

# Associations of locus of control, information processing style and anti-reflexivity with climate change scepticism in an Australian sample

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## Abstract

A proportion of the Australian public remains sceptical about the reality of climate change, its causes, impacts and the need for mitigatory action. To date, scepticism research largely focuses on factors highly resistant to change, particularly socio-demographic and value factors. This mixed-methods study investigated whether more malleable psychological factors: locus of control; information processing style; and anti-reflexivity, predicted climate change scepticism above and beyond socio-demographic and value factors. A sample of 390 participants (*Mean* age = 41.31, *standard deviation* = 18.72; 230 male) completed an electronic survey. Using hierarchical regression, trust in forces of anti-reflexivity and external locus of control predicted impact scepticism. Decreased trust in forces of reflexivity also predicted attribution and impact scepticism. Finally, external locus of control predicted response scepticism. Key qualitative themes identified were, trust in alternative science; mistrust of climate science; belief in natural cycles; predictions not becoming reality; and ulterior motives of interested parties.

## Keywords

anti-reflexivity, climate change, information processing style, locus of control, public beliefs

## 1. Introduction

According to the Intergovernmental Panel on Climate Change (IPCC), climate change refers to statistically identifiable long-term changes in the Earth's climate (IPCC, 2013). Owing to its rapid rate and association with human behaviour, climate change represents an unprecedented global challenge that threatens aspects of both the natural environment and human life (IPCC, 2018).

Climate change scepticism takes on a variety of different meanings throughout the literature. Some researchers define scepticism as the complete rejection of climate change while others have

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described it as uncertainty about climate change trends, causes and consequences (Tuitjer et al., 2022; Van Rensburg and Head, 2017; Weckroth and Ala-Mantila, 2022).

Drawing on previous criticisms of uni-dimensional definitions, climate change scepticism can be divided into categories that help explain how people find ways to reject climate science or question the reality of climate change (Rahmstorf, 2004; Wang and Kim, 2018). Rahmstorf (2004) developed a three-dimensional definition of: trend, impact and attribution scepticism, with Capstick and Pidgeon (2014) proposing a fourth category, response scepticism. In detail, these comprise: trend scepticism – the rejection of or uncertainty about the *reality* of climate change; attribution scepticism – rejection or uncertainty about the *causes* of climate change; impact scepticism – rejection or uncertainty about the *impact* of climate change; and response scepticism – the *need to act* in ways recommended by scientists.

Australia is one of many countries that are particularly vulnerable to climate change, with water scarcity, public health, sea-level rise and species loss at the forefront of concern (Malerba et al., 2022; Nishant et al., 2022; Watson et al., 2017; Zhang et al., 2018). Despite the challenges of climate change, public beliefs in Australia are polarised with scepticism on the rise (Akter et al., 2012; Connor and Higginbotham, 2013; Hine et al., 2013; Tranter and Lester, 2017). Approximately 7% of the Australian population reject the notion of climate change with a further 10% to 15% sceptical (Hine et al., 2013; Morrison et al., 2018; Tranter and Booth, 2015). Moreover, research has also shown that 40% of the Australian public are sceptical about the cause and projected impacts of climate change while approximately 20% are sceptical about the nature/degree of responses proposed (Ashworth et al., 2011). It is clear that sceptics are a major barrier to combating climate change as they not only resist mitigation policies but also unrealistically amplify uncertainties within the general populace (Berger and Wyss, 2021; Hornsey et al., 2016). Understanding the determinants of climate change scepticism is therefore an important area of current and future research.

### Value factors

The gap between the scientific and public consensus about climate change is influenced by a multitude of factors (Milfont et al., 2015). Findings consistently demonstrate that those who favour conservative political parties and hold low pro-environmental values are more likely to express scepticism about climate change (Capstick and Pidgeon, 2014; Engels et al., 2013; Fielding and Head, 2012; Kahan et al., 2012; Smith and Hempel, 2022; Tranter, 2013). Such findings are frequently explained by the theoretical concept of motivated reasoning (Campbell and Kay, 2014; Corner et al., 2011). Motivated reasoning refers to the process by which information is intentionally interpreted to match one's pre-existing values or beliefs (Kunda, 1990). Regarding political preference, those who support conservative parties value capitalism and minimal government intervention whereas those who support more progressive parties value equality and are thus more likely to support governmental action that seeks to enhance sustainability values within society (Ziegler, 2017). Since climate change mitigation policies run contrary to the values of political conservatives, it could be that conflicting evidence is intentionally misinterpreted to match one's existing values and beliefs.

Cultural worldviews also have a polarising effect on an individual's beliefs about climate change (Lubke, 2022; Wang and Kim, 2018). Consistent across several Westernised countries including Australia, those who subscribe to individualistic values are significantly more likely to be sceptical (Capstick and Pidgeon, 2014; Haltinner and Sarathchandra, 2022; Leiserowitz et al., 2013; Price et al., 2014) and express less concern about climate change in comparison to those who endorse egalitarian values. The Cultural Cognition Thesis (CCT) stipulates that beliefs about

societal risks are influenced by the characteristic values of the groups with which they identify (Hornsey et al., 2018; Kahan, 2013; Kahan et al., 2012; Kunda, 1990). Thus, as with the concept of motivated reasoning, to reach a state of congruence, individuals interpret scientific evidence in a way that aligns with their prevailing cultural values. Mitigating the effects of climate change will involve placing restrictions on capitalism and industry, therefore conflicting with activities valued by those who endorse individualism (Capstick and Pidgeon, 2014; Hornsey et al., 2018). Therefore, as posited by the CCT, an individual's pre-existing beliefs and values may bias their interpretation of evidence.

### *Socio-demographic factors*

Regarding socio-demographic factors, relatively small effects have been observed (Ashworth et al., 2011; Leviston and Walker, 2011; Lubke, 2022; Tranter and Skrbis, 2014). The majority of findings indicate that older (Akter et al., 2012; Ashworth et al., 2011; Whitmarsh, 2011) men (Ashworth et al., 2011; McCright and Dunlap, 2011; Reser et al., 2012; Tranter and Skrbis, 2014), living rurally (Leviston and Walker, 2011; Reser et al., 2012) are more likely to express climate change scepticism than any other group. The relationship between scepticism and factors such as education, income and religiosity is less clear, with both significant and non-significant findings (Lubke, 2022; Morrison et al., 2013). Although substantial efforts have been made to investigate the role of socio-demographic and value factors, such factors are arguably resistant to change and are therefore unlikely to be altered.

### *Individual differences*

Arguably, socio-demographic and value factors may be of little use when attempting to increase public support for mitigation policies as such factors are entrenched and highly resistant to change. Thus, it seemed valuable to explore and expand on the small body of psychological factors associated with climate change scepticism (Coleman et al., 2022). Further to this, the researchers saw the practical implications of exploring malleable contributing factors: specifically the potential to enhance the public's perceptions of control, analytical information processing and trust in forces of reflexivity.

### *Locus of control*

Despite the potential to serve as a catalyst for behavioural action (Ryon and Gleason, 2014; Trivedi et al., 2015), limited research has explored the association between Locus of Control (LoC) and climate change scepticism. LoC refers to the extent to which individuals attribute control over outcomes in life internally, or externally (to factors such as chance or powerful others) (McCarty and Shrum, 2001; Pickering et al., 2021). Given the sheer magnitude and complexity of climate change, LoC is expected to play a pivotal role in shaping public beliefs. Previous studies have shown that having an internal LoC in regard to the environment increases environmental concern as well as pro-environmental intentions and behaviour (Cleveland et al., 2020; Fielding and Head, 2012; Pavalache-Ilie and Unianu, 2012).

Given that climate change is a pressing global challenge, it is likely that LoC influences beliefs about climate change differently to environmental/conservation beliefs. Research by Mostafa (2016) and Pickering et al. (2021) determined that a positive association exists between LoC and concern for global warming, suggesting it is worthwhile exploring its unique association with climate change scepticism.

### *Information processing style*

Epstein's (1994) Cognitive-Experiential Self Theory (CEST) provides a theoretical framework for determining an individual's information processing style, proposing two independent and interrelated processing modes: rational-analytical and experiential-intuitive. The rational-analytical mode is conscious, analytical and informed by established rules and hence considered superior in the evaluation of evidence and consideration of potential consequences to the experiential-intuitive approach, which is preconscious, automatic and rapid (Betsch and Glockner, 2010). Research demonstrates that analytical processing is negatively associated with unfounded beliefs above and beyond variables such as cognitive ability and socio-demographics (Pennycook et al., 2012; Shenhav et al., 2011). Research also shows that intentionally eliciting analytical thinking through experimental manipulations is effective in reducing conspiracy beliefs (Swami et al., 2014). Given the potential for analytical information processing to counteract misconceptions, it is pertinent to examine whether variance in climate change scepticism is predicted by information processing style.

### *Anti-reflexivity*

In environmental sociology, the Anti-Reflexivity Thesis (ART) is a relatively recent theoretical paradigm used to explain organised climate change denial (Givens et al., 2021; McCright, 2016; McCright et al., 2016). The ART stems from the concept of reflexive modernisation which refers to the process by which an individual acknowledges and challenges the problems associated with our modern industrial capitalist system (McCright and Dunlap, 2010). As such, the ART suggests that proponents seek to defend the industrial capitalist system against the accusations of reflexive forces (McCright, 2016). While considerable literature has successfully utilised the ART to explain organised denial (McCright and Dunlap, 2010; McCright et al., 2013), evidence for its utility in explaining individual scepticism is sparse. McCright (2016) sought to address this gap within the literature by showing that public trust in groups representing the industrial capitalist system increased the likelihood of scepticism regarding the actuality and cause of climate change. Conversely, increased trust in environmental groups and the scientific community decreased the likelihood of scepticism. Given that this research was conducted exclusively in the United States, where some of the world's highest levels of scepticism (and lower levels of climate change concern) have been reported, these insights should be treated as tentative in their application elsewhere (Burn-Murdoch and Hook, 2019; Egan and Mullin, 2017). With increasing rates of climate change scepticism and prominent manifestations of anti-reflexivity, research assessing the ART in an Australian context is clearly of interest.

The present study extends past research to focus on the more potentially malleable features of LoC, information processing style and trust in forces of anti-reflexivity in their utility as predictors of climate change scepticism above and beyond socio-demographic and value factors. We hypothesised that all three would predict scepticism about **(H1)** the reality (trend scepticism), **(H2)** the cause (attribution scepticism), **(H3)** the consequences (impact scepticism) and **(H4)** the types of responses necessary to mitigate climate change (response scepticism).

A content analysis of climate change beliefs was also undertaken as we identified a lack of qualitative research that allowed individuals to elaborate on and justify their beliefs. The qualitative analysis provides additional insight into individual reasoning and captures additional themes/reasons for climate change scepticism, which may highlight areas for future research. In short, we were interested in hearing directly from participants as to how they justified/argued their position when expressing scepticism about each of the four domains.

## 2. Method

### *Participants, design, materials and procedure*

A 10 to 15 minute online survey was designed and hosted via Survey Monkey. Participants were eligible to participate in the current study if they were 18 years or older and resident in Australia. The final sample ( $N=390$ ) comprised 142 women, 230 men and 16 individuals who did not specify their gender. Participant ages ranged between 18 and 79 years ( $M=41.31$ , standard deviation ( $SD$ )= $18.72$ ). The online supplemental file details further information regarding the demographics.

No incentives were offered. Participants were recruited through snowball sampling, the questionnaire being shared on the researchers personal social media as well as weekly on online social networking sites such as Facebook (e.g. Group; Climate Change Battle Royale), Reddit (such as r/psychologyresearch; r/climate; r/australianpolitics) and Twitter. Informed consent was obtained from all individual participants included in the study. All procedures involving human participants were in accordance with the ethical standards of the Human Research Ethics Committee of the University of the Sunshine Coast (approval number S191316).

The first component of the survey required participants to answer basic socio-demographic questions regarding age, gender, education, employment, area of residency, state, income, political preference and religiosity. Next, participants' environmental values were measured by a shortened, seven-item version of the New Environmental Paradigm (NEP) (Dunlap et al., 2000; Whitmarsh, 2011). Items were rated on a 5-point Likert-type scale from (1) 'Strongly Disagree' to (5) 'Strongly Agree'. Higher scores were indicative of stronger pro-environmental values. Individualism and egalitarianism were then measured using a six-item worldview scale derived from Capstick and Pidgeon (2014). These items were rated on a 5-point Likert-type scale from (1) 'Strongly Disagree' to (5) 'Strongly Agree'. Higher scores on an index reflected greater endorsement of the given worldview. To measure processing style, participants completed a shortened version of the Rational-Experiential Inventory (REI-10) (Epstein et al., 1996). Items were rated on a 5-point Likert-type scale, from (1) 'Completely False' to (5) 'Completely True'. Higher scores on each subscale reflected a greater preference for the given processing style (Epstein et al., 1996).

Climate change scepticism was measured using eight items developed in previous research (Capstick and Pidgeon, 2014; Leiserowitz et al., 2013; Poortinga et al., 2011; Whitmarsh, 2011). The scale included four two-item subscales – measuring trend, attribution, impact and response scepticism. Items were rated on a 5-point Likert-type scale ranging from (1) 'Strongly Disagree' to (5) 'Strongly Agree', with higher scores on each subscale reflecting greater scepticism about climate change. An open-ended question was then posed, inviting participants to explain their reasoning for their beliefs about climate change.

Next, anti-reflexivity and reflexivity were measured with four items adapted from McCright (2016) to fit an Australian context. Participants were asked to indicate how much they trust certain groups to provide them with information from (1) 'Do not trust at all' to (5) 'Trust completely'. Higher scores on a subscale represented greater trust in the given entity. Finally, respondents completed Levenson's Multidimensional Locus of Control Inventory (Levenson, 1973). This inventory contains three eight-item subscales: internal, chance and powerful others. All 24 items were rated on a 6-point Likert-type scale, ranging from (1) 'Strongly Disagree' to (6) 'Strongly Agree'. Higher scores on the internal sub-scale indicated a stronger internal LoC. Similarly, higher scores on the chance and powerful others subscales indicated a stronger external LoC.

## Data analysis

Quantitative analyses were completed with the Statistical Package for the Social Sciences (SPSS). To identify the predictors of trend, attribution, impact and response scepticism, four hierarchical multiple regression models were produced using two blocks each. Socio-demographic (i.e. age; gender; education; area of residency; income; religiosity) and value factors (i.e. political preference; environmental values; cultural worldviews) were included in the first block. LoC, information processing style, trust in forces of reflexivity and anti-reflexivity were included in the second block.

An *a priori* Gpower analysis was undertaken to determine the required number of participants for this study design (Erdfelder et al., 1996). Using a medium effect size, power of .80, error .05 and 17 predictors, Gpower calculated 146 participants as adequate.

The data were initially screened for redundant responses (e.g. if the participant dropped out after the first question). Inappropriate and ambiguous responses (e.g. 'pepper pig') were also removed. Thematic analysis was then employed to identify major themes. Braun and Clarke's (2006) six-phase guide was followed. In short, stages one and two involved becoming acquainted with the data and generating initial codes. Stage three involved considering how individual themes might combine to form overarching themes. Stage four involved assessing whether themes are internally consistent and externally distinct. The fifth and sixth stages, respectively, involved defining and naming themes, and describing the findings.

## 3. Results

Participants were removed if they dropped out after the first question. Missing completely at random (MCAR) analysis revealed data were missing at random aside from the two-item subscale assessing trend scepticism. One item was identified as problematic and was not included in later analyses. Pairwise deletion was therefore used in the statistical analyses. Tolerance statistics and variance inflation factor (VIF) scores were within recommended limits.

### *Hierarchical multiple regression results*

Please see the online supplemental file for correlations between variables.

The hierarchical multiple regression for trend scepticism (Table 1) shows that age, political preference and environmental values were significant predictors in Block 1, explaining 20% of the variance in trend scepticism,  $F(10, 274) = 6.84, p < .001, R^2 = .20$ . Variables entered in the second block did not result in a significant  $\Delta R^2$  above Block 1,  $F(7, 267) = 1.93, p < .07, \Delta R^2 = .04$ .

The hierarchical multiple regression for attribution scepticism shows (Table 2) that age, political preference, environmental values, egalitarianism and individualism were all significant predictors in Block 1, explaining 77% of the total variance in attribution scepticism,  $F(10, 274) = 92.65, p < .001, R^2 = .77$ . The addition of psychological variables in the second block resulted in significant  $\Delta R^2$  above Block 1,  $F(7, 267) = 7.48, p < .001, \Delta R^2 = .04$ . Analytical information processing style and trust in forces of reflexivity were significant predictors, uniquely explaining 6% and 16% of attribution scepticism, respectively. The full model explained 81% of total variance, with age, religiosity, political preference, environmental values, individualism, analytic processing style and trust in forces of reflexivity identified as significant predictors.

For the hierarchical multiple regression for impact scepticism (Table 3) age, religiosity, political preference, environmental values and egalitarianism predicted impact scepticism in Block 1.  $F(10, 274) = 56.60, p < .001, R^2 = .67$ . The second block resulted in a significant  $\Delta R^2$  above Block 1,  $F(7, 267) = 6.41, p < .001, \Delta R^2 = .05$ . Trust in forces of reflexivity, anti-reflexivity and external LoC

**Table 1.** Hierarchical multiple regression for trend scepticism.

	$\Delta R^2$	Step 1				Step 2			
		B	CI	$\beta$	sr <sup>2</sup>	B	CI	$\beta$	sr <sup>2</sup>
<b>Block 1</b>	<b>.20***</b>								
Gender		.17	[-.14, .48]	.07		.16	[-.16, .48]	.06	
Age		.02	[.01, 0.3]	.25***	.19	.01	[.00, .02]	.19	
Education		-.06	[-.13, .01]	-.10		-.04	[-.11, .03]	-.06	
Residential area		.15	[-.06, .35]	.08		.09	[-.11, .30]	.05	
Income		-.01	[-.04, .03]	-.03		-.01	[-.05, .03]	-.03	
Religiosity		-.08	[-.18, .01]	-.10		-.08	[-.18, .01]	-.10	
Political pref		.16	[.01, .30]	.16*	.11	.12	[-.04, .27]	.12	
Environ value		-.36	[-.61, -.12]	-.27*	-.16	-.24	[-.50, .02]	-.18	
Egalitarianism		.14	[-.07, .33]	.14		.16	[-.05, .36]	.16	
Individualistic		-.02	[-.25, .21]	-.02		-.14	[-.39, .11]	-.10	
<b>Block 2</b>	<b>.04</b>								
Analytical						-.13	[-.33, .08]	-.07	
Intuitive						.19	[.01, .36]	.13	
Trust reflexivity						-.23	[-.44, -.03]	-.23	
Trust anti-reflexivity						.10	[-.06, .26]	.09	
Internal						-.00	[-.03, .02]	-.02	
Chance						-.02	[-.04, .01]	-.08	
Powerful others						.01	[-.01, .04]	.08	

Note. CI: confidence interval;  $\beta$ =Standardised Betas; sr<sup>2</sup>=semi-partial correlations; R<sup>2</sup>=.20, Adj R<sup>2</sup>=.17 for Model 1; R<sup>2</sup>=.24, Adj R<sup>2</sup>=.19 for Model 2.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

(subscale; powerful others) were significant predictors within Model 2, uniquely explaining 17%, 10% and 7% impact scepticism, respectively. In the final model, religiosity, political preference, environmental values, reflexivity, anti-reflexivity and external LoC (subscale; powerful other) predicted impact scepticism. The final model accounted for 72% of total variance, with religiosity, political preference, environmental values, reflexivity, anti-reflexivity and external LoC (subscale; powerful other) identified as significant predictors of impact scepticism.

The hierarchical multiple regression for response scepticism shows (Table 4) that gender, age and environmental values were significant predictors of response scepticism in Block 1, explaining 48% of the total variance in response scepticism,  $F(10, 274)=25.60$ ,  $p < .001$ ,  $R^2=.48$ . The second block resulted in a significant  $\Delta R^2$  above Block 1,  $F(7, 267)=4.66$ ,  $p < .001$ ,  $\Delta R^2=.06$ . External LoC (subscale; chance) was the only significant predictor in Step 2 explaining 14% response scepticism. In the full model, environmental values and external LoC (subscale; chance) were identified as significant predictors.

### *Self-reported reasoning for climate change scepticism*

Using Braun and Clarke's (2006) six-phase guide, five main themes were identified (Table 5) in response to the question 'What are the primary reasons for your beliefs/attitudes towards climate change?' The first theme, trust in alternative science, articulates the belief that research opposing anthropogenic climate change is superior and more legitimate than climate science.

**Table 2.** Hierarchical multiple regression for attribution scepticism.

	$\Delta R^2$	B	Step 1			Step 2				
			CI	$\beta$	$sr^2$	B	CI	$\beta$	$sr^2$	
<b>Block 1</b>	<b>.77***</b>									
Gender		.03	[-.18, .24]	.01		.07	[-.13, .27]	.02		
Age		.02	[.01, .03]	.25***	.20	.01	[.01, .02]	.16***	.12	
Education		.00	[-.05, -.05]	.00		-.00	[-.05, .04]	-.00		
Residential area		-.03	[-.17, .10]	-.01		-.05	[-.18, .08]	-.02		
Income		.00	[-.02, .03]	.01		.00	[-.02, .03]	.01		
Religiosity		-.06	[-.13, .00]	-.06		-.07	[-.13, -.01]	-.06*	-.06	
Political pref		.21	[.11, .31]	.17***	.12	.14	[.04, .24]	.12**	.08	
Environ value		-.60	[-.76, -.44]	-.35***	-.21	-.43	[-.60, -.27]	-.26***	-.14	
Egalitarianism		-.17	[-.31, -.04]	-.14**	-.07	-.08	[-.21, .05]	-.06		
Individualistic		.30	[.15, .46]	.17***	.11	.17	[.02, .33]	.10*	.06	
<b>Block 2</b>	<b>.04***</b>									
Analytical						.16	[.03, .29]	.07*	.06	
Intuitive						.08	[-.03, .19]	.05		
Trust reflexivity						-.40	[-.52, -.27]	-.31***	-.16	
Trust anti-reflexivity						.10	[-.00, .20]	.07		
Internal						.00	[-.02, .02]	-.00		
Chance						.00	[-.01, .02]	.01		
Powerful others						-.01	[-.03, .00]	-.05		

Note. CI: confidence interval;  $\beta$ =Standardised Betas;  $sr^2$ =semi-partial correlations;  $R^2$ =.77, Adj  $R^2$ =.76 for Model 1;  $R^2$ =.81, Adj  $R^2$ =.80 for Model 2.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

The belief that climate change is part of a natural cycle was the second most commonly cited explanation for scepticism. Respondents noted that historical and current changes in the climate are cyclic and asserted that human behaviour plays no role in the changing climate. Consequently, it was frequently noted that there is no need for mitigation action.

The next theme included mistrust in climate science. Respondents frequently alleged misconduct by climate scientists, selective data collection and biased analyses, and the ignoring of contradictory data.

Predictions not becoming a reality formed the fourth theme. Within this theme, individuals stated that they were not observing what had once been projected. Respondents also commented that the portrayal of risk communication and perceived projections was both alarmist and false.

The final theme (ulterior motives of interested parties) involves a belief that climate change is a deception designed for the accumulation of power. This theme has a political rather than scientific basis. Example statements characterising each theme are in Table 5.

## 4. Discussion

### Quantitative findings

The aim of this study was to investigate the factors that predict climate change scepticism in Australia. This study adds to the literature by exploring whether potentially malleable psychological factors such as LoC, information processing style and trust in forces of anti-reflexivity predict



**Table 3.** Hierarchical multiple regression for impact scepticism.

	$\Delta R^2$	B	Step 1			Step 2			
			CI	$\beta$	$sr^2$	B	CI	$\beta$	$sr^2$
Block 1	.67								
Gender		-.02	[-.24, .21]	-.01	.03		[-.19, .24]	.01	
Age		.01	[.01, .02]	.18***	.14	.01	[-.00, .01]	.07	
Education		.01	[-.04, .05]	.01	.01	.01	[-.04, .06]	.02	
Residential area		.07	[.07, .22]	.04	.07	.07	[-.07, .21]	.03	
Income		.00	[-.02, .03]	.01	.01	.01	[-.02, .03]	.01	
Religiosity		-.12	[-.19, -.05]	-.13***	-.12	-.13	[-.19, -.06]	-.13***	-.12
Political pref		.27	[.17, .38]	.25***	.18	.18	[.07, .28]	.16***	.11
Environ value		-.51	[-.69, -.34]	-.34***	-.20	-.33	[-.51, -.15]	-.22***	-.12
Egalitarianism		-.17	[.31, -.02]	-.15*	-.08	-.09	[-.23, .05]	-.08	
Individualistic		.13	[-.04, .29]	.08		-.01	[-.18, .16]	-.01	
Block 2	.05								
Analytical					.07		[-.08, .21]	.03	
Intuitive					.02		[-.10, .14]	.01	
Trust reflexivity					-.37		[-.51, -.23]	-.33***	-.17
Trust anti-reflexivity					.17		[.06, .28]	.13***	.10
Internal					.01		[-.01, .03]	.05	
Chance					.02		[-.00, .03]	.08	
Powerful others					-.02		[-.03, -.00]	-.09*	-.07

Note. CI: confidence interval;  $\beta$  = Standardised Betas;  $sr^2$  = semi-partial correlations;  $R^2 = .67$ , Adj  $R^2 = .66$  for Model 1;  $R^2 = .72$ , Adj  $R^2 = .70$  for Model 2.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

climate change scepticism above and beyond more rigid socio-demographic and value factors. In addition, the present study sought to address key methodological limitations within the literature by applying a multi-dimensional framework of scepticism, breaking it into categories of trend, attribution, impact and response scepticism. We also undertook a thematic analysis to better understand variations in public beliefs as expressed by the participants themselves.

Individuals who were older were found to be more likely to be sceptical about the actuality and human causality of climate change. Furthermore, individuals who favoured conservative political parties were also more likely to be sceptical about the reality, human causality and impacts of climate change. Environmental values had a strong negative effect on all dimensions of scepticism. Concerning the influence of values, such findings are best explained by theories of motivated reasoning and the cognitive reflection test (CRT) which argue that individuals intentionally process evidence in line with their existing beliefs (Kahan, 2013). These findings align with those from previous research (Aker et al., 2012; Capstick and Pidgeon, 2014; Hornsey et al., 2016).

Unique to attribution scepticism (*cause*), individuals with stronger individualistic worldviews were found to be more sceptical about the human causality of climate change. As supported in the literature and posited by the CRT, this association is likely due to the fact that mitigation efforts would place restrictions on activities valued by those who endorse individualism (Barel, 2012; Capstick and Pidgeon, 2014).

Contrary to the consensus within the literature, religiosity was found to have a significant negative effect on attribution (*cause*) and impact scepticism. Best explained by the fact that science and religion are conflicting explanatory frameworks (Gauchat, 2012), the majority of

**Table 4.** Hierarchical multiple regression for response scepticism.

	$\Delta R^2$	Step 1				Step 2				
		B	CI	$\beta$	$sr^2$	B	CI	$\beta$	$sr^2$	
<b>Block 1</b>	<b>.48***</b>									
Gender		-.28	[-.54, -.01]	-.10*	-.09	-.22	[-.48, .04]	-.08		
Age		.01	[.00, .12]	.12*	.09	.01	[-.00, .02]	.10		
Education		-.04	[-.10, .02]	-.06		-.01	[-.07, .04]	-.02		
Residential area		-.17	[-.34, .00]	-.09		-.15	[-.31, .02]	-.08		
Income		.01	[-.02, .04]	.04		.02	[-.01, .05]	.06		
Religiosity		-.08	[-.16, .00]	-.09		-.07	[-.15, .01]	-.08		
Political pref		.12	[-.00, .25]	.12		.07	[-.06, .20]	.07		
Environ value		-.58	[-.78, -.37]	-.41***	-.24	-.43	[-.65, -.22]	-.30***	-.17	
Egalitarianism		-.04	[-.21, .13]	-.04		-.07	[-.23, .10]	-.07		
Individualistic		.13	[-.07, .33]	.09		.12	[-.09, .32]	.08		
<b>Block 2</b>	<b>.06***</b>									
Analytical						.06	[-.11, .23]	.03		
Intuitive						-.02	[-.17, .12]	-.02		
Trust reflexivity						-.16	[-.33, .00]	-.16		
Trust anti-reflexivity						.04	[-.10, .17]	.03		
Internal						.01	[-.12, .03]	.03		
Chance						.04	[.02, .06]	.20***	.140	
Powerful others						.01	[-.01, .03]	.04		

Note. CI: confidence interval;  $\beta$ =Standardised Betas;  $sr^2$ =semi-partial correlations;  $R^2$ = .48, Adj  $R^2$ = .46 for Model 1;  $R^2$ = .54, Adj  $R^2$ = .51 for Model 2.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

previous findings indicate that religiosity is positively associated with climate change scepticism (Ecklund et al., 2017; Morrison et al., 2013). Thematic analyses revealed trust in alternative science to be a leading theme for individuals expressing climate change scepticism, suggesting that such individuals may be privileging a pseudoscience-based explanatory framework over a religious framework.

### *Locus of control*

Conflicting with earlier research, LoC failed to explain any additional variance in trend (H1) or attribution (H2) scepticism. This finding may be explained by the fact that certain variables absent in previous studies, for example, geographical location, lifestyle, knowledge/lack of knowledge on climate change, news source, employment were included in the current study and mediate the effect of LoC (Mostafa, 2016; Smith and Hempel, 2022). In addition, the majority of research assessing LoC has investigated environmental concern rather than climate change scepticism as a multi-dimensional construct (Fielding and Head, 2012; Pavalache-Ilie and Unianu, 2012); so, although LoC may influence concern more broadly, it fails to affect the more nuanced constructs of trend and attribution scepticism.

A subscale of external LoC was found to predict impact scepticism after controlling for socio-demographic and value factors. Yet the directionality of the relationship failed to support the hypothesis. Accordingly, individuals who perceived ‘powerful others’ as having little control over events in their life were more likely to be sceptical about the impacts of climate change.

**Table 5.** Major themes of reasoning for climate change scepticism.

Reason for scepticism	Examples
Trust in alternative science	Real science concerning solar activity and other factors such as planetary tides. (110) The best science shows us that the Solar Cycle is responsible for the temperature and climate on earth. We are heading into a Grand Solar Minimum that will cause another Little Ice Age that will last hundreds of years. CO2 is not responsible for climate change. (228)
Belief in natural cycle	The climate has always changed quite naturally and always will. Nothing we can do about it. (178) Climate is always changing naturally warming and cooling. It has done so for eons. (297)
Mistrust in climate science	Science. How can anyone support a premise supported by consensus science based on adjusted temps. (271) The bad science and propaganda coming from the religion of climatology. (207)
Predictions not becoming a reality	Have not seen any evidence justifying its existence. (225) Seeing climate change alarmists' predictions being completely false. (103)
Uterior motives of interested parties	The Man-Made climate change HOAX is pushed by the UN to transfer wealth to poorer nations and make wealthier nations poorer. It is called socialism and cannot be allowed. (352) It is a wealth redistribution scheme and cash cow for academics and subsidy harvesting rent seeking companies. (183)

Given that governments and those in power have the ability to implement mitigation and adaptation policies, such individuals may be less likely to trust in and support such figures (Kolmodin et al., 2019). The thematic analysis supports this inference, with ulterior motives of interested parties being a key theme. This inference echoes previous research (Cermak and Patockova, 2020; Tranter and Booth, 2015) that found a negative relationship between governmental trust and climate change scepticism.

In support of Hypothesis 4, individuals who favoured explanations of chance were more likely to express response (*need to act*) scepticism. This suggests that those who believe that outcomes in life are out of their control are more likely to perceive individual efforts to address climate change as being of little use. With previous research suggesting that individuals who feel in control of the environment are more likely to seek to mitigate potential threats (Pavalache-Ilie and Unianu, 2012), increased efforts should be made to enhance and validate public perceptions of the effectiveness of individual action (Coleman et al., 2022; Kwon et al., 2019).

### *Information processing style*

Contradicting Hypothesis 2 and the propositions of the CEST, individuals high in analytical processing were found to be more likely to be sceptical about the human causality of climate change. Although the majority of previous research findings have found a negative association to exist between analytical processing style and unfounded beliefs (Pennycook et al., 2012; Swami et al., 2014), Kahan et al. (2017) demonstrated that individuals with an increased cognitive ability were more likely to misinterpret information that was inconsistent with their political views. Thus, to protect one's values, analytical processing is utilised to generate alternative interpretations of the data. The content analysis, including mistrust in climate science and trust in alternative science,

further suggest that analytical processing is used to reject the scientific consensus and generate alternative explanations (Haltinner and Sarathchandra, 2022; Sarathchandra and Haltinner, 2020).

Information processing style failed to explain any additional variance of trend (*reality*), impact and response (*need to act*) scepticism. Intuitive information processing style was significantly associated with trend scepticism and impact scepticism, indicating that information processing style is related to both constructs, yet adds no extra variance after accounting for socio-demographic and value factors. Interestingly, information processing style was not significantly correlated with response scepticism in this study. Thus, it appears that response scepticism does not involve unconscious and emotionally driven processing as predicted by the CEST but is rather a result of favoured explanations of chance and the belief that climate change is too large and too complex for individuals to address alone (Capstick and Pidgeon, 2014).

### *Anti-reflexivity*

Anti-reflexivity failed to explain any additional variance in trend (*reality*) and response (*need to act*) scepticism. This finding contradicts both the ART and earlier research by McCright (2016) who concluded that increased trust in groups of anti-reflexivity increases the likelihood of climate change scepticism independent of political ideology and socio-demographic factors. Unlike McCright (2016), the current study assessed political preference rather than political ideology. Such constructs differ in that political preference refers to the party with which one identifies whereas political ideology refers to an individual's political beliefs and requires a more nuanced measure (Cruz, 2017; Smith and Hempel, 2022). Furthermore, McCright (2016) did not control for environmental values, the variable which was found to be the strongest predictor of both trend and response scepticism in the current study and exhibited a moderate correlation with anti-reflexivity.

In addition to socio-demographic and value factors, decreased trust in forces of reflexivity predicted attribution scepticism but increased trust in anti-reflexivity did not. Although this finding does not directly support the hypothesis, the observed relationship is supported by the ART and from the literature (Givens et al., 2021; McCright, 2016). As with trend scepticism, political ideology and environmental values may mediate the relationship between trust in forces of anti-reflexivity and attribution scepticism.

In support of Hypothesis 3, individuals who reported less trust in forces of reflexivity and increased trust in forces of anti-reflexivity were more likely to be sceptical about the impacts of climate change. As posited by the ART, anti-reflexive forces mobilise to defend the industrial capitalist system against accusations that its activities are causing harm. Thus, this finding is supported by the ART and others' research findings (Davidson and Stedman, 2018; Givens et al., 2021; McCright, 2016).

### *Thematic analysis*

Thematic analysis of responses revealed five overarching themes. Two (trust of alternative science mistrust in climate science; past projections not becoming reality) relate to perceptions of the legitimacy of climate science (Capstick and Pidgeon, 2014). Responses contextualised by casting doubt on the consensus position and legitimacy of climate science while showing increased support for opposing claims may exemplify public efforts towards anti-reflexivity. The consequence of discrediting the scientific consensus is profound and likely to impede efforts aimed at increasing public acceptance (Bertoldo et al., 2019; Bloomfield and Tillery, 2019).

The theme involving 'belief that climate change is part of a natural cycle' may also be associated with mistrust in climate science. Alternatively, it may reflect the influence of entrenched

ideologies about how natural systems operate, although recent research suggests the climate change scepticism is decreasing in a warming world (Hornsey et al., 2022). Responses that contextualised doubts by undermining the human contribution of climate change may also be suggestive of public efforts of anti-reflexivity (Bertoldo et al., 2019; Bloomfield and Tillery, 2019; Capstick and Pidgeon, 2014).

Results pertaining to the final theme ‘ulterior motives of interested parties’ are consistent with the findings of Jacques and Knox (2016). Similar to themes relating to perceptions of the legitimacy of climate science, responses within this theme demonstrate a lack of reflexivity through efforts to actively deny the actuality of climate change and the legitimacy of mitigation efforts.

### Limitations

Self-selection bias is a methodological limitation of the current study. There is research to suggest that data drawn from self-selected samples differ from that drawn from the general population (Khazaal et al., 2014). Typically, respondents who self-select to participate in research hold strong opinions and are thus overrepresented in comparison to those who are impartial and therefore less likely to participate. This disproportionate contribution may mean the sample does not accurately reflect the general population, thus limiting external validity and the interpretation of findings.

A further methodological limitation of the current study is the self-report nature of the survey. Self-report studies are often confounded by socially desirable responding (SDR), especially when the research area is highly topical or controversial (e.g. climate change). SDR has the potential to overestimate or generate false relationships between included variables (Van de Mortel, 2008). It is argued that reasonable steps were taken to mitigate the potential of SDR by explaining that individual responses were unidentifiable.

Although qualitative comments provided useful insights, it is recommended that future research seeks to ensure a better balance between quantitative and qualitative data. For example, interviews could be conducted to probe and draw out a participant’s reasoning for their beliefs. Doing so would strengthen the rigour and enrich the findings. To enhance the generalisability of findings, future research should also address the methodological limitation of self-selection bias by using random sampling. Finally, investigating other potentially influential psychological factors such as personality or self-efficacy is recommended.

## 5. Conclusion

This study found that determinants of scepticism have varied effects depending on the dimension being investigated, namely *reality* (trend scepticism), *causes* (attribution scepticism), *consequences* (impact scepticism) or efficacy of *mitigation* strategies (response scepticism). These findings have important implications for effective communication and public engagement. For while increasing perceptions of external control may increase public trust and prove to be an effective strategy for reducing impact scepticism, the same strategy may worsen the amount and the degree of response scepticism. Since response scepticism was found to increase alongside external control, increasing public perceptions of control that individual action can make a difference are more likely to be effective for countering response scepticism.

The themes from the thematic analysis, as well as the finding that decreased trust in forces of reflexivity increases multiple dimensions of scepticism, highlight the importance of increasing public trust in such forces, particularly climate scientists. Perhaps facilitating open discussions about the competing forces of reflexivity would lessen the extent to which information shared by the forces of anti-reflexivity distorts the scientific consensus (McCright et al., 2013). Furthermore,

identifying individuals and organisations trusted by those sceptical about climate change and having them put forward their views on the need for widespread global action may also prove to be a persuasive communication technique (Dixon et al., 2017; Stevenson et al., 2018).

Drawing on a range of theoretical perspectives, this study shows that climate change scepticism in Australia is influenced by a multitude of factors. Scepticism about the actuality of climate change is fundamentally shaped by existing socio-demographics and values. Yet LoC, information processing style and trust in forces of anti-reflexivity all had significant and varied effects on scepticism regarding the cause of climate change, its impacts and the efficacy of individual mitigatory behaviour. Overall, this study contributes to the understanding of the determinants of climate change scepticism and highlights the need to increase public trust in forces of reflexivity and perceptions of control in mitigating climate change.

### **Author contributions**

The study reported formed part of Breanna Fraser's psychology thesis which was co-supervised by Rachael Sharman and Patrick Nunn. All authors contributed to the conceptualisation, design and methodology of the study; Breanna Fraser collected and analysed the data; all authors had significant contributions in the writing and editing of the final paper.

### **Availability of data and material**

Stored on the University of the Sunshine Coast's Research (R) network drive.

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Informed consent was obtained from all individual participants included in the study. All procedures involving human participants were in accordance with the ethical standards of the Human Research Ethics Committee of the University of the Sunshine Coast (approval number S191316) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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### **Supplemental material**

Supplemental material for this article is available online.

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