Assessing climate change beliefs: Response effects of question wording and response alternatives

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Abstract
To date, there is no 'gold standard' on how to best measure public climate change beliefs. We report a study (*N* = 897) testing four measures of climate change causation beliefs, drawn from four sources: the CSIRO, Griffith University, the Gallup poll, and the Newspoll. We found that question wording influences the outcome of beliefs reported. Questions that did not allow respondents to choose the option of believing in an equal mix of natural and anthropogenic climate change obtained different results to those that included the option. Age and belief groups were found to be important predictors of how consistent people were in reporting their beliefs. Response consistency gave some support to past findings suggesting climate change beliefs reflect something deeper in the individual belief system. Each belief question was assessed against five criterion variables commonly used in climate change literature. Implications for future studies are discussed.

1. Introduction

Climate change is one of the most prominent, contested, and critical issues confronting the world at the start of the 21st century. Different governments have followed various courses of action to address climate change, including, perhaps most commonly, choosing to 'wait and see'. Whether or not a government, an industry, an organisation, or an individual supports or opposes proposed actions in response to climate change depends on prevailing public beliefs about climate change and its causes (Lorenzoni and Pidgeon, 2006). Levels of sentiment in the broader community can also serve as indicators for politicians, who judge whether policies are likely to accord with the wishes, values, and priorities of their constituents, or whether they risk defeat at the next election

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by introducing broadly unpopular measures. But establishing just what the prevailing beliefs about climate change and its causes *are*, is no easy task. A recent review of beliefs and attitudes about climate change revealed that quite different conclusions can be drawn based on relatively minor methodological differences (Leviston et al., 2011).

Scientists have long acknowledged the contribution of human activity to changing climatic conditions (e.g. Doran and Zimmerman, 2009; IPCC, 2001, 2007; Min et al., 2011). Survey or polling results from different countries have similarly indicated that a large proportion of people believe that climate change is caused by human activity (Evans, 2009; Gallup, 2011; Hanson, 2010; Ipsos-Eureka, 2010; Kim, 2011; Leviston and Walker, 2010; Newspoll, 2010; Reser et al., 2012). However, these majorities have lately been overshadowed by strong voices from those who do not believe that humans play a role in shaping the climate. In Australia, media coverage of the climate change 'debate' has polarised public concerns on the issue by amplifying the voices of a disbelieving minority (Bacon, 2011).

It has been three decades since the first survey on climate change beliefs (Brulle, Carmichael and Jenkins, 2012), yet there is no 'gold standard' for measuring public beliefs on climate change and its causation. Various methods to measure climate change beliefs can be found in the literature. The most common method is to directly ask people what they believe has caused climate change, followed by a range of options from which the respondent can choose. Most studies have chosen to use their own question wordings and response options (Akerlof and Maibach, 2011; Leviston and Walker, 2010; Newspoll, 2010; Pugliese and Lyons, 2010; Reser et al., 2011), with some combining responses to several sequential questions to derive climate change beliefs (e.g. Reser et al., 2011). A variation on this method involves asking people to indicate their level of agreement with whether human activity has contributed to climate change (Donnelly et al., 2009; Essential Media, 2010; ISSR, n.d.; Ong, Zafiris and Gowan, 2010). Other research has used a series of statements to infer people's climate change beliefs. By factor analysing a series of climate change belief statements, Whitmarsh (2011) obtained four factors, one of which was related to scepticism/uncertainty-type beliefs and later called a 'scepticism scale'. Similarly, using a series of statements, Poortinga et al. (2011) differentiated among various types of climate scepticism. Maibach, Roser-Renouf and Leiserowitz (2009) used segmentation analysis to create six homogeneous groups of people with different beliefs, attitudes, and policy preferences towards climate change. The current research examines the most common method in use and determines the extent to which differences in categorical question wordings from four prominent climate change studies affect responses by administering an online survey to 897 respondents.

2. Study background

Support for behavioural responses, such as climate change mitigation actions, depends significantly on whether people consider climate change to be the result of human activity (anthropogenic), a naturally occurring phenomenon, a mixture of both drivers, or whether they deny it is happening at all (Bord, O'Connor and Fisher, 2000). General patterns can be discerned in published polls and survey literature, but specific conclusions as to what people believe are elusive at times owing to question framing, the mode of data collection, and where the questions were placed in the surveys. For example, in 2010 the percentage of people in Australia who believed in some levels of anthropogenic climate change varied from 50.4% to 94% depending on the poll or survey used. Such variation makes it difficult to utilise the findings to inform policy decisions and gauge the actual level of public support. It also brings into question the validity of poll or study results.

Research into the influence of question wording on climate change beliefs has so far focussed on the effect of individual words used to describe climate change as a phenomenon, and how these words affect people's perception of climate change (Akerlof and Maibach, 2011; Schuldt, Konrath and Schwarz, 2011; Villar and Krosnick, 2011). There is evidence that the terms 'global warming', 'climate change', and 'global climate change' influence how people perceive the phenomenon, however recent research in the US suggests that the effect is less pronounced amongst Democrat supporters (Schuldt et al., 2011). One of the reasons offered by Schuldt et al. (2011) is that Democrats with more liberal views may have more crystallised climate change beliefs, therefore their responses are less likely to be affected by question wording. Other attitudinal studies, however, indicate that people with strong beliefs can be equally influenced by question wording (Bassili and Krosnick, 2000).

The present study investigates the wording effects of four climate change causation questions. Question wording effects on climate change causation beliefs are assessed by applying the same research methodology to control for differences in reported beliefs due to the mode of survey administration. Order effects are tested for by applying a split-sample design that systematically varies the order in which climate change belief questions are presented to respondents. Respondents' consistency in answering the four causation questions is examined. Attributes of people's attitudes towards climate change that can potentially make someone more or less likely to change his/her reported beliefs are also investigated. Attributes included in this study are *certainty, importance, knowledge*, and *direct experience*, which have been linked in previous research to attitudes resistant to change (see Krosnick et al., 1993 for a review).

Opinion stability is an important indicator of opinion strength and how deeply an opinion is embedded in one's ideological system (Sciarini and Kriesi, 2003). Recent studies suggest that climate change beliefs may represent something deeper in the individuals' ideological structure (Poortinga et al., 2011; Whitmarsh, 2011). Expressions of support or opposition may reflect underlying social identity needs (Hart and Nisbet, 2012), cultural values (Kahan et al., 2012), or even desires to maintain prevailing social systems and institutions (Feygina, Jost and Goldsmith, 2010). We therefore hypothesised that respondents in the study would be fairly consistent in nominating their climate change causation belief. If differences exist, we expected individuals consistent in their responses to exhibit the four attributes strongly, as outlined in Krosnick et al. (1993). Specifically, consistent respondents were expected to be more certain and knowledgeable about climate change, and to express greater concerns and report more personal experience with climate change and its impacts.

In order to examine the potential wording effects on study results, the present study also examined how people's beliefs relate to criterion variables commonly used in climate change research. In particular, we investigated the extent to which each causation question could account for:

- engagement in pro-environmental behaviours;
- perceived harm from climate change;
- perceived seriousness of climate change;
- moral duty to do something about climate change; and
- support for carbon reduction policies.

The authors know of no studies that have specifically examined how each climate change causation belief group relates to the five criterion variables above. However, there is some evidence (Leviston and Walker, 2010; Poortinga et al., 2011; Whitmarsh, 2011) to suggest that people who believe in human induced climate change adopt more pro-environmental behaviours, perceive greater harm

from climate change, and think that it is more serious. We expected these respondents to also feel a higher moral obligation to do something and show stronger support for climate change policies.

3. Method

Data collection

An online survey company was contracted to administer the survey. Respondents were selected from the company's survey panel, which consisted of more than 300,000 people from across Australia. In total, 11,300 invitations were sent to the potential respondents. Of these, 100 were considered ineligible as they had participated in a similar climate change study in the last 12 months. With 897 completed surveys, the present study recorded a participation rate of 8%. This participation rate is similar to those of other panel studies (e.g. Singer et al., 2010).

Measures

The four causation questions. Four prominent Australian climate change causation questions were used, taken from two large-scale Australian climate change studies: the CSIRO study (Leviston and Walker, 2010), and the Griffith University study (Reser et al., 2011); and from two polling studies: the Newspoll (Newspoll, 2011, 2010) and the Gallup poll (Pugliese and Lyons, 2010). Table 1 summarises the four causation questions used along with percentage agreement rates reported in the original studies and the current study. The proportions of climate change belief groups found in the original four studies and the present study were comparable with the exception of the Gallup poll. When faced with the Gallup question, the majority of respondents (65.3%) in the present study chose both anthropogenic and natural processes as the cause of climate change. In the original Gallup study, the main proportion of respondents (44%) chose anthropogenic as the only cause of climate change. It is likely that the different mode of administration has led to this discrepancy in findings.

Table 1. Climate change belief question wording from the four studies.

Study	Original method	Belief in causation question wording	Original (%)	Current (%)
CSIRO National Survey (2010)	2010; *N* = 5036; online survey; stratified research panel	Given what you know, which of the following statements best describes your thoughts about climate change? *Tick one box only*		
		☐ I don't think that climate change is happening	5.6	5.5
		☐ I have no idea whether climate change is happening or not	3.8	5.5
		☐ I think that climate change is happening, but it's just a natural fluctuation in Earth's temperatures	40.2	42.6
		☐ I think that climate change is happening, and I think that humans are largely causing it	50.4	46.5

Table 1. (Continued)

Study	Original method	Belief in causation question wording	Original (%)	Current (%)
Australian Gallup poll (2010)	2010; N = 1000+; online survey; random selection	Temperature rise is a part of global warming or climate change. Do you think rising temperatures are a result of human activities, or a result of natural causes? *Tick one box only*		
		☐ A result of human activities	44	13.2
		☐ A result of natural causes	31	15.2
		☐ Both from human activities and natural causes	21	65.3
		☐ Don't know/refused	2	2.6
		☐ Have not heard of climate change	2	N/A
		☐ I do not believe that climate change is happening at all[a]	N/A	3.8
Griffith	2010; N = 3096; online survey; stratified research panel	Thinking about the causes of climate change, which, if any, of the following best describes your opinion? *Tick one box only*		
		☐ Climate change is *entirely* caused by natural processes	4.9	6.5
		☐ Climate change is *mainly* caused by natural processes	12.6	12.4
		☐ Climate change is partly caused by natural processes and partly caused by human activity	45.8	52.8
		☐ Climate change is *mainly* caused by human activity	27.6	17.3
		☐ Climate change is *entirely* caused by human activity	4.2	4.3
		☐ I think there is no such thing as climate change	2.7	4.0
		☐ Don't know	1.9	2.1
		☐ No opinion	0.4	0.9
Newspoll	2010; telephone survey; random selection	Do you personally believe that climate change is …? *Tick one box only*		
		☐ *Entirely* caused by human activity	24	9.6
		☐ Partly caused by human activity	70	69.0
		☐ Or, do you believe climate change is not caused by human activity at all	5	8.4
		☐ Uncommitted	1	6.7
		☐ I do not believe that climate change is happening at all[a]	N/A	6.4

[a]This option was not offered in the original study.

The four causation questions were selected for several reasons. Firstly, the framing of the initial question and the response options given are subtly different in each. Specifically, the Griffith question with eight response options allows for respondents to select between climate change being caused solely by natural processes, solely by human processes, or by mixtures of both. The Gallup poll has five similar response options, but refers to rising temperatures in the framing of the question as well as climate change per se. The Newspoll question, with four response options, allows the respondent to nominate climate change as partially or wholly due to human processes, but does not provide a clear option that climate change can be attributed as part of natural processes.[1] The CSIRO question provides a forced choice set which commits the respondent to nominate one of four response options: that they don't think climate change is happening at all, that they don't know, that climate change is due solely to natural processes, or that climate change is largely due to human processes. Unlike the other three questions, the CSIRO question does not include an option which states climate change is equally attributable to human and natural processes.

It is important to note here that there were other climate change belief questions asked in the original four studies and the current study. In particular, the Griffith study used a combination of four climate change belief questions to determine their climate change belief/disbelief groups; these four questions were also included in the present survey. However, only two of the questions are reported here. One question relates to the causation question mentioned above and the other relates to certainty of people's climate change beliefs. The latter question is used in the study as a *certainty* attribute for measuring the strength of people's attitudes towards climate change (discussed further below). An additional question from Newspoll on climate change beliefs was also included in the present study but not reported here. It is included as a comparison to a similarly worded question in the Griffith study. The exclusion of these Griffith and Newspoll questions does not alter the results of the study or their interpretation.

Socio-demographics. Respondents were asked their gender, age, and level of educational attainment. Gender was dummy coded with males being one (49.7%) and females two (50.3%). Age was coded into six categories: 18–24, 25–34, 35–44, 45–54, 55–64, and 65 years and over (11.3%, 18.6%, 18.2%, 18.1%, 16.6%, and 17.3% respectively). Education was measured in ten categories ranging from completion of some of primary school to postgraduate qualification. The majority of participants had attended high school (29.8%), had trade or TAFE (technical and further education) qualifications (24.6%), or an undergraduate degree (28.9%).

Political affiliation. Respondents were asked which political party they voted for in the last federal election. They were given six political parties to choose from: Labor (29.9%), Liberal (31.4%), National (3.8%), Greens (11.8%), Independent (3.0%), and Family First (1.2%). They could also nominate Other party (3.6%), or choose Don't know (6.5%) or Refuse (8.8%).

The four attributes of attitude strength. Four attributes measuring people's resistance to changing their climate change beliefs were included. For each attribute, scores were recoded so that a higher score represents more of the attribute.

Certainty and concern about climate change were measured by two separate items (adopted from the Griffith study, Reser et al., 2011). Respondents were asked *To what extent do you agree or disagree with the following statement about climate change? I am certain that climate change is really happening* (from 1 = strongly agree to 5 = strongly disagree, and separate categories 6 = no opinion and 7 = don't know). The concern question asked *How concerned, if at all, are you about climate change, sometimes referred to as global warming?* (from 1 = very concerned to 4 =

not at all concerned, with 5 = don't know and 6 = no opinion). 'Don't know' and 'no opinion' responses were coded as missing.

Knowledge about climate change was taken from Reser et al. (2011): *How much do you feel you know about climate change?* (from 1 = a lot to 6 = nothing).

Personal experience with climate change was measured with an item from the CSIRO study (Leviston and Walker, 2010): *How much have you personally experienced the effects of climate change?* (from 4 = not at all to 1 = a great deal).

The five criterion variables. These variables were selected on the basis of their applied relevance and were taken from Leviston and Walker (2010), Reser et al. (2011), and Whitmarsh (2011).

A pro-environmental behaviour score taken from the original CSIRO study (Leviston and Walker, 2010). Respondents were asked a set of 17 items designed to measure pro-environmental behaviours relevant to climate change mitigation and adaptation (e.g., *I switch lights off around the house whenever possible; I usually walk/cycle/carpool/take public transport to work*), and whether their engagement was mainly for environmental reasons or for other reasons (e.g., for convenience or cost-saving). A score of '2' was assigned for each behaviour engaged in primarily for environmental reasons, '1' for each behaviour engaged in primarily for other reasons, and a score of '0' was given where a behaviour was not performed at all. A final pro-environmental behaviour score was calculated by aggregating the scores of all 17 responses (α = .81).

Respondents were asked how *serious* they thought climate change was: *How serious a problem do you think climate change is right now?* (from 1 = very serious to 6 = not at all serious). The scale was adopted from Reser et al. (2011). It was recoded so higher scores represented higher seriousness ratings.

Perceived levels of personal *harm* associated with climate change were measured with an item taken from the original CSIRO study: *How much do you think climate change will harm you personally?* (from 1 = a great deal to 4 = not at all, recoded so higher scores represent greater personal harm perceived from climate change).

Moral obligation was measured with a question taken from Whitmarsh (2011): *I feel a moral duty to do something about climate change* (from 1 = strongly disagree to 5 = strongly agree).

Support for carbon pricing was measured with two items. The first question asked participants directly about their levels of support or opposition to reducing Australia's carbon emissions by putting a price on carbon emitted by industry. The second question framed the carbon policy to include a compensation element, namely, that the money raised by pricing carbon would be used to fully compensate low and middle income households for anticipated energy price rises. Participants rated both questions on a seven-point scale (from 1 = oppose strongly to 7 = support strongly).

Survey design

A split-sample question-wording experiment was embedded within an online survey conducted in June 2011. Two versions of the survey were used to control for potential order effects and cognitive consistency bias: that is, the desire to respond to all causation questions in a manner consistent with the first response. Respondents were randomly assigned to one of the two survey conditions. About half of the respondents answered version one (49.3%, *N* = 442) and the other half answered version two (50.7%, *N* = 455).

The two versions contained the same questions with the order of the questions altered. In version one, all four Griffith climate change belief questions were presented first to participants. This was followed by socio-demographic questions, and then the other four causation questions (two

from the Newspoll, one from the Gallup and one from the CSIRO). Participants were then asked questions relating to attributes of causation beliefs and criterion variables. The structure for version two was the same as version one, except that the four Griffith questions and the other four belief questions were swapped around.

Analysis

We performed a Pearson chi-square test and derived Cramer's V values to measure the strength of the relationships between the two survey types. The same analysis was also performed to examine the consistency of responses between any two questions. In order to determine attributes of high- and low-consistency respondents, a logistic regression was performed. A series of one-way analyses of variance was performed to examine how different belief groups related to each of the five criterion variables. Tukey's HSD test ($p < .01$) was used to make post-hoc comparisons to locate significant cell mean differences.

Consistency of responses. In order to measure people's consistency in responses, we created categories based on their responses to the four causation questions. People who consistently selected the same belief group across the four questions were categorised as the high consistency group (59%, $n = 529$). People who did not consistently select the same belief group in all of the four questions were categorised as the low consistency group (41%, $n = 368$).

For ease of presenting findings in this paper, we categorised respondents into *Anthropogenic, Natural, Mixed, Disbelievers, Don't know* or *Uncommitted* groups. These categories were based on responses to each climate change causation question. *Anthropogenic* respondents were those who stated belief in the human causation of climate change. They chose (1) *I think that climate change is happening and I think that humans are largely causing it*[2] in the CSIRO question; (2) *as a result of human activities* in the Gallup question; (3) *climate change is either entirely or mainly caused by human activity* in the Griffith question; or (4) *entirely caused by human activity* in the Newspoll question.

Natural respondents were those who chose (1) *I think that climate change is happening but it is just a natural fluctuation in Earth's temperatures* in the CSIRO question; (2) *as a result of natural causes* in the Gallup question; (3) *climate change is either entirely or mainly caused by natural processes* in the Griffith question; or (4) *not caused by human activity* in the Newspoll question.

Mixed respondents refer to those who answered (1) *both from human activities and natural causes* in the Gallup question; or (2) *climate change is partly caused by natural processes and partly caused by human activity* in the Griffith question. Closely related to this group were those who chose *partly caused by human activity* in the Newspoll question.[3]

Don't know respondents were those who chose the *do not know* option in all causation questions. The *Uncommitted* group applied to respondents who said they were *uncommitted* in the Newspoll question.

4. Results

Order effects

The manipulation of question order had no significant effects on individual responses to any of the sets of questions: CSIRO study, $\chi^2(3, N = 897) = 2.93$, $p = 0.40$; Gallup poll, $\chi^2(4, N = 897) = 4.71$, $p = 0.32$; Griffith study, $\chi^2(7, N = 897) = 13.68$, $p = 0.6$; and Newspoll, $\chi^2(4, N = 897) = 3.21$, $p =$

0.52. This suggests that cognitive consistency bias was not a major influence on response patterns. For ease of presentation, the results of both survey types are combined for the remainder of this section.

Assessing consistency between question wordings

To assess consistency between question wordings, responses to each question-pair were cross-tabulated. In general, responses to one question were strongly related to responses to each of the other questions. However, there were several interesting and important points of difference, and it is these we focus upon here.

Tables 2 and 3 present the cross-tabulated comparisons of, respectively, the Griffith wording and the CSIRO wording, and the Newspoll wording and the Gallup wording.

Griffith wording and CSIRO wording. Respondents with consistent responses between the two questions are indicated by the italicised and bolded cells. Italicised cells show the distribution of *Mixed* respondents in the Griffith question across the CSIRO question.

Table 2. Comparisons between Griffith wording and CSIRO wording (N = 897)[a].

Causation type	CSIRO wording				% in Griffith study
	Disbelievers	Don't know	Natural	Anthropogenic	
Griffith wording					
(Entirely) Natural	**1.1%**	0.5%	*4.5%*	0.5%	6.5%
(Mainly) Natural	**1.1%**	0.7%	*10.1%*	0.5%	12.4%
Mixed	*0.2%*	2.7%	25.7%	24.2%	52.8%
(Mainly) Anthropogenic	0	0	0.6%	**16.7%**	17.3%
(Entirely) Anthropogenic	0	0	0	**4.0%**	4.0%
Disbelievers	**2.9%**	0.3%	0.7%	0.1%	4.0%
Don't know	0.1%	*1.0%*	0.7%	0.3%	2.1%
No opinion	0	0.3%	0.3%	0.2%	0.9%
Total % in CSIRO wording	0	0.3%	0.3%	0.2%	0.9%

[a]$\chi^2(21, N = 897) = 752.94$, $p < 0.01$, *Cramer's V* = 0.53, indicating a large effect size.

Table 3. Comparisons between Gallup wording and Newspoll wording (N = 897)[a].

Causation type	Newspoll wording					% in Gallop study
	Anthropogenic	Mixed	Natural	Uncommitted	Disbelievers	
Gallop wording						
Anthropogenic	**7.25%**	5.80%	0	0	0.11%	13.2%
Natural	0.11%	3.90%	**6.24%**	**2.34%**	**2.56%**	15.2%
Mixed	2.22%	**58.19%**	1.67%	3.01%	0.22%	65.3%
Don't know	0	0.89%	0.11%	*1.11%*	0.45%	2.6%
Disbelievers	0	0.22%	0.33%	0.22%	**3.01%**	3.8%
% in Newspoll wording	9.6%	69.0%	8.4%	6.7%	6.4%	100%

[a]$\chi^2(16, N = 897) = 1035.65$, $p < 0.01$, *Cramer's V* = 0.54, again indicating a large effect size.

Most of the *Anthropogenic* and *Natural* respondents in the CSIRO question were in the *Mixed* belief category in the Griffith question. *Anthropogenic* participants remained fairly consistent in their responses in comparison to those of the *Natural* group. Some *Disbelievers* in the CSIRO question changed to *Natural* in the Griffith question (shown in standard bolded cells).

Newspoll wording and Gallup wording. Again, italicised and bolded cells show the consistent responses across both question wordings. *Mixed* respondents in the Newspoll question also stated they were *Mixed* in the Gallup question. Some *Mixed* respondents in the Newspoll question, however, changed to either *Natural* or *Anthropogenic* groups in the Gallup question. Responses from *Mixed* respondents in both questions are indicated by italicised cells.

Interestingly, *Uncommitted* participants in the Newspoll question were found to spread across mostly the *Natural* and *Mixed* groups in the Gallup question. Very few of the *Uncommitted* participants stated *don't know* in the Gallup question.

Predictors of consistent responses

Direct logistic regression was conducted to examine factors that significantly affected the likelihood that respondents would provide highly consistent responses across the four causation questions. The model contained nine independent variables and was entered from least to most importance to the study: gender, educational attainment, age, political affiliation, causation belief group, certainty and knowledge of climate change, concern, and personal experience with climate change. The full model containing all predictors was statistically significant, $\chi^2(16, N = 816) = 121.91$, $p < 0.01$, indicating the model was able to differentiate between respondents with high and low consistency of response.

The model as a whole explained between 13.9% (Cox and Snell R square) and 18.8% (Nagelkerke R square) and correctly identified 67.5% of respondents. Only two factors made a unique contribution to the model – age and belief groups, as shown in Table 4. For every unit increase in age group of respondents, the odds of the respondent having consistent responses increased by a factor of 1.11, all other factors being equal. The belief groups variable was dummy coded using the *Mixed* belief as the reference group. Only *Anthropogenic* and *Natural* respondents were significantly less consistent than *Mixed* respondents. The odds of either *Anthropogenic* or *Natural* groups responding highly consistently in their belief about climate change were 0.51 *less* than *Mixed* respondents. *Disbelievers* and *Mixed* respondents were not statistically different in their response consistency.

Assessing criterion validity

Different belief groups derived from the four causation questions were assessed against the five criterion variables. The results are summarised in Table 5.

Belief groups derived from the CSIRO question accounted for the most variance in all five criterion variables. In all four question versions, *Anthropogenic* respondents were found to have the highest score on *all* criterion variables. They were found to:

- engage in more pro-environmental behaviours;
- rate climate change as a more serious problem;
- perceive more harm;
- feel more morally obliged to do something about climate change; and
- be more supportive of carbon policy.

Table 4. Logistic regression results predicting consistency of participants' responses (*N* = 816).

Variable	β	SE β	Wald's χ^2	df	p	Odds ratio e^β
Gender	0.22	0.17	1.71	1	0.19	1.24
Education	0.01	0.37	0.06	1	0.81	1.01
Age[a]	0.11	0.05	4.11	1	0.04	1.11
Political party[b]			7.00	5	0.22	
Belief group[b]			33.74	4	0.00	
Natural[a]	−0.67	0.28	5.96	1	0.02	0.51
Disbelievers	−0.40	0.48	0.69	1	0.41	0.67
Anthropogenic[c]	−0.67	0.23	8.45	1	0.00	0.51
No consistency[c]	−4.67	1.02	20.85	1	0.00	0.01
Certainty	0.17	0.10	2.64	1	0.10	1.18
Knowledge	−0.10	0.08	1.60	1	0.21	0.91
Concern	−0.05	0.12	0.16	1	0.69	0.95
Direct experience	−0.10	0.12	0.77	1	0.38	0.90

[a]Significant predictors at *p* < 0.05.
[b]Categorical data.
[c]Significant predictors at *p* < 0.01.

For the CSIRO question, there were significant differences between *Natural* and *Disbelievers* in all criterion variables. By contrast, for the Newspoll question there were no significant differences between *Natural* respondents and *Disbelievers* on all criterion variables. For the Gallup and Griffith question wording, *Natural* respondents were similar to *Disbelievers* on most of the criterion variables. *Natural* respondents were not statistically different from *Disbelievers* in their pro-environmental behaviours, or their perceived harm and support ratings. For the Gallup question, *Natural* respondents felt significantly higher moral obligation than *Disbelievers*. The Griffith question wording found no difference between the two groups. In addition, respondents who believed climate change was *Mainly Natural* were significantly different to *Disbelievers* in their seriousness rating. The Gallup poll did not find significant differences between the two groups.

Mixed believers were found to be a distinct group in the Gallup, Griffith, and Newspoll questions (the CSIRO wording did not provide this response option). On all five criterion variables, the mean ratings of *Mixed* believers were significantly lower than *Anthropogenic* but higher than either *Natural* believers or *Disbelievers*. Their relationships with *Don't know* respondents varied; the Griffith question wording found no significant differences between the two groups on any of the criterion variables, but the Gallup question found differences between the two groups on four of the criterion variables: *perceived harm, personal experience, seriousness*, and *policy support ratings with compensation details*. For the Newspoll question, significant differences were noted between *Mixed* and *Uncommitted* respondents across all criterion variables.

Also of interest here are the results from the Griffith question on the use of different levels to define climate change causation. No significant differences were found between respondents who believed climate change was either *Entirely* or *Mainly Anthropogenic* on all criterion variables. Similarly, there were no differences between respondents who believed climate change was either *Entirely* or *Mainly Natural* on all criterion variables with the exception of the perceived seriousness ratings.

Table 5. Mean comparisons for each belief group across eight criterion variables[a]

Question wording	Criterion variable	Overall M	Anthropogenic M	Mixed M	Natural M	Disbelievers M	Don't know M	F-statistics
CSIRO	Pro-environmental behaviour	13.11	15.29[a]	N/A	11.58[b]	8.31[c]	11.18[b,c]	$F(3,893) = 50.54, p < 0.01, \eta^2 = 0.14$
	Perceived harm	2.29	2.87[a]	N/A	1.86[b]	1.12[c]	1.90[b]	$F(3,893) = 154.16, p < 0.01, \eta^2 = 0.34$
	Perceived seriousness	3.71	4.77[a]	N/A	2.92[b]	1.31[c]	3.37[b]	$F(3,893) = 244.71, p < 0.01, \eta^2 = 0.45$
	Perceived support – no compensation details	3.65	4.87[a]	N/A	2.61[b]	1.55[c]	3.37[b]	$F(3,893) = 142.61, p < 0.01, \eta^2 = 0.32$
	Perceived support – with compensation details	4.46	5.51[a]	N/A	3.63[b]	2.63[c]	3.73[b,c]	$F(3,893) = 97.39, p < 0.01, \eta^2 = 0.25$
	Moral obligation	3.27	3.84[a]	N/A	2.87[b]	1.86[c]	2.98[b]	$F(3,893) = 120.37, p < 0.01, \eta^2 = 0.29$
Gallup	Pro-environmental behaviour	13.11	15.77[a]	13.69[b]	10.07[c]	7.82[c]	10.39[b,c]	$F(4,892) = 29.74, p < 0.01, \eta^2 = 0.12$
	Perceived harm	2.29	3.09[a]	2.43[b]	1.43[c]	1.09[c]	1.56[c]	$F(4,892) = 93.46, p < 0.01, \eta^2 = 0.29$
	Perceived seriousness	3.71	5.19[a]	3.95[b]	2.12[c,d]	1.41[d]	2.83[c]	$F(4,892) = 134.58, p < 0.01, \eta^2 = 0.38$
	Perceived support – no compensation details	3.65	5.28[a]	3.84[b]	1.92[c]	1.82[c]	3.22[b,c]	$F(4,892) = 63.82, p < 0.01, \eta^2 = 0.22$
	Perceived support – with compensation details	4.46	5.67[a]	4.68[b]	2.90[c]	3.29[c]	3.35[c]	$F(4,892) = 43.70, p < 0.01, \eta^2 = 0.16$
	Moral obligation	3.27	3.87[a]	3.48[b]	2.37[c]	1.50[d]	2.96[b,c]	$F(4,892) = 84.82, p < 0.01, \eta^2 = 0.28$
Griffith	Pro-environmental behaviour	13.11	Entirely = 14.42[a,b] Mainly = 15.69[a]	13.63[b]	Entirely = 10.09[c] Mainly = 10.67[c]	8.78[c]	10.53[b,c]	$F(6,882) = 18.85, p < 0.01, \eta^2 = 0.11$
	Perceived harm	2.29	Entirely = 3.03[a]	2.36[b]	Entirely = 1.46[c]	1.25[c]	1.74[b,c]	$F(6,882) = 18.85, p < 0.01, \eta^2 = 0.11$

Table 5. (Continued)

Question wording	Criterion variable	Overall M	Anthropogenic M	Mixed M	Natural M	Disbelievers M	Don't know M	F-statistics
			Mainly = 3.01[a]		Mainly = 1.67[c]			
	Perceived seriousness	3.71	Entirely = 5.03[a] Mainly = 4.95[a]	3.92[b]	Entirely = 1.95[c,d] Mainly = 2.39[c,e]	1.50[d]	3.32[b,e]	$F_{(6, 882)} = 96.62$, $p < 0.01$, $\eta^2 = 0.40$
	Perceived support – no compensation details	3.65	Entirely = 4.97[a,d] Mainly = 5.23[a]	3.79[b]	Entirely = 2.03[c] Mainly = 1.92[c]	1.83[c]	3.42[b,c,d]	$F_{(6, 882)} = 55.94$, $p < 0.01$, $\eta^2 = 0.28$
	Perceived support – with compensation details	4.46	Entirely = 5.47[a,d] Mainly = 5.72[a]	4.66[b,d]	Entirely = 2.84[c] Mainly = 3.13[c]	2.72[c]	3.47[b,c]	$F_{(6, 882)} = 39.05$, $p < 0.01$, $\eta^2 = 0.28$
	Moral obligation	3.27	Entirely = 3.67[a,b] Mainly = 3.99[a]	3.45[b]	Entirely = 2.26[c,d] Mainly = 2.45[c,d]	1.89[c]	3.05[b,d]	$F_{(6, 882)} = 61.36$, $p < 0.01$, $\eta^2 = 0.29$
Newspoll	Pro-environmental behaviour	13.11	15.42[a]	13.86[a]	10.56[b]	8.26[b]	9.77[b]	$F_{(4, 892)} = 28.77$, $p < 0.01$, $\eta^2 = 0.11$
	Perceived harm ratings	2.29	3.05[a]	2.46[b]	1.44[c]	1.19[c]	1.63[c]	$F_{(4, 892)} = 76.67$, $p < 0.01$, $\eta^2 = 0.26$
	Perceived seriousness	3.71	5.10[a]	4.01[b]	1.97[c]	1.40[c]	3.02[d]	$F_{(4, 892)} = 121.60$, $p < .01$, $\eta^2 = 0.35$
	Perceived support – no compensation details	3.65	5.01[a]	3.93[b]	1.88[c,d]	1.58[c]	2.92[d]	$F_{(4, 892)} = 51.13$, $p < 0.01$, $\eta^2 = 0.19$
	Perceived support – with compensation details	4.46	5.59[a]	4.73[b]	2.83[c]	2.88[c]	3.50[c]	$F_{(4, 892)} = 39.13$, $p < 0.01$, $\eta^2 = 0.15$
	Moral obligation	3.27	3.78[a]	3.49[a]	2.16[b]	1.91[b]	3.00[c]	$F_{(4, 892)} = 72.47$, $p < 0.01$, $\eta^2 = 0.24$

[a]Mean scores with different superscripts are significantly different on the basis of Tukey's HSD test (at $p < .01$). Likewise, mean scores with the same superscripts are not statistically different ($p > 0.01$).

5. Discussion

The present study investigated the influence of question wording on stated climate change beliefs, by assessing the consistency of people's responses across questions and the relationship of different climate beliefs on a range of criterion variables. Question wording for climate change causation beliefs was found to influence people's responses. In the Gallup, Griffith, and Newspoll questions, the majority of respondents nominated that climate change was the result of *both* anthropogenic and natural causes. For the CSIRO question, which did not include this *Mixed* response option, the majority of respondents were split down the middle as to whether climate change was natural or anthropogenic.

The significant predictors of people's consistency in responses were age and causation beliefs. Older and *Mixed* believers were found to be most consistent. *Disbelievers* were also not statistically different in their response consistency to *Mixed* believers. Surprisingly, certainty, knowledge, importance, and direct experience with climate change, which were used to indicate one's resistance to change, did not contribute significantly to people's response consistency. Nonetheless, Bassili and Krosnick (2000) noted it is possible that different sets of attributes could be at play for different research domains. Examples of such attributes include intensity (i.e. the level of emotional reaction elicited by climate change events), personal interest (i.e. how interested the individuals are to seek out climate change information), and accessibility (i.e. how accessible climate change is in people's memory). Other attributes used in previous studies to indicate how crystallised people's beliefs are should be included in future studies.

The non-significant results might also be attributable to a methodological limitation of the present study. Some respondents may have purposely responded to the four causation questions inconsistently. While this is unlikely given the low percentages of inconsistent respondents, future research should nonetheless consider using the classic split ballot design by randomly allocating people to answer one of the questions only (see Noelle-Neumann, 1970).

Age is one of the demographic variables that has often been associated with causation beliefs: older people are more often disbelieving of climate change (Upham et al., 2009; Whitmarsh, 2011). Climate change causation beliefs are another significant predictor of response consistency. With *Disbelievers* found to be very consistent in their responses, the significant relationship between older respondents and response consistency is perhaps to be expected.

The belief that climate change is a mixture of natural and anthropogenic causes ('*Mixed* group') was chosen by the majority of respondents, if the question made that response available. This may reflect some 'middling tendency' when people are uncertain about climate change. Research has indicated that many people are ambivalent towards climate change (Poortinga et al., 2011), and that those who consider it solely natural still rate polluting sources as partly responsible for causing it (Leviston and Walker, 2010). For those who believe in climate change but are ambivalent towards it, a mixed option of attribution may be appealing, as it allows for both sides of climate change causation beliefs to be employed, and may be perceived as more 'neutral' than other response options.

The present study also gave some support to the notion that climate change beliefs are a reflection of the individuals' deeply held values and orientations. Respondents in the study were fairly consistent in their responses across the four causation questions, particularly *Disbelievers* and those with *Mixed* beliefs. Although *Anthropogenic* respondents were less consistent in comparison to the *Mixed* believers, their responses did not deviate greatly. Where changes were made, their responses often went to *Mixed* beliefs. It was highly unlikely for respondents to change their beliefs to either *Don't know* or to *Disbelieving* of climate change. The same finding applied to

Natural respondents. As the present study is limited to using only response consistency, future studies should incorporate other value indicators to understand the relative depth of different climate change causation beliefs. Successfully engaging with people's climate change beliefs and adaptive behaviours depends upon how crystallised their beliefs are. It will be harder to change those whose climate change beliefs are well crystallised.

Each of the four causation question wordings related to the criterion variables as hypothesised. *Anthropogenic* respondents in the study scored significantly higher in all criterion variables: these people performed more pro-environmental behaviours, considered climate change to be a more serious problem, felt more moral obligation to act, perceived more harm, and were more supportive of climate change policies. Analyses also revealed several strengths and weaknesses of each question. For example, the Newspoll question accounted for the least amount of variance across the criterion variables. The response options presented in the Newspoll question might also be criticised on the grounds of leaning toward more anthropogenic causes of climate change. Although respondents could choose the option *not caused by human activity*, the alternative to human causation of climate change was not clearly stated (i.e. *natural fluctuations* or *none, because it is not occurring*). It was only through comparisons with the Gallup question that we found an indication that most people who selected the option *not caused by human activity* actually believed climate change was the result of natural processes.

The CSIRO and Gallup question wordings produced the most consistent results across all five criterion variables. Unlike the Gallup wording, however, the CSIRO question produced different results for *Natural* respondents and *Disbelievers*. In contrast, the Gallup and Griffith questions found *no* significant differences between the two groups in all criterion variables except on the ratings of seriousness of climate change and support for carbon policy with compensation details. The Newspoll question also produced no significant difference between the two groups. The difference in findings between the CSIRO question wording and the other three question wordings is likely due to the way the CSIRO response options were constructed. The CSIRO response options do not include a *Mixed* belief group, but this option was chosen by most respondents when available. Past studies have argued both for and against a middle category such as this in questions. Schuman and Presser (1981) assert that, in some circumstances, forcing participants to choose between two competing alternatives may introduce random errors in the study. Sturgis, Roberts and Smith (2010) state that a middle category can sometimes attract people who have no opinion on the issue who find it easier to choose a neutral position than to say *don't know*, a phenomenon known as 'face-saving don't knows'. By contrast, O'Muircheartaigh, Krosnick and Helic (2000), and Bishop (1987), found that offering a middle alternative increased the validity of study results. Presenting a middle alternative in survey questions was found to reduce random measurement errors in people's responses, especially when they were asked to make decisions under uncertainty.

Schuman and Presser (1981) offered one alternative for attracting people away from the middle category: offering intermediate options between polar positions and the middle point. This scale-like response format was observed in the Griffith study where *Mainly Anthropogenic/Natural contribution* can be treated as an intermediate option between *Entirely Anthropogenic/Natural* and *Partly Anthropogenic/Natural*. The *Mixed* belief category in the Griffith study (52.8%) was smaller than the Gallup (65.3%) and Newspoll (69.0%) groups. However, in line with previous studies, we found that the difference was not large enough to make substantial changes to the research outcome (Schuman and Presser, 1981). The present study showed that people generally did not discriminate between the *entirely* and *mainly* categories for either anthropogenic or natural causes of climate change, with the majority of the criterion variables recording non-significant

differences between these two groups. These findings suggest that including intermediate options might have some benefit in drawing people away from the middle category, but will not produce belief types that are meaningfully different from the two polar positions.

Similar to the other three question wordings, the Gallup question covered all alternative response options of climate change causation. Although it did not account for as much variance in criterion variables as the CSIRO question, it produced results consistent with those of the Griffith and Newspoll questions. The belief groups derived from the question acted reasonably consistently across all criterion variables. The main criticism for the Gallup question is how the question was asked. Unlike other questions, it drew participants' attention to rising temperatures and then asked them to determine the cause of rising temperatures. Other important climate change impacts such as changes to precipitation and sea level rises were excluded.

In conclusion, the present study marks the initial step into establishing some level of standards in climate change causation measurements. The study indicated that response options in any climate change belief questions should include all possible causes of climate change. The current research also showed that it was not essential to differentiate a particular climate change cause to a finer degree (e.g. entirely or mainly anthropogenic). The influence (and potential pros and cons) of including a 'mixed belief' option in causation questions was highlighted. Future studies will be required to determine whether this mixed option represents an accurate reflection of one's belief, or just simply a 'face-saving don't know'. The present study also highlighted the limitations in using a single survey item to determine people's climate change beliefs. The inconsistency in some survey results may be an indication that climate change beliefs are multi-dimensional. This conceptualisation of climate change beliefs as multi-dimensional is in line with recent research by Whitmarsh (2011). Other conceptual issues to consider in future investigations are the centrality, malleability, and complexity of such uni- or multi-dimensional measurements and categorisations.

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Notes

1. For Gallup poll and Newspoll questions, the present study had to add another response option to account for people who did not believe in climate change. The original Gallup poll did not have the disbelief response option. During the preliminary testing of the present survey, the lack of this response choice in the Gallup poll question concerned participants. Participants who did not believe in climate change could not answer the question. The original Newspoll question used a filter question before asking people the causation question. Only people who believed that climate change was occurring could answer the causation question. As we do not rely on the filter question, we include the disbelief option.
2. It is categorised into the *Anthropogenic* rather than the *Mixed* belief group as it implicitly suggests that the contribution of human activity to climate change is larger than natural contributions to climate change. This categorisation is in line with how other response options are categorised (e.g. 'mainly by human activity' in the Griffith question was also categorised as *Anthropogenic*).
3. *Partly caused by human activity* was categorised into the *Mixed* belief group as the response option implied an equal contribution of human activity and natural processes to climate change.

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