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Political orientation and climate concern shape visual attention to climate change

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Abstract Despite the scientific consensus, there is widespread public controversy about climate change. Previous explanations focused on *interpretations* hampered by political bias or insufficient knowledge of climate facts. We propose that public views of climate change may also be related to an *attentional* bias at a more basic level of cognitive processing. We hypothesized that selective visual attention towards or away from climate-related information would be associated with climate concern. To test prioritization of climate-related stimuli under conditions of limited attention, we asked participants to identify climate-related and neutral words within a rapid stream of stimuli. Undergraduate students attended to climate-related words more readily than neutral words. This attentional prioritization correlated with self-rated climate concern. We then examined this relationship in a more diverse community sample. Principal component analysis of survey data in the community sample revealed a component indexing a relationship between climate concern and political orientation. That component was correlated with the degree of selective inattention to climate-related words. Our findings suggest that climate-related communications may be most effective if tailored in a manner accounting for how attentional priorities differ between audiences—particularly those with different political orientations.

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1 Introduction

Despite the scientific consensus about anthropogenic climate change (Oreskes 2004), widespread public skepticism remains (e.g., Hornsey et al. 2016; Hulme 2009; Poortinga et al. 2011; Rainie et al. 2015; Weber and Stern 2011). One way to address this discrepancy is to tailor communications to improve public understanding (Lieserowitz 2007; Lorenzoni et al. 2007; Sheppard 2012). That improvement will be fundamental to achieving climate change mitigation and adaptation (Clayton et al. 2015). Previous accounts of the discrepancy between public understanding and the scientific consensus have focused on how interpretations can be biased by opposing political convictions (e.g., Giddens 2009; Lieserowitz 2006; McCright and Dunlap 2011; Rainie et al. 2015; Zhao et al. 2011) and hampered by insufficient knowledge about climate facts (Kahan et al. 2012; Lorenzoni et al. 2007).

We propose that public understanding of climate change may also be hampered by a more basic selective attentional process. Here, we define attention as the visual prioritization of information in the environment. Visual selective attention is often described as enhancing the perception of relevant stimuli and filtering out competing information. In our account, attitudes about climate change are associated with attentional biases determining how likely an individual is *to see climate-related information* in the environment. For example, in a crowded visual scene such as a news website, the ability to notice climate-related words would be associated with an individual's level of existing concern about climate change.

To test our hypothesis, we examined whether existing concerns about climate change were associated with attention to climate-related information (e.g., words such as carbon). We measured attentional prioritization of climate-related words using an attentional blink (AB) task (Di Lollo et al. 2005; Raymond et al. 1992). The AB task measures attentional biases governing how a given *visual stimulus* is processed under conditions of high attentional demand. The "blink" is a phenomenon in which people are unable to report the identity of a target stimulus if it is presented shortly after a previous target, with both targets embedded in a rapidly presented stream of distractor stimuli. After seeing the first target (T1), people typically fail to see the second target (T2), as if the mind blinks (for about 500 ms).

Previous research has shown that when T2 is associated with emotional arousal or reward, there is a consistently observed reduction in the attentional blink, or "emotional sparing" (e.g., Anderson 2005; Huang et al. 2008; Keil and Ihssen 2004; Lee et al. 2013; Todd et al. 2013, 2014). The degree of sparing from the attentional blink can also reflect individual differences in prioritization of specific categories of stimuli (Lee et al. 2013; Todd et al. 2013). We thus hypothesized that individual differences in concern about climate change would be associated with sparing effects for climate-related information.

In this paper, we first examined whether climate-related words were prioritized within a student sample at a university where there is a strong emphasis on sustainability and awareness of climate change. In experiment 1, we found an overall pattern of climate word sparing in undergraduate students. The degree to which the sparing was observed was correlated with reported concerns about climate change. In experiment 2, we examined whether performance on the AB task was associated with demographic measures in a larger sample from the general public in British Columbia. Here, principal component analysis revealed a component indexing concerns about climate change and political orientation. Liberal politics and greater concern were associated with overall higher accuracy in reporting climate-related target words. A pattern of "climate change blindness" reflecting poorer accuracy for climate-related words at early lags was strongest in conservatives with low concern. The results collectively

demonstrate that the people concerned about climate change attend to climate-related information most readily, at the level of rapid visual processing.

2 Results

2.1 Experiment 1: attention correlates with climate concerns

To test attentional prioritization of information about climate change, we analyzed the accuracy with which target words were reported in an AB task. The sequence of events for each trial in this task is portrayed in Fig. 1a. Embedded in each stream of rapidly presented distractor words, the first target (T1) was always a repeating digit. The second target (T2) was either a word related to climate change or a neutral word. After the AB task, participants rated each target word for intensity of emotional arousal and for semantic relatedness to climate change. In a sample of UBC undergraduate students, we examined attentional blink effects for climate-related and neutral words and assessed whether a pattern of AB sparing for climate-related words was related to individual differences in climate concern. Specifically, we tested whether those more concerned about climate change showed a stronger AB sparing effect for climate-related words (relative to neutral words).

Climate-related words were rated as significantly more climate-related, $t(94) = 21.82$, $p < 0.001$, and significantly more arousing, $t(94) = 14.42$, $p < 0.001$, than neutral words. In order to ascertain whether undergraduates demonstrated AB sparing for climate-related words, accuracy scores for all conditions were analyzed using a two-way repeated-measures ANOVA with word category (climate-related vs. neutral) and lag (1, 2, 4, and 7) as within-subjects factors. The dependent variable was the accuracy with which the identities of T2 targets were reported on trials where T1 targets were also correctly reported. All pairwise contrasts were Bonferroni corrected to control for multiple comparisons.

Results revealed a significant main effect of lag, $F(3, 282) = 53.02$, $p < 0.001$, $\eta^2 = 0.36$, with accuracy increasing at later lags. There was no significant main effect of word category averaged across lags, $p = 0.91$. Typically, differences in AB effects between conditions are indicated by an interaction between lag and word category, with differences observed at early

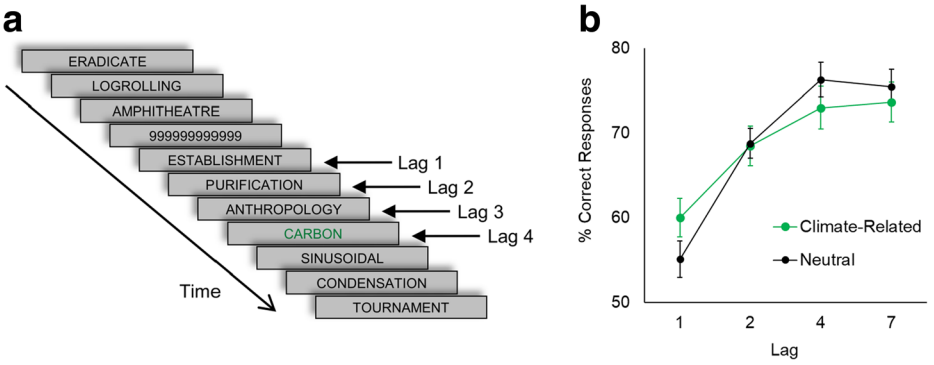

Fig. 1 **a** Attentional blink (AB) task. After each rapid stream of stimuli, participants reported both the first and second targets (T1 and T2). T1 was always a string of repeating digits. T2, presented in green, was either a neutral word or a climate-related word. **b** Participants in experiment 1 reported climate-related words more accurately than neutral words at lag 1 but not at late lags. Error bars represent one standard error of the mean

lags (MacLean and Arnell 2012). Crucially, we observed an interaction between word category and lag, $F(3, 282) = 5.20$, $p = 0.002$, $\eta^2 = 0.05$, as can be seen in Fig. 1b. AB effects are typically reported at either lag 1 or 2, as the lag at which the AB is greatest depends on the stimulus onset asynchrony used, the type of stimuli used, and individual processing speed (Di Lollo et al. 2005). In young adults, when T2 belongs to a separate category from T1 (e.g., digits vs. words), the greatest blink effect is observed at lag 1 (Di Lollo et al. 2005). We observed the greatest blink effects at lag 1 in our previous research (Todd et al. 2013, 2014) and in the current study (see Fig. 1b). Planned contrasts showed higher lag 1 accuracy for climate-related words than neutral words, $p = 0.005$. This demonstrates that at lag 1, where the AB was most pronounced, the participants were literally more likely to see words associated with climate change. Importantly, the difference in lag 1 accuracy between conditions (climate-related > neutral) was correlated with self-rated levels of concern about climate change, $r(95) = 0.24$, $p = 0.02$. The variability in AB sparing at lag 1 is depicted in a histogram in Supplemental Fig. S1. This supports our hypothesis that concerns about climate change are linked to prioritized attention to climate-related information. Within the same set of Bonferroni-corrected planned comparisons, there were no significant differences in accuracy between climate-related and neutral words at lags 2, 4, or 7; $p = 0.875$, $p = 0.052$, $p = 0.281$, respectively.

2.2 Experiment 2: political orientation and climate concerns prioritize attention

In experiment 1, we found AB sparing for climate words in an undergraduate sample. Importantly, we observed a relationship between climate concerns and the degree of AB sparing, measured as the difference in lag 1 accuracy between climate-related and neutral words. However, if we wish to draw conclusions about the broader implications of these individual differences in AB effects, we must examine how they relate to individual differences between members of a larger and more diverse demographic group.

Thus, the primary goal of experiment 2 was to examine variables related to individual differences in the selective attention for or against climate-related information. More specifically, we explored a range of sociocultural, situational, and demographic measures that might be associated with climate concerns (Kahan et al. 2012; McCright and Dunlap 2011; Milfont et al. 2012; Rainie et al. 2015). Each participant in experiment 2 completed a survey reporting their age, gender, income, profession, cultural background, religion, preferred news sources, and experience with natural disasters. They also independently rated their level of approval of several Canadian political parties, their degree of concern about the environment, and their perception of the probability that climate change would have negative impacts in their local geographical area, in wider geographical areas, in the near and distant future. We also calculated how much each participant's self-reported level of concern (Likert scale rating) varied as a function of geographical distance by using linear regression to calculate a slope for each participant. We performed an analogous regression for temporal distance. A list of 52 key questions is provided in the Supplementary material. Additional questions answered by a subset of participants are in survey code available at https://figshare.com/s/92cc8f300459c6bfc8de, along with data files and code used for stimulus presentation. Prior to the survey, each participant performed the attentional blink task. AB effects have been consistently found to be delayed with age (for a review, see Willems et al. 2016). Thus, to examine individual differences while adjusting for the wider age range in the general public, we binned accuracy scores into early (lags 1 and 2) and late (lags 4 and 7) lags within each word category.

We used the survey data to conduct an exploratory investigation of measures associated with climate concerns. To assess the associations between responses to different survey questions, we used principal component analysis. This allowed us to identify the dominant pattern(s) in the survey data in an unbiased, data-driven manner. Our primary goal was to identify the patterns of intercorrelations between measures, rather than to identify how much variance was attributable to each measure. One principal component (PC1) clearly emerged as the strongest pattern in the data upon visual inspection of the scree plot (see Supplementary Fig. S2). It accounted for 8.5% of the variance, while the remaining PCs each accounted for less than 4%. The strongest loadings for PC1 are depicted in Fig. 2. The strongest positive loadings included eight slightly different judgments of the likelihood of negative consequences from climate change. The strongest negative loadings were for right-wing political orientation and support for the Conservative Party of Canada. Based on study 1 and our previous research (e.g., Todd et al. 2013, 2014), we hypothesized that the difference in early-lag accuracy for climate-related relative to neutral words would be associated with this component. Individual scores on PC1 correlated significantly with differences between word categories in accuracy at early lags, $r(578) = 0.19$, $p < 0.001$. This reflected a pattern of "climate change blindness" in those with conservative political orientations and low climate concerns, involving reduced early-lag accuracy for climate-related relative to neutral words. In other words, those less concerned about climate change were selectively inattentive to climate-related information. We have also included correlations between all survey variables and AB sparing effect at early lags—see Supplementary Table S1. Additional correlations between survey variables are available in the spreadsheet at https://figshare.com/s/9ff3587724cb8faf799c.

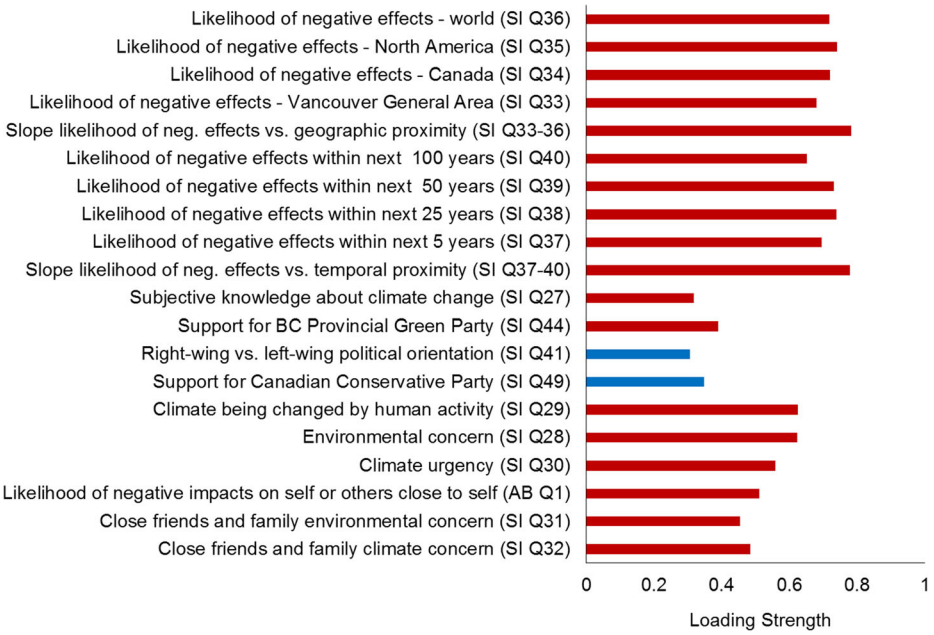

Fig. 2 Positive (red) and negative (blue) loadings from the principal component analysis of questionnaire responses in experiment 2. The questions with the strongest 20% of loadings are depicted. Question numbers refer to those listed in the Supplementary materials. Positive scores on this component correlated with attentional prioritization of climate-related words

To more thoroughly investigate the relationship between PC1 and attentional blink sparing, we performed a median split on PC1 and conducted a 2 × 2 × 2 repeated measures ANOVA with word category (climate-related vs. neutral) and lag (early vs. late) as within-subjects factors and group (concerned liberal vs. unconcerned conservative) as a between-subjects factor. All pairwise contrasts were Bonferroni corrected for multiple comparisons. Results revealed a main effect of lag, $F(1, 576) = 913.77$, $p < 0.001$, $\eta^2 = 0.61$, with higher accuracy at late lags. There was also a main effect of word category $F(1, 576) = 7.77$, $p = 0.005$, $\eta^2 = 0.01$, with overall higher accuracy for climate-related words. There was no significant main effect of group, $F(1, 576) = 0.12$, $p = 0.73$, $\eta^2 = 0.00$.

There was a significant word category × group interaction, $F(1, 576) = 10.34$, $p = 0.001$, $\eta^2 = 0.02$ (see Fig. 3a). Across all lags, the liberal concerned group showed greater accuracy for climate-related than neutral words, $p < 0.001$. In contrast, the conservative unconcerned group showed no difference in accuracy between word categories, $p = 0.763$. Thus, in addition to correlational differences related to PC1 at early lags, the liberal concerned group was more highly tuned to climate-related words across lags. Results also indicated a lag × group interaction, $F(1, 576) = 7.46$, $p = 0.006$, $\eta^2 = 0.01$. This reflected a pattern of higher accuracy for the conservative unconcerned group at early lags and the liberal concerned group at late lags; however, pairwise comparisons revealed these contrasts to be nonsignificant, $ps > 0.1$. There was also a word category × lag interaction, $F(1, 576) = 219.97$, $p < 0.001$, $\eta^2 = 0.28$ (Fig. 3b). Pairwise comparisons showed overall greater accuracy for climate-related words at late lags, and vice versa at early lags ($ps < 0.005$).

There was no significant three-way interaction of word category × lag × group, $F(1, 576) = 2.57$, $p = 0.11$, $\eta^2 = 0.00$. However, to allow for a clearer interpretation of the findings reported above, the mean values for each cell in this design are depicted in Fig. 3c. At early lags, the

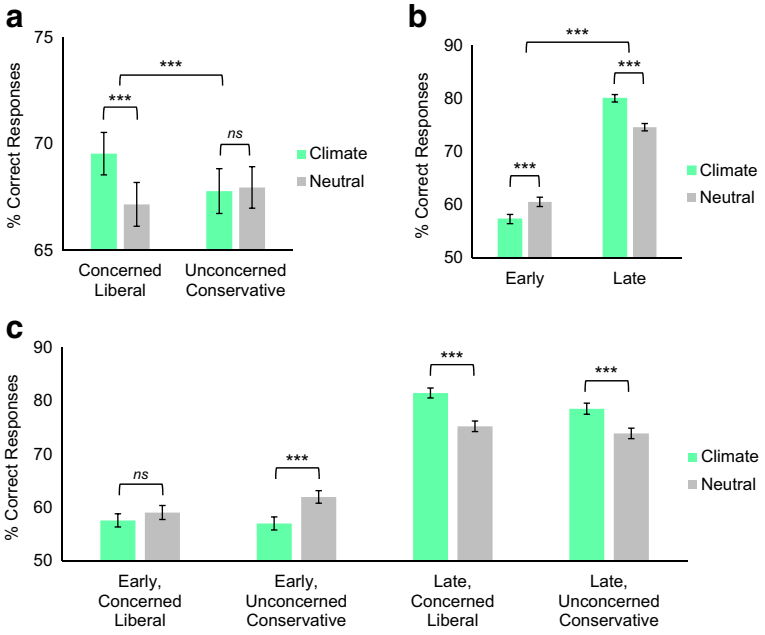

Fig. 3 Estimated marginal means from ANOVAs reported for experiment 2. **a** Group × word category. **b** Lag × word category. **c** Group × lag × word category (*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$)

unconcerned conservative group was less accurate for climate-related words than for neutral words, $p < 0.001$. The smaller difference in the same direction for the concerned liberal group was not significant, $p = 0.053$. Thus, whereas neither group in this population showed the climate word sparing effect observed in undergraduates, a pattern of relative climate word blindness at early lags was more pronounced in the conservative unconcerned group. On a continuous scale, it was variation in this early AB difference between word conditions that was linked to scores on the principal component indexing political orientation and concern about climate change. To summarize, the liberal concerned group showed greater overall accuracy for climate-related words, while the conservative unconcerned group showed no difference. At early lags, where the AB is evident, unconcerned conservatives showed a pronounced AB effect for climate-related relative to neutral words, consistent with a pattern of "climate change blindness."

Of course, a median split is rather arbitrary cutoff for categorizing people's political orientations and levels of concern. The correlational analysis reported initially better captures the gradation of individual differences. Moreover, 40% of participants exhibited higher accuracy for climate-related words than for neutral words at early lags. The variability in AB sparing at early lags is depicted in a histogram in Supplemental Fig. S3.

3 Discussion: attentional prioritization of information about climate change

In this paper, we examined whether attentional biases associated with the likelihood of perceiving climate-related information are associated with existing concerns about climate change. We first examined this within an undergraduate sample at a university where there is a strong emphasis on sustainability and climate change awareness (experiment 1). We found that climate words were given more attentional priority than neutral words. This was evident in sparing from the attentional blink—an effect where identification of target words presented within a stream of rapidly presented distractors is impaired (e.g., Anderson 2005; Huang et al. 2008; Tibboel et al. 2011; Todd et al. 2013, 2014). Importantly, the AB sparing for climate words was correlated with the self-rated strength of concerns about climate change. Participants also rated the climate-related words as more emotionally arousing than the neutral words. As emotionally arousing words also elicit blink sparing (Anderson 2005; Todd et al. 2013), the effect we observe may be due in part to the emotional salience of the climate-related words. Future research may examine further the relationship between the emotional salience of climate-related stimuli and climate concern.

In a larger community sample (experiment 2), the early-lag accuracy difference between climate and neutral words was correlated with a principal component indexing the negative relationship between concerns about climate change and conservative political orientation. At early lags, unconcerned conservatives showed higher accuracy for neutral words than for climate words, suggesting selective inattention to climate-related cues. Moreover, although it does not reflect selective attention effects indexed by the AB per se, the liberal and concerned group showed overall greater accuracy for climate-related words, while the conservative unconcerned group did not. This suggests that the relationship between explicit concern and attention to climate cues extends beyond the effects of rapid selective attention and includes persistent prioritization of climate-relevant cues when attentional resources are less constrained. These findings support our hypothesis that levels of concern about climate change are linked to attentional prioritization of climate-related information. By focusing on the

principal component representing the dominant pattern in the survey data, we optimized our analysis for testing whether individual differences reflected in the survey responses were associated with the visual attentional priority given to climate-related words in the attentional blink task. Now that this association has been established, future research may explore its precise nature in more detail, assessing how much each individual measure contributes to the relationship.

In both experiments, early-lag differences between climate-related and neutral words were reliably associated with climate concerns; however, there were differences between experiments in the overall AB effects. In experiment 1, UBC undergraduate students were a relatively homogenous group demographically and showed a pattern of early-lag climate word sparing. In experiment 2, the community sample contained a broader public population and showed climate word blindness at early lags. The early-lag sparing in students was likely due to high levels of climate concern among UBC students, since they encounter numerous cues related to sustainability and climate change on campus on a daily basis.[1] Other factors by which students differ from the community sample include their younger age, small variability in age, and attending a university with extremely selective admission standards. This academic selectivity is associated with more extensive vocabularies, a better ability to sustain attention in a computerized task, and faster processing speed, compared to the community sample.

The two experiments also revealed different patterns of blink recovery as indexed by patterns of accuracy at late lags. In the student sample in experiment 1, there were no reliable differences between conditions at late lags, consistent with previous studies examining modulation of the blink by stimulus category in the AB (Anderson 2005; Anderson and Phelps 2001; Waters et al. 2007). In experiment 2, there was an advantage for climate-related words at late lags, although across all lags a climate advantage was observed only in the concerned liberal group. Such crossover effects in AB patterns have been previously reported (Jolicoeur 1998; Maclean and Arnell 2011; MacLean and Arnell 2012; Olson et al. 2001), but late-lag effects are notoriously difficult to interpret. Such late-lag effects can reflect differences in AB *recovery*. They can also reflect slower cognitive processes that follow rapid attentional selection. These in turn are influenced by a host of individual difference and demographic factors, including age, attention, working memory capacity, and cognitive control (Arnell et al. 2010; Colzato et al. 2011; Dale and Arnell 2010; Lahar et al. 2001).

The finding that individual differences in concern are associated with attention to climate-related information has important implications. It indicates that prior beliefs and concerns are associated with how individuals orient to information in the environment, selectively prioritizing or filtering evidence of climate change. This attentional prioritization could ultimately give rise to confirmation bias favoring new information expected to support existing opinions (Nickerson 1998). Our current findings point to another promising direction for future research, which is to design interventions to increase visual attention to climate-related information among climate deniers.

The current findings have important implications for climate-related communications. For example, future communication strategies should consider how best to draw the attention of people who are unconcerned or in denial. One approach might be to pair climate-related information with terms linked to other politically polarized issues likely to draw the attention

[1] UBC is one of the most sustainable campuses in the world, e.g., offering 647 sustainability-related courses, engaging 3100 students in residence on sustainable actions, reducing 59% water use per student since 2000, reducing 30% greenhouse gases since 2007, and diverting 67% of waste (UBC Sustainability Initiative 2017).

of climate deniers. Certainly, we should tailor our climate-related communications in a manner accounting for how attentional priorities vary with political orientation. Such manipulations might be effective if we employ moral framings appealing to those with right-wing politics (appealing to values such as purity, patriotism, and obedience to authority) (Wolsko et al. 2016). Another potential avenue is to tailor climate communication with the message that climate actions can lead to a more considerate and caring society and greater economic/technological development (Bain et al. 2012). The optimal strategy would simultaneously address both barriers to attention and biases involving interpretational frameworks. Such adjustments will be fundamental to boosting public understanding and, in turn, boosting efforts toward mitigation and adaptation.

4 Methods

Ethics approval for all experiments reported here was obtained from the UBC Behavioural Research Ethics Board. All participants provided written informed consent.

4.1 Code availability

The code for all tasks and surveys is available at https://figshare.com/s/92cc8f300459c6bfc8de.

4.2 Experiment 1

4.2.1 Participants

Ninety-five UBC undergraduates (mean age 20.7 years, 69 females) participated for course credit. As a rule of thumb, we consider $N = 80$ to be a minimum sample size for any study using correlational analyses to test for individual differences. A more detailed discussion of statistical power and rationale for sample sizes, for both experiments 1 and 2, can be found in the Supplementary material.

4.2.2 Procedure

Participants first performed an attentional blink task. On each trial, participants viewed (see Fig. 1a) a stream of stimuli presented in rapid succession. Stimulus onset asynchronies (SOAs) ranged from 116 to 183 ms in 16.6 ms increments, depending on individual performance in the practice session. They then reported the identities of two *targets*: a string of repeating digits (T1) and a word in green font (T2). T2 was either climate-related or neutral. Full lists of each type of target word are included in the Supplemental materials. As in previous works (Todd et al. 2013, 2014), target word categories were matched in terms of word length, English language frequency, and neighborhood frequency, to ensure that neither simple familiarity nor visual characteristics of the words drove any differences in findings between target word types. The assignment of individual target words to different lags was randomized across participants.

T1 was randomly placed 3rd, 4th, 5th, or 6th in the rapid serial visual presentation (RSVP) stream. There were four T1–T2 lags: T2 either immediately followed T1 (lag 1) or followed it after 1, 3, or 6 intervening distractors (lags 2, 4, and 7, respectively). The number of distractors

following T2 was kept constant across trials, so that they were equated in terms of working memory load. Participants completed 56 trials for each of the two target word types, for a total of 112 trials.

Task timing was individually calibrated to minimize performance differences stemming from individual differences in perceptual processing speed. During the practice session, we presented 30 trials with proper names used as targets, at five different SOAs, ranging from 116 to 183 ms in 16.6 ms increments. We added 16.6 ms to the fastest SOA for which participants reported T2 with greater than 80% accuracy at lag 7, then used that value as the SOA for all items in the subsequent main experiment.

Following the attentional blink and word rating tasks, participants also responded to the question "How concerned are you about climate change?" by using a mouse to move a cursor along a Likert scale with the following labels, arranged with equal spacing: "Not at all concerned," "Somewhat concerned," "Very concerned," and "Extremely concerned." Participants also rated each target word for how emotionally arousing it was (intensity regardless of positive or negative valence).

4.3 Experiment 2

4.3.1 Participants

$N = 578$ participants were recruited from the general public (mean age 34.1 years, SD = 15.5 years, 315 women, 261 men, 2 reporting their gender as "other") and reimbursed $10 per hour. $N = 442$ participants were recruited and tested (on laptop computers) at shopping malls in several municipalities adjacent to Vancouver, BC, Canada, spanning a range of urban and suburban areas. $N = 56$ participants were recruited and tested in a mall in Kamloops, BC, where the economy relies strongly on consumption of natural resources and there is a history of electing more conservative political representatives than in Vancouver. The remaining participants were recruited within community centers, libraries, public parks, and the UBC campus. The sample of $N = 578$ participants was in keeping with a rule of thumb where we consider $N = 500$ to be a bare minimum for identifying individual differences in a community sample and in a study with multiple predictors (which we expected to be more independent from each other a priori), and with the fact that a minimum sample size of $N = 354$ is necessary for detecting a population correlation of $\rho = 0.19$ (the observed correlation from experiment 1). A more detailed discussion of statistical power and rationale for sample sizes, for both experiments 1 and 2, can be found in the Supplementary material.

4.3.2 Procedure

The procedures were identical to those of experiment 1 (e.g., same number of trials, same words used as targets, etc.) with the following exceptions: SOAs ranged from 116 to 250 ms in 33.5 ms increments, depending on individual performance in the practice session. This wider range of SOAs was optimized for the increased variability in age, visual acuity, and processing speed in the community sample (relative to the undergraduate sample). The assignment of individual target words to different lags was not randomized across participants. This ensured that any between-subjects comparisons, within a given lag and word category (i.e., lag 1, climate-related) could not be confounded with features such as word length or written frequency, because

the same target words were used for each participant within a given lag (and word category).

For the sake of expedient data collection in a community setting, we included no word ratings. There was one question about climate concern incorporated as part of the code for the attentional blink task. It asked "How likely is it that climate change will have a negative effect on you personally or someone close to you? Please enter 1–7 and press the <ENTER> key." Following completion of the AB task, participants also completed the survey described in Section 2.2 and the Supplementary material. Some participants completed longer forms of the survey. Missing values were replaced by the mean for that variable prior to analysis. All PCA results depict the unrotated solution, from Matlab's SVD function.

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Author contribution R. M. T. conceived the study with J. Z. R. M. T., J. C. W., J. Z., and K. H. R. contributed to the study design and J. C. W. analyzed the data and wrote the paper with R. M. T and J. Z.Funding informationThis research was supported by NSERC Discovery grants to R. M. Todd (RGPIN-2014-04202) and to J. Zhao (RGPIN-2014-05617), the Leaders Opportunity Fund from the Canadian Foundation for Innovation to R. M. Todd (32102), by a Canadian Institutes for Health Research New Investigator Award to R. M. Todd, the Canada Research Chairs Program to J. Zhao, by a SSHRC Postdoctoral Fellowship (756-2016-0829) to J. C. Whitman, and by a SSHRC Insight Development Grant (430-2016-00031) awarded to R.M. Todd, J. Zhao, and J.C. Whitman.

Compliance with ethical standards

Conflict of interest There are no potential conflicts of interest to disclose.

Ethical approval Ethical review was conducted by the University of British Columbia Behavioural Research Ethics Board.

Informed consent All participants provided written informed consent prior to participation.

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