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# Psychological and experiential factors affecting climate change perception: learnings from a transnational empirical study and implications for framing climate-related flood events

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## Abstract

Understanding the underlying values, beliefs and emotions that influence the public's perceptions and opinions on climate change (CC) is increasingly important, as CC is a complex and politicized phenomenon. Additionally, optimizing messaging for communicating CC and encouraging greater mitigation behavior can yield significant benefits to global stakeholders. Here we evaluated the effectiveness of *informative*, *persuasive* and *empathic* message frames about a major climate-related local flooding event through online surveys administered to 370 adults in Manitoba and Saskatchewan, Canada and 360 adults in Queensland, Australia. Measures of trust in climate communicators and climate science, concern over CC effects, and belief that most recent floods are due to CC were assessed before and after message exposure, along with related values, beliefs and emotions. Willingness to support pro-environmental groups was assessed as a proxy measure of behavioural intent. Cumulative odds ordinal regression and multinomial regression were used to predict group membership (no support, passive support, active support). Political affiliation, trust and belief in CC, belief in anthropogenic CC, pro-environmental values, and, in some regressions, previous flood exposure, were significant predictors of activism support. Respondents who received the *empathic* message frame and had low to medium pro-environmental values were more likely to believe the link between flooding and CC compared to those who received the *informative* message frame. These results, including the finding that some elicited emotions predicted behavioral intent, provide insight into how to construct climate information for groups with varying beliefs, values and experiences, to reduce climate skepticism and encourage pro-environmental behavior.

## Introduction

The media is an important source of climate change information for the public and helps to determine their attitudes and beliefs on climate change and subsequent mitigation and adaptation efforts. However, how that information is received and acted on is mediated by several psychological factors, including existing attitudes and values, experience of climate change, and trust in the communicators. In turn, information may be framed in various ways to encourage specific behavioral responses; persuasive and empathetic framing of climate change impacts may have some potential in this regard. These considerations inform the current study, where we seek to understand if and how these factors vary between countries, influence pro-environmental intent and extend to perceptions of flood-related events.

### Context and role of media

The increasing urgency of anthropogenic climate change due to interaction between ‘hazard (triggered by an event or trend related to climate change), vulnerability (susceptibility to harm) and exposure (people, assets or ecosystems at risk),’ underscores a need to understand how the public understands and engages with climate change science (Intergovernmental Panel on Climate Change 2014, p. 36). The diverse impacts of climate change on people, broader societies, ecosystems, and economic sectors and the way in which these are experienced and learned about, can play a significant role in determining motivation for engaging in sustainable practices.

The public typically learns of climate change impacts through a combination of indirect, mediated forms of communication from others (media, peers, neighbours, community members, etc) and direct experiences of change in the environment (Moser 2014). Unsurprisingly, direct experience of climate impacts is associated with perception of risk and beliefs around the certainty and origins of climate change. For instance, in the context of climate-related flood events, individuals who report experience of floods are more concerned about climate change and see it as less uncertain than those who have not experienced floods (McDonald *et al* 2015).

Nevertheless, the media (television, radio, newspapers, internet) remains a central source of climate change information. Research on mainstream media coverage identifies two tendencies which are likely to impact attitudinal patterns—the journalistic aim of ‘balance’ with a propensity towards disproportionate inclusion of skeptical voice in debates, and the fluctuations in media attention on climate change (Happer and Philo 2016). Prior attitudinal positions, experience of climate change, and trust in the source and communicators of knowledge may influence public interpretation of media coverage on climate science (Corbett and Durfee 2004).

Given that people generally do not have the time, resources, skill or desire to interpret all information and its certainty, they rely significantly on social cues and predispositions to form judgements on multiple issues, particularly on topics that are ambiguous and controversial (Wood and Vedlitz 2007, Hahnel and Brosch 2016). In addition, those with strong preconceived ideas may not easily change existing attitudes and attributions of trust (Poortinga and Pidgeon 2004).

Perception of the trustworthiness of climate sources, information, communicators, and experts has a significant impact on the acceptability of information and the translation of knowledge into concern (Malka *et al* 2009). For example, previous research found that pluralistic advocacy, a factor in cultural cognition risk theory, plays a role in the acceptance of new information. Individuals reflexively reject information inconsistent with their predispositions when it is advocated by experts who do not share their values (Kahan *et al* 2011). This theory may also help to explain strong resonance or dissonance with the public values of heads of political parties and members of parliament.

While ideology, partisanship, income, religion, and social orientation are all important to the information-processing filter, over the past decade political ideology and cultural worldviews specifically have been attributed to differences in levels of climate change engagement across societal groups (Wood and Vedlitz 2007, Corner *et al* 2014). Studies have found that individuals with stronger egalitarian/communitarian worldviews or a social rationality (what is best for the group or others) are more likely to perceive climate change as riskier and be more supportive of policy change to reduce greenhouse gas emissions when compared to individuals with individualistic and hierarchical values (Corner *et al* 2014, Hahnel and Brosch 2016, Aasen and Vatn 2018). Hence, political orientation is one of the central determinants of perceptions of climate science with, for instance, Democrats in the USA expressing the most trust and concern in climate science and Republicans the least (Joslyn and LeClerc 2016). Similarly, climate skepticism is highly correlated with political conservatism, which as an identity marker strongly influences beliefs and likelihood of seeking out new information (Pickering 2015, Rutjens *et al* 2018). Nevertheless, emerging research suggests the significance of being able to relate to those impacted. For example, depicting an extreme weather event to appeal to ‘consideration of others’ increases individuals’ willingness to act on climate change, especially among conservatives and climate skeptics, by decreasing perceived social distance (McDonald *et al* 2015, p. 115; Kühne and Schemer 2015).

So, while media helps inform climate science, values, experience of climate change and trust all affect how this information is received and mediate the effectiveness of climate change communications. Further research is required to understand if and how these factors vary between countries, influence behavioural intent towards the environment, and extend to perceptions around flood-related events.

### Message framing

In trying to understand the public’s interpretation of climate change science, message framing is an important consideration. Generally understood to mean the way a message is organized, arranged and portrayed, framing is a contentious but valuable tool for climate communicators and is informed by multiple theories. It has been described as a constructivist concept, whereby perception and communication contain combinations of

'selection and salience' (Entman 1993) or 'persistent selection, emphasis, and exclusion' (Gitlin 1980) (reviewed in Schäfer and O'Neill 2017). According to Entman (1993), to frame is to select some aspects of a perceived reality and make them more salient in order to promote a particular problem definition, causal interpretation, moral evaluation and/or treatment recommendations for the related item. In the context of climate communication, Hurlstone *et al* (2014) state that the process of message framing occurs when 'different but objectively equivalent descriptions of the same decision problem can yield systematically different responses'. According to the theory of narrative framing, individuals tend to assimilate information by fitting it to pre-existing narrative templates that invest the information with meaning, and this influences how they selectively recognize information about risk that reinforces their cultural predispositions (Kahan *et al* 2011). Message framing is also informed by behavioural decision research that suggests that attention-catching and emotionally engaging informational interventions may raise visceral concern for climate change (Weber 2006). Empathic message framing builds on functional emotion theories that claim emotions trigger a set of physiological, perceptual and behavioural responses that enable the individual to deal quickly with problems or opportunities and that empathy increases pro-social outcomes (Batson and Ahmad 2009, Kühne and Schemer 2015). For example, Kühne and Schemer (2015: p. 392) suggest that sadness elicited by an emotional message frame results from 'the appraisal that a situation is highly negative and uncontrollable, that no responsibility for it is attributable to any actor, and that the focus is on the consequences experienced by the individuals affected by it.' Empathic-perspective message framing may be a suitable device through which to engage readers in climate science and motivate them toward a goal of relieving another's need rather than toward self-benefit (Batson *et al* 1995).

### Current study

Several studies have explored how message framing may affect the desire or intent to adopt more environmentally sustainable behaviour (e.g. Nisbet 2009, Gifford and Comeau 2011, Hurlstone *et al* 2014, Stea and Pickering 2018, Pickering *et al* 2020). Particularly noteworthy is the report of Rabinovich *et al* (2012), where *informative* versus *persuasive* message frames were compared with respect to the willingness of participants to act in line with the message (encouraging specific pro-environmental behaviors). Participants reported higher trust when their belief in the purpose of scientists (either to inform or persuade) aligned with the frame of the message (informative versus persuasive), and higher trust associated with greater willingness to adopt the pro-environmental actions. The aforementioned study informed our current research which examines how a Canadian and Australian cohort perceive climate change information and how issues of trust are implicated in the impact of the message. Canada and Australia share some notable characteristics with respect to climate change policy and inaction: both countries have very high levels of carbon emissions per capita, are among the world's major producers and exporters of coal and petroleum, and in recent history have avoided participation in global greenhouse gas emission mitigation initiatives, 'despite their carbon intensity and relative stage of wealth and development' (Brown 2012: p. 325). Additionally, a proportion of residents in both countries believe that climate change is not happening, or that it poses only a minor threat (Kurl 2014, Pickering 2015, Richie *et al* 2019).

In the current study, we assess the impact of message frames about climate-related flooding on several variables: (i) support for climate change activism, (ii) trust/belief in climate science and communicators, and (iii) belief in climate-related flooding. We also examine the role that emotions, values/beliefs, knowledge, flood experience and message framing play in influencing climate change activism and belief/trust in climate science.

### Materials and methods

Our general approach was an online survey of approx. 400 Canadian and 400 Australian adults from regions that had experienced significant flood events both historically and in more recent history. For each country, participants were given a description about the most recent major flood in their respective region which was positioned within either an informative, persuasive or empathetic message frame. Collected responses included measures of environmental values, climate beliefs, flood exposure, emotional response to the flood message and willingness to support environmental organizations (as a proxy measure of pro-environmental behavioral intent). Multinomial regression analysis examined which factors influenced support of environmental organizations and concern in climate effects, whereas cumulative odds ordinal regressions were used to explore which variables predicted levels of trust in climate science, trust in climate experts and belief in climate effects on recent flooding.

### Recruitment and sample

An online survey (see Supplementary Materials for full text is available online at [stacks.iop.org/ERC/2/045003/mmedia](https://stacks.iop.org/ERC/2/045003/mmedia)) was administered using the Qualtrics™ survey platform and recruitment occurred through the online sampling and data collection company Research Now™. A total of 799 online surveys were completed by adult Australian (399) and Canadian (400) populations. Due to concern about data quality, 62 of these responses were removed because their survey completion time was 5.4 min or less (median time for entire sample = 9.3 min), of which 39% also had incomplete responses on important measures of climate source trust. A further seven participants were removed for not answering questions on their level of trust in sources of climate change information, leaving a total of 730 responses used for analysis. The target cohorts from Queensland, Australia and Manitoba or Saskatchewan, Canada, were chosen as these locations having experienced significant flood events both historically and in more recent history—within two years for Manitoba/Saskatchewan participants and within five years for Queensland residents. Content included in the experimental message frames reflected the dates and events of the most recent major floods to occur in the respective regions. Ethics approval for this study was obtained from the Brock University Research Ethics Board (#15–337).

Canada: Of the 370 Canadians, 52% were female with an average age of 48 years ( $SD = 17$ , range = 21–82). Respondents primarily identified their ethnicity as Canadian (67%), European (7%) or multiple ethnicities (13%). The most common political affiliations expressed were none (34%), the Liberal Party of Canada (26%) and the Conservative Party of Canada (25%). Average individual and household incomes were \$39,860 and \$73,874, respectively. 37% had a general education at the university level, while only 20% reported a university science education.

Australia: The 360 Australian respondents were comprised of 53% female with an average age of 48 years ( $SD = 16$ , range = 21–82). Respondents primarily identified their ethnicity as Australian (62%), the British Isles (11%) or multiple ethnicities (9%). The most common political affiliations expressed were none (40%), the Liberal-National Coalition (24%) and the Australian Labor Party (23%). The average individual and household incomes were \$40,295 and \$72,449, respectively. 37% of Australian respondents reported a bachelor's degree or higher for general education, while only 14% reported this level of attainment for science education. Full socio-demographic characteristics can be found in Supplementary Material.

### Experimental manipulation (message frames)

Participants were randomly assigned one of six possible messages depending on their location—Canadian respondents received one of the Canadian-Informative, Canadian-Persuasive or Canadian-Empathic messages, while Australian respondents received one of Australian-Informative, Australian-Persuasive or Australian-Empathic messages (see Supplementary Material). All the Canadian messages contained a description of a local and factual flooding event in Manitoba and Saskatchewan created from mainstream media sources (The Huffington Post Canada 2014, Canadian Broadcast Company CBC News Saskatchewan (2014)), a Canadian government media release (Government of Manitoba 2014) and the results from a study by Szeto *et al* (2015). The Australian messages contained a description of a real flooding event that occurred in Queensland and included information from articles published by the mainstream newspaper The Sydney Morning Herald (Harvey and Brown 2011, Marr 2011) and multiple studies, specifically: Van den Honert and McAneney (2011), Smith and McAlpine (2014) and Alexander and Arblaster (2009). Both the Canadian and Australian message frames contained an opening excerpt on climate trends for the respective continents from chapters of the 2014 Intergovernmental Panel on Climate Change (IPCC) Working Group II. Small changes between countries in the wording of the messages were necessary to provide historical accuracy of the events and communications depicted.

The language in each of the three versions of the message was adapted and altered to suit the frames. Similar to the approach of Rabinovich *et al* (2012), the *Persuasive* message frame was constructed in a 'rhetorical style suggesting that there are certain beliefs that need to be disproved' whereas the *Informative* frame was constructed on a 'facts-only' basis with the use of unemotional or neutral language. The *Empathic* frame used perspective-taking language that detailed the negative effects of the flood on local people, as well as a direct quotation from someone personally affected. The different message frames, along with all survey measures, were piloted with a convenience sample of 17 people consisting primarily of family and friends of the authors and Master of Sustainability Science students to ensure they captured the desired construct and to refine the language. To assess the degree to which individuals were able to take the perspective assigned with the message frames, study participants were asked on a 5-point Likert scale the extent to which they 1) remained objective about the information in the article and 2) imagined themselves in the situation presented in the article (Swim and Bloodhart 2015).

## Survey measures

### *Environmental values and climate beliefs*

Participants indicated their self-identification as an environmentalist using a 5-point Likert agreement scale (*strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree and strongly agree*; Swim and Bloodhart 2015). The shortened version of the New Environmental Paradigm (NEP) scale comprising of six items was used as a measure of environmental worldviews as previous research highlighted participants' difficulty with interpreting nine of the 15 original NEP items (Whitmarsh 2011). According to Stern (2000), joining and contributing to environmental organizations is considered an active class of pro-environmental behaviour that is psychologically distinct from mere support or acceptance of public policies. Additionally, assessing behavioural response with intended organizational support has the advantage of avoiding memory recall issues encountered with other frequently used measures. Accordingly, participants were given descriptions of three environmental organizations after message exposure (see Supplementary Material 1). The selection of these international NGOs was based on their varying approaches towards climate change activism. To identify the level of participant support, a check-all-that-apply option was given for the following statements for all three organizations: *I would like to receive more information about this organization*; *I would like to join this organization*; and *I would like to donate money to this organization* (Swim and Bloodhart 2015). To further gauge support, participants were given four options of what they would want to be done with \$100 if given to them by the researcher: keep the \$100; return the \$100 back to the researcher; donate the \$100 to the environmental organizations; or donate some to the environmental organizations and keep the rest (amount then specified by participant) (Swim and Bloodhart 2015).

To assess trust in climate science, climate communicators and concern about climate change, agreement with the following questions was assessed using a 5-point Likert agreement scale, both before and after message exposure: *if I hear or read a statement coming from a climate change expert, I generally believe it is true*; *I am very concerned about the effects of climate change*; and *I generally do not trust climate science* (Rabinovich et al 2012). To capture participants' knowledge of climate-related flood events, they were asked to use a 5-point Likert agreement scale to respond to the statement: *most recent floods in this country are due to climate change* (Whitmarsh 2008). These statements were repeated post-message exposure to capture whether belief and trust were altered by the message frame. To assess this, the value for the pre-message frame belief statement was subtracted from that for the post-message frame statement to yield a 'delta value'; a negative score indicated the belief decreased after message exposure, while a positive score indicated an increase in belief.

Belief in climate change was determined by asking which of the following statements they personally believed: climate change is happening now, caused mainly by human activities; climate change is happening now, but caused mainly by natural forces; climate change is not happening now; or no opinion (Hamilton et al 2015). Participants were asked to identify their sources of climate change information from several common sources: books, government, friends/family, scientists, internet, newspapers/magazines, research reports, television, school/education, non-governmental organizations, radio, other and none using a check-all-that-apply response option (Morris and Pickering 2019). For each source selected by a participant, degree of trust in the source was captured on a 5-point Likert agreement scale. Participants then responded to an open-ended question on why they did/did not trust a source or why they were neutral on their trust in the source.

### *Emotions rating*

Emotional response to the message frame was determined by having participants indicate (5-point Likert agreement scale) to what extent the message made them 'feel this way' for 18 emotions. The emotions selected were from the widely used Positive and Negative Affect Schedule (PANAS) (Watson et al 1988)—*interested, distressed, upset, strong, guilty, scared, enthusiastic, irritable, alert, ashamed, inspired, nervous, determined, attentive, afraid* - and supplemented with three emotions included in the Swim and Bloodhart (2015) study (*compassionate, regretful, bored/disinterested*). The piloting process eliminated 5 (*jittery, active, proud, hostile and excited*) of the 20 original PANAS scale emotions, as 55% or more of respondents did not identify with them.

### *Flood exposure*

Using a 5-point Likert scale, participants responded to the following statements: *I was directly affected by the Manitoba/Saskatchewan/Queensland major flood event*; *I live close to an area that frequently floods*; *the effects of the 2014/2011 flood were severe, and my family has been historically affected by floods*. Several questions on socio-demographic indicators were included post-message exposure: age, gender, household/individual income, ethnicity, nativity to the country, political identification, level of education, level of science education and current location.

### Data treatment & analysis

730 complete/valid responses were retained for analysis and initially described using descriptive statistics. Multinomial regression analyses were used to determine which independent variables influenced activism support and concern in climate effects. Cumulative odds ordinal regressions were used to explore which independent variables predicted levels of trust in climate science, trust in climate experts and belief in the climate effects on recent flooding. The responses from the dependent variables for four of the five main regression analyses—concern of effects, trust in climate science, trust in climate experts and climate-related flooding belief—were collapsed from a 5-point Likert agreement scale to 3 categories (disagree, neutral and agree). To more specifically classify the levels of activism support, a new variable was created: if a participant only selected ‘receive more information’ they were classified a passive supporter, but if they selected ‘receive more information’ and either ‘join’ or ‘donate’ to the organizations or only ‘join’ or ‘donate’ to the organizations then they were classified as an active supporter. The independent variables included in the multinomial and ordinal regressions were 1) socio-demographic variables (country of residence, science education, political affiliation); 2) climate change belief (anthropogenic versus other); 3) past flood exposure (a combination of the variables *I live close to an area that frequently floods* and *My family has historically been affected by floods* split into low/high by distribution); 4) message frame (*persuasive*, *empathic* and *informative*); and 5) pro-environmental values (NEP score). Only significant predictors ( $p < 0.05$ ) were included in the final models for all regressions and all of the final models predicted the dependent variable over and above the intercept-only model. Chi-square and Kruskal-Wallis tests were used to examine differences between countries for all variables; in order to adhere to word limits, we do not report null results.

### Results

Firstly, we summarize pre-message exposure environmental values, environmental identity, flood exposure, climate change information sources, and trust and beliefs in climate effects and science. Then we determine the changes for many of these measures due to message exposure and the specific message frame used, as well as the emotions elicited. Finally, we assess the impact of messaging on level of support for environmental organizations (‘activism’). For most measures, Australian and Canadian participants responded in a very similar manner. Unless otherwise stated, data presented below is from the entire sample (i.e. pooled across both countries).

Overall pro-environmental values, determined before message exposure, were high with an average NEP score of 3.8 (SD = 0.86). There was no significant difference between countries for NEP scores ( $\chi^2(3) = 1.43$ ,  $p = 0.840$ ). Most respondents reported neutrally on identifying as an environmentalist (38%;  $n = 276$ ) whereas 28% ( $n = 201$ ) agreed or strongly agreed (3%;  $n = 25$ ). The remaining respondents disagreed (21%;  $n = 153$ ) or strongly disagreed (10%;  $n = 75$ ) with the environmentalist label. Only 13% of Canadians ( $n = 48$ ) claimed to be directly affected by the major flood event referenced in the message frame, compared with 31% of Australians ( $n = 113$ ). A past flood exposure variable (low or medium/high) was calculated by combining the level of agreement with the statements ‘*I live close to an area that frequently floods*’ and ‘*My family has historically been affected by floods*.’ Approximately half of the participants had a low flood exposure (53%,  $n = 386$ ). Most participants (96%;  $n = 697$ ) reported using at least one of the following sources for climate change information: television (76%;  $n = 554$ ), newspapers/magazines (58%;  $n = 424$ ) and internet (58%;  $n = 422$ ). The less cited sources were radio (37%,  $n = 273$ ), government (36%,  $n = 259$ ), scientists (32%,  $n = 234$ ), friends and family (32%,  $n = 230$ ), NGOs (26%,  $n = 191$ ), non-governmental research reports (24%,  $n = 174$ ), books (16%,  $n = 114$ ), school/education (14%,  $n = 101$ ) and other (1%,  $n = 10$ ) (see Supplementary Material). Overall, more Australians selected ‘no’ sources than did Canadians ( $\chi^2(1) = 4.163$ ,  $p = 0.041$ ), and more Canadians reported using books, education/school, newspapers/magazines, internet, friends/family and radio than did Australians ( $p < 0.05$ ).

### Trust and beliefs in climate effects and science

Prior to message exposure, most respondents (sample pooled across both countries) believed that climate change is happening now and that it is caused mainly by human activities (62%,  $n = 451$ ) whereas 28% of respondents believed climate change is caused mainly by natural forces ( $n = 202$ ). The remaining respondents believed either that climate change is not currently happening or had no opinion (10%,  $n = 77$ ). Most participants were very concerned about the effects of climate change (46% Agree,  $n = 332$ ; 23% Strongly Agree,  $n = 170$ ) whereas a combined 31% ( $n = 228$ ) of respondents were not concerned or were neutral. In regard to the belief that recent flooding is an outcome of climate change, most respondents agreed (44%;  $n = 321$ ) followed closely by those who were neutral (31%;  $n = 229$ ) or disagreed (25%;  $n = 179$ ). Many participants disagreed with the statement *I generally do not trust climate science* (44%;  $n = 323$ ), while 35% ( $n = 252$ ) were neutral and 21% ( $n = 155$ ) agreed. Reported levels of trust in climate change experts was high with the majority of respondents

**Table 1.** Odds ratio of predictor variables for multinomial logistic regression on level of activism support. Reference category is *No Support* (46.5%).

Variables	Passive Support OR	CI 95%	Active Support OR	CI 95%
<b>Political Affiliation</b>				
Other	Reference		Reference	
Right-leaning (CPC or LNC)	1.04	0.69–1.58	0.79	0.41–1.54
Left-leaning (GPC/NDP/LPC or AG/ALP)	1.80**	1.22–2.66	2.48**	1.46–4.22
<b>Flood Exposure</b>				
Medium/high	Reference		Reference	
Low	0.91	0.65–1.27	0.47**	0.29–0.76
<b>CC Belief</b>				
Not anthropogenic/not happening	Reference		Reference	
Anthropogenic-caused	2.59*	1.22–5.49	3.85*	1.04–14.19
<b>CC Belief x NEP Score</b>				
High NEP	Reference		Reference	
Medium NEP	0.59*	0.37–0.96	1.00	0.54–1.87
Low NEP	0.62	0.35–1.10	1.00	0.48–2.08
<b>No CC Belief x NEP Score</b>				
High NEP	Reference		Reference	
Medium NEP	1.58	0.69–3.6	0.44**	0.07–2.92
Low NEP	0.67	0.31–1.45	1.33	0.35–5.12
<b>Level of Science Education</b>				
University Bachelors or higher	Reference		Reference	
College	1.01	0.54–1.86	0.74	0.33–1.69
High School or less	0.59*	0.37–0.93	0.44	0.24–0.80

OR: Odds Ratio; CPC: Conservative Party of Canada; LNC: The Liberal-National Coalition; GPC: Green Part of Canada; NDP: New Democratic Party; LPC: Liberal Party of Canada; AG: Australian Greens; ALP: Australian Labor Party

\* $P \leq 0.05$ , \*\* $P \leq 0.01$

agreeing (50%;  $n = 364$ ) that *If I hear or read a statement coming from a climate change expert, I generally believe it is true*, whereas 31% ( $n = 228$ ) were neutral and 19% ( $n = 138$ ) responded negatively. There was a significant difference between countries with an opinion on recent flooding as related to climate change, with more Canadians agreeing with *Most recent floods in this country are due to climate change* (50% v 38%), while comparatively more Australians were neutral or disagreed with the statement (62% v 50%) ( $\chi^2(4) = 10.06$ ,  $p = 0.040$ ).

For all four trust and belief variables, most respondents showed no change after message exposure. Specifically, no change in average responses pre- and post- message exposure was observed in 62% for trust in climate change communicators ( $n = 449$ ), 59% for trust in climate change science, 66% for concern for climate change effects ( $n = 483$ ), and 56% for the belief that most recent floods are due to climate change ( $n = 412$ ). All four delta values had a positive average indicating that overall respondents tended to increase belief and trust post-message exposure, however these effects are small: concern for climate change effects was  $0.05 \pm 0.79$  SD, trust in climate expert was  $0.09 \pm 0.78$  SD, trust in climate science was  $0.04 \pm 0.93$  SD, and flooding related to climate change was  $0.15 \pm 0.88$  SD.

### Activism support

Post-message exposure, almost half of all respondents (47%;  $n = 341$ ) reported no interest in learning more about or supporting environmental organizations. For those who were interested in learning more, or joining or donating to three possible organizations, the majority reported wanting more information on the organizations (42%–43%). Joining (4%–8%) and donating money (3%–7%) were substantially less common. Chi-square tests showed that levels of activism support did not differ with message frame ( $\chi^2(4) = 1.03$ ,  $p = 0.906$ ). Chi-square tests showed no significant difference in the selected use of money donation by country ( $\chi^2(4) = 7.50$ ,  $p = 0.112$ ).

As seen in table 1, a multinomial regression was performed to model the relationship between predictors and the three levels of activism support (*no support*, *passive support* and *active support*). The model fitting information indicated that the chi-square ratio tests had a value of 102.82, Nagelkerke  $R^2 = 0.154$  ( $\chi^2(20)$ ,  $n = 719$ ,  $p = 0.000$ ). Political affiliation, past flood exposure, climate change belief, the interaction between pro-environmental values (NEP score) and climate change belief and level of formal science education made significant contributions to activism support.

## Emotions

A binary logistic regression analysis was performed to examine whether identifying with certain emotions can predict support for environmental activism at a rate better than chance for the entire sample ( $\chi^2(18) = 94.38$ ,  $p < 0.001$ ). The dependent variable in this regression was dichotomous: any support versus none. Determination and alertness predicted support, and under the final model, an accurate prediction can be made 69.1% of the time that participants who identify with these emotions will support activism groups ( $\chi^2(2) = 66.99$ ,  $p < 0.001$ ). Participants were 1.8 times more likely to support activism if they reported feeling *alert* after reading the mock article on a climate change-related local flooding event (compared to feeling neutral or unalert; Wald  $\chi^2(1) = 11.92$ ,  $p = 0.001$ ). Whereas if participants reported feeling *determined* post-exposure, they were 2.8 times more likely to support activism compared to participants who felt neutral or not determined ( $\chi^2(1) = 29.43$ ,  $p = 0.000$ ). Negative and positive PANAS scores were calculated to determine whether there was a relationship between overall positive emotions (8) or overall negative emotions (10) elicited by the individual message frames; there were no significant results for the combined positive ( $\chi^2(4) = 1.12$ ,  $p = 0.891$ ) or negative ( $\chi^2(4) = 7.46$ ,  $p = 0.113$ ) emotion groups. With regards to single emotions: there was a higher than expected number of respondents who reported feeling scared who read the *informative* message frame ( $\chi^2(2) = 12.14$ ,  $p = 0.002$ ), whereas the number of respondents who reported feeling scared who received the *persuasive* or *empathic* message frames was lower than expected.

## Predicting concern, trust, and belief

A multinomial regression was performed to model the relationship between predictors and the level of concern in the effects of climate change for the entire sample. The model fitting information indicated that the chi-square ratio tests had a value of 263.24, Nagelkerke  $R^2 = 0.379$  ( $\chi^2(14)$ ,  $n = 719$ ,  $p = 0.000$ ). The reference category for the model is strongly/somewhat agree in concern about climate change effects as it accounts for 69.1% of the participants. Climate change belief had a significant effect on the level of concern: participants who do not believe in anthropogenic climate change were 7.0 times more likely to not be concerned about climate change effects when compared to those who do believe in anthropogenic climate change (Wald  $\chi^2(1) = 47.687$ ,  $p = 0.000$ ). Similarly, participants who do not believe in anthropogenic climate change were 7.4 times more likely to be neutral on their concern for climate change effects when compared to those who do believe in anthropogenic climate change ( $\chi^2(1) = 67.828$ ,  $p = 0.000$ ). Participants with a low NEP score were 5.2 times more likely to not be concerned about climate change effects compared to those with a high NEP score ( $\chi^2(1) = 19.537$ ,  $p = 0.000$ ). Participants with a low NEP score were also 5.6 times more likely to be neutral on their concern for climate change effects when compared to those with a high NEP score ( $\chi^2(1) = 27.316$ ,  $p = 0.000$ ).

A cumulative odds ordinal logistic regression was run to determine the relationship between the belief that climate change experts communicate trustworthy information and its predictors. The final model included only the statistically significant predictors ( $p < 0.05$ ). As seen in table 2, the odds of respondents with a left-leaning political affiliation trusting climate change experts were 3.3 times that of those who have a right-leaning political affiliation ( $\chi^2(1) = 31.798$ ,  $p = 0.000$ ) and 3.0 times that of those who have either no or 'other' political affiliation ( $\chi^2(1) = 119.428$ ,  $p = 0.000$ ). The odds of Australians trusting climate change experts were 1.4 times that of Canadians ( $\chi^2(1) = 4.358$ ,  $p = 0.037$ ).

A cumulative odds ordinal logistic regression was run to assess what predicted participants' trust in climate science. Predictors that were statistically significant ( $p < 0.05$ ) were included in the final model (table 3).

A cumulative odds ordinal logistic regression was used to try to predict belief in climate change-related flooding. Predictors that were statistically significant ( $p < 0.05$ ) were included in the final model, as shown in table 4.

## Discussion

The main goal of this research was to determine trust and beliefs around climate change, how framing information influences these beliefs, and what determines support for pro-environmental activism. Personal values and experiences were the most significant predictors of both behavioural intent and climate beliefs. Our results suggest that empathetic message frames may be useful in helping the public to accept the link between climate impacts and CC for individuals with lower existing pro-environmental values. These findings are discussed below in the context of theory and existing literature, and recommendations are made for climate communicators and educators.



**Table 2.** Results of ordinal logistic regression using levels of agreement with trust in climate experts as three ordered categories.

Co-variable	$\beta$	SE	p-value	Odds ratio	95% of OR	Single score test (p-value)
<b>Intercept 1 (Disagree)</b>	-0.50	0.23	0.03	0.61	0.39–0.96	—
<b>Intercept 2 (Neutral)</b>	1.47	0.24	0.00	4.33	2.70–6.93	—
<b>CC Belief</b>						
[Do not believe in anthropogenic CC as Reference]						
Anthropogenic-caused	1.91	0.18	0.00	6.75	4.80–9.51	0.00
<b>Political Affiliation</b>						
[Other as Reference]						
Right-leaning (CPC or LNC)	-0.11	0.19	0.54	0.89	0.62–1.29	0.00
Left-leaning (GPC/NDP/LPC or AG/ALP)	1.09	0.19	0.00	2.98	2.05–4.34	
<b>NEP Score</b>						
[High as Reference]						
Medium	-0.12	0.20	0.56	0.89	0.60–1.32	0.00
Low	-0.62	0.20	0.00	0.54	0.36–0.80	
<b>Country</b>						
[Canada as Reference]						
Australia	0.33	0.16	0.04	1.38	1.02–1.88	0.04

**Score test for the proportional odds assumption:** Chi-square = 11.615, df = 6, p-value = 0.071.

**Goodness-of-fit test of overall model (Likelihood Ratio):** Chi-square = 254.309, df = 6, p-value = 0.000.

CPC: Conservative Party of Canada; LNC: The Liberal-National Coalition; GPC: Green Part of Canada; NDP: New Democratic Party; LPC: Liberal Party of Canada; AG: Australian Greens; ALP: Australian Labor Party.

**Table 3.** Results of ordinal logistic regression using levels of agreement with trust in climate science as three ordered categories.

Co-variable	$\beta$	SE	p-value	Odds ratio	95% of OR	Single score test (p-value)
<b>Intercept 1 (Agree)</b>	-0.38	0.22	0.09	0.69	0.45–1.06	—
<b>Intercept 2 (Neutral)</b>	1.74	0.23	0.00	5.71	3.61–9.03	—
<b>CC Belief</b>						
[Do not believe in anthropogenic CC as Reference]						
Anthropogenic-caused	2.00	0.18	0.00	7.31	5.18–10.32	0.00
<b>Political Affiliation</b>						
[Other as Reference]						
Right-leaning (CPC or LNC)	-0.18	0.19	0.34	0.84	0.58–1.21	0.00
Left-leaning (GPC/NDP/LPC or AG/ALP)	0.80	0.18	0.00	2.24	1.57–3.19	
<b>NEP Score</b>						
[High as Reference]						
Medium	-0.02	0.19	0.93	0.98	0.67–1.44	0.00
Low	-0.72	2.00	0.00	0.49	0.33–0.72	
<b>Flood Exposure</b>						
[Medium/high as Reference]						
Low	0.32	0.15	0.03	1.38	1.03–1.86	0.03

**Score test for the proportional odds assumption:** Chi-square = 7.935, df = 6, p-value = 0.243.

**Goodness-of-fit test of overall model (Likelihood Ratio):** Chi-square = 267.366, df = 6, p-value = 0.000.

CPC: Conservative Party of Canada; LNC: The Liberal-National Coalition; GPC: Green Part of Canada; NDP: New Democratic Party; LPC: Liberal Party of Canada; AG: Australian Greens; ALP: Australian Labor Party.

### Political affiliation

Political affiliation was a significant predictor of activism support as well as belief and trust in climate change science and experts - those with a left-leaning political affiliation were more likely to be active or passive supporters than not support climate activism. The rejection of anthropogenic climate change was best predicted by political conservatism as supported by previous research (Rutjens *et al* 2018, Pickering *et al* 2020). A similar result was found for trust in climate experts and climate science which suggests that left-leaning political parties tend to acknowledge the effects of climate change and the trustworthiness of the science and experts who study it. These results also show that participants whose ideology aligns with the Conservatives or the Liberal-National Coalition (of Australia) are more skeptical of climate science, experts and the severity of climate change effects. When compared to a right-leaning political affiliation, those who had an 'other' or left-leaning affiliation were more likely to believe that major flooding events are an outcome of anthropogenic climate change, which is supported by research that found perceptions of local weather conditions are influenced more by partisan affiliation than by objectively measured conditions (Shao and Goidel 2016).

**Table 4.** Results of ordinal logistic regression using levels of agreement with belief in climate-related flooding as three ordered categories.

Co-variable	$\beta$	SE	p-value	Odds ratio	95% of OR	Single score test (p-value)
<b>Intercept 1 (Disagree)</b>	-1.04	0.31	0.00	0.35	0.19–0.65	—
<b>Intercept 2 (Neutral)</b>	0.71	0.31	0.02	2.04	1.10–3.76	—
<b>CC Belief</b>						
[Do not believe in anthropogenic CC as Reference]						
Anthropogenic-caused	1.34	0.17	0.00	3.80	2.74–5.28	0.00
<b>Political Affiliation</b>						
[Other as Reference]						
Right-leaning (CPC or LNC)	0.21	0.27	0.44	1.24	0.72–2.12	0.00
Left-leaning (GPC/NDP/LPC or AG/ALP)	0.71	0.26	0.01	2.03	1.23–3.37	
<b>NEP Score</b>						
[High as Reference]						
Medium	-0.63	0.33	0.06	0.53	0.28–1.02	0.00
Low	-1.02	0.33	0.00	0.36	0.19–0.69	
<b>Country</b>						
[Canada as Reference]						
Australia	-0.45	0.152	0.00	0.64	0.47–0.86	0.00
<b>Low NEP Score × Message Frame</b>						
[Informative MF as Reference]						
Persuasive MF	-0.34	0.30	0.27	0.716	0.40–1.30	0.00
Empathic MF	0.65	0.30	0.03	1.916	1.07–3.42	
<b>Medium NEP Score × Message Frame</b>						
[Informative MF as Reference]						
Persuasive MF	0.05	0.32	0.88	1.05	0.56–1.98	—
Empathic MF	0.91	0.32	0.00	2.48	1.33–4.64	
<b>High NEP Score × Message Frame</b>						
[Informative MF as Reference]						
Persuasive MF	-0.18	0.32	0.58	0.84	0.44–1.60	—
Empathic MF	-0.18	0.36	0.62	0.84	0.41–1.70	
<b>Right-leaning Pol. Affiliation × Flood Exposure</b>						
[Medium/high FE as Reference]						
Low Flood Exposure	-0.81	0.30	0.01	0.45	0.25–0.80	0.04
<b>Left-leaning Pol. Affiliation × Flood Exposure</b>						
[Medium/high FE as Reference]						
Low Flood Exposure	0.24	0.28	0.40	1.27	0.74–2.18	—
<b>Other Pol. Affiliation × Flood Exposure</b>						
[Medium/high FE as Reference]						
Low Flood Exposure	0.07	0.22	0.76	1.07	0.69–1.66	—

Score test for the proportional odds assumption: Chi-square = 9.180, df = 15, p-value = 0.868.

Goodness-of-fit test of overall model (Likelihood Ratio): Chi-square = 221.973, df = 15, p-value = 0.000.

CPC: Conservative Party of Canada; LNC: The Liberal-National Coalition; GPC: Green Part of Canada; NDP: New Democratic Party; LPC: Liberal Party of Canada; AG: Australian Greens; ALP: Australian Labor Party.

### Belief in anthropogenic climate change and pro-environmental values

Belief in anthropogenic climate change was highly relevant to all trust and support predictions. Individuals who believe in anthropogenic climate change were more likely to be activism supporters (active and passive), be concerned about the effects of climate change, trust climate experts and science, and acknowledge the effect that climate change has on flooding. Our results showed that the higher the NEP score—or the greater the pro-environmental values—the more likely participants are to be concerned about the effects of climate change, believe in the connection between climate change and flooding events, and trust climate change experts and science. For those who believe in anthropogenic climate change, the higher the NEP score, the more likely they are to be supporters (as opposed to non-supporters). For those who do not believe in anthropogenic climate change, they were still more likely to be supporters if they had a medium NEP score compared to a low score. This suggests that belief in climate change alone does not indicate a willingness to support pro-environmental activism and that the underlying values have a direct and somewhat more salient impact on someone's desire to support NGO activism. These findings are consistent with previous literature that found that environmental values and behaviour are strong negative determinants of climate uncertainty (Whitmarsh 2011).

### Previous flood exposure

Prior personal experiences with flooding increased participants' likelihood of being active supporters.

Interpretation of this finding is complicated by previous research that found flood victims no more likely to

mention flooding as a consequence of climate change than non-flood victims (Whitmarsh 2008). This could suggest that while flood victims' direct experiences may not influence their climate beliefs, they are more likely to be supporters of general pro-environmental organizations as the firsthand experience made them more interested or concerned about extreme natural disasters and their effects on people's livelihoods. Participants with low flood exposure were also more likely to trust climate science than those with higher exposure. It is possible that participants with higher levels of exposure may become desensitized to the 'science' behind extreme flooding events; this remains to be determined. This could also indicate that participants who have had more direct experiences with major flooding events attribute those weather phenomena to regular patterns as opposed to the more catastrophic and infrequent events often associated with climate change in the media. This speculation requires further testing as, for instance, it contrasts with the findings of Capstick *et al* (2015) who surveyed the British public after the winter flooding of 2013/2014. The authors concluded that the public had made several connections between the floods and climate change, including the belief that climate change was one of the causes of the flooding. Similarly, McDonald *et al* (2015) found that individuals who have experienced floods are more concerned about climate change and view it as more certain than those without experience of floods. The power of political identity also has a significant effect on flooding beliefs: those with a right-leaning political affiliation and medium-high flood exposure are more likely to believe the link between climate change and recent flood events when compared to right-leaners with less flood exposure, which suggests that those who are politically conservative may need more frequent and/or direct experiences of climate effects in order to overcome their skepticism.

### Formal science education

Higher formal science education levels associated with participants being more likely to support pro-environmental activism and to be concerned about the effects of climate change. This suggests that exposure to science, especially earth science, can help people understand the complexity of climate change and conceptualize how harmful its effects are, consistent with the knowledge deficit model (Bulkeley 2000) for climate change communication. However, previous studies are inconclusive on the specific role that science literacy can play in addressing climate science skepticism and have also indicated the influence of political ideology. For instance, greater science literacy and education among Democrats increases the probability that climate change will be perceived as a threat, while greater education decreases the perceived threat among Republicans (Hamilton 2011, Whitmarsh 2011, Drummond and Fischhoff 2017). Taken overall, our findings support the role of science education in eliciting pro-environmental intent, but show that it is not sufficient; values and beliefs—including political orientation - are key moderators of the knowledge-behavior gap.

### Emotions and message frame

Negative perceptions of climate change can make it difficult for people to have a hopeful outlook. Swim and Bloodhart (2015) found that hope—described as having a sense of agency and plan of action—was an important predictor of pro-environmental action. Our emotions matrix did not include the word 'hopeful', however, it is possible that determination and alertness as significant predictors of activism support were representing a form of or proxy for hopefulness. This speculation remains to be determined. While it is difficult to interpret this finding with respect to informing how to best frame information to promote activism support, it does suggest that incorporating messaging elements that elicit these emotions may be important.

The overall valence of the message (positive or negative) did not differ between the message frames we employed, suggesting that any differences between frames in the perceptual or behavioral changes targeted are linked more closely with specific emotion(s) elicited by the frames. In regard to specific message frames, feeling scared was more prevalent among participants receiving the *informative* message frame. This suggests that a 'facts-only' style of writing as opposed to the clarifying language used in the *persuasive* message frame or the emotional perspective-giving of the *empathic* message frame, may not provide readers with enough reassurance on the unsettling topic that is climate change.

Perhaps surprisingly, message frame was a predictor only for flooding belief, and even then, it was only significant as an interaction term with NEP scores. These results showed that respondents who received the *empathic* message frame and had low to medium NEP scores were more likely to believe the link between flooding and climate change when compared to those who received the *informative* message frame. This finding suggests that to 'convince' the public of the argument being made in the message frame (that the particular flooding event is linked to climate change) utilizing an *empathic* frame is more effective than an *informative* message frame. This also suggests that those with strong, pre-existing pro-environmental values require less intentional message framing when compared to those with lower pro-environmental values. Previous research supports the finding that underlying values inform the efficacy of message framing, but in this case, it is a hopeful

result (Hurlstone *et al* 2014). Those with less of an environmentally-friendly worldview can still be convinced of the link between climate change and flooding if exposed to writing that is more perspective-giving and empathic.

### Limitations and final considerations

Measuring behavioural intent through activism support should be further explored, as it may be prone to social desirability bias that can be an issue in self-reported pro-environmental behavioural measures (Kormos and Gifford 2014). Further, the relative merits of using a hypothetical rather than actual sum of money for individuals to allocate as a proxy for activism support are unclear and require further investigation. For instance, Clements *et al* (2015) have reported that actual donations for environmental movement organizations are smaller than hypothetical donations, with the latter over-estimating what would actually be donated by 27%. Using an online survey makes it harder to recruit participants who have accessibility issues with technology as well as creating challenges with ensuring correct interpretation. The text-heavy format of the survey with a lack of visual representation, particularly within the message frames, could be considered a weakness. Most of the questions in the survey were forced-response which is helpful for obtaining a complete dataset, however previous research has found this can substantially increase dropout as well as encourage reactance (Stieger *et al* 2014). The study was given in English and thus Francophones and other participants who do not have English as their first language in both countries would have been unlikely to take the survey. Finally, survey pre-testing could have been more rigorous by way of a larger sample of people outside of academia to ensure that the message frames were achieving the desired/expected emotional responses.

Interestingly, Canadians were more likely to believe the link between climate change and flooding while Australians were more likely to trust climate experts. This may reflect a difference in how these issues are depicted in the media and how prominently these issues are represented in each country. How and what about climate change is communicated through various media sources has an impact on public perception of the global phenomenon. It is important that educators and communicators consider what informs their readers' perceptions of information and how to effectively reach their audiences with the messages that are going to help support pro-environmental behaviour and address climate skepticism and inaction.

The results from this study should inform approaches to communicating climate change information to readers who are highly influenced by their political beliefs, pro-environmental values, and past experiences. For instance, communications targeted at politically right-leaning individuals could stress the anthropogenic origins of CC, as acceptance of this has been shown to predict specific pro-environmental actions (Pickering *et al* 2020) and may lead to greater uptake of climate mitigation behaviours more generally.

A strength of this work was the specific, factually based and regional-context of the information within message frame which may inform practitioners who are seeking to effectively engage Canadians or Australians on climate-related flooding information. This research adds to the existing literature positing that people's values inform their worldview which in turn informs their beliefs, especially when it comes to the politicized topic of climate change. Further research could investigate alternative formats for presenting the informative, persuasive and empathetic message frames, such as incorporating imagery, interactive multimedia or augmented reality.

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### Declaration of interest

Author Munoz-Carrier declares no conflict of interest, financial or otherwise, with this study and publication. Author Thomsen declares no conflict of interest, financial or otherwise, with this study and publication. Author Pickering declares no conflict of interest, financial or otherwise, with this study and publication.

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