Efficacy, Action and Support for Reducing Climate Change Risks

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ABSTRACT

A growing body of research demonstrates that believing action to reduce the risks of climate change is both possible (self-efficacy) and effective (response efficacy) is essential to motivate and sustain risk mitigation efforts. Despite this potentially critical role of efficacy beliefs, measures and their use vary wildly in climate change risk perception and communication research, making it hard to compare and learn from efficacy studies. To address this problem and advance our understanding of efficacy beliefs, this paper makes three contributions. First, we present a theoretically motivated approach to measuring climate change mitigation efficacy, in light of diverse proposed, perceived, and previously researched strategies. Second, we test this in two national survey samples (MTurk N=405, GfK N=1820), demonstrating largely coherent beliefs by level of action and discrimination between types of efficacy. Four additive efficacy scales emerge: personal self-efficacy, personal response efficacy, government and collective self-efficacy, and government and collective response efficacy. Third, we employ the resulting efficacy scales in mediation models to test how well efficacy beliefs predict climate change policy support, controlling for specific knowledge, risk perceptions, and ideology, and allowing for mediation by concern. Concern fully mediates the relatively strong effects of perceived risk on policy support, but only partly mediates efficacy beliefs. Stronger government and collective response efficacy beliefs and personal self-efficacy beliefs are both directly and indirectly associated with greater support for reducing the risks of climate change, even after controlling for ideology and causal beliefs about climate change.

KEYWORDS: Efficacy; climate change; risk perception

1. INTRODUCTION

Advice on offer regarding what can and should be done about climate change and how effective such actions are[1-3] appears to ignore how easy or hard those actions are to take[4] and aligns weakly, at best, with public perceptions.[5] Household behaviors can help mitigate climate change [6-7], and some progress has been made in this regard, even as federal laws have stalled in the U.S. [8] Yet there is evidence of considerable uncertainty about what behaviors will help slow or stop climate change,[9-13] even among those who report having taken action.[5]

Beliefs about what actions will be effective—response efficacy—and what is feasible—self-efficacy—influence both intentions and actions in other environmental domains.[13-15] Is it that people underestimate the actual energy savings from energy-saving behaviors,[11,16-17] that leads to fewer than half reporting engaging in all of them?[18] Could declines in individuals' confidence that energy-saving efforts will reduce global warming[19] reduce interest in acting on climate change?

Those who have taken individual actions to slow or stop global warming mention environmentally friendly behaviors such as recycling, driving less and purchasing more eco-friendly products.[5] Asking them what government might do elicits mentions of stopping coal use, increasing use of renewable energy sources, and public policy approaches such as stricter laws and implementing cap-and-trade. While slightly under 2% mention reducing CO2 emissions, actions such as family planning and geoengineering do not appear to be at the top of their minds.[5] When asked, people judge geoengineering as very hard for the U.S. government to do, and not likely to have much of an effect. Government measures such as conducting research on renewable energy and enforcing the pollution control provisions in the U.S Clean

Air Act are seen as more effective than individual actions, with liberals consistently rating the effectiveness of government measures higher than moderates or conservatives.[5]

In this paper we tackle two key knowledge gaps regarding how "efficacy" relates to slowing or stopping climate change. First is the lack of a comprehensive framework for measuring efficacy beliefs consistently. While it appears that people distinguish between actions that are more or less effective, or more or less easy to take individually or collectively,[5] an overarching assessment of whether the distinctions people make correspond to coherent scales and theorized differences is lacking. Second is an incomplete understanding of how useful such measures might be for predicting behavioral intentions or actions. To address these gaps, we build on prior research[5] to derive a general framework for measuring efficacy. From these results we develop a new set of efficacy scales and characterize their properties. Finally we test how well these efficacy scales predict behavioral intentions.

1.1. Climate change mitigation efficacy

1.1.1. Definitions and distinctions

Bandura's concepts of *individual self-* and *response efficacy*, *collective efficacy*, and *proxy efficacy*,[20-23] lay the groundwork for a socio-ecological modeling perspective that considers actions at different social scales, from individual, to collective, and to institutional,[24-26] and distinguishes between ease of taking action (*self-efficacy*) and effectiveness of action (*response efficacy*). Bandura and subsequent researchers make fewer distinctions regarding how efficacy and related concepts,[27-29] such as ascription of responsibility [30-32] and carbon capability,[33] vary across actors (e.g., individuals, collectives such as communities, institutions such as government, and proxy actors such as elected officials).[14.26,28,30-31,34-36] For respondent-nominated actions in response to open-ended questions, initial findings suggest that within a

given level of action judgments of how easy or hard an action is are weakly correlated with judgments of that action's effect on climate change, if at all.[5] Individuals' interest and willingness to act also includes strategic considerations, such as whether others will act, as climate change is a collective problem.[34.40,46-48]

Further, findings are mixed regarding the relationships between efficacy concepts within and across socio-ecological levels, [27-28, 30-31, 34, 37-42] although one study finds evidence from confirmatory factory analysis that for *political* action on climate change people do distinguish individual and collective self-efficacy from government response efficacy[43] (political scientists refer to *internal efficacy*, which corresponds to self-efficacy, *external efficacy* which corresponds to proxy efficacy, and to concepts related to response efficacy[44-45]).

We use principal component analysis and exploratory factor analysis to test the initial findings from Crosman et al., hypothesizing that response and self efficacy represent distinct factors, and that respondents distinguish individual actions from collective or government actions. We also test whether action options load together on distinct factors or underlying factors exist that encompass multiple levels of action.

1.1.2. Predicting action with efficacy beliefs

Because self- and response efficacy are often conflated in studies, mapping what type of efficacy is being used as an independent variable or predicted as a dependent variable is challenging. A few trends emerge nonetheless.

Consistently, response efficacy predicts behavioral intentions,[28,39,49-50] climate risk perception,[27] and how important respondents say climate change is in driving their own mitigation actions.[46] Furthermore, manipulations of perceived governmental response efficacy increase information seeking and political action intentions.[43]

Whether self-efficacy beliefs influence action is less clear. Personal self-efficacy (loosely defined) has been found to predict behavioral intentions,[14,39, 43] past behaviors,[32,43,51] and information-seeking.[29] Barriers to self-efficacy (specifically behavioral and other costs) are also found to predict behavioral intentions,[49] and behaviors perceived as more difficult or costly are less likely to be adopted.[48-49,52] However, while some authors find that collective—but not personal—self-efficacy predicts behavioral intentions[5,34] and is associated with past behavior,[42] others find that for individuals alarmed about climate change, collective self-efficacy has no effect on action.[51]

Efficacy beliefs have also been found to predict concern about climate change and global warming,[30-31] and to mediate the influence of experimental manipulations of framing or uncertainty on behavioral intentions,[37] the relationship between personal norms and behavioral intentions,[39] and the relationship between exposure to climate-related events (e.g., flooding) and preparedness to reduce energy use.[38]

Our model, derived from the extended parallel process model (EPPM),[53-55] takes into account the findings summarized above, as well as related health belief and behavior change research.[e.g., 56-57] Controlling for political ideology, belief in anthropogenic climate change, and other causal beliefs, we expect both efficacy beliefs and threat to be positively associated with concern, and concern to predict support for climate change mitigation.[1]

2. METHODS

We recruited U.S. respondents nationally through Amazon's Mechanical Turk (MTurk) and through the GfK Knowledge Panel (GfK) to answer questions on efficacy beliefs,

[1] Note that we aim to clarify how to measure efficacy concepts related to support for reducing the risks of climate change, and whether those measures predict support for such policies, rather than to assess what leads to stronger efficacy beliefs as has been the focus of some environmental hazards research,[58].

knowledge, concern and policy support.[5] MTurk is an opt-in survey platform, but still more representative of U.S. public than student samples.[59-60] producing results similar to those from conventional samples across an wide variety of social and behavioral science experiments and surveys .[61-67] KnowledgePanel is an address-based U.S. population sample, representative of the U.S. adult population.[5]

A few of the questions analyzed here were worded as either being about climate change or about global warming in the MTurk study.[68] Responses to these climate change and global warming frames do not differ in our results, and so are combined in all analyses.[2] The GfK survey was conducted as an experiment, with respondents assigned randomly to one of three conditions: abstract, concrete, or control, in which they were asked either why (abstract) or how (concrete) people try to slow or stop climate change, or what comes to mind when you think of climate change (control)? Experimental assignment does not appear to influence the relationships investigated in this study, for which reason we collapse across conditions here.[3]

2.1 Measures

2.1.1 Efficacy Framework and Measures

An integrated climate assessment model and prior mental models research form the basis our measurement framework, as detailed in Crosman et al. [5,9,70-72] Survey items represent climate change mitigation actions considered highly effective (e.g.,[7,11,52])[4] or suggested by

[2] See [68] for additional details about the parent survey. This approach contrasts with that of [69], which finds a difference between responses to items framed as "climate change" versus those framed as "global warming." Their analysis attributes the difference they observe to a difference in how Republican respondents react to the two terms.[69] We conducted sensitivity analyses to insure that this was not influencing our results for scale construction, and control for political ideology in our modeling. The Mturk sample is a subset of a larger sample (N=1013) from a framing experiment; respondents who were randomized into a frame other than global warming/climate change were omitted from the analysis, leaving a sample size of 405.

[3] Sensitivity analyses available from the authors on request.

[4] See also the discussions in [3,4] which were published after this study was conducted.

laypeople in prior research (e.g.,[5,9,70-71], see Table 2). They include self- and response efficacy questions at personal, collective, and governmental levels of action.

All MTurk respondents received a common initial set of ten closed-ended efficacy-related items, after which each respondent was randomly assigned to receive one of three additional sets with seven or four items, respectively, for a total of 28 efficacy questions. Efficacy items asked respondents to rate "How easy or hard would it be for [actor] to [change behavior in specific way]," with a seven-point Likert response scale (extremely hard to extremely easy, centered on "neither easy nor hard" and randomly reversed); one closed-ended item included a "do it already" option. This was followed by "What effect would [actor] taking this action have on global warming?" with a five-point Likert response scale (speed global warming to slow or stop global warming, centered at no effect). We presented each efficacy question to all GfK study participants with the same wording that appears in the MTurk survey with the exception of two efficacy questions that were not included in the GfK survey[5].

2.1.2 Policy support

We asked participants the general policy support question: "How much do you support or oppose reducing global warming by reducing carbon emissions?" with a 5-point Likert response scale (strongly oppose to strongly support, centered at "neither support nor oppose"), and a "don't know" response option.

2.1.3 Concern

[5] The two questions omitted from the GfK survey relate to the self and response efficacies of "talking[ing] about global warming with others who do not agree with your view." Sensitivity analysis conducted removing these two items from the MTurk dataset does not substantively change the results reported below.

To assess concern as a potential mediator of the relationship between efficacy and policy support, we measured concern with a single item: "How concerned, if at all, are you about climate change [global warming] ?" MTurk respondents were assigned randomly to this question worded as either climate change or global warming. Respondents rated their concern on a 5-point Likert scale (Not at all/A little bit/A fair amount/A good deal/A great deal), with an additional "don't know" response option.

2.1.4 Harms as a measure of perceived risk

Perceived personal threat is a key construct in the Extended Parallel Process Model,[53-56] which guides our approach to modeling determinants of policy support. To assess this as well as a broader measure of perceived risk, we measured harm at two different social scales: "How much do you think (global warming/climate change) harms you personally/people around the world?" Respondents rated perceived harms on a 5-point Likert scale identical to the scale used for ranking concern.

2.1.5 Decision relevant knowledge

Our assessment of climate change knowledge focuses on key elements of mental models of climate change/global warming, measured with a set of questions about causes and effects of climate change. These are based on prior mental models research.[9,49,71] which takes a decision analytic perspective on what scientific information can and should inform the climate change mitigation preferences and choices people face. Respondents rate this suite of statements about the causes and effects of climate change on a 5-point Likert scale (True/Probably true/Don't know/Probably false/False). All MTurk participants received eight common items, in addition to which each participant was randomly assigned to receive one of two sets of fourteen additional items; in total 30 items are used in this study. All GfK participants received a set of 33 items, of

which 28 are used here (Appendix A). The absolute distances of responses from the correct answer are averaged to create a distance-from-correct knowledge index

2.1.6 Demographics

Political ideology predicts not only response efficacy judgments[5] but also support for climate change policy[68,73-75 see also 76]) We measured political ideology by asking: "In general do you think of yourself as…" with a seven-point response scale: "Extremely liberal / Liberal / Slightly liberal / Moderate, middle of the road / Slightly conservative / Conservative/Extremely conservative." We also assessed belief in anthropogenic climate change ("Is the global climate changing?" [Yes/No] If yes, "Have humans caused any of this change?" [Yes/No]). Given previous observations of the white male effect, showing that white males tend to perceive environmental risks as lower than do other demographic groups,[77-78 but see 79] we also included questions about age (in years), sex (male/female), and race (White, White non-Hispanic, African-American, Hispanic, Asian/Pacific Islander, Native American, Other).

2.2 Data handling and analysis

An incentive of $1.25 was paid to each respondent who completed the MTurk survey. A total of 405 MTurk respondents provided complete responses and passed an attention check question. GfK incentivizes their KnowledgePanel participants as well, with what they describe as modest incentives, including special raffles or sweepstakes with cash rewards and other prizes.

Because the MTurk survey presented each respondent with a subset of efficacy questions, no individual respondent answered every efficacy question in the survey[6]. We

[6] In a sensitivity analysis, we have re-estimated the model presented in section 3.4 without imputed MTurk data, using instead only the subset of efficacy items presented to each

conducted multiple imputation to impute distributions for those closed-ended efficacy items that were missing at random in the MTurk data, in order to minimize the effects of missing data and avoid the perils of listwise deletion.[80] Respondents who skipped any question were excluded from the imputation process to ensure that all data used in the imputation were missing completely at random. In all cases, reported means, first differences, and correlations were combined by pooling across imputations according to the rules set out in [81]. See also [82-85]. Sample sizes reported in tables generally refer to the sample size of each individual imputed dataset once NAs were removed, which is identical across imputations for each variable.

We use principal component analyses (PCA) and exploratory factor analyses (FA) to construct efficacy scales to test the extent to which efficacy types and actions represent distinct factors. For the MTurk study, both the reported PCA and FA loadings result from running the analysis on each imputed dataset separately, and averaging the unrotated loadings after controlling for possible factor- and sign-switching due to random variations between imputations, and applying a varimax rotation to the final averaged loadings. These results inform our construction of additive efficacy scales.

The resulting efficacy scales are included as inputs in an ordered probit model of policy support, with a specification derived from the extended parallel process model [54-56], in which efficacy and severity of harm are key predictors. Efficacy and expected harms may be related to both an individual's level of concern about climate change as well as the political support an individual would lend to a potential policy to address climate change. Because concern about climate change would also be expected to relate to policy support, we use a mediation analysis

respondent as a measure of the efficacy construct corresponding to those items. For the sake of clarity, the results are not presented here, but do not diverge qualitatively from the results presented in section 3.4.

approach to estimate the total relationship between the efficacy measures we develop and policy support. This includes the 'direct effect' of efficacy on policy support as well as an 'indirect effect' on policy support through the relationship between efficacy and climate change concern. As discussed above, we control for causal beliefs and expected harms as well as other covariates at both stages of the analysis. The reliability and adequacy of the additive efficacy scales are assessed with Tukey's test of non-additivity and Cronbach's alpha (internal consistency reliability).[7]

In the first stage of the mediation analysis we estimate an ordered probit model of concern; the second stage is an ordered probit model of policy support. The direct, indirect, and total estimated effects of self- and response efficacy on policy support are calculated according to the non-parametric general approach to mediation analysis outlined in Imai et al.(86) First, coefficient estimates for both models are bootstrapped across all imputations. Next, expected policy support is calculated for each observation in the dataset when self- and response efficacy are separately set to two values: the mean and the top of the 95% confidence interval for ten randomly drawn bootstrapped estimates. This constructs a hypothetical counterfactual estimate of the 'treatment effect' for each efficacy type; this is the estimated effect on policy support of moving from the mean to the upper-bound on the 95% confidence interval. The *total effect* is calculated as the expected change in likelihood of expressing strong policy support based on moving from the mean efficacy level to the 97.5th percentile efficacy level across both models in the mediation analysis, for response and self-efficacies individually. The *direct effect* is calculated as the expected change in policy support of changing only the efficacy value for the

[7] Tukey's test of non-additivity is a pre-requisite to Cronbach's alpha that determines whether treating the scale as additive is appropriate; if Tukey's test is significant then there is multiplicative interaction between the items and the cases. Cronbach's alpha tests whether a given item should be included in a scale: if alpha increases when an item is omitted, that term should be excluded from the scale.

outcome model (leaving the value in the mediation model at the mean), while the *indirect effect* is the expected effect of changing only the efficacy value for the mediation model (leaving the value in the outcome model at the mean).

3. RESULTS

3.1 Descriptive statistics

3.1.1. Samples

Respondent characteristics are similar across samples, with the exception that the MTurk sample is younger (average age 37) than the GfK sample (average age 51), and more liberal, avg 3.3 for MTurk vs avg 4.1 for GfK on political ideology), as anticipated. The GfK sample is similar to the U.S. national adult population on benchmark measures (18+ US population benchmarks from March 2016 Current Population Survey supplement data; not all questions asked in MTurk), e.g., gender (% female MTurk 51%, GfK 50%, CPS 52%), education (% Bachelors degree or higher GfK 36%, CPS 31%), race (% white non-hispanic MTurk 79%, GfK 73%, CPS 64%), and income (GfK 34% <$50K, 15% $150K+; CPS 37% <$50k, 16% $150K+).

3.1.2 Dependent variables

While MTurkers are slightly more concerned about climate change (avg 2.8, or "*a good deal*" concerned) than GfK respondents (avg 2.2, or "*a fair amount*"), both are above the midpoint on the concern scale. On average respondents support reducing climate change by reducing carbon emissions, with GfK respondents averaging slightly lower (avg 1.05, on a five-point scale where 2="*strongly support"* and 1="*slightly support"*), than MTurk (avg 1.27).

3.1.3 Efficacy items

Both reducing annual air travel by 50% and reducing household energy use by 20% are seen as considerably easier for individuals to do personally than for everyone in the United

States to do collectively $p<0.001$, all paired-t-tests).[5] As also expected, respondents indicate that, on average, actions taken personally are less effective in slowing or stopping climate change than those same actions taken collectively. Respondents judge all of these actions taken at a personal level (reducing annual air travel by 50%, reducing household energy use by 20%, voting for candidates committed to reducing or stopping global warming, and stopping the use of aerosol spray cans) to have between *no effect* and a *slight* effect, and taken collectively to have on average a *slight* effect on climate change (all $p<0.001$, paired t-tests).[5] Respondents judge government actions as far more effective than personal.

3.2 Principal Component Analysis and Exploratory Factor Analysis

Principal component and exploratory factor analyses of actions by actor show that by actor, for personal, collective, and government actions, response efficacy items load on a single principal component or factor that explains most of the variance. Also by actor, self-efficacy items load on a second component or factor that explains additional variance, although self-efficacy factors tend to be somewhat less consistent. Findings are clearest for collective actions (Table 1), but are evident across all three actors (see Appendix B). For personal actions, judgments of how easy or hard it would be to perform most surveyed mitigative behaviors do not load consistently onto distinct self efficacy factors. Government actions demonstrate greater consistency in judgment of self efficacy, but even here judgments of how easy it would be for the U.S. government to complete the surveyed activities do not load as consistently onto a single factor as the corresponding response efficacy items do. In sum, respondents seem to treat self- and response efficacy as distinct constructs, by actor. However, conceptions of self-efficacy appear to vary by type of action, as well as by actor.

Collective self- and response efficacy		Mturk		GfK		Mturk		GfK	
	Abbr.	**PC 1**	**PC 2**	**PC 1**	**PC 2**	**FA1**	**FA2**	**FA1**	**FA2**
Self-efficacy: How easy/hard would it be for everyone in the United States to collectively:									
Reduce their annual air travel by 50%	*fly*	0.04	**0.80**	-0.01	**0.88**	0.06	**0.50**	0.00	**0.52**
Reduce our household energy use by 20%	*heu*	0.12	**0.79**	0.12	**0.86**	0.14	**0.54**	0.08	**0.995**
Response efficacy: If everyone in the United States collectively took this action, what effect would it have on global warming?									
Reduce their annual air travel by 50%	*fly*	**0.84**	0.12	**0.84**	0.04	**0.74**	0.16	**0.77**	0.07
Reduce our household energy use by 20%	*heu*	**0.82**	-0.02	**0.88**	0.00	**0.70**	0.05	**0.85**	0.03
Stop all use of aerosol spray cans at home	*aer*	**0.83**	0.11	**0.84**	0.05	**0.73**	0.18	**0.77**	0.07
Vote for candidates committed to reducing or stopping global warming	*vot*	**0.81**	0.17	**0.81**	0.03	**0.77**	0.21	**0.73**	0.05
Proportion of explained variance		*0.45*	*0.22*	*0.47*	*0.25*	*0.37*	*0.11*	*0.41*	*0.21*

Table 1. Principal component and factor analyses of closed-ended collective-level efficacy items. Number of components/factors is selected using the Kaiser criterion. For both the PCA and the FA, Kaiser guidance was consistent across the GfK data and the MTurk data imputations at the collective level, with the preferred solution of 2 components reported here. Loadings above 0.50 appear in bold.

When efficacies are pooled in exploratory factor analysis across all actors and actions (Table 2), the resulting factors reflect systematic differences between response and self-efficacy, rather than differences by actor. Response efficacy items generally load strongly and consistently onto the first factor, suggesting that response efficacy is a relatively consistent latent construct across the majority of closed-ended mitigative actions presented, regardless of actor. However, four items (governmental level geo-engineering and population planning, and personal level talking about global warming with those with different views and reducing annual air travel by half) load onto the first factor at between 0.32 and 0.5 (Table 2). Consistent with the earlier results, self-efficacy loads less consistently on the second factor than response efficacy does on the first.

		Mturk		GfK	
	Abbr.	FA1	FA2	FA1	FA2
Governmental self-efficacy. *How easy or hard would it be for the United States government to:*					
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	0.06	**0.54**	0.12	**0.56**
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	0.14	0.39	-0.04	0.40
Reduce the amount of heat from the sun that reaches the Earth, either by putting dust in the stratosphere, making more clouds high in the atmosphere, or other technological solutions	*geo*	-0.17	0.34	-0.16	0.43
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	0.19	0.42	0.18	0.46
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	0.27	**0.52**	0.16	**0.73**
Slow population growth nationally and internationally by supporting family planning programs and access to birth control	*pop*	0.10	0.34	0.14	**0.52**
Governmental response efficacy. *What effect would the United States government taking this action have on global warming?*					
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	**0.70**	0.14	**0.77**	0.07
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	**0.67**	0.13	**0.70**	0.04
Reduce the amount of heat from the sun that reaches the Earth, either by putting dust in the stratosphere, making more clouds high in the atmosphere, or other technological solutions	*geo*	0.34	-0.06	0.39	-0.03
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	**0.74**	0.13	**0.77**	0.09
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	**0.70**	0.16	**0.82**	0.05
Slow population growth nationally and internationally by supporting family planning programs and access to birth control	*pop*	0.40	0.14	**0.60**	0.08
Collective self-efficacy. *How easy/hard would it be for everyone in the United States to collectively:*					
Reduce their annual air travel by 50	*fly*	0.05	**0.53**	-0.02	**0.59**
Reduce our household energy use by 20%	*heu*	0.12	**0.63**	0.07	**0.71**
Collective response efficacy. *If everyone in the United States collectively took this action, what effect would it have on global warming?*					
Reduce their annual air travel by 50%	*fly*	**0.67**	0.09	**0.76**	0.07
Reduce our household energy use by 20%	*heu*	**0.78**	0.13	**0.83**	0.06
Stop all use of aerosol spray cans at home	*aer*	**0.73**	0.17	**0.76**	0.10
Vote for candidates committed to reducing or stopping global warming	*vot*	**0.77**	0.18	**0.78**	0.09
Personal self-efficacy. *How easy or hard would it be for you personally to:*					
Reduce your annual air travel by 50%	*fly*	0.21	0.34	0.09	0.26
Reduce your household energy use by 20%	*heu*	0.12	**0.57**	0.15	**0.60**
Stop all use of aerosol spray cans at home	*aer*	0.31	0.29	0.26	0.27
Vote for candidates committed to reducing or stopping global warming	*vote*	0.49	0.38	**0.50**	0.37
Talk about global warming with others who do not agree with your view	*talk*	0.17	0.40		
Personal response efficacy. *What effect would your taking this action have on global warming?*					
Reduce your annual air travel by 50%	*fly*	**0.53**	0.20	**0.64**	0.16
Reduce your household energy use by 20%	*heu*	**0.67**	0.21	**0.72**	0.16
Stop all use of aerosol spray cans at home	*aer*	**0.62**	0.16	**0.64**	0.17
Vote for candidates committed to reducing or stopping global warming	*vot*	**0.64**	0.33	**0.69**	0.14
Talk about global warming with others who do not agree with your view	*talk*	0.48	0.21		
Proportion of explained variance		*0.24*	*0.11*	*0.29*	*0.13*

Table 2. Exploratory factor analyses across all efficacy items. Number of factors was selected using the Kaiser criterion. Kaiser guidance was inconsistent across MTurk data imputations, with the preferred solution varying between 2 and 3 factors; the 2-factor solution is reported here. For the GfK data, the 2-factor solution is preferred, and varimax rotation applied. Loadings above 0.50 appear in bold.

3.3 Efficacy Scale Construction and Reliability

Many response efficacy items are strongly and positively correlated with each other, with the lowest correlations observed for geo-engineering and population planning.(5) Overall, if a respondent believes a particular government action will be effective in mitigating climate change he or she is more likely to believe that other government or collective activities are also relatively effective, regardless of what the science suggests. However, closed-ended self-efficacy items are not generally strongly correlated with one another (with the exception of self-efficacy for personal and collective household energy use), and some of the correlations are on average negative. For example, perceived ease of government geo-engineering is mildly inversely correlated with perceived ease of personally voting for candidates committed to reducing or stopping global warming. These correlations help clarify the implications of the PCA and FA analyses above for scale construction; for example they suggest omitting geo-engineering and population planning from general efficacy scales. Further, government/collective self- and response efficacy scales that include geo-engineering and family planning fail tests of non-additivity ($p<.01$) (see Appendix B).

Overall, the above results suggest that government and collective response efficacy form a coherent scale, if one excludes population planning and geo-engineering, and that individual response efficacy may be somewhat distinct from government and collective response efficacy. The results also suggest that respondents differentiate between self- and response efficacy, but that self-efficacy is a complex concept, both within and across levels and types of action. In light of these findings, after conducting sensitivity analyses to insure that results would not vary substantially with other specifications, we present a four-scale approach to efficacy here, with additive efficacy scales for personal self-efficacy, collective/government self-efficacy, personal

response efficacy, and collective/governmental response efficacy, excluding geoengineering and population planning.[8] We selected items for inclusion based on the factor analyses (Table 1, Appendix B) and after testing for reliability and non-additivity. The government/collective response efficacy scale includes *governmental* CAA, TAX, RNW, GGE; and *collective* AER, FLY, HEU, VOT (see Table 2 for complete wording). The personal response efficacy scale includes TALK, AER, FLY, HEU, and VOT. Reliability is high for government/collective response efficacy and personal response efficacy at alpha=0.92 in GfK (0.91 MTurk) and 0.83 in GfK (0.83 MTurk), respectively. The governmental/collective self-efficacy scale includes *governmental* CAA, TAX, RNW, GGE; *and collective FLY, HEU*. The personal self-efficacy *scale includes* TALK, AER, FLY, HEU, and VOT. Reliability is somewhat lower for government collective self-efficacy (0.76 GfK, 0.71 MTurk), and personal self-efficacy (0.59 GfK, 0.62 MTurk, see Appendix B). In all cases, items were individually normalized before scale construction.

3.4 Predicting action

Estimated coefficients for both the concern and policy support models in the mediation analysis are reported in Figure 1, with details in Appendix C. Estimated direct, indirect, and overall treatment effects of both response and self-efficacy are presented in Figure 2.

As expected, higher government/collective response efficacy is associated with higher concern. Higher personal self-efficacy is also associated with higher concern about climate change. Concern increases with perceived harms from climate change, to both oneself and to socially distant others, controlling for self- and response efficacy as well as gender and age (Fig.

[8] Sensitivity analyses of two-scale and three-scale approaches and mediation modeling results from two and three-scale approaches are available from the authors on request.

1, Appendix C).[9] Concern also increases the more correct one's knowledge of climate change causes and effects (i.e., the smaller the average distance from the correct answer), and increases with liberal political ideology. The largest single coefficient is that on belief in anthropogenic climate change: those who believe that climate change is human caused are more concerned. However, the effect of perceived harms is likely greater: moving from the middle of the harms scale to the top would produce an expected increase in the latent dependent variable of roughly 1 for each type of perceived harm, while the effect of moving from non-belief to belief in anthropogenic climate change would be 0.83 in the Mturk estimate and 0.55 in the GfK estimate.

As expected based on prior research, greater concern is strongly associated with increased policy support. Concern almost fully mediates the effects of perceived harm on policy support (Fig. 1). Interestingly, concern also partly mediates the effects of belief in anthropogenic climate change in the MTurk model.

As modeled here, mean distance from correct decision-relevant knowledge is a strong predictor of support for reducing global warming by reducing carbon emissions in the MTurk data, but is fully mediated by concern in the GfK data; the more closely one's beliefs about causes and consequences of climate change mirror scientific consensus as reflected in the decision-relevant items represented in our knowledge index (Appendix A), the stronger the concern and support for climate emissions reductions. Along with knowledge, concern and response efficacy are also positively related to policy support, as is personal self-efficacy. Those who identify as white are less supportive of reducing climate change by reducing carbon

[9] Sensitivity analysis was carried out to see whether assignment to experimental condition in the GfK data influenced parameter estimation (results available from authors on request). Estimating the models separately by condition resulted in qualitatively equivalent results, with minor variations in estimates that had no discernible pattern.

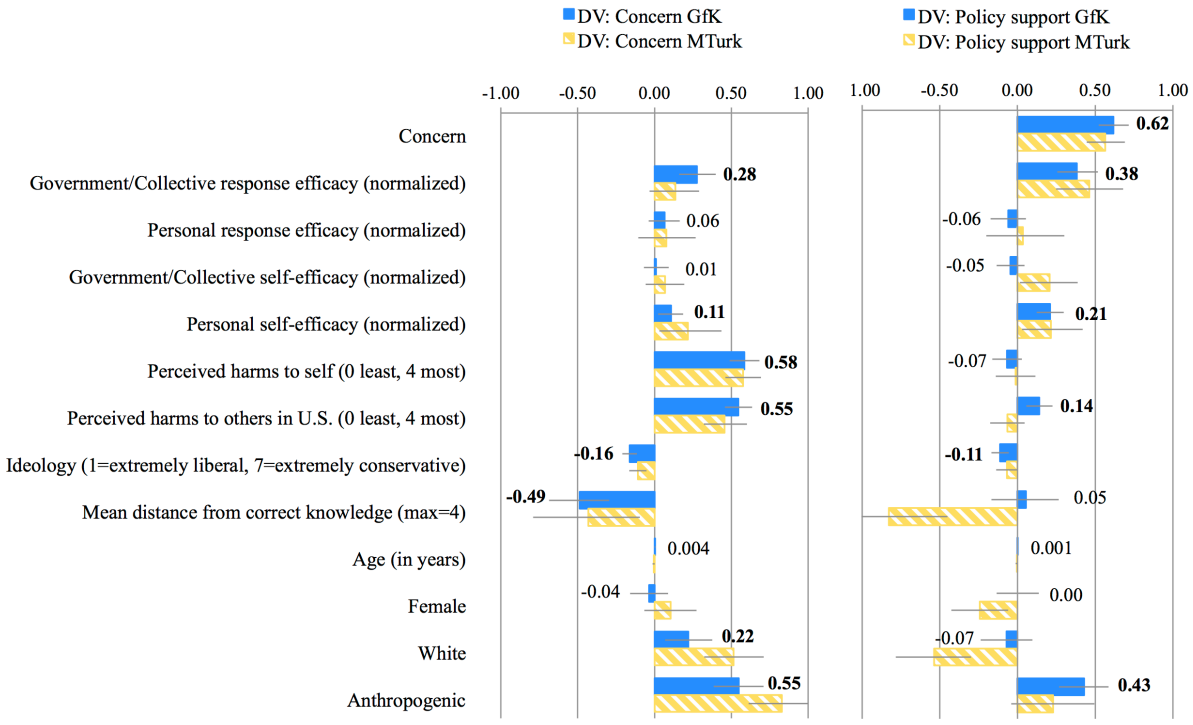

Figure 1. Mediation (Concern) and outcome (Policy support) ordered probit models. Numerical estimates in bold are significant at the 0.05 level (only GfK shown). For the concern model using the GfK (Mturk) data, mean log likelihood = -1420.032 (-826.349); mean AIC = 2872.065 (1684.699), bootstrapped percent correctly predicted = 48.2% (53.6%). For the policy support model, mean log likelihood across imputations = -1233.366 (-680.850); mean AIC = 2500.732 (1395.699), bootstrapped percent correctly predicted = 52.4% (62.6%). The bootstrapped samples used to calculate percent correctly predicted are drawn independently from the samples used to generate the model estimates.[10]

emissions than those who do not, once we control for concern, largely cancelling out the positive coefficient on race in the concern model, though GfK and MTurk results differ a little in this regard). Gender has little effect on policy support, overall. Conservative political ideology is associated with decreased policy support. The models also control for age.

Response efficacy influences policy support more strongly than self-efficacy. While there is a positive relationship between how easy a respondent thinks it is overall to take personal action on climate change, and their support for reducing global warming by reducing carbon emissions, that effect is smaller than that of the respondent's perceptions of

[10] The decrease in percent correctly predicted in the GfK model compared to the Mturk model is likely attributable to the more uniform distribution of both dependent variables in the GfK data.

the overall effectiveness of climate change action. The Mturk model shows some evidence that there is also a positive relationship between perception of how easy it would be to take joint (government or collective) action and support for climate change policy, but this relationship is not present in the GfK data. Of possible relevance in this regard is that the MTurk data were collected well before the 2016 elections, whereas the GfK data were collected afterward.

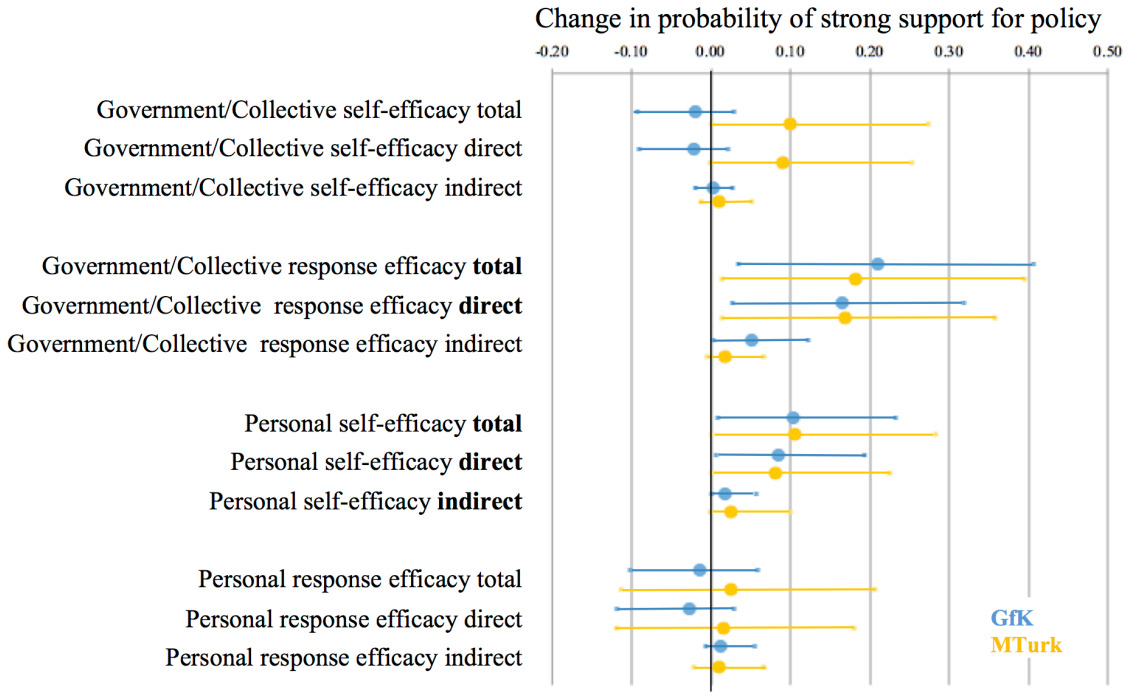

Figure 2. Comparison of estimated change in proportion of respondents strongly supporting climate policy (based on moving from mean efficacy to an efficacy score equal to the 97.5th percentile) across the two datasets. The model is shown in Figure 1 and Appendix C. Direct, indirect, and total estimated effects are calculated as follows: 1) coefficient estimates are bootstrapped equally across all imputations in MTurk; 2) expected policy support is calculated for each observation in the two datasets when self- and response efficacy are separately set to two values: the mean and the top of the 95% confidence interval for ten randomly drawn bootstrapped estimates.

The mediation analyses (Fig. 2) also demonstrate that any indirect effect of efficacy on policy support is consistently overwhelmed by the direct influence of efficacy on policy support, regardless of the type of efficacy in question. How much concern a respondent expresses about climate change is a statistically significant mediator of the effect of personal self-efficacy on

policy support, but the key impact both personal self-efficacy and government/collective response efficacy have on policy support is direct rather than indirect.

4. DISCUSSION

This study provides new insights into how people think about the ease with which climate change actions may be undertaken and the effectiveness of these actions in addressing climate change. Using results from two U.S. national surveys, we identify and assess dimensions of efficacy, examine their coherence, and test their usefulness. Our surveys build on several strands of prior research, including social cognitive theory, the extended parallel process model, decision analyses and mental models research, and consideration of the types of actions that should be included to represent the range of causal and intervention strategies most likely to influence, or be perceived to influence, climate change.

For both response and self-efficacy these findings also indicate that in aggregate respondents do not effectively distinguish between those responses science shows may have an effect on climate change (e.g., collectively reducing household energy use), and those that will not (e.g., collectively reducing aerosol spray can use). Results also indicate that people do not effectively distinguish actions that might successfully mitigate climate change from those that are unlikely to reduce atmospheric greenhouse gas concentrations, even though they represent good environmental practice.[9]

The previous literature has been inconsistent with respect to measuring self and response efficacy, often conflating the two concepts.[5] By contrast, we find self and response efficacy is a key distinction in measuring efficacy. More so, perhaps, than action level, as self and response efficacy represents the primary dimension along which items loaded onto coherent factors. Judgments of response efficacy, much more so than self efficacy, tend to correlate with one

another across actions, and within and even across actors. This is particularly true for government and collective actions. However, this holds less for judgments of the response effectiveness of items relating to geoengineering and family planning. A wide variety of ethical and political considerations arise with regard to both geo-engineering [87] and family planning/population planning [88] as mitigation strategies. Further, a companion paper shows that both types of strategies are nearly absent from the volunteered, open-ended responses.[5] As might be expected, these strategies appear to be less familiar to respondents, and are viewed by respondents as less palatable, less directly affecting atmospheric concentrations of CO_2, and as having more uncertain effects.

Self-efficacy is a much less consistent latent construct than response efficacy. This finding may in part explain the inconsistent findings of previous studies on whether, and how, self-efficacy influences climate change actions. Our results raise questions about how internally consistent a generalized concept of personal self-efficacy is. This may in part be due to the inclusion of actions that are substantively different from one another in our items, as well as items that may be difficult for some respondents to parse, such as reducing annual air travel by half. Government and collective actions are both seen as much more challenging than personal actions.[5] Factor analyses support combining the response effectiveness of government and collective actions into a single scale; the evidence is more mixed regarding whether judgments of the ease of taking government and collective actions form a single coherent scale.

Judgments both of how easy it is for an individual oneself to take actions (personal self-efficacy) and of how effective government and collective actions will be (government/collective response efficacy) are associated with concern about climate change and support for reducing CO_2 emissions to slow or stop climate change. The easier one judges it to take action oneself,

and the more effective one sees government and collection actions as being, the more one is concerned and supportive of reducing CO_2 emissions to slow or stop climate change, all else equal.

The Extended Parallel Process Model [53] posits that efficacy interacts with threat perception to determine type of response, yet recent meta-analyses have found no such interaction.[56] In the context of climate change, for example, the EPPM might lead one to expect that high perceived harms from climate change would result in mitigative behaviors or support for climate change policy when efficacy is high, and message avoidance or fear control when efficacy is low. Consistent with EPPM, we find that concern is positively associated with both efficacy and perceived harms. However, in line with recent meta-analyses of EPPM,[56] even after controlling for threat perception, policy support increases directly with increases in government/collective response efficacy, as well as with increases in personal self-efficacy.

4.1 Future directions

These results suggest that respondents in the U.S. judge as similar the effectiveness of climate change mitigation when undertaken by society whether the action is collective or taken by government. However, the actions that come to mind for lay respondents only weakly align with the advice and the science currently on offer.

Theories of efficacy posit that the specificity of the intended action should determine the strength of association between self-efficacy and action.[20] In these results, a scale constructed from personal self-efficacies of specific actions is a significant predictor of support for policy, broadly construed. However, given both theory and our findings that some types of actions and policies—such as geoengineering and family planning—may be treated differently by

respondents, future research should explore how well specific self- and response efficacies predict specific types of actions. It may also be relevant to consider a broader set of research on efficacy, for example from related risk domains such as extreme weather hazards.[58,89] Recent experimental research examining knowledge interventions in museums finds important interactions between knowledge, self- and response efficacy, and actions such as talking with others about climate change. [84] A more nuanced understanding of such relationships might be developed by, for instance, comparing how well perceived self-efficacy and response efficacy of geoengineering strategies predict support for geoengineering, with how well perceived self-efficacy and response efficacy of greenhouse gas emissions reductions per se predict support for greenhouse gas emissions reductions. Of course, even for those who support greenhouse gas emissions reductions, the mechanism may matter (e.g., a fossil fuel tax vs. a cap-and-trade scheme), for which reason it may also be worthwhile to model perceived costs as a separate independent variable. More nuanced modeling of the influence of efficacy beliefs on specific policies might also provide further insight into how efficacy beliefs interact with other drivers of support for policies to reduce the risks from climate change, such as specific emotions.[90-95]

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Appendix A. Knowledge items and scoring

Survey item wording	Corr resp.	Avg distance GfK	Avg distance Mturk	Avg resp. GfK	Avg resp. Mturk	Mturk n**
China is among the top five nations contributing to global warming.	T	1.01	0.74	0.99	1.26	207
The temperature of the earth is affected by the gases that make up the atmosphere.	T	1.03	1.96	0.97	0.04	198
The "greenhouse effect" occurs when the atmosphere traps solar heat as it reradiates from the ear...	T	1.11	1.74	0.89	0.26	198
Deforestation is a major cause of global warming.	T	1.20	1.88	0.80	0.12	198
Clearing tropical rainforests is a major cause of global warming.	T	1.21	0.93	0.79	1.07	207
The temperature of the earth is affected by the ocean.	T	1.22	0.81	0.78	1.19	405
Global warming will lead to ecological disasters all over the world.	T	1.30	1.93	0.70	0.07	198
The space program is a major cause of global warming.	F	1.30	1.10	-0.70	-0.90	207
The United States is among the top five nations contributing to global warming.	T	1.32	0.94	0.68	1.06	405
The earth's climate has been pretty much the same for millions of years.	F	1.33	.	-0.67	.	.
The temperature of the earth is affected by clouds.	T	1.40	1.29	0.60	0.71	207
Global average sea level is the same or lower now than it was a century ago.	F	1.59	2.12	-0.41	0.12	198
Global warming will lead to shorter, milder winters all over the world.	T	1.61	1.56	0.39	0.44	207
The temperature of the earth is affected by large volcanic eruptions.	T	1.67	1.83	0.33	0.17	198
Climate means pretty much the same thing as weather.	F	1.71	.	-0.29	.	.
The "greenhouse effect" is what keeps parts of the earth from being as cold as outer space.	T	1.76	1.45	0.24	0.55	207
The temperature of the earth is affected by whether the earth's surface is light or dark colored.	T	1.78	1.69	0.22	0.31	198
Use of nuclear power is a major cause of global warming.	F	1.87	2.52	-0.13	0.52	198
Cows, rice paddies, termites and swamps all contribute to global warming.	T	1.91	1.60	0.09	0.40	405
Bangladesh is among the top five nations contributing to global warming.	F	2.00	2.39	0.00	0.39	198
The "greenhouse effect" will reduce photosynthesis in most plants.	F	2.07	2.11	0.07	0.11	198
Global warming will lead to a shortage of oxygen in the atmosphere.	F	2.21	2.29	0.21	0.29	207
Aerosol spray cans are a major cause of global warming.	F	2.27	2.32	0.27	0.32	207
The hole in the Antarctic ozone layer is a major cause of global warming.	F	2.29	2.34	0.29	0.34	198
The "greenhouse effect" will cause an increase in precipitation and humidity all over the earth.	F	2.31	2.50	0.31	0.50	207
Global warming will increase the occurrence of skin cancer.	F	2.40	2.50	0.40	0.50	207
Toxic wastes (e.g., hazardous chemicals in dumps) are a major cause of global warming.	F	2.42	2.29	0.42	0.29	198
Ozone in cities (e.g., smog in Los Angeles) is a major cause of global warming.	F	2.68	2.95	0.68	0.95	405
Burning fossil fuels (e.g., coal and oil) is a major cause of global warming.	T		0.69		1.31	405
Global warming will lead to more and larger storms all over the world.	T		0.92		1.08	405
The concentration of carbon dioxide found in the Earth's atmosphere today has existed before, in the last 650,000 years.	F		1.93		-0.07	207
Global warming is the main cause of species extinction today.	F		2.01		0.01	405

Table A1. Knowledge items are derived from mental models research and decision modeling, as described in Bostrom et al. (1994), Read et al. (1994), Reynolds et al., 2010, and Morgan et al., 2002; and amended with reference to Shi et al. (2016), Tobler et al. (2012) and discussions with UW Program on Climate Change members. The order of knowledge questions was randomized by respondent in the GfK survey. The response scale was randomly reversed by respondent across all knowledge questions, and included the following options: True (2), Maybe True (1), Don't know (0), Maybe False (-1), False (-2). Average distance is calculated as the average absolute difference from the correct answer. *GfK responses in this table are weighted to represent the general U.S. population and were collected February 17-28, 2017. **Raw MTurk data (no imputations), from the global warming and climate change frames of the experiment reported in Mossler et al. (2017); MTurk data collected Nov 2016.

Appendix B. Factor and principal component analyses run separately at the personal, government, and government-collective levels (together) with and without geo-engineering and family planning, along with reliability (Cronbach's alpha) and additivity (Tukey's test of non-additivity) results.

Table B1. Personal self-and response efficacy..

Personal self- and response efficacy	*Abbr.*	Mturk **PC1**	Mturk **PC2**	GfK **PC1**	GfK **PC2**	Mturk **FA1**	Mturk **FA2**	GfK **FA1**	GfK **FA2**
Personal self-efficacy. ***How easy or hard would it be for you personally to:***									
Reduce your annual air travel by 50%	*fly*	0.03	**0.67**	-0.04	**0.68**	0.10	0.43	0.05	0.41
Reduce your household energy use by 20%	*heu*	0.07	**0.68**	0.15	**0.72**	0.10	0.48	0.17	**0.57**
Stop all use of aerosol spray cans at home	*aer*	0.25	0.48	0.15	**0.66**	0.22	0.37	0.17	0.48
Vote for candidates committed to reducing or stopping global warming	*vote*	0.36	**0.59**	0.47	**0.50**	0.28	**0.55**	0.41	0.46
Talk about global warming with others who do not agree with your view	*talk*	0.17	**0.55**			0.17	0.38		
Personal response efficacy. ***What effect would your taking this action have on global warming?***									
Reduce your annual air travel by 50%	*fly*	**0.77**	0.08	**0.80**	0.09	**0.73**	0.13	**0.74**	0.09
Reduce your household energy use by 20%	*heu*	**0.72**	0.32	**0.84**	0.13	**0.58**	0.46	**0.81**	0.12
Stop all use of aerosol spray cans at home	*aer*	**0.78**	0.13	**0.80**	0.11	**0.72**	0.21	**0.73**	0.12
Vote for candidates committed to reducing or stopping global warming	*vot*	**0.71**	0.36	**0.76**	0.11	**0.57**	0.49	**0.65**	0.15
Talk about global warming with others who do not agree with your view	*talk*	**0.71**	0.12			**0.54**	0.28		
Proportion of variance explained		*0.29*	*0.20*	*0.35*	*0.21*	*0.22*	*0.16*	*0.30*	*0.12*

Table B2. Government self- and response efficacy with geoengineering and family planning.

Governmental self- and response efficacy	*Abbr.*	Mturk **PC1**	Mturk **PC2**	GfK **PC1**	GfK **PC2**	Mturk **FA1**	Mturk **FA2**	GfK **FA1**	GfK **FA2**
Governmental self-efficacy. *How easy or hard would it be for the United States government to:*									
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	0.07	**0.73**	0.10	**0.72**	0.08	**0.65**	0.10	**0.65**
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	0.14	**0.56**	-0.06	**0.59**	0.14	0.43	-0.04	0.46
Reduce the amount of heat from the sun that reaches the Earth, either by putting dust in the stratosphere, making more clouds high in the atmosphere, or other technological solutions	*geo*	-0.29	**0.55**	-0.24	**0.54**	-0.21	0.41	-0.20	0.44
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	0.27	**0.55**	0.19	**0.65**	0.24	0.45	0.19	**0.54**
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	0.28	**0.68**	0.13	**0.75**	0.26	**0.65**	0.13	**0.71**
Slow population growth nationally and internationally by supporting family planning programs and access to birth control	*pop*	0.02	**0.57**	0.14	**0.64**	0.05	0.42	0.13	**0.54**
Governmental response efficacy. *What effect would the United States government taking this action have on global warming?*									
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	**0.81**	0.12	**0.83**	0.07	**0.78**	0.12	**0.80**	0.08
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	**0.76**	0.07	**0.80**	0.03	**0.70**	0.09	**0.74**	0.05
Reduce the amount of heat from the sun that reaches the Earth, either by putting dust in the stratosphere, making more clouds high in the atmosphere, or other technological solutions	*geo*	0.39	-0.05	**0.51**	-0.06	0.29	-0.01	0.41	-0.03
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	**0.80**	0.16	**0.83**	0.12	**0.74**	0.16	**0.80**	0.12
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	**0.81**	0.16	**0.84**	0.08	**0.79**	0.17	**0.80**	0.09
Slow population growth nationally and internationally by supporting family planning programs and access to birth control	*pop*	**0.52**	0.16	**0.67**	0.11	0.41	0.16	**0.59**	0.10
Proportion of variance explained		*0.27*	*0.20*	*0.30*	*0.22*	*0.23*	*0.14*	*0.26*	*0.16*

Table B3. Government and collective self- and response efficacy with geoengineering and family planning.

Governmental and collective self- and response efficacy	*Abbr.*	Mturk **PC1**	Mturk **PC2**	Mturk **FA1**	Mturk **FA2**	GfK **PC1**	GfK **PC2**	GfK **FA1**	GfK **FA2**
Governmental self-efficacy. *How easy or hard would it be for the United States government to:*									
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	0.06	**0.71**	0.06	**0.66**	0.12	**0.67**	0.12	**0.60**
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	0.16	**0.51**	0.16	0.42	-0.04	**0.50**	-0.03	0.40
Reduce the amount of heat from the sun that reaches the Earth, either by putting dust in the stratosphere, making more clouds high in the atmosphere, or other technological solutions	*geo*	-0.24	**0.52**	-0.20	0.41	-0.20	**0.54**	-0.18	0.46
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	0.23	**0.51**	0.22	0.43	0.20	**0.55**	0.20	0.46
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	0.30	**0.64**	0.28	**0.61**	0.15	**0.76**	0.15	**0.74**
Slow population growth nationally and internationally by supporting family planning programs and access to birth control	*pop*	0.06	**0.53**	0.08	0.41	0.15	**0.63**	0.14	**0.55**
Governmental response efficacy. *What effect would the United States government taking this action have on global warming?*									
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	**0.76**	0.12	**0.72**	0.14	**0.81**	0.05	**0.78**	0.06
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	**0.72**	0.08	**0.68**	0.10	**0.76**	0.03	**0.72**	0.04
Reduce the amount of heat from the sun that reaches the Earth, either by putting dust in the stratosphere, making more clouds high in the atmosphere, or other technological solutions	*geo*	0.39	-0.10	0.33	-0.06	0.45	-0.04	0.39	-0.03
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	**0.80**	0.12	**0.78**	0.13	**0.82**	0.09	**0.79**	0.09
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	**0.77**	0.15	**0.73**	0.17	**0.85**	0.05	**0.84**	0.06
Slow population growth nationally and internationally by supporting family planning programs and access to birth control	*pop*	0.46	0.15	0.40	0.16	**0.65**	0.10	**0.61**	0.08
Collective self-efficacy. *How easy/hard would it be for everyone in the United States to collectively:*									
Reduce their annual air travel by 50	*fly*	0.02	**0.59**	0.04	0.48	-0.05	**0.65**	-0.03	**0.59**
Reduce our household energy use by 20%	*heu*	0.13	**0.57**	0.14	0.48	0.07	**0.71**	0.07	**0.66**
Collective response efficacy. *If everyone in the United States collectively took this action,*									
Stop all use of aerosol spray cans at home	*aer*	**0.75**	0.18	**0.71**	0.20	**0.78**	0.05	**0.76**	0.06
Reduce their annual air travel by 50%	*fly*	**0.69**	0.11	**0.64**	0.13	**0.84**	0.05	**0.82**	0.05
Reduce our household energy use by 20%	*heu*	**0.80**	0.13	**0.78**	0.14	**0.78**	0.07	**0.75**	0.08
Vote for candidates committed to reducing or stopping global warming	*vot*	**0.79**	0.14	**0.77**	0.15	**0.79**	0.09	**0.76**	0.10
Proportion of variance explained		0.29	0.16	0.26	0.12	0.33	0.18	0.31	0.15

Table B4. Government self- and response efficacy without geoengineering and family planning.

Governmental and collective self- and response efficacy	*Abbr.*	Mturk **PC1**	Mturk **PC2**	Mturk **FA1**	Mturk **FA2**	GfK **PC1**	GfK **PC2**	GfK **FA1**	GfK **FA2**
Governmental self-efficacy. *How easy or hard would it be for the United States government to:*									
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	0.04	**0.73**	0.04	**0.67**	0.12	**0.69**	0.12	**0.60**
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	0.14	**0.56**	0.14	0.44	-0.06	**0.56**	-0.04	0.41
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	0.19	**0.58**	0.20	0.46	0.20	**0.59**	0.20	0.47
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	0.27	**0.66**	0.25	**0.63**	0.16	**0.77**	0.15	**0.75**
Governmental response efficacy. *What effect would the United States government taking this action have on global warming?*									
Fully enforce all the air pollution control standards currently specified in the U.S. Clean Air Act	*CAA*	**0.76**	0.14	**0.72**	0.17	**0.82**	0.06	**0.78**	0.07
Increase taxes on all fossil fuels (e.g. coal and oil)	*tax*	**0.73**	0.11	**0.68**	0.13	**0.76**	0.04	**0.71**	0.05
Fund research to make renewable energy technologies cheaper and more effective	*rnw*	**0.80**	0.14	**0.77**	0.16	**0.82**	0.10	**0.79**	0.09
Reduce annual greenhouse gas emissions by 20% (in five years or less) through Clean Air Act regulations	*gge*	**0.77**	0.18	**0.72**	0.22	**0.85**	0.06	**0.83**	0.07
Collective self-efficacy. *How easy/hard would it be for everyone in the United States to collectively:*									
Reduce their annual air travel by 50	*fly*	0.00	**0.59**	0.03	0.44	-0.05	**0.65**	-0.04	**0.57**
Reduce our household energy use by 20%	*heu*	0.10	**0.61**	0.12	0.48	0.06	**0.73**	0.06	**0.67**
Collective response efficacy. *If everyone in the United States collectively took this action, what effect would it have on global warming?*									
Stop all use of aerosol spray cans at home	*aer*	**0.75**	0.20	**0.70**	0.23	**0.79**	0.06	**0.76**	0.07
Reduce their annual air travel by 50%	*fly*	**0.70**	0.11	**0.63**	0.15	**0.84**	0.05	**0.82**	0.06
Reduce our household energy use by 20%	*heu*	**0.81**	0.12	**0.78**	0.15	**0.79**	0.07	**0.75**	0.08
Vote for candidates committed to reducing or stopping global warming	*vot*	**0.79**	0.14	**0.77**	0.16	**0.79**	0.09	**0.76**	0.10
Proportion of variance explained		0.34	0.18	0.31	0.14	0.33	0.18	0.31	0.15

Table B5. Reliability (Cronbach's alpha) and p-values for Tukey's test of non-additivity.

Cronbach's alpha*	Dataset	All	Personal	Government	Collective	Gov/Col (with geo/pop)	Gov/Col (without geo/pop)
Self Efficacy	GfK	0.80	0.59	0.70	0.68	0.78	0.76
Self Efficacy	Mturk	0.78	0.62	0.67	0.45	0.72	0.71
Response Efficacy	GfK	0.93	0.83	0.87	0.86	0.92	0.92
Response Efficacy	Mturk	0.92	0.83	0.80	0.85	0.89	0.91

Tukey (p-value)*	Dataset	All	Personal	Government	Collective	Gov/Col (with geo/pop)	Gov/Col (without geo/pop)
Self Efficacy	GfK	0.16	0.11	0.49	0.62	0.00	0.00
Self Efficacy	Mturk	0.02	0.37	0.00	0.70	0.01	0.60
Response Efficacy	GfK	0.00	0.90	0.53	0.01	0.00	0.12
Response Efficacy	Mturk	0.06	0.38	0.00	0.45	0.01	0.27

* Mean Cronbach's alpha and median Tukey p-value reported for Mturk imputations

Appendix C. Concern and policy support model details.

MTURK STUDY (N=388)	DV: Concern		DV: Policy support	
Variable	**Estimate (s.e.)**	**[95% CI]**	**Estimate (s.e.)**	**[95% CI]**
Concern	-	-	**0.56**	[0.445,0.690]
			(0.063)	
Government/collective response efficacy (normalized)	0.13	[-0.033,0.290]	**0.46**	[0.249,0.679]
	(0.083)		(0.113)	
Personal response efficacy (normalized)	0.08	[-0.107,0.268]	0.04	[-0.201,0.301]
	(0.099)		(0.135)	
Government/collective self-efficacy (normalized)	0.07	[-0.059,0.193]	**0.21**	[0.016,0.387]
	(0.065)		(0.094)	
Personal self-efficacy (normalized)	**0.22**	[0.031,0.435]	**0.22**	[0.030,0.419]
	(0.107)		(0.104)	
Perceived harms to self (0=least, 4=most)	**0.58**	[0.461,0.692]	-0.01	[-0.139,0.115]
	(0.060)		(0.065)	
Perceived harms to others (0=least, 4=most)	**0.46**	[0.320,0.602]	-0.07	[-0.176,0.046]
	(0.071)		(0.057)	
Ideology (1=extremely liberal, 7=extremely conservative)	**-0.11**	[-0.165,-0.053]	-0.07	[-0.1360.001]
	(0.029)		(0.036)	
Mean distance from correct knowledge (max=4)	**-0.43**	[-0.790,-0.096]	**-0.83**	[-1.258,-0.449]
	(0.178)		(0.209)	
Age (in years)	-0.01	[-0.014,0.001]	0	[-0.012, 0.003]
	(0.004)		(0.004)	
Female	0.1	[-0.068,0.273]	**-0.24**	[-0.424, -0.060]
	(0.087)		(0.094)	
White	**0.51**	[0.323,0.711]	**-0.54**	[-0.783,-0.299]
	(0.099)		(0.124)	
Anthropogenic	**0.83**	[0.613,1.046]	0.23	[-0.039,0.494]
	(0.111)		(0.135)	
Concern cutpoints		**Policy support cutpoints**		
"not at all"| "a little bit"	-0.64	"strongly oppose"| "slightly oppose"	-3.69	
	(0.381)		(0.422)	
"a little bit"| "a fair amount"	0.74	"slightly oppose"| "neither support nor oppose"	-3.34	
	(0.386)		(0.417)	
"a fair amount"| "a good deal"	1.78	"neither support nor oppose"| "slightly support"	-2.7	
	(0.387)		(0.419)	
"a good deal" | "a great deal"	2.88	"slightly support"| "strongly support"	-0.89	
	(0.4)		(0.433)	

Table C1. Mediation (Concern) and outcome (Policy support) ordered probit models. Estimates in bold are significant at the 0.05 level. For the concern model, mean log likelihood across imputations = -826.349; mean AIC = 1684.699, bootstrapped percent correctly predicted = 53.6%. For the policy support model, mean log likelihood across imputations = -826.349(-680.850); mean AIC = 1684.699 (1395.699), bootstrapped percent correctly predicted = 62.6% (62.6%). The bootstrapped samples used to calculate percent correctly predicted are drawn independently from the samples used to generate the model estimates.

GfK STUDY (N=1532)	DV: Concern		DV: Policy support	
Variable	**Estimate (s.e.)**	**[95% CI]**	**Estimate (s.e.)**	**[95% CI]**
Concern			**0.62**	[0.522, 0.715]
			(0.049)	
Government/collective response efficacy (normalized)	**0.27**	[0.162, 0.385]	**0.37**	[0.251, 0.488]
	(0.057)		(0.061)	
Personal response efficacy (normalized)	0.07	[-0.025, 0.164]	-0.05	[-0.15, 0.06]
	(0.048)		(0.053)	
Government/collective self-efficacy (normalized)	0.01	[-0.068, 0.09]	-0.05	[-0.137, 0.04]
	(0.04)		(0.045)	
Personal self-efficacy (normalized)	**0.10**	[0.024, 0.183]	**0.21**	[0.124, 0.293]
	(0.041)		(0.044)	
Perceived harms to self (0=least, 4=most)	**0.58**	[0.487, 0.68]	-0.07	[-0.166, 0.026]
	(0.049)		(0.049)	
Perceived harms to others (0=least, 4=most)	**0.55**	[0.46, 0.638]	**0.14**	[0.06, 0.229]
	(0.045)		(0.043)	
Ideology (1=extremely liberal, 7=extremely conservative)	**-0.16**	[-0.211, -0.114]	**-0.11**	[-0.168, -0.057]
	(0.025)		(0.028)	
Mean distance from correct knowledge (max=4)	**-0.49**	[-0.692, -0.305]	0.03	[-0.186, 0.246]
	(0.099)		(0.11)	
Age (in years)	0.004	[0, 0.007]	0.001	[-0.003, 0.005]
	(0.002)		(0.002)	
Female	-0.04	[-0.162, 0.085]	-0.004	[-0.14, 0.133]
	(0.063)		(0.069)	
White	**0.22**	[0.068, 0.374]	-0.07	[-0.238, 0.096]
	(0.079)		(0.085)	
Anthropogenic	**0.55**	[0.386, 0.708]	**0.43**	[0.263, 0.582]
	(0.083)		(0.082)	
Concern cutpoints		**Policy support cutpoints**		
"not at all"| "a little bit"	-1.01	"strongly oppose"| "slightly oppose"	-1.53	
	(0.265)		(0.293)	
"a little bit"| "a fair amount"	0.47	"slightly oppose"| "neither support nor oppose"	-1.05	
	(0.267)		(0.294)	
"a fair amount"| "a good deal"	1.68	"neither support nor oppose"| "slightly support"	0.33	
	(0.272)		(0.289)	
"a good deal" | "a great deal"	2.83	"slightly support"| "strongly support"	1.67	
	(0.277)		(0.295)	

Table C2. Mediation (Concern) and outcome (Policy support) ordered probit models. Estimates in bold are significant at the 0.05 level. For the concern model using the GfK data, log likelihood = -1420.032; mean AIC = 2872.065, bootstrapped percent correctly predicted = 48.2%. For the policy support model, log likelihood = -1233.366 ; mean AIC = 2500.732 , bootstrapped percent correctly predicted = 52.4%. The bootstrapped samples used to calculate percent correctly predicted are drawn independently from the samples used to generate the model estimates.

Supplemental information on analysis (for online supplement)

Data were analyzed in R version 3.3.2. In addition to the base and stats packages, multiple imputation was conducted and combined using the Amelia package [80, 82]; the psych package [83] was used to conduct principal component analysis and factor analysis.

Likert scales were standardized after data collection to run from -1 to 1 with a center at 0 for ease of interpretation. Where scales were asymmetric, the fourth item was collapsed into the nearest value (i.e., "do it already" was collapsed into "extremely easy"). Items that included a "don't know" response were handled in one of two ways. Where "don't know" was analogous to another response (e.g., policy support, where a "don't know" response could be interpreted as similar to a "neither support nor oppose" response), don't knows were re-specified to the center of the response scale. In cases where "don't knows" were substantively different to other responses on the scale (e.g., concern items, scale from "not at all concerned" to "extremely concerned" plus "don't know"), "don't knows" were treated as missing. Categorical responses were not manipulated.

We use both principal component analysis (PCA) and exploratory factor analysis (EFA) to construct scales measuring efficacy beliefs. Principal component analysis provides insight into the dimensionality of the data, with the goal of explaining the maximum amount of observed variance with the minimum number of components. We ran PCA across imputed data for the closed-ended efficacy survey items within and across each level of action, using the Kaiser criterion (retention of those components with eigenvalues greater than one) to specify the number of components. Where the number of components indicated by the Kaiser criterion was inconsistent across imputed data sets, we explored both alternatives (e.g., both two and three components for personal level efficacy). The reported component loadings result from running

PCA for each imputed data set, averaging loadings across imputations, then applying a varimax rotation. Given that our aims include testing the match between theoretical efficacy constructs and how people understand efficacy in practice, we also applied exploratory factor analysis (FA) to examine common variance across survey items. Exploratory factor analysis is often used to identify hypothesized latent variables (factors) that drive the observed variance. If types of efficacy and/or levels of action (e.g., personal self-efficacy) are in fact distinct latent constructs in the minds of respondents, and are accurately captured by survey items, these items should load separately onto different factors in FA. We first ran a separate maximum-likelihood factor analysis for all closed-ended items within each level of action to determine whether self- and response efficacy items loaded on distinct factors for any given level of action (Table 1 and Appendix B). Finally, we included all closed-ended efficacy items in a single factor analysis (Table 2)

To conduct the factor analysis using imputed data, we took the unrotated average factor loading across imputations after controlling for possible factor- and sign-switching due to random variations between imputations [81-82], applied a varimax rotation to the final averaged factor loadings, and used the Kaiser criterion to limit the number of factors in each.

In the first stage of the mediation analysis (Figure 1 and Appendix C) we estimated an ordered probit model of concern as a function of self- and response efficacy, controlling for perceived harms at both proximate (personal) and remote (others around the world) social distances, and for correctness of causal beliefs (measured as the average distance from correct answers for climate change knowledge items). The model also controls for political ideology, gender, age, and race, which have previously been shown to predict policy support [64], as well as belief in anthropogenic climate change. The second stage (Figure 1, Appendix C) is an

ordered probit model of policy support as a function of concern, self-efficacy, and response efficacy, with the same covariates. The direct, indirect, and total estimated effect of self- and response efficacy on policy support were calculated according to the non-parametric general approach to mediation analysis outlined in Imai et al.[86] First, coefficient estimates for both models were bootstrapped across all imputations. Next, expected policy support was calculated for each observation in the dataset when self- and response efficacy are separately set to two values: the mean and the top of the 95% confidence interval for ten randomly drawn bootstrapped estimates. This constructs a hypothetical counterfactual estimate of the 'treatment effect' for each efficacy type; this is the estimated effect on policy support of moving from an efficacy score of zero to the 97.5th percentile (from the mean to the upper-bound on the 95% confidence interval). Estimated treatment effects are also reported in Figure 2 and Appendix C.