event tended to have higher risk perceptions than those who had not. However, the striking finding here was that affect was the single largest predictor of risk perception of all the predictors examined.

Lastly, socio-cultural influences include norms concerning climate change mitigation action, and the value orientations that guide an individual's worldview. *Descriptive norms* refer to the extent to which important others are personally acting to address climate change, and *prescriptive norms* refer to the extent to which important others expect an individual to act to address climate change. According to van der Linden (2015), these two variables capture the importance of social influences — social norms reinforced by important social referents — in transforming public risk perceptions into personal risk perceptions. Value orientations capture the influence of broader cultural values on personal risk perceptions, in line with the cultural theory of risk (Douglas & Wildavsky, 1982) and the cultural cognition approach (Kahan, 2012). The CCRPM assesses three value orientations: *biospheric* (respecting the environment), *socio-altruistic* (advocating for social justice), and *egoistic* (pursuing self-serving activities) values. Descriptive norms, prescriptive norms, and biospheric values significantly predicted risk perception in the final model (van der Linden, 2015).

It is worth noting that van der Linden (2015) deconstructed risk perception into *societal risk* and *personal risk*, each with its own profile of predictors. However, in our sample, societal and personal risk were highly correlated both with each other ($r = 0.87$, $p < .001$), and with the holistic risk variable that combined items assessing personal and societal risk ($r = 0.96$ to 0.97, $p < .001$). Additionally, a principal components analysis suggested that a unidimensional (one-factor) solution fit the data better than a two-factor solution (see Appendix C for details). We therefore deemed it inappropriate to separate the holistic risk index into two separate indices. Our goal remains determining the predictors of *holistic risk perception,* and therefore, all results presented will use the composite holistic risk measure.

1.2. Additional predictors: Free-market ideology and mitigation response inefficacy

1.2.1. Free-market ideology

Free-market ideology is the belief that markets should be left alone to function through supply and demand, without intervention by regulating bodies such as government (Heath & Gifford, 2006; Hornsey et al., 2016). One explanation for the inverse relationship between free-market ideology and support for climate change mitigation action, is that the two beliefs are inherently opposed. Supporting market autonomy and supporting large-scale mitigation strategies (e.g., government regulation) are cognitively dissonant attitudes (i.e., they are not psychologically consistent with each other; Festinger, 1962). One way to resolve this dissonance is to deny, or downgrade the importance of, climate change, thereby rendering mitigation or regulation unnecessary and allowing free-market ideology to exist unabated. Indeed, greater support for the free-market is associated with less belief in climate change (Heath & Gifford, 2006; Hornsey et al., 2016), the belief that climate change is natural or will not lead to negative consequences (Heath & Gifford, 2006), and the rejection of climate science findings (Lewandowsky, Gignac, & Oberauer, 2013).

1.2.2. Mitigation response inefficacy

Gifford (2011) identified one of seven 'dragons of inaction' to be 'limited cognition', which manifests itself as low perceived behavioural control or *inefficacy*. In the climate change domain, inefficacy beliefs can arise from the perception that climate change is an entrenched, global problem, and therefore individual behaviours, or even the mitigation efforts of a single group or nation, will have little effect (Gifford, 2011). For example, a commonly-cited reason for not adopting better climate change-related behaviours is the belief that changing one's own behaviour will not make a difference (e.g., Fielding & Head, 2012; Semenza et al., 2008). Efficacy beliefs are often deconstructed into the trait-like personality variable of *self-efficacy* and the state-like cognitive component of *response efficacy*. Self-efficacy is the belief in one's ability to successfully perform some action or response (Bandura, 1977), whereas response efficacy is the perceived ability of the response to effectively reduce or control a threat (Beck & Frankel, 1981; Witte,

1992). Although both are important for initiating protective behaviour, our inefficacy scale targets beliefs about the limited effectiveness of climate change mitigation actions. Hence, it is more closely related to previous conceptions of response efficacy than trait self-efficacy.

A second reason for introducing a new cognitive variable relates to van der Linden's (2015) finding that cognitive variables explain relatively little variance in risk perception, compared to affect. However, this may be due to the content overlap between items in the affect and risk perception measures. For example, the affect item "I see climate change as something that is [very pleasant to very unpleasant]" seems to address similar issues as the risk perception items "How concerned are you with climate change?" or "How often do you worry about the potentially negative consequences of climate change?". This large content overlap would cause affect to absorb a large amount of the explained variance among the full set of predictors, thus reducing the variance accounted for by cognitive variables. We expect our new response inefficacy variable to be an independent contributor to risk perception, which will therefore explain additional variance in risk perception.

While the existing predictors in the original CCRPM promote risk perception, free-market ideology and mitigation response inefficacy *undermine* risk perception. Thus, free-market ideology and mitigation response inefficacy function as 'resistance' factors that should be negatively correlated with risk perception and, presumably, behavioural willingness.

1.3. From risk perception to action—the predictors of behavioural willingness

Risk perception is undoubtedly crucial, but if the ultimate goal of research like ours is to encourage climate change mitigation and adaptation strategies, then an equally important construct to predict is *behavioural willingness*. Although some studies demonstrate that greater climate change risk perception predicts greater behavioural intention (O'Connor et al., 1999) and more energy conservation behaviours (Lacroix & Gifford, 2017), other researchers point out that perceived barriers to action (e.g., high financial cost, competing motives) may disrupt the oft-assumed pathway between risk perception and behaviour. For example, Bubeck, Botzen, and Aerts (2012) conclude that risk perception does not necessarily lead to flood mitigation behaviour. Engaging in mitigation behaviour also requires response efficacy (belief that the behaviour will be effective), self-efficacy (belief that they themselves can carry out the behaviour) and a sufficiently low response cost. Akompab et al. (2013) found that risk perception did not significantly predict adaptive heatwave behaviours (e.g., drinking plenty of water, seeking shade), but perceiving high benefit of an adaptive behaviour and experiencing "cues to action" (e.g., personal experience with a previous heatwave) did.

Thus, risk perception and behavioural willingness are not identical constructs, and it is important to examine the predictive profile of behavioural willingness separately. We will therefore use the original CCRPM, and the extended CCRPM including free-market ideology and mitigation response inefficacy, to predict both risk perception and behavioural willingness.

2. Method

2.1. Participants

Australian residents were recruited using the Qualtrics panel provider service. We obtained a quota sample to approximate the distribution of age and gender within the Australian population. Data were cleaned to omit people who failed an attention check question (n = 136), completed the survey too quickly (n = 73), or provided incomplete responses (n = 99). The final sample of 921 Australian residents was composed of 53% female respondents and the modal age bracket was 65 and over (compared to 35–44 in van der Linden, 2015). See Table 1 for the age and gender distribution and Appendix A for all other demographic characteristics.

Table 1
Sample sizes and gender split for each age bracket.

Age bracket	N (% of total sample)	% of Australian population [a]	Gender split (% female)
18–24	80 (9%)	12%	53.8%
25–34	148 (16%)	16%	45.3%
35–44	164 (18%)	15%	48.2%
45–54	161 (17%)	15%	50.9%
55–64	170 (19%)	13%	41.2%
65 or over	198 (21%)	18%	47.5%

[1] Australian Bureau of Statistics (2017) 2016 Census QuickStats. Retrieved from http://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/036?opendocument.

2.2. Materials and Procedure

The majority of materials were taken from van der Linden's (2015) survey instrument. Two additional predictor measures (free-market ideology and mitigation response inefficacy) and one additional outcome measure (behavioural willingness) not included in van der Linden's (2015) survey are described below. All items are provided in Appendix A. The survey was administered online from April to May 2016.

2.2.1. Free-market ideology

We included the six items used by Heath and Gifford (2006) in their 'Support for the free-market system' index. These items measure the relative priority placed on a system that supports an unrestrained free-market compared to a system that sustains environmental quality. For example, "The preservation of the free market system is more important than localized environmental concerns", scored from 1 = *Strongly disagree* to 7 = *Strongly agree*. Higher scores indicate more support for the free-market, relative to environmental sustainability. The full six-item index provided low internal reliability (Cronbach's α = 0.29) — we therefore removed two double-barrelled items (items 2 and 3), and report results using the four-item version (Cronbach's α = 0.69).

2.2.2. Mitigation response inefficacy

We created a four-item measure to assess the extent to which participants believed that climate mitigation action is unnecessary (because other issues should take priority and because technological solutions will be created) and/or ineffective (because we cannot make a difference) (Cronbach's α = 0.81). All items were scored on a seven-point Likert scale from 1 = *Strongly disagree* to 7 = *Strongly agree*, and are shown in Table 2. Higher scores indicate greater perceived inefficacy of climate mitigation action.

2.2.3. Behavioural willingness

This new outcome measure consisted of three scales measuring participants' willingness to engage in several climate change mitigation behaviours. In the Societal Willingness scale, participants were asked to rate the extent to which society should be willing to take actions such as "Increase the price of fuel for vehicles", and "Use public funds to give rebates to households that install solar and other renewable energy devices", from 1 = *Not at all willing* to 4 = *Very willing* (Cronbach's α = 0.87). The Personal Willingness scale asked participants to rate the extent to which they personally would be willing to take actions such as "Pay more for and use less electricity" and "Increase the number of times that I use public transportation, walk, or cycle each week", on the same 4-point Likert scale (Cronbach's α = 0.89). Lastly, the Advocacy Index scale asked participants to rate the extent to which they

Table 2
Items used in the Mitigation Response Inefficacy scale.

1	There is no urgency about taking action on climate change because new technologies will be developed to solve the issue of climate change.
2	I believe that we can act collectively and make a difference in reducing the negative effects of global warming. (reverse-scored)
3	We cannot take strong action on climate change now because other issues should take priority.
4	Whatever behaviour we, as a nation, engage in to reduce carbon emissions will make no real-difference in reducing the negative effects of global warming.

Table 3
Descriptive statistics and intercorrelations.

$N = 921$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	M (SD)
1. Cause Knowledge	(.56)														6.28 (1.88)
2. Impact Knowledge	.53***	(.58)													6.13 (2.29)
3. Response Knowledge	.52***	.50***	(.72)												7.43 (2.76)
4. Mitigation Response Inefficacy	-.07*	-.25***	-.40***	(.81)											3.13 (1.39)
5. Affect	.12***	.23***	.36***	-.65***	(.93)										5.35 (1.34)
6. Personal Experience	.05	.12***	.20***	-.28***	.29***	NA									NA
7.Descriptive Norms	-.04	-.02	.17***	-.35***	.27***	.14***	(.95)								4.07 (1.48)
8. Prescriptive Norms	.03	.15***	.32***	-.59***	.48***	.21***	.72***	(.78)							4.60 (1.26)
9. Biospheric Values	.01	.10**	.20***	-.47***	.47***	.20***	.38***	.50***	(.93)						6.48 (1.27)
10. Altruistic Values	.04	.102**	.21***	-.41***	.42***	.13***	.29***	.43***	.70***	(.89)					6.65 (1.24)
11. Egoistic Values	-.11**	-.17***	-.05	.09**	-.03	.07*	.19***	.09***	.17***	.16***	(.82)				4.77 (1.50)
12. Free-Market Ideology	-.17***	-.29***	-.32***	.47***	-.44***	-.15***	-.15***	-.34***	-.34***	-.34***	.14***	(.69)			3.49 (1.09)
13. Risk Perception	.07*	.21***	.40***	-.71***	.73***	.37***	.49***	.61***	.50***	.41***	.09*	-.43***	(.96)		4.46 (1.58)
14. Behavioural Willingness	.15***	.23***	.38***	-.55***	.53***	.26***	.41***	.54***	.43***	.34***	.04	-.43***	.66***	(.93)	2.23 (.73)

Note. Mean scale reliabilities (Cronbach's α) are provided along the diagonal. *$p < .05$, **$p < .01$, ***$p < .001$.

personally would be willing to take advocacy actions such as "Support a political candidate based on their commitment to climate change action" and "Encourage your family and friends to reduce greenhouse gases and energy consumption", again on the same 4-point Likert scale (Cronbach's $\alpha = 0.88$). The three subscales were significantly correlated with each other ($r = 0.72$ to 0.77, $p < .01$). Therefore, in the following regression models, the three scales were combined into a global *behavioural willingness* scale (Cronbach's $\alpha = 0.93$).

3. Results

3.1. Descriptive statistics

Table 3 shows the means and standard deviations of the variables used in the study and correlations between them (Appendix B shows the intercorrelations for demographic variables). All variables were significantly correlated with risk perception and behavioural willingness (except egoistic values, which was not correlated with behavioural willingness).

3.2. Predicting risk perception

3.2.1. Replicating van der Linden (2015)'s CCRPM

Following van der Linden (2015), we performed a hierarchical multiple regression analysis to examine the extent to which socio-demographic characteristics, cognitive factors, experiential processes, and socio-cultural influences predict risk perceptions of climate change. Each of these four variable sets was entered into the regression equation on separate steps. In Table 4, we report the regression results for each of the resulting prediction models.

Model 1 included socio-demographic characteristics. Participants who were younger, female, and relatively more liberal in their party affiliation, showed higher levels of risk perception than older, male, more conservative participants. Collectively, socio-demographic variables explained 11% of the variance in risk perception.

Model 2 added cognitive factors, to examine whether knowledge explains additional variance in risk perception beyond that explained by socio-demographic characteristics. All knowledge variables were significant predictors, collectively explaining an additional 15% of variance in risk perception. As we observed high collinearity among the three knowledge variables ($r = 0.50$ to 0.52, $p < .001$), we do not interpret their individual β values.

Model 3 added experiential processes, to test their effect on risk perception above and beyond the effects of socio-demographic and cognitive variables. As found in van der Linden (2015), more negative affect about climate change and reporting personal experience with an extreme weather event were significant predictors of increased risk perception. Affect and personal experience explained an additional 33% of variance in risk perception, greater than the 25% reported in van der Linden (2015).

Lastly, Model 4 added socio-cultural influences, and found descriptive norms, prescriptive norms, and biospheric values to be significant predictors. This is the same pattern of significant predictors reported in van der Linden (2015). Participants who perceived more norms around mitigation action, and those with stronger biospheric values, showed increased risk perception. Socio-cultural influences explained an additional 9% of variance, about half the 16% reported in van der Linden (2015). The final model accounted for 68% of the total variance in climate change risk perceptions — the same amount of explained variance reported by van der Linden (2015).

3.2.2. Extending the CCRPM

We repeated the above hierarchical regression, but added mitigation response inefficacy in Model 2 (Cognitive Factors) and free-market ideology in Model 4 (Socio-cultural Influences). As shown in Table 5, both response inefficacy and free-market ideology were significant predictors of perceived risk. Adding response inefficacy to the cognitive variables substantially increased the variance accounted for by cognitive factors (42%) compared to the original CCRPM model (14%; Table 4). Thus, those who perceive greater response inefficacy about climate change mitigation actions also perceive less risk. The extended CCRPM explains 72% of the variance in risk perception, 3% more than the original CCRPM without the two additional predictors.

In order to determine the significance of the improved fit of the extended CCRPM compared to the original CCRPM, we ran another hierarchical regression. Variables were entered into Models 1 to 4 as per the original CCRPM, before response inefficacy and free-market ideology were added in Model 5. The improved fit of the extended CCRPM, relative to the original CCRPM, was significant, $\Delta R^2 = 0.032$, $\Delta F = 51.642$, $p < .001$.

Table 4
Using the CCRPM to predict risk perception.

Independent Variables	Socio-demographics	Cognitive Factors	Experiential Processes	Socio-cultural Influences
	Model 1 (β)	Model 2 (β)	Model 3 (β)	Model 4 (β)
Age	-.13***	-.12***	-.03	-.07***
Gender	.09**	.08**	.00	-.01
Higher Education	.05	.02	.01	-.01
Party - conservative	-.10*	-.10**	-.03	-.06
Party - liberal	.20***	.15***	.08**	.03
Cause Knowledge		-.15***	-.10***	-.06*
Impact Knowledge		.08*	.00	.04
Response Knowledge		.42***	.20***	.13***
Affect			.59***	.46***
Personal Experience			.15***	.12***
Descriptive Norms				.19***
Prescriptive Norms				.12***
Biospheric Values				.11***
Altruistic Values				-.03
Egoistic Values				.04
N	921	921	921	921
Adj. R^2	.11	.26	.59	.68
R^2_{change}		.15	.33	.09
F_{change}	23.40***	64.48***	367.12***	53.927***

Note: Entries are standardised beta coefficients; *$p < .05$, **$p < .01$, ***$p < .001$. Significant predictors in the final model are shown in bold.

3.3. Predicting behavioural willingness

As often presumed, greater risk perception was significantly positively correlated with behavioural willingness ($r = 0.66$, $p < .001$). We further examined how well the predictors of risk perception also predict behavioural willingness. Table 6 shows the same four variable sets as Table 4 (entered into the hierarchical regression in the same order), but the outcome variable for Table 6 is behavioural willingness (not risk perception). In the final model, the profile of significant cognitive, experiential, and socio-cultural predictors is largely the same as when predicting risk perception. There are some notable differences however, in the role of socio-demographic characteristics. Although gender and higher education were non-significant predictors for risk perception, they were significant predictors for behavioural willingness. Specifically, females and those with education beyond high school (Year 12) showed greater behavioural willingness to take action compared to males and those without higher education. The total variance explained for behavioural willingness (44%) is considerably lower than the variance explained for risk perception (68%).

Table 5
Using an extended CCRPM to predict risk perception.

Independent Variables	Socio-demographics	Cognitive Factors	Experiential Processes	Socio-cultural Influences
	Model 1 (β)	Model 2 (β)	Model 3 (β)	Model 4 (β)
Age	-.13***	-.10***	-.04*	-.07***
Gender	.09**	.03	.00	.00
Higher Education	.05	.03*	.00	.00
Party - conservative	-.10*	-.03	-.02	-.04
Party - liberal	.20***	.07**	.06*	.03
Cause Knowledge		-.04	-.05*	-.03
Impact Knowledge		-.00	-.02	.02
Response Knowledge		.17***	.12***	.08***
Mitigation Response Inefficacy		-.60***	-.35***	-.26***
Affect			.41***	.36***
Personal Experience			.12***	.10***
Descriptive Norms				.20***
Prescriptive Norms				.04
Biospheric Values				.08**
Altruistic Values				-.04
Egoistic Values				.07***
Free-market Ideology				-.05*
N	921	921	921	921
Adj. R^2	.11	.54	.66	.72
R^2_{change}		.43	.12	.06
F_{change}	23.40***	213.45***	151.33***	34.13***

Note: Entries are standardised beta coefficients; *$p < .05$, **$p < .01$, ***$p < .001$. Significant predictors in the final model are shown in bold.

Table 6
Using the CCRPM to predict behavioural willingness.

Independent Variables	Socio-demographics	Cognitive Factors	Experiential Processes	Socio-cultural Influences
	Model 1 (β)	Model 2 (β)	Model 3 (β)	Model 4 (β)
Age	-.06	-.07*	.00	-.06*
Gender	-.02	-.01	-.06*	-.09***
Higher Education	.13***	.10***	.08**	.08***
Party - conservative	-.09*	-.08*	-.04	-.06
Party - liberal	.17***	.13***	.09**	.04
Cause Knowledge		-.07	-.04	.01
Impact Knowledge		.08*	.02	.04
Response Knowledge		.34***	.20***	.12***
Affect			.40***	.22***
Personal Experience			.09**	.06*
Descriptive Norms				.12**
Prescriptive Norms				.20***
Biospheric Values				.16***
Altruistic Values				-.02
Egoistic Values				-.01
N	921	921	921	921
Adj. R^2	.08	.20	.35	.45
R^2_{change}		.12	.15	.10
F_{change}	16.80***	47.02***	101.77***	35.27***

Note: Entries are standardised beta coefficients; *$p < .05$, **$p < .01$, ***$p < .001$. Significant predictors in the final model are shown in bold.

3.3.1. Extending the CCRPM

We added response inefficacy and free-market ideology to the above hierarchical regression in Models 2 and 4 respectively. We again found both of these predictors to be significant (see Table 7). The total variance explained by the extended model was 47%. As described for risk perception, we again sought to determine the significance of the improved fit of the extended CCRPM compared to the original CCRPM, when predicting behavioural willingness. Adding response inefficacy and free-market ideology significantly improved the fit of the model, compared to the original CCRPM, $\Delta R^2 = 0.026$, $\Delta F = 22.507$, $p < .001$.

3.4. The relative importance of predictors

The standardised β coefficients shown in Table 4 through 7 cannot be used to compare the relative explanatory power of these predictors (because β coefficients fail to account for the effect each predictor has in combination with other predictors). In order to compare predictors, we follow van der Linden's (2015) use of Pratt's (1987) technique of partitioning explained variance among predictors. As shown in

Table 7
Using an extended CCRPM to predict behavioural willingness.

Independent Variables	Socio-demographics	Cognitive Factors	Experiential Processes	Socio-cultural Influences
	Model 1 (β)	Model 2 (β)	Model 3 (β)	Model 4 (β)
Age	-.06	-.05	-.02	-.06*
Gender	-.02	-.05	-.07**	-.09***
Higher Education	.13***	.11***	.09***	.09***
Party - conservative	-.09*	-.04	-.03	-.03
Party - liberal	.17***	.08*	.07*	.04
Cause Knowledge		.01	.01	.03
Impact Knowledge		.02	.00	.02
Response Knowledge		.16***	.13***	.08*
Mitigation Response Inefficacy		-.45***	-.30***	-.14***
Affect			.24***	.15***
Personal Experience			.07**	.06*
Descriptive Norms				.14***
Prescriptive Norms				.14***
Biospheric Values				.13***
Altruistic Values				-.04
Egoistic Values				.02
Free-market Ideology				-.15***
N	921	921	921	921
Adj. R^2	.08	.35	.39	.47
R^2_{change}		.27	.04	.08
F_{change}	16.80***	97.47***	29.51***	24.01***

Note: Entries are standardised beta coefficients; *$p < .05$, **$p < .01$, ***$p < .001$. Significant predictors in the final model are shown in bold.

Table 8
Partitioning explained variance among all predictor variables in the extended CCRPM.

Independent variables	Partitioning of explained variance in;	
	Risk Perception	Behavioural Willingness
Socio-demographics		
Age	1.36%	0.77%
Gender	0.03%	0.28%
Higher Education	0.01%	1.17%
Party - conservative	0.98%	0.66%
Party - liberal	0.76%	0.89%
Total Variance Explained	**3.14%**	**3.75%**
Cognitive Factors		
Cause Knowledge	0.22%	0.39%
Impact Knowledge	0.36%	0.45%
Response Knowledge	3.22%	3.09%
Mitigation Response Inefficacy	18.12%	7.55%
Total Variance Explained	**21.91%**	**11.48%**
Experiential Processes		
Affect	26.30%	7.66%
Personal Experience	3.77%	1.46%
Total Variance Explained	**30.06%**	**9.12%**
Socio-cultural Influences		
Descriptive Norms	10.08%	5.61%
Prescriptive Norms	2.39%	7.52%
Biospheric Values	3.78%	5.77%
Altruistic Values	1.71%	1.29%
Egoistic Values	0.63%	0.09%
Free-market Ideology	2.21%	6.27%
Total Variance Explained	**20.80%**	**26.55%**
Overall Variance Explained	**75.91%**	**50.91%**

Note: The overall variance explained here is slightly higher than the final Adjusted R^2 values given in Tables 4 and 6, as adjusted R^2 values adjust for the number of predictors in a model.

Equation (1), the total standardised explained variance of a regression model (R^2) is the sum of each predictor's standardised regression coefficient (β_j) multiplied by its zero-order correlation with the dependent variable (r_j). Each predictor's 'importance' is equivalent to its variance explained ($\beta_j r_j$). Table 8 shows the partitioning of variance in risk perception and behavioural willingness, among the predictors of the extended CCRPM.

$$R^2 = \sum_j \beta_j r_j \quad (1)$$

Looking firstly at risk perception, we can see that affect was the single strongest relative predictor (26.30%) in the extended CCRPM. A novel finding here is the large role of mitigation response inefficacy. Response inefficacy was the second strongest relative predictor (18.12%) behind affect. Furthermore, response inefficacy was by far the most important cognitive factor, as the three knowledge variables contributed relatively little explained variance. Of the socio-cultural influences, descriptive norms were the strongest predictor. This is contrary to van der Linden's (2015) finding that prescriptive norms were more important than descriptive norms. Somewhat surprisingly, free-market ideology contributed little explained variance (2.21%).

Turning to behavioural willingness, we now see that socio-cultural influences and cognitive factors were more important than experiential processes (Table 8). Although affect continued to be the single predictor that explained the most variance (7.66%), it was closely followed by response inefficacy (7.55%) and prescriptive norms (7.52%). Prescriptive norms played a larger role than descriptive norms in predicting willingness, which was opposite to the pattern observed with risk perception. Another notable difference from the risk perception profile is the role of free-market ideology (6.27% variance explained). Free-market ideology was relatively unimportant for risk perception, but did contribute to the prediction of behavioural willingness.

Thus, affect and mitigation response inefficacy are important for predicting both risk perception and behavioural willingness. Socio-cultural influences however, played different roles in risk perception and behavioural willingness. Given the oft-implied causal pathway from risk perception to behavioural willingness, these differences are somewhat surprising. To further investigate the nature of these differences, we determined whether the effects of affect, response inefficacy, and socio-cultural influences on behavioural willingness were mediated by risk perception. In particular, we sought to distinguish between two possible mediation pathways. Given the similar roles of affect and response inefficacy for both outcome variables, one may expect their effects on behavioural willingness to be fully mediated by risk perception. Conversely, the different roles of prescriptive norms, biospheric values, and free-market ideology suggest these variables are only partially mediated by risk perception. That is, these variables may also have direct effects on behavioural willingness.

3.5. Risk perception partially mediates behavioural willingness

In the mediation model shown in Fig. 1, we included the two strongest predictors overall (affect and mitigation response inefficacy), and the three strongest predictors from the socio-cultural variable set — prescriptive norms, biospheric values, and free-market ideology.

Fig. 1 shows the bias-corrected standardised regression coefficients, following bootstrapping analyses with 1000 samples (as recommended by Preacher, Rucker, & Hayes, 2007). The standardised total effect of each of the five predictors on behavioural willingness was significant ($p < .004$, two-tailed). However, the direct effects of response inefficacy (95% *CI* [-0.07, 0.02], $p = .181$) and affect (95% *CI* [-0.03, 0.04], $p = .778$) on behavioural willingness were not significant, indicating that the effects of response inefficacy and affect on behavioural willingness were fully mediated by risk perception. On the other hand, the direct effects of prescriptive norms (*95% CI* [0.06, 0.13], $p = .002$), biospheric values (*95% CI* [0.002, 0.07], $p = .030$), and free-market ideology (*95% CI* [-0.13, −0.06], $p = .002$) on behavioural willingness *were* significant. Thus, the effects of the three socio-cultural influences on behavioural willingness were only partly mediated by risk perception. Standardised indirect effects reveal that prescriptive norms had the largest effect on behavioural willingness ($ab = 0.10$), relative to biospheric values ($ab = 0.04$) and free-market ideology ($ab = -0.02$).

As further exploration of the direct and indirect effects on behavioural willingness, we compared the fit of Model 1 with a reduced Model 2 where the two direct paths from response inefficacy and affect were removed. Table 9 reports various fit indices for the two models. Although the model fit was relatively poor in both cases,[1] the relevant finding is that removing the two direct paths in Model 2 did not reduce fit (but did improve parsimony).

The effect of response inefficacy on behavioural willingness being fully mediated by risk perception is surprising, given our initial proposal that response inefficacy would independently predict willingness. One reason for this full mediation may be the high correlation between response inefficacy and affect ($r = -0.65$, $p < .001$). This high correlation results in a large amount of shared variance between response inefficacy and affect, and thus little unique contribution by response inefficacy to the prediction of behavioural willingness. However, we reiterate that Table 7 shows that response inefficacy *was* a significant predictor of behavioural willingness.

[1] Poor model fit may indicate that the model has missing variables that impact behavioural willingness and/or that there are non-recursive relationships among variables in the model that have not been tested.

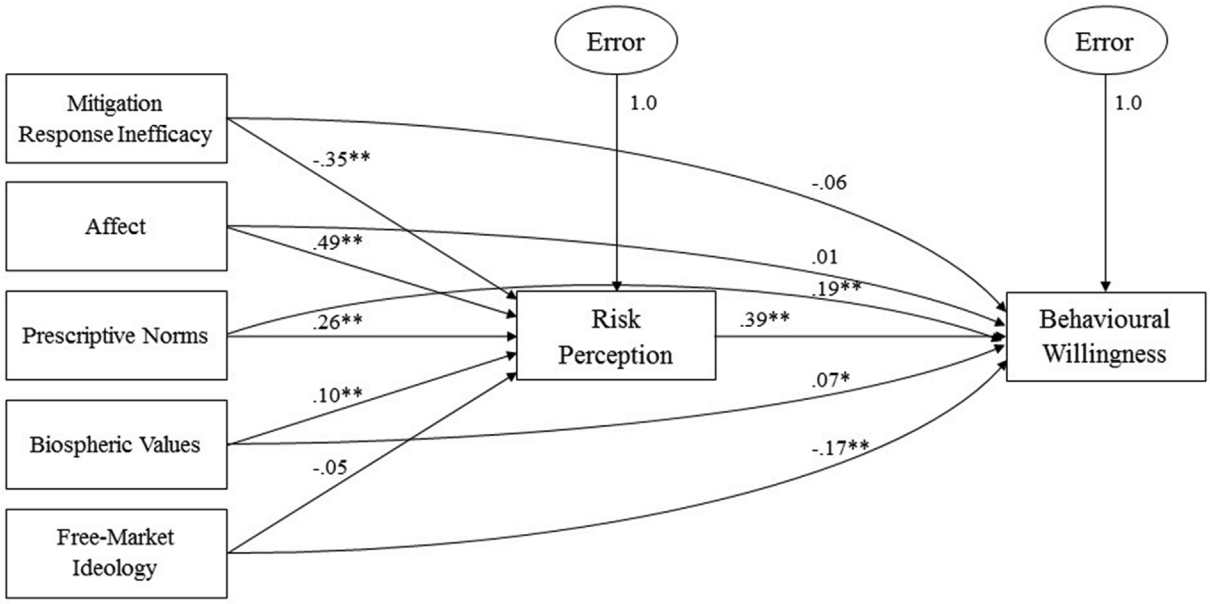

Fig. 1. Model 1, showing all direct and indirect paths from mitigation response inefficacy, affect, prescriptive norms, biospheric values, and free-market ideology to behavioural willingness. Standardised regression coefficients are shown for each path. $*p < .05$, $**p < .01$.

Table 9
Model fit indices for Model 1 and Model 2.

Fit Index	Model 1 (all direct and indirect effects)	Model 2 (partial mediation)
Degrees of freedom	10	12
Chi-square (p)	1636 (< .001)	1638 (< .001)
Root Mean Square Error of Approximation (RMSEA)	.399	.365
Comparative Fit Index (CFI)	.513	.513
Parsimony-Adjusted Comparative Fit Index (PCFI)	.244	.293

4. Discussion

This study's aims were to (1) test the generalisability of the CCRPM in a different national context and time period, (2) test whether free-market ideology and mitigation response inefficacy increased the CCRPM's explanatory power, and (3) explore the extent to which the predictors of risk perception also predict behavioural willingness. Overall, we found that van der Linden's (2015) CCRPM replicated well for an Australian population surveyed in 2016. On top of this replication, we found that mitigation response inefficacy was a strong predictor for both risk perception and behavioural willingness, while free-market ideology was relatively more important in predicting behavioural willingness. By separately examining risk perception and behavioural willingness, we found that risk perception was strongly dependent on experiential processes, whereas behavioural willingness was also driven by socio-cultural influences. Furthermore, behavioural willingness was not merely a 'secondary' process to risk perception, as certain socio-cultural predictors exerted direct effects on behavioural willingness, without being fully mediated by risk perception.

4.1. Predicting risk perception

The CCRPM accounted for as much variance (68%) in the risk perceptions of an Australian sample surveyed in 2016, as for a UK population surveyed in 2012. The relative contribution of predictors, and the direction of their effects on risk perception, were largely the same in our study as reported by van der Linden (2015). We agree with van der Linden's (2015) claim that experiential processes are important in shaping risk perception, as we also found affect to be the single strongest predictor of risk perception. These results reinforce the usefulness of the CCRPM as a model of climate change risk perception in Western industrialised democracies.

4.2. Extending the CCRPM

Adding mitigation response inefficacy and free-market ideology further increased the explanatory power of the CCRPM. The extended CCRPM model accounted for 72% of total variance in holistic risk perception. Mitigation response inefficacy was the second strongest predictor of risk perception, suggesting risk perception involves a significant cognitive component. Greater belief that mitigation action is unnecessary or ineffective is associated with perceiving less risk of climate change — mitigation response inefficacy thus 'put the brakes on' risk perception. Furthermore, we found that mitigation response inefficacy also indirectly exerts this 'braking' effect on behavioural willingness.

Our finding that mitigation response inefficacy's effect on behavioural willingness was fully mediated by risk perception is empirically explained by the high correlation between response inefficacy and affect. Although the items in the response inefficacy and affect measures seem very different at face value, a close reciprocal relationship between cognition and emotion is consistent with current literature. Studies in decision-making, social reasoning, and neuroscience have demonstrated bidirectional links between cognition and emotion generally (e.g., Dolcos, Iordan, & Dolcos, 2011; Schwarz, 2000), and in a climate change context (van der Linden, 2014). The high correlation between response inefficacy and affect also encourages a rethinking of van der Linden's (2015) claim that cognitive processes are much less important than experiential processes in predicting risk perception — it is possible that the affect variable absorbs much of the variance shared by cognitive variables, thus diluting the contribution of cognitive factors such as response inefficacy.

Given the importance of mitigation response inefficacy in reducing risk perception and behavioural willingness, we should consider how Australians form such beliefs. One source may be the Australian political rhetoric, in which response inefficacy frequently features in discussions around (hypothetical) climate change policy. At times of both data collection and writing, Australia has been under the leadership of

the conservative Liberal and National Party Coalition. Exceptional even in the context of other national conservative parties, the Coalition has consistently rejected policies seeking to regulate carbon emissions (Båtstrand, 2015). To justify this inaction, political elites often espouse mitigation response inefficacy. For example, in response to the IPCC Special Report on Global Warming of 1.5 °C (IPCC, 2018), Prime Minister Scott Morrison recommended we "… not forget that Australia accounts for just over 1% of global emissions …".[2] Likewise, the federal Minister for the Environment reassured us that "… every year there's new technology with respect to coal, and what its contribution is to emissions" ,[3] while the federal Treasurer warned that "If we were to take coal out of the system the lights would go out on the east coast of Australia overnight" .[4] In this way, public discourse — and political leadership — is dominated by the belief that we neither can, nor should, take mitigation action.

The political reluctance to implement even a market-based mitigation strategy (e.g., carbon trading) is related to our finding that free-market ideology was also influential in predicting willingness. Greater prioritisation of an unrestrained free market was associated with less willingness to take personal action or support societal interventions to combat climate change. This finding seems intuitive, but it is novel — existing research has only connected free-market ideology with risk perception (Heath & Gifford, 2006; Hornsey et al., 2016; Lewandowsky et al., 2013). As an interesting supplement to this previous research, we found that free-market ideology explained less than 3% of the variance in risk perception.

4.3. Behavioural willingness is not the same as risk perception

The extended CCRPM explained less variance in behavioural willingness (47%), compared to risk perception (72%). This suggests that important factors outside the scope of the CCRPM drive behavioural willingness. Factors such as the perceived cost of mitigation behaviours and low efficacy, can prevent behavioural willingness completely 'flowing on' from risk perception (Bubeck et al., 2012).

Nonetheless, we can use the CCRPM to illustrate some key differences between willingness and risk perception. For example, affect held a large 'advantage' over other predictors (in terms of variance explained) in risk perception. This advantage was eliminated when explaining behavioural willingness, as response inefficacy and prescriptive norms were almost equally as important as affect. In addition, descriptive norms were a stronger predictor of risk perception than prescriptive norms, whereas prescriptive norms were a stronger predictor of behavioural willingness than descriptive norms. That is, the extent to which important others are already acting against climate change (descriptive norms) influences your level of perceived threat, while the extent to which others *expect you* to act against climate change (prescriptive norms) drives your actual willingness to act. Thus, risk perception and behavioural willingness did not have identical profiles of predictors.

The 'behaviour motivation hypothesis' states that risk perception alters behaviour. For example, perceiving greater risk of Lyme disease can motivate vaccination (Brewer, Weinstein, Cuite, & Herrington, 2004). This is in line with the view that climate-related risk perception precedes and causally affects behavioural willingness (e.g., O'Connor et al., 1999; Spence et al., 2011; van der Linden, 2015). However, structural equation modelling in the current study revealed that prescriptive norms, biospheric values, and free-market ideology exerted direct effects on behavioural willingness. Unlike response inefficacy and affect, these socio-cultural influences affected behavioural willingness without being fully mediated by risk perception. For example, the extent to which others expect you to take climate change action (prescriptive norms) can directly affect your willingness to take such action, without necessarily increasing your risk perception of the intervening hazard (climate change). Thus, we should not conflate risk perception with behavioural willingness.

4.4. Implications and future directions

As demonstrated by van der Linden (2015) and van der Linden, Maibach, and Leiserowitz (2015), findings from the CCRPM can inform climate risk communication. For example, given the importance of experiential processes, van der Linden et al. (2015) recommended that policy-makers emphasise relevant, personal experience and affective stories. The clearest novel suggestion from the current study would be to decrease mitigation response inefficacy. To combat the 'should not' component of mitigation response inefficacy, communicators could emphasise that emissions reduction is not necessarily inconsistent with other legitimate concerns (e.g., economic growth, energy affordability). For example, policymakers could provide reliable evidence that certain renewable energy sources have already reached price parity with conventional sources (Motyka, Slaughter, & Amon, 2018). To combat the 'cannot' component of mitigation response inefficacy, we must communicate the feasibility of emissions reduction policies (e.g., transitioning to renewable energy), and the importance of reducing emissions despite constituting a relatively small proportion of global emissions. For example, the fact that Australia is one of the highest emitters per capita in the world (Olivier, Janssens-Maenhout, Muntean, & Peters, 2013) may more effectively illustrate the potential benefit of any mitigation policy (see Hurlstone, Lewandowsky, Newell, & Sewell, 2014 for further framing effects). Of course, public communication can address more than one facet of risk perception. For example, mitigation response inefficacy and prescriptive norms could be targeted simultaneously, by combining information about the economic viability of renewable energy with information about the international expectation for each nation to reduce its emissions (e.g., as represented by the Paris Agreement).

A second implication of the current work is that interventions targeting the factors that predict risk perceptions may fail to produce behavioural change. Though van der Linden's (2015) original work suggested the potential benefits of emphasizing personal experiences, this study highlights that strategies aimed at bringing climate change closer to home may be ineffective if they do not simultaneously target factors such as cost and efficacy perceptions.

To further inform communication strategies, future research should systematically examine the predictors of behavioural willingness and actual behaviour. Just as the CCRPM provided an integrated framework in which to study risk perception, a model consolidating the existing behavioural willingness literature would significantly advance our understanding of this related construct. For example, the importance of socio-cultural influences identified in the current study should be weighted relative to other previously-identified factors (e.g., resource cost of action) not explored in the current study.

In the context of promoting climate mitigation, we proposed behavioural willingness as a more important outcome variable than risk perception. However, we note that behavioural willingness is ultimately different from actual behaviour. Given previous research demonstrating a 'behaviour-intention gap' (see Gifford, Kormos, & McIntyre, 2011 for a review), this is another important avenue for

[2] Australian Broadcasting Corporation. Can we quit coal in time? IPCC warns world has just 12 years to avoid climate change catastrophe. (2018). https://www.abc.net.au/news/2018-10-11/can-we-quit-coal-in-time/10361552 Accessed 13 December 2018.

[3] Australian Broadcasting Corporation. Melissa Price; Paris commitment, IPCC and the Opera House. (2018). www.abc.net.au/radio/programs/am/melissa-price-paris-commitment-ipcc-and-the-opera-house/10354540 Accessed 13 December 2018.

[4] ParlInfo. The Hon Josh Frydenberg MP Interview with Sharri Markson, Sky News. (2018). https://parlinfo.aph.gov.au/parlInfo/download/media/pressrel/6263422/upload_binary/6263422.pdf;fileType=application%2Fpdf#search=%22media/pressrel/6263422%22. Accessed 13 December 2018.

future research (see also van der Linden, 2017). By identifying the relative contribution of various predictors to behavioural willingness and actual behaviour, researchers will be better positioned to provide specific and effective advice for policymakers and public communicators seeking to increase mitigation action.

Declarations of interest

None.

Statement of institutional ethics review and approval

This study was carried out in accordance with the recommendations of the National Statement on Ethical Conduct in Human Research. The protocol was approved by the Human Research Ethics Advisory Panel C at the University of New South Wales. All subjects gave informed consent in accordance with the Declaration of Helsinki.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2019.101331.

Appendix B

Table A1
Intercorrelations for demographic variables and all other predictors

n = 921	Age	Gender	Higher Education	Party – conservative	Party - liberal
1. ause Knowledge	.11**	-.22***	.11***	.04	-.02
2. Impact Knowledge	.08*	-.12***	.06	-.03	.06
3. Response Knowledge	-.01	-.04	.09**	-.06	.10*
4. Mitigation Response Inefficacy	.10**	-.09**	-.01	.22***	-.24***
5. Affect	-.18**	.10**	.09**	-.22***	.23***
6. Personal Experience	.13***	-.03	-.03	.12***	-.09*
7. Descriptive Norms	.03	.07*	.01	-.05	.15***
8. Prescriptive Norms	-.02	.11**	.01	-.12***	.21***
9. Biospheric Values	.06	.19***	.01	-.10**	.13***
10. Altruistic Values	.04	.24***	-.03	-.12***	.15***
11. Egoistic Values	-.06	-.03	-.02	.08*	-.01
12. Free-Market Ideology	.02	-.03	-.03	.22***	-.18***
13. Risk Perception	-.19***	.077***	.05	-.25***	.28***
14. Behavioural Willingness	-.12***	-.03	.13***	-.21***	.24***

Note. *$p < .05$, **$p < .01$, ***$p < .001$. Gender compares males relative to females; Higher Education compares those with higher education (beyond Year 12) to those without; Party – conservative compares those who are relatively more conservative to all others; and Party – liberal compares those who are relatively more liberal to all others.

Appendix C

Table A2
Factor loadings for Risk Perception items.

Risk Perception Items	Factor loadings (one-factor solution)
How concerned are you with climate change? *(Personal)*	.92
In your judgment, how likely are you, sometime during your life, to experience serious threats to your health or overall well-being, as a result of climate change? *(Personal)*	.81
How serious of a threat do you believe that climate change is, to you personally? *(Personal)*	.90
How often do you worry about the potentially negative consequences of climate change? *(Personal)*	.85
In your judgment, how likely do you think it is that climate change will have very harmful, long-term impacts on our society? *(Societal)*	.91
How serious of a threat do you think that climate change is to the natural environment? *(Societal)*	.91
How serious would you rate current impacts of climate change around the world? *(Societal)*	.92
How serious would you estimate the impacts of climate change for Australia? *(Societal)*	.94

Table A2 shows that the factor loadings onto one component were sufficiently high (ranging from 0.81 to 0.94 — compare to van der Linden's (2015) factor loadings of 0.77–0.92 for his 2-factor solution). Furthermore, all eight items were significantly correlated with each other (r = 0.63 to 0.87, $p < .001$), and the scree plot and distribution of eigenvalues suggested one component.

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