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Support for climate policy and societal action are linked to perceptions about scientific agreement

Ding Ding[1,2], Edward W. Maibach[3]*, Xiaoquan Zhao[3], Connie Roser-Renouf[3] and Anthony Leiserowitz[4]

Although a majority of US citizens think that the president and Congress should address global warming, only a minority think it should be a high priority[1]. Previous research has shown that four key beliefs about climate change—that it is real, human caused, serious and solvable—are important predictors of support for climate policies[2]. Other research has shown that organized opponents of climate legislation have sought to undermine public support by instilling the belief that there is widespread disagreement among climate scientists about these points[3]—a view shown to be widely held by the public[1]. Here we examine if this misperception is consequential. We show that the misperception is strongly associated with reduced levels of policy support and injunctive beliefs (that is, beliefs that action should be taken to mitigate global warming). The relationship is mediated by the four previously identified key beliefs about climate change, especially people's certainty that global warming is occurring. In short, people who believe that scientists disagree on global warming tend to feel less certain that global warming is occurring, and show less support for climate policy. This suggests the potential importance of correcting the widely held public misperception about lack of scientific agreement on global warming.

There is near-unanimous agreement among climate scientists[4,5]—and by the academies of science in the G8 nations, Brazil, China, India, Mexico and South Africa[6]—that the mean global temperature has increased significantly from preindustrial-age levels and that human activity is a principal cause[4,5], although a small number of climate scientists remain unconvinced[6]. In 2002, Republican strategist Frank Luntz advised President George W. Bush: "Voters believe that there is no consensus about global warming in the scientific community. Should the public come to believe that the scientific issues are settled, their views about global warming will change accordingly. Therefore, you need to continue to make the lack of scientific certainty a primary issue in the debate."[7] The Bush administration responded by stressing scientific uncertainty in subsequent official reports[8]. Likewise, many within the fossil-fuel industry, conservative think tanks and political pundits argued there is no scientific consensus that global warming is happening, human caused or a serious risk[3]. Before 2004, mainstream news media reports on climate change often featured duelling scientists, presenting a false 'balance'[9], inadvertently suggesting that the climate science community remained strongly divided[10]. Perhaps as a result, only a minority of the US adult public believe that 'most scientists think global warming is happening'—47% in 2008, decreasing to 39% in 2011 (ref. 1).

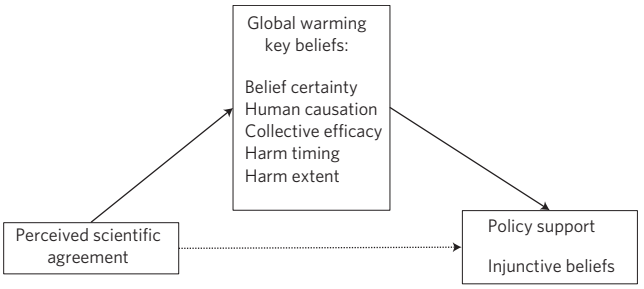

Figure 1 | Conceptual model. Indirect relationship of perceived scientific agreement with policy support and injunctive beliefs through mediators (key beliefs).

Public perceptions of the scientific agreement on climate change are likely to play a critical role in determining opinions on the issue, given that most people are unable to read or evaluate the evidence on their own. Only about 20% of US citizens are scientifically literate, as defined by the ability to read and understand science news in *The New York Times*[11]. A recent study found that most US citizens have limited climate literacy[12]. When people are unable or unwilling to weigh the evidence on an issue to develop their own reasoned opinions, they rely instead on cognitive heuristics—mental short-cuts—to guide their decision-making[13]. The opinions of trusted sources provide just such a short-cut[13], and surveys show that scientists are one of the most trusted sources of information on climate change[1].

Here we investigate whether public misunderstanding of the scientific agreement about climate change is consequential, or not. Previous research has found that four key beliefs, as well as political ideology[14] and certain underlying cultural worldviews[15,16], predict public support for taking action against climate change. These key beliefs include that climate change is real, human caused and harmful (which we treat in the current study as having two dimensions—timing and extent of harm), and that actions can be taken to limit it[2].

The aims of our current study are to assess whether perceptions of scientific agreement are associated with support for action to limit global warming, and if so, to determine whether this association is mediated by other beliefs about

[1]Department of Family and Preventive Medicine, University of California San Diego, La Jolla, California 92093, USA, [2]Graduate School of Public Health, San Diego State University, 9245 Skypark Ct. Suite 230, San Diego, California 92123, USA, [3]Center for Climate Change Communication, Department of Communication, George Mason University, 4400 University Drive, Research 1/251, Fairfax, Virginia 22030, USA, [4]Yale Project on Climate Change Communication, School of Forestry and Environmental Studies, Yale University, 195 Prospect Street, New Haven, Connecticut 06405, USA.
*e-mail: emaibach@gmu.edu.

Table 1 | Measures of key variables about global warming.

	Questions	Coded responses
Independent variable		
Perceived scientific agreement	'Which comes closer to your own view?'	1 = Consensus understood ('most scientists think global warming is happening') 0 = Consensus not understood ('a lot of disagreement among scientists about whether or not global warming is happening', or 'most scientists think global warming is not happening ' or 'do not know enough to say')
Dependent variables		
Injunctive beliefs	'Do you think each of the following should be doing more or less to address global warming?' (7 items*, $\alpha = 0.971$).	5-point scale: 1–5 (should do: much less, less, about the same, more, much more)
Policy support	'How much do you support or oppose the following policies?' (6 items†, $\alpha = 0.878$)	4-point scale: 1–4 (strongly oppose, oppose, support, strongly support)
Mediators (key beliefs)		
Belief certainty	'Do you think that global warming is happening?' 'How sure are you that global warming is/is not happening'	9-point scale: 1 (complete certainty that global warming is not occurring) to 5 (not certain/don't know) to 9 (complete certainty that global warming is occurring)
Human causation	'Assuming global warming is happening, do you think it is…'	3-point scale: (1) 'global warming is not happening' or 'it is caused mostly by natural changes in the environment'; (2) 'global warming is caused by both human activities and natural change'; (3) 'global warming is caused mostly by human activities'.
Collective efficacy	'Which of the following statements comes closest to your view?'	4-point scale: (1) 'global warming is not happening' or 'Humans cannot reduce global warming even if it is happening'; (2) 'Humans could reduce global warming, but people are not willing to change their behaviour, so we are not going to'; (3) 'Humans could reduce global warming, but it is unclear at this point whether we will do what is needed'; (4) 'Humans can reduce global warming, and we are going to do so successfully'.
Harm timing	'When do you think global warming will start to harm people in the United States/other people around the world?' (2 items, $\alpha = 0.969$)	6-point scale: 1–6 (never, in 100 years, in 50 years, in 25 years, in 10 years, right now)
Harm extent	'How much do you think global warming will harm' (7 items‡, $\alpha = 0.967$)	4-point scale: 1–4 (not at all, only a little, a moderate amount, a great deal)

*Seven items included: local government officials, state legislators, governors, the US Congress, the president, corporations and industry, and citizens themselves. †Six policy items included: regulating carbon dioxide as a pollutant; signing an international treaty that requires the United States to cut its carbon dioxide emissions by 90% by 2050; adding a surcharge to electrical bills to establish a fund to help make buildings more energy efficient and to teach US citizens how to reduce energy use; requiring electric utilities to produce at least 20% of their electricity from renewable energy sources; providing tax rebates for people who purchase energy-efficient vehicles or solar panels; and increasing taxes on gasoline (by 25 cents per gallon) and returning the revenues to taxpayers by reducing the federal income tax. ‡Seven items included: respondents themselves, their family, people in their community, people in the United States, people in other modern industrialized countries, people in developing countries and future generations. α is Cronbach's α.

global warming. Specifically, we propose that (1) misperception of the scientific agreement is associated with reduced support for societal action to limit climate change and (2) this relationship is mediated by key beliefs about global warming identified in previous public opinion research, particularly belief certainty (Fig. 1).

In June 2010, we conducted an online survey among a nationally representative sample of US adults. The survey measured individuals' beliefs, opinions and behaviours about global climate change; Table 1 shows the questions and response options used in the current study. Respondents' demographic characteristics, values and political ideology are described in Table 2; these variables served as control variables in our analyses.

Notably, 66% of the respondents are classified as 'consensus not understood' because they responded 'there is a lot of disagreement among scientists about whether or not global warming is happening' (45%), 'most scientists think that global warming is not happening' (5%) or they 'do not know enough to say' (16%).

Perceived scientific agreement (that is, the independent variable) is significantly associated with all five key beliefs (that is, the mediators), which in turn are significantly associated with policy support (that is, the dependent variable) (Table 3). Mediation analysis shows that perceived scientific agreement is indirectly associated with support for climate change mitigation policies ($B_{\text{total indirect effect}} = 0.214$; 95% CI, 0.175, 0.262) through all five key beliefs, the strongest of which is belief certainty that global warming is happening ($B = 0.104$; 95% CI, 0.067, 0.147). This model explains a majority of the variance in policy support ($R^2 = 0.581$).

The five key beliefs are also significantly associated with the second dependent variable, injunctive beliefs (the belief that various societal actors should do more to address global warming; Table 4). Mediation analysis shows that perceived scientific consensus is also indirectly associated with injunctive beliefs through the five other key beliefs ($B_{\text{total indirect effect}} = 0.379$; 95% CI, 0.295, 0.429), the strongest of which is belief certainty that global warming is

Table 2 | Descriptive statistics of the study sample.

	Total sample ($n = 751$)
Demographic characteristics	
Age (years)	47.9 (16.2)
Gender (female %)	51.0
Education attainment (bachelor's degree %)	29.6
Marital status (married/cohabiting %)	55.7
Cultural worldviews	
Egalitarianism (1–4 scale)	2.5 (0.7)
Individualism (1–4 scale)	2.7 (0.8)
Political orientation (1–5 scale: very liberal–very conservative)	3.2 (1.1)
Scientific consensus not understood (%)	66.3
Key beliefs about global warming	
Belief certainty (1–9 scale)	6.2 (2.3)
Human causation (primarily human %)	50.5
Collective efficacy (1–4 scale)	2.3 (0.9)
Harm timing (1–6 scale)	3.8 (1.9)
Harm extent (1–4 scale)	2.1 (1.2)
Injunctive beliefs (1-5 scale)	3.6 (1.1)
Policy support (1–4 scale)	2.6 (0.7)

Standard deviation is given in parentheses.

happening ($B = 0.174$; 95% CI, 0.114, 0.241). This model explains a majority of the variance in injunctive beliefs ($R^2 = 0.570$).

Using the same procedures, we tested two alternatives to the model presented in Fig. 1. To examine the possibility that other key beliefs about global warming influence perceptions about scientific consensus, which subsequently influence policy support and injunctive beliefs (a hypothesis consistent with the motivated reasoning literature[17]), the first alternative model treated the five key beliefs as independent variables, perceived scientific agreement as the mediator, and policy support and injunctive beliefs as the dependent variables. These analyses demonstrated direct associations of the five key beliefs with policy support and injunctive beliefs ($B_{\text{direct effect}} = 0.08 \sim 0.19$, all $P < 0.01$) but failed to show any indirect effects of these beliefs as mediated through perceived scientific agreement ($B_{\text{indirect effect}} = 0$–$0.03$, all $P > 0.05$). To examine the possibility that people form their global warming beliefs in a manner that justifies their pre-existing policy preferences (a hypothesis consistent with the cultural cognition literature[16]), the second alternative model treated policy support and injunctive beliefs as independent variables, the five key beliefs as mediating variables and perceived scientific agreement as the dependent variable. These analyses failed to show any indirect effects through the mediation of the five key beliefs ($B_{\text{indirect effect}} = 0.01 \sim 0.05$, $P > 0.05$). These results strongly indicate that neither of the alternative models is consistent with the data; we conclude that our hypotheses were supported.

Our findings must be interpreted with some caution: causal relationships cannot be definitely established with cross-sectional data. Although the pattern of associations we documented is consistent with our proposed model, and we controlled for important known correlates of climate change policy support (political orientation, cultural worldviews and demographics), and we examined and ruled out two alternative models, proving causality in our hypothesized model requires experimental data.

This study clarifies the attributes of citizens who are sufficiently engaged in the issue of climate change to support societal threat-reduction actions, and the relationship among these attributes. Citizens who support societal action against climate change are certain that it is real and human caused, they recognize that it poses a serious threat to humans and that human action can reduce the threat, and they correctly understand that there is widespread agreement about climate change among scientists. Misunderstanding the widespread scientific agreement about climate change is a particularly serious misperception because it seems to undermine people's other key beliefs that support public engagement in climate change, especially the certainty of belief that climate change is happening.

Although the literature demonstrates that motivated reasoning—the process of interpreting information so that it conforms to their pre-existing beliefs—can influence people's acceptance or rejection of scientific evidence[18], our findings suggest that many US citizens' perceptions of scientific agreement about climate change are not the product of motivated reasoning. Whereas the motivated reasoning model may characterize the minority of highly committed partisans with strongly held views, our findings are consistent with the Elaboration Likelihood Model[13], which suggests that the majority of US citizens—who have lower levels of involvement in the issue—are likely to base their beliefs about climate change on their perceptions of scientists' views. Indeed, experimental research supports that this is the information-processing style of a large segment of the public: When presented with information about the impacts of global warming and told that scientists had definite evidence for these projections, participants' levels of concern about climate change increased significantly[19]. Further research is needed to examine when each of these two processes is occurring, and for whom.

Importantly, these findings are actionable: the myth of widespread disagreement among climate scientists over whether global warming is happening has little to no basis in truth[5,20], and it emerged, at least in part, as the result of a concerted effort to deceive the public[3,15,21,22]. Purposive campaigns can be mounted to correct important misperceptions[23,24].

Table 3 | Mediation effects of perceived scientific agreement on climate change policy support through key beliefs, adjusting for covariates* .

	IV → mediators		Mediators → DV		Indirect effect IV → mediators → DV	
	B (SE)	95% CI	*B* (SE)	95% CI	*B* (SE)	95% CI_{bc}
Mediators: key beliefs						
Certainty	1.445 (0.150)	1.151, 1.739	0.071 (0.013)	0.045, 0.096	0.104 (0.020)	0.067, 0.147
Human causation	0.422 (0.071)	0.283, 0.561	0.082 (0.025)	0.033, 0.131	0.035 (0.012)	0.015, 0.063
Collective efficacy	0.155 (0.039)	0.079, 0.231	0.092 (0.044)	0.006, 0.178	0.014 (0.008)	0.002, 0.035
Harm timing	0.788 (0.134)	0.525, 1.051	0.046 (0.015)	0.017, 0.075	0.036 (0.014)	0.013, 0.069
Harm extent	0.541 (0.091)	0.363, 0.719	0.048 (0.020)	0.009, 0.087	0.026 (0.013)	0.005, 0.055
Total indirect effects					0.214 (0.026)	0.175, 0.262

*Covariates were age, gender, education attainment, marital status, political orientation, egalitarianism, individualism. IV: independent variable (perceived scientific agreement); DV: dependent variable (climate change policy support); *B*: unstandardized regression coefficient; SE: standard error; 95% CI_{bc}: bias-corrected and accelerated confidence interval based on 10,000 bootstrap samples.

Table 4 | Mediation effects of perceived scientific agreement on climate change injunctive beliefs through key beliefs, adjusting for covariates* .

	IV → mediators		Mediators → DV		Indirect effect IV → mediators → DV	
	B (SE)	95% CI	*B* (SE)	95% CI	*B* (SE)	95% CI_{bc}
Mediators: key beliefs						
Certainty	1.447 (0.150)	1.153, 1.741	0.120 (0.018)	0.085, 0.155	0.174 (0.033)	0.114, 0.241
Human causation	0.420 (0.071)	0.283, 0.557	0.207 (0.036)	0.136, 0.278	0.087 (0.022)	0.050, 0.138
Collective efficacy	0.156 (0.039)	0.080, 0.232	0.130 (0.062)	0.008, 0.252	0.020 (0.012)	0.031, 0.050
Harm timing	0.788 (0.134)	0.525, 1.051	0.063 (0.021)	0.022, 0.104	0.049 (0.019)	0.016, 0.092
Harm extent	0.543 (0.091)	0.367, 0.719	0.089 (0.029)	0.032, 0.146	0.048 (0.020)	0.017, 0.097
Total indirect effects					0.379 (0.045)	0.295, 0.429

*Covariates were age, gender, education attainment, marital status, political orientation, egalitarianism, individualism. IV: independent variable (perceived scientific agreement); DV: dependent variable (injunctive beliefs); *B*: unstandardized regression coefficient; SE: standard error; 95% CI_{bc}: bias-corrected and accelerated confidence interval based on 10,000 bootstrap samples.

Some studies suggest that repeating myths in efforts to debunk them—for example, stating 'many people incorrectly believe that there is much disagreement among scientists about whether global warming is happening'—will backfire and strengthen the misperception in many minds; this occurs because information that is more familiar is deemed more likely to be true, and repeating the myth only makes it more familiar over time[24]. Instead, efforts to 'debias' audiences should repeatedly assert the correct information—for example, 'the vast majority of climate scientists agree that human-caused global warming is happening'—because repeated assertions, in time, become more familiar and therefore more likely to be deemed true. This strategy is consistent with the literature on public information campaigns, which has long emphasized the importance of the repetition of simple, clear messages to communicate effectively with the public[25].

Methods

Data collection. Data for this study were obtained from a national survey conducted in June 2010. Of the 1,143 US adults (18 years or older) invited to participate, 751 (65.7%) provided consent and completed the survey. Respondents were adult members of an online, non-volunteer, probability-based panel with 50,000-members. The panel has been recruited and maintained by the survey research firm Knowledge Networks. Members are recruited using random digit dialling and address-based sampling; this dual sampling strategy covers both listed and unlisted phone numbers, and telephone, non-telephone and mobile-phone-only households. Panellists complete an average of two surveys of 5–20 min per month, for which they receive small incentives in the range of $4–$6. Those without a home computer receive a free netbook and Internet service to ensure that segments of the population without computers are represented in the panel.

Our study (approved by George Mason and Yale institutional review boards) uses data derived from a random sample of adults (18 and older) from the Knowledge Networks panel; any demographic differences between this sample and the general US population have been controlled for in the analysis. A total of 1,143 adults 18 and older were sampled; responses were received from a total of 751 for a completion rate of 65.7%.

The cumulative response rate for an online panel survey may be calculated as the product of the panel's recruitment rate, profile rate (the proportion of respondents who complete the initial profile survey to become panel members) and completion rate. The current study has a recruitment rate of 17.8% (using AAPOR Response Rate 3), a profile rate of 59.7%, a completion rate of 66.5% and a cumulative response rate of 7.1%. Response-rate metrics for online panel surveys should be compared with other probability-based survey sampling methods with caution, because the cumulative response rate is the product of multiple figures, thereby reducing it greatly. Recent research comparing online panel surveys to other probability-based sampling methods has shown that online panel surveys produce equally if not more valid population estimates, despite the low cumulative response rates[26,27].

Data analysis. To test our hypotheses, we conducted mediation analysis using an SPSS script developed by Preacher and Hayes[28]. This script allows for simultaneous examination of multiple mediators while adjusting for covariates, and it permits comparison of specific indirect effects through different mediators. Covariates controlled for included age, gender, educational attainment, marital status, self-identified political ideology and the cultural worldviews of individualism and egalitarianism. Significance of indirect effects was determined by bootstrapping with 10,000 resamples. Bootstrapping is a recommended approach to mediation analysis because it has greater statistical power than alternative methods and makes no assumption about the sampling distribution of the indirect effect[28,29]. Significance was ascertained using bias-corrected accelerated bootstrap confidence intervals.

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Author contributions

E.W.M. and D.D. conceptualized the research question. D.D. conducted data analysis and wrote the first draft of the manuscript. X.Z. provided statistical assistance. E.W.M., C.R-R., X.Z and A.L. wrote and revised parts of the manuscript. A.L., E.W.M. and C.R-R. designed and conducted the national survey.

Additional information

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