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Effects of fear on donations to climate change mitigation☆

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ABSTRACT

Despite 70 years of research, there is no consensus about the effects of threat messages on behavior, partly because of publication bias. The lack of consensus concerns situations such as climate change where people tend to believe that they cannot easily make a major difference. Using a 2 × 2, (threat, neutral) × (efficacy, no efficacy) between-subjects design, we tested four hypotheses: the effect of threat stimuli on (1) mitigation of climate change and (2) experienced fear depends on efficacy information, (3) threat stimuli increase monetary donations to mitigation regardless of efficacy information, and (4) the effect of the threat stimuli depends on political identity. The threat stimuli were climate change related pictures and a prompt to write either about one's knowledge of or about the threat of climate change. The efficacy stimuli were an efficacy related picture and written information about the efficacy of a climate change mitigating organization. We collected a representative online sample of 1517 U.S. citizens. The manipulations affected experienced fear and self-efficacy, but there was no statistically significant main effect of threat on donations nor a statistically significant interaction between threat and efficacy or between threat and political identity. It is concluded that threat appeals do not increase climate change mitigation behavior by more than a very small amount compared to making people think about the subject.

Does arousing fear about climate change motivate its mitigation? The very few studies about the question have not yet provided a clear answer (Meijnders, Midden, & Wilke, 2001; Scharks, 2016), and the normative recommendations are in conflict (McQueen, 2021; Reser & Bradley, 2017). In addition, the literature of the effects of threat appeals on behavior, in general, and on health related behavior, in particular, has not reached a consensus after 70 years of research (Peters, Ruiter, ten Hoor, Kessels, & Kok, 2018). Several recent meta-analyses report conflicting results with unclear theoretical and normative implications (de Hoog, Stroebe, & de Wit, 2007; Peters et al., 2018; Peters, Ruiter, & Kok, 2013; Tannenbaum et al., 2015; Witte & Allen, 2000). Especially contested are the effects of threat messages in situations where people tend to have low efficacy beliefs. Climate change and one's estimated possibility to mitigate its effects form such a situation nowadays. One suggested reason for the conflicting results is publication bias. Peters et al. (2013) argue that the published literature is biased to studies among populations without an interaction between threat and efficacy. This is because some models predict that one will get statistically significant and theoretically expected results from threat appeals only among populations with low threat and high efficacy appraisals at baseline and there is a bias to publish statistically significant results. The meta-analysis by Peters et al. (2013) could have produced different results from those by others because they included only studies manipulating the effects of both efficacy and threat on behavior rather than intentions which may be more prone to biases. Requiring an efficacy manipulation can catch studies with low efficacy states and therefore allow the interaction effect to appear. However, efficacy or threat manipulations may lead to low and high levels in these states in a relative sense only (Hovland, 1953). Furthermore, Peters et al. (2013) were not able to control for more general publication bias and *p*-hacking which can produce conflicting results in different meta-analyses because they increase the overall likelihood of random noise being mistaken for signals. The present study tested hypotheses from the threat appeal literature to contribute to solving the existing conflicts. We aimed to do this by testing the effects of threat and efficacy stimuli 1) on actual behavior in the low efficacy context of climate change, 2) in a high-powered

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design with a representative sample, 3) and by using the Registered Report format which minimizes publication bias and *p*-hacking.

In this text, we follow Dillard, Li, and Huang (2017) in using the word threat to refer to stimulus or message features, and in using fear to refer to an emotional response that follows from perceived threat. A stimulus can include objective signs of threat without being accompanied by fear reactions. For example, people can react to a threat with other emotions or with no emotions at all. It is possible that the participants appraise the stimuli and the experiment as threats to their freedom to think or act in a certain way and become angry (Dillard & Shen, 2005).

Current threat appeal models mostly concern individual health-related behaviors rather than political or collective action. All models, however, incorporate the basic ideas of Aristotle who wrote about the usefulness of threat appeals to motivate political action against distant threats (McQueen, 2021). Climate change is such a threat: although potentially catastrophic, climate change tends to appear abstract and distant which can lead to a lack of action via a lack of fear (Wiener, 2016). Compared to scientists, the general population is relatively unconcerned about the threat of climate change, which suggests an erroneous cognitive threat appraisal (Steentjes et al., 2017; Wang, Leviston, Hurlstone, Lawrence, & Walker, 2018; Weber & Stern, 2011; Wiener, 2016). The Affective Intelligence Theory (Marcus, Neuman, & MacKuen, 2000) models the effects of emotions on political decision-making and predicts that fear and anxiety lead to more intensive and conscious information processing. Fear could therefore eventually lead to a more accurate view of climate change. In addition, fear may change values and motivate action. The relevance of emotions such as fear in the climate change context is supported by surveys showing that emotions are associated with policy support for climate change mitigation (Smith & Leiserowitz, 2014; Wang et al., 2018).

As mentioned above, current threat appeal models include the ideas of Aristotle who thought people's fear can be aroused when the threat appears remote. Although people are not generally frightened of remote events, reminders or signs of threats can make people feel fear as if the event is imminent (Aristotle, 2000; Aristotle, 2004). This fear will then lead to thoughts and actions aimed at avoiding the threat. Two kinds of people are likely to be unaffected: those who think nothing bad can happen to them and those who expect that nothing can be done to avert the threat (Aristotle, 2004). Similarly, for example, the Extended Parallel Processing Model (EPPM) (Witte, 1992) predicts that people will respond to threat messages only if they think that the threat is real (threat appraisal) and that it is not too difficult for them to avert it (efficacy appraisal). People who think the threat is nonexistent will not respond to it, and people who do not believe they are able to avert the threat will attempt to control their emotional reactions (e.g. by denial) rather than respond to the threat itself. Assuming that EPPM is applicable to climate change related behavior, it predicts that the highest donations to climate change mitigation would be made by participants with the highest threat and efficacy beliefs. A modified Protection Motivation Theory (Cismaru & Lavack, 2007) predicts that stimuli need to pass individuals' cut-off levels for threats and for efficacy before they influence behavior. Both models predict that threat messages will not lead to donations when people do not have much belief in efficacy (*hypothesis 1 in the current study: an interaction between efficacy and threat on donations*). EPPM also predicts that people will experience fear when they believe there is a threat but their efficacy is low (*hypothesis 2: an interaction between efficacy and threat on fear*).

Most models and meta-analyses support the hypothesis that threat appeals have a positive effect on individuals' behaviors when both threat and efficacy are high (de Hoog et al., 2007; Peters et al., 2013, 2018; Tannenbaum et al., 2015; Witte & Allen, 2000). All seem to also agree that threat appeals do not have an effect when there is no efficacy at all. What is not known or agreed upon is what happens when there is some, but not much, belief in efficacy. For example, EPPM predicts that, in such a situation, people will engage in fear control processes which could include denying the message or acting against recommendations in order to relieve anxiety (Witte, 1992, 1994). The Stage Model, in contrast, predicts that, if the recommended action is at least somewhat plausible and not impossible to carry out, low efficacy will not prevent people from carrying out the recommended action (de Hoog et al., 2007). Vulnerable people will seek safety in the recommendations and will be biased towards believing that the recommendations are effective (*hypothesis 3: a main effect of threat*).

Climate change is a low-efficacy context for individuals because climate change mitigation requires collective action. Unlike for most health-related behavior, a single person's climate change actions have an infinitesimally small effect, and the assumption of a perfectly selfish, materialistic, and rational individual would lead to a prediction that their perception of their own response efficacy and the perceived utility from mitigating climate change is nonexistent. At the same time, the objective response efficacy or the possibility to influence is large for whole countries or for all people on Earth collectively. Experimental literature shows that, on average, people in Western societies do not follow a strictly narrow self-interest, but contribute a non-zero amount to the common good in situations similar to climate change where the individual contributions to the common good have a material net cost to the individual but a net benefit to the collective (Balliet & Van Lange, 2013; Chaudhuri, 2011; Henrich et al., 2005; Herrmann, Thöni, & Gächter, 2008; Milinski, Semmann, Krambeck, & Marotzke, 2006). The study of political participation has led researchers to similar conclusions. For example, people vote even when the costs associated with voting such as time and travel exceed the marginal benefit from the voted policies (Groenendyk, 2011). Emotions such as fear are one suggested reason for unselfish collective actions (Marcus et al., 2000). Based on the context and the previous results, we expect that people will have low efficacy beliefs, especially for individual action, but the efficacy beliefs will not be non-existent and the incentive structure of the problem will not prevent people from donating.

Climate change mitigation has a political aspect which we expect to complicate the effects of climate change threat appeals. Threat appeals can be interpreted as threats to the freedom to think or act against the appeal's recommendation which can lead to reactance (Dillard & Shen, 2005). Although a threat ad, for example, can lead to a change in political candidate choice (Brader, 2005), there is evidence suggesting that climate change related threat appeals backfire if they are in conflict with political values and identity (Scharks, 2016). Climate change is politically polarized unlike, for instance, the relative size of electrons and atoms. People use scientific literacy, numeracy, and critical thinking skills to support the positions on climate change reality, risks, and solutions that are consonant with their political values and party identification; the most skilled and knowledgeable parts of the general population have the most politically polarized positions on climate change (Kahan, 2017; Kahan et al., 2012; Kahan & Corbin, 2016). Conservative Republicans and Hierarchical Individualists tend to believe more that global warming is not the result of human action and is less of a threat than do Liberal Democrats and Egalitarian Communitarians (Kahan, 2017; Kahan et al., 2012). We expect that asking participants about climate change related threats and for donations to their mitigation will be interpreted as a threat to the identity and values of those who think that climate change is not real, not caused by humans, and does not require action. We therefore expected that people categorizing themselves as Republicans would donate less than others as a response to the threat appeal (*hypothesis 4)*.

1. Threat appeal experiments related to climate change

There are very few studies of the effects of threat appeals on climate change related behavior (Meijnders et al., 2001; Scharks, 2016). Reser and Bradley (2017) reviewed studies that have attempted to manipulate fear specifically in the context of climate change mitigation. They found only one study which included stimuli directly related to climate change

and had behavior as a dependent variable (Meijnders et al., 2001). Its sample consisted of 120 non-students. The moderate-threat condition included a text of approximately 700 words about the greenhouse effect. The high-threat condition added five black-and-white photographs of negative consequences of climate change (e.g. floods and insect plagues). Participants in the high-threat condition rated the message as more frightening than participants in the moderate-threat condition. However, the authors did not clearly report the effects of threat manipulation on behavior (i.e., ordering an energy-saving light bulb). The effect is therefore likely to have been statistically non-significant.

In his dissertation, Scharks (2016) had a study design similar to the current study. Scharks used EPPM (Witte, 1992) to draw hypotheses about threat messages, reactance against the message, climate change policy support, and donations to non-profit organizations. The study was a $2 \times 2 \times 2 + 1$ (collective efficacy $\times$self-efficacy $\times$ psychological distance + paint advertisement no-threat control).

between-subject design. The sample was collected via Amazon MTurk ($N = 1083$). The dependent variables were reactance against the message, support for various climate change policies, and decision about whether and to which organization to donate some or all of ten cents given to participants. Scharks did not find evidence of a three-way interaction on reactance, but threatening and neutral climate change information increased reactance against the message. There was no evidence that any of the conditions increased fear. Scharks noted that the study had a low power to test effects on non-normally distributed donations (64 people made a donation to contrarian organization) and did not report a statistically significant effect of treatment on donations. It is also noteworthy that Scharks (2016) asked about participants' political orientation before the climate change stimuli and had the donation task after all other questionnaires and stimuli. Thus, the design first reminded the participants of their political identities and thereby biased the processing of climate change information.

Moreover, the effects of the threat stimuli on donations were probably reduced because of the many tasks presented between the threat stimuli and the donation.

Two experimental studies manipulated the salience of climate change risk and concerns for future generations, and found a statistically significant increase in donations to organizations mitigating climate change (Shrum, 2021; Zaval, Markowitz, & Weber, 2015). The studies, however, did not explicitly test threat appeal effects nor did they check whether the manipulations increased fear.

The few studies of the effects of threat messages on behavior in the context of climate change have therefore found both significant (Shrum, 2021) and likely non-significant effects (Meijnders et al., 2001; Scharks, 2016). Only Meijnders et al. (2001) reported of a successful fear manipulation but did not report results on behavior.

Most empirical studies of threat appeals have been conducted in the context of health. Meta-analyses usually find no interaction but additive effects of efficacy and threat messages (Tannenbaum et al., 2015; Witte & Allen, 2000). The results imply that a threat stimulus can have a positive effect on behavior even when efficacy beliefs are low or non-existent. In contrast, one meta-analysis used stringent criteria for study inclusion and found an interaction between efficacy and threat in their effects on behavior (Peters et al., 2013). The authors noted that previous meta-analyses had lumped overt behavior together with intentions and attitudes as an outcome variable. This is problematic because fear without a belief in one's efficacy to overcome the threat might lead to defensive reactions and self-reported (and self-perceived) intentions to do something which reduces fear without any actual change in behavior (Peters et al., 2018). There is also evidence of such discrepancies between attitudes and behavior with regard to climate change (Hall, Lewis, & Ellsworth, 2018). Peters et al. (2013) suggested that other meta-analyses were unreliable because of the common bias towards publishing statistically significant findings. According to the authors, this would lead the literature to mostly include studies with high efficacy and low threat at the baseline in the samples of the published papers. To circumvent the problem of measuring absolute levels of emotion and efficacy, the meta-analysis excluded much of the literature and included only studies with experimental manipulations of both efficacy and threat (Peters et al., 2013). However, as noted by Janis (1967), experimental manipulations do not solve the difficulty of defining fear and efficacy levels in absolute terms. Because there is no established measure of an absolute scale of emotion and thought, high condition, in one experiment, can be at the same absolute level as low condition, in another experiment. Furthermore, only including studies with manipulations of all variables does not remove the problems of selective publication and analysis. It is likely that only registered reports can avoid these biases.

In summary, the experiments that have specifically studied the effects of threat stimuli on behavior related to climate change have not reported statistically significant increases in climate change mitigation behavior (Meijnders et al., 2001; Scharks, 2016). Shrum (2021) found that writing about risks related to climate change increased donations to climate mitigation compared to the control condition. The current study aimed to contribute to the literature by improving on previous designs. First, the study sample size was based on a power analysis and the study was well-powered. Second, we checked whether the threat manipulation worked by measuring threat appraisals and fear.

Third, the protocol started with strong threat stimuli right before donation decisions reducing contamination by other less important variables such as being reminded of political identity by inquiring about it. If we assume that climate change related stimuli in the manipulations affect decisions, we must assume that similar questionnaire stimuli can affect decisions as well. Furthermore, a delay between the manipulations and the donation decision, as in the study by Scharks (2016), is likely to reduce the effectiveness of the manipulations (Skilbeck, Tulips, & Ley, 1977). After the donation decision, the rest of the questionnaires (fear, threat, efficacy, political party, attention, and anger) were filled. Because we considered donation to be our most important dependent variable, we wished to preserve it as undisturbed as possible and did not have other questions possibly affecting its measurement. However, the other measurements can be affected by the donation decision. After committing to a choice by making a decision, people tend to justify it afterwards by strengthening beliefs and attitudes consonant with the decision (Beasley & Joslyn, 2001; Festinger, 1962; Knox & Inkster, 1968). We could therefore have expected that the decision to donate (rather than not to donate) would decrease the reported anger and threat to freedom as the participants have not reacted against the perceived goal of the manipulations. The donation decision would decrease identification as a Republican and increase efficacy. It was difficult to predict what the effect of donation decision on fear would be. If people justify their decision by thinking that the threat is significant, fear and threat appraisals would increase. More likely, if people choose to donate to lessen their fear, they think they have made a rational decision which reduces fear, and they may additionally justify their decision afterwards by thinking that the threat and fear had decreased.

Fourth, we reported all results from all tests. And fifth, we used a writing task similar to Shrum (2021) which may reduce reactance by actively engaging participants. We also used validated visual stimuli for climate change related threat and efficacy as there is some evidence that the combination of visual and textual stimuli works well for threat appeals (Halim & Muttaqin, 2014; Schmuck & Matthes, 2017).

The meta-analyses of threat appeals in the health literature have been inconclusive and contradictory. Registered reports are needed to solve the suspected problems, and, to our knowledge, this study is the first registered report on threat appeals.

In order to state the hypotheses appropriately for a Neyman-Pearson type testing (Perezgonzalez, 2015), we needed to determine the alternative hypotheses and smallest effects of interest. The theoretical models do not give any specific predictions regarding the effect sizes and we therefore decided to use conventionally small effect sizes in the power analysis based on Cohen's $d = 0.20$. Because the distributions for

donations have several peaks and are not normal we used ordered categorical variables for donations. A proportional odds ratio parameter β of 1.40 has been estimated to be a small effect size comparable to Cohen's $d = 0.20$ (Rahlfs & Zimmermann, 2019). The estimates of effect sizes in the literature have been higher. The reported effect size of threat appeals in the most comprehensive meta-analysis is Cohen's $d = 0.29$, 95% CI [0.22, 0.35] (Tannenbaum et al., 2015). The true population effect size could be smaller because of selective analyses and reporting, and it is likely to be smaller when real resources are allocated rather than when answering a questionnaire. The effect of including an efficacy statement to a threat appeal was $d = 0.22$ (Tannenbaum et al., 2015). The lowest absolute value of the estimate of the most stringent meta-analysis of the interaction between efficacy and threat was Cohen's $|d| = 0.34$ (Peters et al., 2013).

Following Neyman and Pearson (Perezgonzalez, 2015), our hypotheses included intervals of expected effect sizes which we consider to be of research interest. When we set a main hypothesis that there is no effect, we did not consider only effects of exactly zero to be consistent with the hypothesis but also non-zero effects whose size is theoretically and practically insignificant. The alternative hypothesis was that the size of the effect is of research interest. Our minimum expected effect size for considering an effect to be of research interest was Cohen's $d = 0.20$ and its equivalents. The one-sided hypotheses were therefore whether the population's Cohen's d effect sizes are within or outside the interval [0, 0.20].

Having specified hypotheses with an interval, instead of a point with zero probability mass, allowed us to use the error probability β. It denotes the relative frequency of false negative decisions, i.e. the decision to erroneously not to reject a false hypothesis. The more familiar α denotes the probability of erroneously rejecting a true hypothesis. We chose to use $\alpha = 0.05$ and $\beta = 0.05$. Based on these values, we were able to calculate the required sample size and we used the $\alpha = 0.05$ as the critical p-value for deciding between the hypotheses.

The hypotheses were:

Main hypothesis 1: The effect of the threat stimuli on donations is not affected by the presence of the efficacy information.

Alternative hypothesis 1: The effect of the threat stimuli on donations is larger when the efficacy information is presented compared to conditions where no efficacy information is presented.

Main hypothesis 2: The effect of the threat stimuli on fear is not affected by the presence of the efficacy information.

Alternative hypothesis 2: The effect of the threat stimuli on fear is smaller when the efficacy information is presented compared to conditions where no efficacy information is presented.

Main hypothesis 3: The threat stimuli will not increase donations to climate change mitigation.

Alternative hypothesis 3: The threat stimuli will increase donations to climate change mitigation.

Main hypothesis 4: There will be no difference in the effect of threat stimuli on donations between those identifying Republicans and others.

Alternative hypothesis 4: The effect of threat appeals on donations will smaller and possibly negative among Republicans compared to others.

The relationships between the hypotheses and theoretical models are presented in Table 1. The alternative hypothesis 1 is consistent with the EPPM (Witte, 1992) and with a modified Protection Motivation Theory (Cismaru & Lavack, 2007) if the baseline level of efficacy is low and the manipulation increases it. The alternative hypothesis 2 is consistent with the EPPM (Witte, 1992). The main hypothesis 1 and the alternative hypotheses 3 are consistent with the Stage Model if the perceived efficacy in the sampleis not nil (de Hoog et al., 2007).

Table 1
The relationship between hypotheses and models.

Hypothesis	EPPM	Modified PMT	Stage Model
No interaction effect on donation (1 M) No interaction effect on fear (2 M) No main effect on donation (3 M)	inconsistent inconsistent	inconsistent	consistent consistent inconsistent

The order in which participants are asked to make a decision and to answer questions can affect the decisions and the answers. Because we asked about the donation first, the presentation order will not affect the hypotheses 1 or 3. Deciding to donate first would probably lessen the reported fear and increase efficacy through cognitive dissonance and through the substantive fear reduction from acting to reduce threat as hypothesized by threat appeal models (Hovland, 1953). If people decide to donate according to the main or alternative hypothesis 1, the presentation order effect on fear would strengthen the corresponding main or alternative hypothesis 2. Therefore, the acceptance of corresponding main hypotheses 1 and 2, or alternative hypotheses 1 and 2, would mean that the acceptance of the fear hypothesis would be provisional and the hypothesis would require further testing. The effects of a donation on political identity are likely to have a very small favorable effect for the alternative hypothesis 4 that Republicans donate less as a result of threat appeals. Therefore, if the results led to the acceptance of the main hypothesis 4, the presentation order effect working against it would have strengthened the conclusions. If the results led to the acceptance of the alternative hypothesis 4, the presentation order effect working for it would have weakened the conclusions and called for further testing of the presentation order effects.

We checked the assumption that the perceived efficacy is not nil by measuring individual and collective self and response efficacy. We checked exploratorily that the manipulations worked as intended by testing the effects of the threat manipulation on threat perceptions and fear, and the effects of efficacy manipulation on efficacy measures. We explored how anger and threat to freedom were related to donations and political identities. We expected that participants identifying as Republicans are most likely to report anger and threat to freedom.

2. Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study in addition to all the analyses we planned to run (Simmons, Nelson, & Simonsohn, 2012).

2.1. Participants

We planned to collect an online sample via SurveyMonkey (https://surveymonkey.com) that would have been representative of adult U.S. citizens in terms of gender and income. Because it was not possible to give participants money according to their decisions via SurveyMonkey and paying with the planned Amazon vouchers was more problematic than giving money directly through Prolific, we bought an online sample via Prolific (https://www.prolific.co). The sample was representative of adult U.S. citizens in terms of gender, age, and ethnicity.

SurveyMonkey was used to collect the questionnaire and decision data, and Prolific was used for sampling and compensating the participants.

3. Sample size

As discussed in Introduction, we set the minimum meaningful effect size of each of the four hypotheses to the conventionally small effect size. We modeled fear as a continuous and normally distributed variable. Because donations in comparable experimental designs are usually not normally distributed but have three peaks at donations of zero, half, and all of the money, we decided to model donations as an ordinal categorical variable. We assumed that the effects of the experiment are

similar or proportional in all categories. In such a model a comparable effect size to Cohen's *d* of 0.20 is an odds ratio (OR) of 0.71 or 1/0.71 = 1.40 (Rahlfs & Zimmermann, 2019). In proportional odds ordinal logistic regression, an odds ratio of 1.40 equals e^{β} when odds are modeled by the formula $e^{\beta j+\beta X}$. This results in $\beta = \ln(1.40) = 0.336$.

The hypotheses were one-sided. We did not have the hypothesis that at least one of the four alternative hypotheses is correct and we did not therefore adjust for multiple tests. The required sample size was estimated using Monte Carlo simulations (Carsey & Harden, 2014) where both alpha and beta were set to 0.05 implying that asymptotically 95% of each test will have a *p*-value <0.05 when there is an odds ratio of 1.40 for donations and a standardised regression coefficient 0.20 for fear.

The simulation R script is available as a supplement (R version 3.6.3). The simulation consisted of 500 iterations of each of the sample sizes from 60 to 2400 incremented by 60. For each hypothesis, we simulated values with the experimental effect's coefficient of 0.336. We estimated proportional odds models (polr function of the MASS package) where the simulated values were predicted by components of the design matrix. We used likelihood ratio tests for the hypotheses that threat and efficacy interact (the null model included only the simple effects of threat and efficacy) and that the threat stimuli have a main effect (the null model included the simple effect of efficacy). We used a contrast matrix to test the hypothesis that the order of the efficacy information and threat stimuli have an interaction. The required sample sizes were determined by the proportion of results where *p*-values of <0.05 were more than.95.

The required sample sizes with simple random sampling were 320 for the interactions on donations (Hypothesis 1 and 4), 280 for the interaction of threat and efficacy stimuli on fear (Hypothesis 2), and 1280 for the threat main effect (Hypothesis 3). The required cell size was 320. To be safe, we aimed at a sample size of 1300 and a cell size of 325.

3.1. Materials

3.1.1. Stimuli

Four threatening pictures (numbers 2, 8, 15, and 24) and four neutral climate change pictures (numbers 12, 57, 69, and 70) were chosen from the Affective Climate Images Database (Lehman, 2018). Each picture has been scored for its relevance to climate change, and for its emotional arousal and valence. All four threatening or all four neutral pictures were shown above the prompt to write about climate change. The prompt below threatening pictures was: "What future climate change related risk do you find most threatening? Please think and write about it below". The prompt below neutral pictures was: "What climate change related topic do you know most about? Please think and write about it below".

Effectiveness stimuli consisted of an image of a solar panel, that has been found to increase self-efficacy (Hart & Feldman, 2016), and the following text. We edited the text after the first conditional approval of the manuscript to make it easier for the participants to understand:

"Everyone can help to mitigate climate change. In the United States, one person will cause 17 tons of greenhouse gas emissions per year on average.[1] A donation of approximately 12 cents to the Coalition for Rainforest Nations will avert one ton of greenhouse gases and mitigate climate change.[2] Offsetting the yearly greenhouse gas contributions costs approximately 2 dollars in donations per person.

"The Coalition of Rainforest Nations consists of 53 nations and it is relatively easy for the Coalition to have an effect in international negotiations. The Coalition has been successful, for instance, in preventing deforestation through the 2015 Paris Agreement. Everyone can contribute to its efforts.

[1] World Bank: https://data.worldbank.org/indicator/en.atm.co2e.pc.

[2] [2]Halstead, J. (2018). Climate change cause area report (p. 152). Founders Pledge. https://founderspledge.com/research/fp-climate-change".

3.1.2. Fear

We measured fear by three items: "Climate change scares me", "I am frightened of the effects of climate change", and "Thinking about climate change makes me anxious." The items used a 7-point response scale from "Strongly disagree" to "Strongly agree". Scharks (2016) reported Cronbach's $\alpha = 0.94$ for the items.

3.1.3. Threat severity

Threat severity was measured by three items: "I believe that climate change is significant", "I believe that climate change is serious", and "I believe that climate change is severe". The items used a 7-point response scale from "Strongly disagree" to "Strongly agree". Scharks (2016) reported Cronbach's $\alpha = 0.96$ for the items.

3.1.4. Threat susceptibility

Threat susceptibility was measured by three items: "The effects of climate change will impact me personally", "It is possible that I will be affected by climate change", and "It is likely that I will be affected by climate change". The items used a 7-point response scale from "Strongly disagree" to "Strongly agree". Scharks (2016) reported Cronbach's $\alpha = 0.94$ for the items.

3.1.5. Climate change efficacy

Adapting items from Bostrom, Hayes, and Crosman (2018), we measured individual and collective **self-efficacy** related to climate change by the items: "How easy or hard would it be for [you | everyone] to offset [your | their] yearly greenhouse gas emissions, in other words, to pay to organizations to reduce greenhouse gas emissions by the same amount you cause yearly?". The items had a seven-point Likert response scale (from extremely hard to extremely easy). We measured individual and collective **response efficacy** by the items: "If [you | everyone] paid to offset [your | their] greenhouse gas emissions, what effect would it have on climate change?". The items had a five-point Likert response scale (from speed climate change to stop climate change). We consulted a native speaker to check and improve the formulation of the items.

3.1.6. Political identity

We measured identification with a political party by a multiple-choice question: "Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent, something else, or do you prefer not to answer?"

3.1.7. Anger

We measured anger by three items ("To what extent do you feel [angry | irritated | annoyed] by the experiment?"). All items had four-point item-specific response scales such as "Not at all angry/A little angry/Somewhat angry/Very angry" (Dillard & Shen, 2005; Scharks, 2016). Scharks (2016) reported Cronbach's $\alpha = 0.85$ and Dillard and Shen (2005) reported Cronbach's α's 0.92 and 0.94 for similar items.

3.1.8. Threat to freedom

We measured threat to freedom by three items: "The study tried to [manipulate | make a decision for | pressure] me." (Dillard & Shen, 2005; Scharks, 2016). The items had a 5-point response scale (from "Strongly disagree" to "Strongly agree"). Scharks (2016) reported Cronbach's $\alpha = 0.86$ and Dillard and Shen (2005) reported Cronbach's α's 0.83 and 0.87 for similar items.

3.1.9. Attention check

We measured whether participants were paying attention by two items. After receiving conditional acceptance for the manuscript, we added unambiguousness to the instructions and the second item to comply with Prolific's Attention Check Policy (Team, 2021). The first item was: "This question is for checking that you read the question. Please answer 'never'. Based on the text you read above, how often have you had a fatal heart attack while watching TV?". There were six

possible answers: “More than four times / Four times / Three times / Twice / Once / Never”. The second item was: “It is important that you pay attention to this study. Please tick ’Strongly disagree’”. It was presented among other items which had a point response scale from “Strongly disagree” to “Strongly agree”.

3.2. Procedure

The participants were first given information about the study so that they could give an informed consent to participate. The participants were told that they could withdraw from the study any time they wanted to, and that the data collected in the study would be made publicly available in such a way that any individual participant could not be identified. The participants’ email addresses would not be made public.

The participants were given the authors’ and the university lawyers’ contact information if they would have had questions about the study.

All participants were randomly assigned to one of four different treatments:

The neutral-efficacy treatment: The participants were first shown the four neutral climate change related pictures and asked to write about the climate change related topic they know most about as described in the Materials section. They were then given the information about the effectiveness of the donations.

The threat-efficacy treatment: The participants were first shown the four threatening pictures with the prompt to write about a climate change related threat, and then the efficacy information.

The neutral, no efficacy treatment: The participants were shown the neutral pictures together with the prompt to write about the climate change related topic they know most about. They were not shown efficacy information.

The threat, no efficacy treatment: The participants were first shown the four threatening pictures with the prompt to write about a climate change related threat. They were not shown efficacy information.

After the treatment stimuli, all participants were prompted to decide how much of $2 they would take as a bonus payment and how much of the $2 they would donate to the Coalition for Rainforest Nations: $0, $1, or $2. The exact prompt was: “We have $2 which we can divide between you and the Coalition for Rainforest Nations, an organization working to mitigate climate change. We will divide the money according to your decision. You will receive your share as a bonus payment. We will donate the share of the Coalition for Rainforest Nations to it and send you the receipt of the total donations by all participants via Prolific. How would you like to divide the $2? $2 to you and $0 to the donation / $1 to you and $1 to the donation / $0 to you and $2 to the donation”.

Finally, the participants were thanked for participation and asked to return to the Prolific website. After all of the data were collected, the Coalition for Rainforest Nations was given the donation determined by the participants and the participants were given compensation for participation, bonus payment according to their decision, and the receipt of the donation to the Coalition for Rainforest Nations.

3.3. Data exclusion criteria

Data from participants were excluded (1) if SurveyMonkey or Prolific reported that the participant had not followed the rules of service, (2) if the participant requested that their data shall not be used for research, (3) if the text written by the participants in the open-ended questions was clearly non-sensical and unrelated to climate change, or (4) the participant gave wrong answers to the attention checks.

3.4. Quality checks

We checked the answers to the open-ended questions manually. There were donations in more than one category (0, 1, or 2 USD) and we were able to test our confirmatory hypotheses 1, 3, and 4.

3.5. Data analysis

The data preprocessing included exporting the data and data summaries from SurveyMonkey, manually checking the answers to the open-ended questions, loading the data to R, checking that formats of the variables were correct, checking that the data were loaded correctly by comparing the summary data given by SurveyMonkey to those calculated with the data in R, and checking that the data were correctly assigned to treatment variables.

Hypotheses were tested with the same models and contrasts which were used in power analysis simulations. The R (R version 3.6.3) script for the analysis is provided as a supplement.

Our assumption was that the experimental effects on donations would be similar or proportional in all response categories and we therefore modeled them with proportional odds ordinal logistic regression models (polr function from MASS package). In case we found evidence against the proportionality assumption, we planned to relax it and to estimate the effects on categories individually. This would have reduced the power of the statistical tests and we would have had to take it into account when discussing statistically non-significant results.

If the data supported the hypothesis of an interaction between the efficacy information and threat stimuli, we would not have run the model of main effects. Rather, we would have studied the interaction pattern to see whether the data supported the hypothesis that threat increases donations both when efficacy information is presented and when it is not presented.

We used the likelihood ratio tests for the interaction hypotheses 1, 2, and 3 (R’s anova function). The compared models in the likelihood ratio test were the null model, which included the simple effects of threat and the presence of efficacy or party identity, and the alternative model, which in addition included the interaction between threat and efficacy or identity. The data would have supported the alternative hypothesis if the test’s p-value was <0.05, and the pattern of coefficients was such that the presence of non-Republican identity or efficacy information would have increased the threat stimuli’s positive effects on donations or decreased fear (Chen, 2003). Otherwise, the data would have supported the main hypotheses.

The data could have been consistent with both an interaction (hypothesis 1) and a main effect (hypothesis 3) if the threat stimuli increased donations both with and without efficacy information (compared to neutral stimuli). The interaction could have manifested as a difference in the magnitude of increase if there would have been an increase in both conditions. If the absence of efficacy information would have led to a negative effect of threat stimuli on donations, the data would not have been consistent with the alternative hypothesis 3 of a main effect of threat. If the data were not consistent with the presence of an interaction, we planned to use the likelihood ratio test to decide between the presence and absence of a main effect of threat stimuli. The null model would have the presence of efficacy as an independent variable and the alternative model would add threat as an independent variable.

Exploratory analyses and manipulation checks were run using the questionnaire data on fear, threat severity, threat susceptibility, threat to freedom, anger, and climate change efficacy. The manipulation checks involved the similar models as in the main confirmatory hypothesis tests but with fear, threat evaluations, and efficacy modeled as continuous dependent variables. We explored the manipulation effects on different aspects of collective and individual self- and response efficacy as well as their combined sum scale.

4. Results

4.1. Descriptive statistics

We collected data from 10 participants in a technical pilot study and from 1701 participants in the actual experiment. The data collection

consisted of two rounds because the first round with 1386 participants failed to achieve the required cell sizes after excluding data according to the criteria we had set. Based on our exclusion criteria, we removed data from 174 participants from the analysis. There were 10 participants with missing data in some items. Because there were so few participants with missing data we removed their data completely from the analysis. In total, we used data from 1517 participants in the analysis. The final cell sizes, shown in Table 2, exceed the required cell sizes of 325.

The descriptive statistics of climate change related fear are shown in Table 3 and the condition-specific distributions are visualized as butterfly plots in Fig. 1 (Supplement 1). On average, the participants agreed somewhat with the claim that they feel fear about climate change. The means and medians of fear were higher in the high threat condition than in the low threat condition.

The descriptive statistics of donations to climate change are shown in Table 4 and the donation histogram is shown in Fig. 2 (Supplement 1). On average, the participants decided to donate a bit >1 USD to climate change mitigation. The lowest mean donation was in the low threat, low efficacy condition and the highest mean donation was in the high threat, high efficacy condition. The histogram shows that, in all conditions, the plurality of the participants decided to donate 2 USD.

On average, the participants agreed that climate change is severe (Table 5 and Fig. 3, Supplement 1) and that they are susceptible to its effects (Table 6 and Fig. 4, Supplement 1). On average the participants considered it between *somewhat hard* and *neither hard nor easy* to offset their own yearly greenhouse gas emissions (Table 7 and Fig. 5, Supplement 1). The participants thought, on average, that it is hard for everybody to offset their greenhouse gas emissions collectively (Table 8 and Fig. 6, Supplement 1). The self-efficacy means are higher in high efficacy conditions than in low efficacy conditions. The mean individual (Table 9 and Fig. 7, Supplement 1) and collective (Table 10 and Fig. 8, Supplement 1) response efficacy was between *no effect* and *slow down climate change*. The mean values were not consistently the highest in the high efficacy conditions. On average, the participants did not report feeling angered by the study (Table 11 and Fig. 9, Supplement 1) and they disagreed with the view that the study presented a threat to their freedom (Table 12 and Fig. 10, Supplement 1). The participants reported feeling anger and threat to freedom most in the high efficacy conditions. Between 13% and 17% of the participants identified themselves as Republicans (Table 13).

The Pearson correlations between the study variables and their overall means and standard deviations are presented in Table 14. The amount of donations was positively correlated with fear, threat perceptions, and efficacy measures, and negatively correlated with Republican identity and with feelings of anger and threat to freedom elicited by the study. Efficacy and threat measures were positively correlated with each other. Fear and threat perceptions were negatively correlated with Republican identity, anger, and threat to freedom.

5. Hypothesis tests

5.1. Hypothesis 1

Our first hypotheses concerned the interaction of the effects of efficacy and threat on donations. The likelihood ratio test comparing proportional odds models with and without the efficacy-threat interaction term did not reject the main hypothesis 1: the effect of the threat stimuli on donations is not affected by the presence of the efficacy information ($\chi^2(1) = 0.23$, $p = 0.63$). Because we had a one-sided hypothesis, we

Table 2
Cell sizes in treatment conditions.

Threat/Efficacy	Low Efficacy	High Efficacy
Low Threat	400	388
High Threat	363	366

Table 3
Descriptive statistics of fear.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	4.23	4.67	1.61	−1.00	3.31
0	1	3.91	4.33	1.67	−0.81	2.81
0	0	4.02	4.33	1.57	−0.81	2.83
1	1	4.12	4.67	1.74	−1.03	3.15

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Fear variable can have values between 0 and 6.

Table 4
Descriptive statistics of donations.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	1.21	1	0.78	−0.38	1.73
0	1	1.23	1	0.80	−0.44	1.69
0	0	1.20	1	0.76	−0.36	1.79
1	1	1.28	1	0.79	−0.53	1.80

Note.
Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Donation can be 0, 1, or 2 USD.

Table 5
Descriptive statistics of threat severity.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	5.01	5.33	1.27	−1.80	6.45
0	1	4.79	5.00	1.45	−1.53	4.92
0	0	4.98	5.33	1.32	−1.81	6.15
1	1	4.90	5.33	1.48	−1.83	5.93

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Threat severity can have values between 0 and 6.

Table 6
Descriptive statistics of threat susceptibility.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	4.70	5	1.26	−1.23	4.48
0	1	4.48	5	1.45	−1.24	4.13
0	0	4.63	5	1.33	−1.32	4.63
1	1	4.56	5	1.48	−1.33	4.33

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Threat susceptibility can have values between 0 and 6.

Table 7
Descriptive statistics of individual self-efficacy.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	2.26	2	1.39	0.22	2.38
0	1	2.94	3	1.52	−0.27	2.12
0	0	2.42	2	1.43	0.07	2.19
1	1	2.93	3	1.55	−0.21	1.97

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Individual self-efficacy variable can have values between 0 and 6.

Table 8
Descriptive statistics of collective self-efficacy.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	1.71	2	1.31	0.59	2.87
0	1	2.46	2	1.51	0.12	2.02
0	0	1.90	2	1.30	0.50	2.78
1	1	2.47	2	1.50	0.12	2.05

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Collective self-efficacy variable can have values between 0 and 6.

Table 9
Descriptive statistics of individual response efficacy.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	0.46	1	0.69	−1.30	5.05
0	1	0.53	1	0.71	−1.26	4.87
0	0	0.51	1	0.65	−1.10	4.51
1	1	0.48	1	0.69	−1.20	4.60

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Individual response efficacy variable can have values between −2 (Speed climate change) and 2 (Stop climate change).

Table 10
Descriptive statistics of collective response efficacy.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	0.75	1	0.75	−1.90	7.38
0	1	0.77	1	0.85	−1.38	5.47
0	0	0.80	1	0.71	−1.43	6.33
1	1	0.76	1	0.81	−1.62	6.41

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Collective response efficacy variable can have values between −2 (Speed climate change) and 2 (Stop climate change).

Table 11
Descriptive statistics of anger at the study.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	0.14	0	0.41	4.08	22.53
0	1	0.19	0	0.49	3.26	14.31
0	0	0.15	0	0.41	3.20	13.46
1	1	0.16	0	0.42	3.03	12.53

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Anger variable can have values between 0 and 3.

Table 12
Descriptive statistics of threat to freedom.

Threat condition	Efficacy condition	Mean	Median	*SD*	Skewness	Kurtosis
1	0	0.75	0.33	0.90	1.09	3.57
0	1	1.03	1.00	1.09	0.89	2.83
0	0	0.75	0.33	0.89	1.15	3.68
1	1	1.01	1.00	1.02	0.77	2.74

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy. Threat to freedom variable can have values between 0 and 4.

Table 13
Political identity proportions in the treatment conditions.

Threat	Efficacy	Republican	Democrat	Independent	Else	No answer
0	0	0.17	0.49	0.27	0.04	0.03
1	0	0.13	0.53	0.26	0.06	0.02
0	1	0.16	0.51	0.26	0.05	0.02
1	1	0.15	0.50	0.29	0.04	0.01

Note. Threat condition 0 = low threat, Threat condition 1 = high threat, Efficacy condition 0 = low efficacy, Efficacy condition 1 = high efficacy.

divide the *p*-value by two to get the value 0.32. We used the Brant-Wald test for testing the proportional odds assumption of our model (Table 15). Because of the Omnibus *p*-value was >0.05, we did not reject the proportional odds assumption. We note that efficacy did have a *p*-value below 0.05.

The interaction term of the proportional odds model had the estimate 0.09 USD,

$SE = 0.19$, $z = 0.48$, with one-sided *p*-value = 0.32.

5.2. Hypothesis 2

Our second hypotheses concerned the interaction of the effects of efficacy and threat on fear. The results of the likelihood ratio test comparing linear models with and without the efficacy-threat interaction term did not reject the main hypothesis 1: the effect of the threat stimuli on fear is not affected by the presence of the efficacy information ($F(1, 1513) = 0.005$, $p = 0.94$). Because we had a one-sided hypothesis, we divide the *p*-value by two to get the value 0.47.

The interaction term of the linear model had the estimate 0.01, $SE = 0.17$,

$t(1513) = 0.07$, with one-sided *p*-value = 0.47.

5.3. Hypothesis 3

Our third hypothesis was about the main effect of threat on donations. Following Type II sum of squares method, we compared a model with the main effect of efficacy to a model with main effects of both efficacy and threat. The likelihood ratio test did not find support for the hypothesis that adding the threat main effect would improve a model that includes only efficacy main effect ($\chi^2(1) = 0.45$, $p = 0.5$). Because we had a one-sided hypothesis, we divide the *p*-value by two to get the value 0.25. The Brant-Wald test did not reject model assumptions (Table 16).

The proportional odds model had the estimate 0.06 USD for the effect of threat,

$SE = 0.1$, $z = 0.67$, with one-sided *p*-value = 0.25.

5.4. Hypothesis 4

The fourth hypothesis was about an interaction between threat and political identity. The likelihood ratio test comparing proportional odds models with and without an identity-threat interaction term did not reject the main hypothesis 4: there is no difference in the effect of threat stimuli on donations between those identifying themselves Republicans and others ($\chi^2(1) = 0.04$, $p = 0.84$). Because we had a one-sided hypothesis, we divide the *p*-value by two to get the value 0.42. The proportional odds assumption was not rejected.

The interaction term of the proportional odds model had the estimate 0.05 USD,

$SE = 0.26$, $z = 0.2$, with one-sided *p*-value = 0.42.

5.5. Exploratory analyses

Using linear regression models, we found evidence that the high

Table 14
Correlations, means, and standard deviations.

	1	2	3	4	5	6	7	8	9	10	11	12	*M*	*SD*
1. Threat condition	–												0.48	0.50
2. Efficacy condition	0.01	–											0.50	0.50
3. Donation	0.02	0.03	–										1.23	0.78
4. Fear	0.06*	−0.03	0.34***	–									4.07	1.65
5. Severity	0.03	−0.05*	0.37***	0.79***	–								4.92	1.38
6. Susceptibility	0.03	−0.05	0.33***	0.74***	0.81***	–							4.59	1.39
7. Individual self	−0.03	0.20***	0.15***	0.15***	0.16***	0.11***	–						2.64	1.50
8. Collective self	−0.03	0.23***	0.08**	0.11***	0.10***	0.10***	0.59***	–					2.14	1.45
9. Individual response	−0.04	0.01	0.16***	0.17***	0.22***	0.20***	0.12***	0.14***	–				0.50	0.69
10. Collective response	−0.02	−0.01	0.18***	0.19***	0.26***	0.21***	0.12***	0.05*	0.66***	–			0.77	0.78
11. Anger	−0.02	0.03	−0.16***	−0.07**	−0.15***	−0.09***	0.02	0.03	−0.10***	−0.14***	–		0.16	0.43
12. Freedom	0.00	0.14***	−0.18***	−0.19***	−0.26***	−0.19***	−0.05*	0.01	−0.16***	−0.20***	0.37***	–	0.89	0.99
13. Republican	−0.03	0.00	−0.17***	−0.32***	−0.37***	−0.31***	−0.12***	−0.08**	−0.02	−0.05*	0.03	0.05	0.15	0.36

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 15
Brant-wald test for threat-efficacy interaction donation model.

	$_{\chi}2$	df	*p*
Omnibus	4.946	3	0.176
Threat	0.750	1	0.387
Efficacy	3.946	1	0.047
Threat:Efficacy	0.540	1	0.462

Table 16
Brant-wald test for threat donation model.

	$_{\chi}2$	df	*p*
Omnibus	4.575	2	0.102
Efficacy	4.281	1	0.039
Threat	0.272	1	0.602

Table 17
Linear regression model predicting fear.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	−0.86	[−1.10, −0.62]	−6.92	1508	< 0.001
Threat	0.14	[0.04, 0.24]	2.73	1508	0.006
Efficacy	0.01	[−0.09, 0.12]	0.26	1508	0.792
Threat to freedom	0.00	[−0.05, 0.06]	0.04	1508	0.971
Anger	0.15	[0.03, 0.28]	2.47	1508	0.014
Republican	−0.14	[−0.28, 0.01]	−1.84	1508	0.066
Threat severity	0.63	[0.56, 0.69]	19.42	1508	< 0.001
Threat susceptibility	0.37	[0.31, 0.43]	12.02	1508	< 0.001
Efficacy sum	0.01	[0.00, 0.03]	1.39	1508	0.166

threat manipulation increased fear as expected (Table 17). The estimate of the effect of efficacy manipulation on fear was positive, but it had a high *p*-value. Models of threat severity and susceptibility without covariates found weak support for higher efficacy decreasing threat severity and susceptibility appraisals, and no evidence (i.e. high exploratory *p*-values) for the effect of threat manipulation on severity and susceptibility although the point estimates had the expected positive signs (Tables 18 and 20). In more comprehensive models, only covariates, rather than the manipulations, had low *p*-values (Tables 19 and 21). (See Table 25.)

We explored the manipulation effects on collective and individual self- and response efficacy as well as their combined sum scale. We found strong exploratory evidence that the efficacy manipulation increased collective and individual self-efficacy ($p < 0.001$) but no evidence that it increased collective nor individual response efficacy (Tables 22 and 23).

We checked whether the manipulations affected the reported threat to freedom or anger towards the study. We found exploratory evidence that the efficacy manipulation increased threat to freedom (Table 23) but no evidence that the manipulations would have increased anger towards the study (Table 24).

Finally, we estimated a linear regression model on donations with the manipulations as well as fear, anger, threat to freedom, threat appraisals, efficacy appraisals, and political identity as predictors (Table 26). We found exploratory evidence for the effects of fear, anger towards the study, threat severity, and individual self-efficacy. There was some weak exploratory evidence for the effects of threat susceptibility, threat to freedom, and collective response efficacy.

Table 18
Regression model predicting threat severity without covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	4.96	[4.84, 5.08]	82.08	1514	< 0.001
Threat	0.07	[−0.07, 0.21]	1.05	1514	0.296
Efficacy	−0.15	[−0.29, −0.01]	−2.10	1514	0.036

Table 19
Linear regression model predicting threat severity with covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	1.56	[1.40, 1.71]	19.32	1508	< 0.001
Threat	−0.03	[−0.10, 0.04]	−0.96	1508	0.339
Efficacy	−0.04	[−0.12, 0.03]	−1.16	1508	0.246
Fear	0.32	[0.29, 0.35]	19.42	1508	< 0.001
Threat to freedom	−0.10	[−0.14, −0.06]	−5.16	1508	< 0.001
Anger	−0.17	[−0.25, −0.08]	−3.77	1508	< 0.001
Republican	−0.35	[−0.45, −0.24]	−6.61	1508	< 0.001
Threat susceptibility	0.47	[0.43, 0.51]	24.01	1508	< 0.001
Efficacy sum	0.02	[0.01, 0.03]	3.45	1508	0.001

Table 20
Regression model predicting threat susceptibility without covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	4.62	[4.51, 4.74]	76.46	1514	< 0.001
Threat	0.08	[−0.06, 0.21]	1.06	1514	0.291
Efficacy	−0.14	[−0.28, 0.00]	−1.96	1514	0.050

Table 21
Regression model predicting threat susceptibility with covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	0.71	[0.51, 0.90]	7.12	1508	< 0.001
Threat	−0.02	[−0.10, 0.06]	−0.42	1508	0.675
Efficacy	−0.03	[−0.11, 0.05]	−0.80	1508	0.423
Fear	0.24	[0.20, 0.28]	12.02	1508	< 0.001
Threat to freedom	0.02	[−0.02, 0.07]	0.90	1508	0.366
Anger	0.05	[−0.05, 0.15]	1.02	1508	0.306
Republican	0.00	[−0.12, 0.11]	−0.08	1508	0.940
Threat severity	0.59	[0.54, 0.64]	24.01	1508	< 0.001
Efficacy sum	0.00	[−0.01, 0.02]	0.24	1508	0.808

Table 22
Regression model predicting collective self-efficacy without covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	1.85	[1.73, 1.97]	30.11	1514	< 0.001
Threat	−0.09	[−0.24, 0.05]	−1.31	1514	0.190
Efficacy	0.66	[0.52, 0.80]	9.13	1514	< 0.001

Table 23
Regression model predicting collective self-efficacy with covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	1.39	[1.05, 1.73]	8.02	1509	< 0.001
Threat	−0.11	[−0.26, 0.03]	−1.58	1509	0.114
Efficacy	0.68	[0.53, 0.82]	9.32	1509	< 0.001
Fear	0.07	[0.00, 0.14]	1.95	1509	0.052
Threat to freedom	−0.02	[−0.10, 0.06]	−0.39	1509	0.697
Anger	0.12	[−0.05, 0.30]	1.35	1509	0.176
Republican	−0.15	[−0.36, 0.06]	−1.44	1509	0.149
Threat severity	0.04	[−0.05, 0.13]	0.93	1509	0.350

Table 24
Regression model predicting threat to freedom.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	0.75	[0.66, 0.85]	15.40	1513	< 0.001
Threat	0.00	[−0.14, 0.14]	0.03	1513	0.974
Efficacy	0.27	[0.14, 0.41]	3.94	1513	< 0.001
Threat × Efficacy	−0.01	[−0.21, 0.18]	−0.14	1513	0.886

Table 26
Regression model predicting donations with covariates.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	0.31	[0.12, 0.50]	3.24	1503	0.001
Threat	−0.01	[−0.11, 0.09]	−0.18	1503	0.854
Efficacy	0.06	[−0.05, 0.16]	1.07	1503	0.285
Fear	0.06	[0.02, 0.09]	2.94	1503	0.003
Individual self-efficacy	0.05	[0.02, 0.08]	3.29	1503	0.001
Collective self-efficacy	−0.02	[−0.05, 0.01]	−1.08	1503	0.282
Collective response efficacy	0.05	[−0.01, 0.12]	1.68	1503	0.093
Individual response efficacy	0.03	[−0.04, 0.10]	0.88	1503	0.381
Threat severity	0.07	[0.02, 0.13]	2.75	1503	0.006
Threat susceptibility	0.05	[0.00, 0.10]	2.08	1503	0.038
Threat to freedom	−0.04	[−0.09, 0.00]	−2.12	1503	0.034
Anger	−0.17	[−0.26, −0.08]	−3.73	1503	< 0.001
Republican	−0.08	[−0.19, 0.02]	−1.54	1503	0.125
Threat × Efficacy	0.03	[−0.12, 0.17]	0.39	1503	0.696

Table 25
Regression model predicting anger.

Predictor	*b*	95% CI	*t*	*df*	*p*
Intercept	0.15	[0.11, 0.20]	7.07	1513	< 0.001
Threat	−0.01	[−0.07, 0.05]	−0.38	1513	0.705
Efficacy	0.03	[−0.03, 0.09]	1.07	1513	0.285
Threat × Efficacy	−0.01	[−0.10, 0.07]	−0.30	1513	0.766

6. Discussion

The current study contributes to the debate about the effects of threat messages on behavior in situations such as climate change mitigation where people tend to believe that they cannot easily make a substantial difference. We tested four hypotheses: the effect of threat stimuli on (1) mitigation and (2) fear depends on efficacy information, (3) threat stimuli increase monetary donations to mitigation regardless of efficacy information, and (4) the effect of the threat stimuli depends on political identity. In all four cases, the statistical tests favored the main or the null hypothesis of no effects: no interaction between efficacy and threat stimuli on (1) donations nor on (2) fear; (3) no main effect of threat stimuli on donations; and (4) no interaction between threat stimuli and political identity.

The participants reported some belief in being able to offset greenhouse gas emissions and slow down climate change. In general, the participants also agreed that the threat of climate change is severe and that they are susceptible to its effects. The average agreement with fear and climate change threat claims was not the strongest possible allowed by the scale. There was therefore room for the threat appeal to strengthen fear and the threat severity and susceptibility appraisals. The situation could be described as people experiencing low but some efficacy and high but not the highest possible threat and fear. This is what we expected. This context is the opposite of high efficacy and low threat appraisals which Peters et al. (2013) claimed to be problematically common in the literature.

The manipulation checks for the threat and efficacy conditions showed that they affected fear and self-efficacy as expected. The participants in the high threat condition reported higher fear than participants in the low threat condition, and the high efficacy condition had higher self-efficacy, but not higher response efficacy, than the low efficacy condition. We did not find evidence that the threat manipulation would have increased threat severity or susceptibility appraisals. It is likely that the elicitation of fear occurred through other channels. Rather than giving new information, we asked the participants to come up with frightening climate change related thoughts by themselves. The climate change related pictures and the attention given to existing fears

may have increased fear without a change to the existing cognitive appraisals about threat severity or susceptibility. It is also possible that there was an experimenter demand effect for agreeing with items related to fear after being asked about climate-change related fears.

The interpretation of the results in relation to the models mentioned in the Introduction is complicated. Although we did not find interaction effects on donations nor on fear (as predicted by EPPM and Modified PMT), and no main effect on donations (as predicted by Stage Model), it is possible that the results are nevertheless consistent with the models (Table 1). According to the modified PMT, individuals have cut-off levels for the variables affecting the decision and all of the values need to be above the cut-off levels before a threat appeal leads to a change in behavior (Cismaru & Lavack, 2007). It is possible that the current context and experiment did not contain values above some relevant cutoff level related to efficacy, cost, or threat, and therefore there were no effects on donations. Defining some cutoffs would help in testing the model. In the high efficacy condition, we offered a reference level of two dollars for offsetting yearly greenhouse gas emissions which was also the amount of money the participants could choose to donate. It could be considered a cutoff level. The relatively low amount of money did not prevent most participants from donating at least one dollar.

The Stage Model makes predictions about threat susceptibility and severity appraisals rather than about fear caused by threat stimuli, and the model could be further tested with stimuli affecting those appraisals rather than more general fear-arousing threat stimuli (de Hoog et al., 2007). The EPPM (Witte, 1992) predicts that fear without cognitive severity and susceptibility appraisals leads to maladaptive responses. We did not observe effects of the threat manipulation on severity and susceptibility appraisals, but we did not observe maladaptive responses or reductions in donations either. This pattern of the results, including the exploratory evidence of higher fear predicting higher donations, contradicts the EPPM predictions about the role of fear.

We did not find an interaction between the threat condition and political identity. There was weak exploratory evidence that Republicans donated less than others on average but there was no backlash or negative effect from the threat stimuli for the Republicans. The high efficacy manipulation increased threat to freedom but the threat manipulation did not. Neither threat nor efficacy manipulation affected anger towards the study. This lack of a backlash or boomerang effect was also noted by Shrum (2021) who speculated that its absence could be caused by the self-generation of the narratives used as a stimulus in the study rather than presenting evidence and recommendations by sources the participants might not find credible. This interpretation is somewhat supported by the increase in threat to freedom due to the efficacy stimuli which included claims rather than open-ended questions.

After collecting the data, we checked whether the assumptions used in the power analyses were sensible. Using the *p*-values of individual coefficients of the models rather than the likelihood ratio of two models confirmed that required sample sizes were the same if the *p*-values divided by two were from the χ^2-distribution or from the *t*-distribution. Not dividing the likelihood-ratio test *p*-value by two resulted in the power of 90% with the required sample size and power of 95% with the realized sample size. We are therefore confident that the study had at least 95% power to detect small effects (Cohen's *d* 0.20). The long-term risk is therefore <5% for making an error when deciding that the threat stimuli or their combination with the efficacy stimuli do not increase donations by more than small effect size in comparison to writing about what one knows about climate change.

Shrum (2021) proved that climate change stimuli can affect relatively small monetary decisions among participants who are doing a survey for a small amount of money. Shrum found a statistically significant positive effect on mitigation donations from both (1) a general essay of climate change risks and (2) a more personal letter to a person in the future compared to (3) a control condition of writing about one's daily tasks. Like the current study, Shrum (2021) did not find a statistically significant difference between the letter and the essay treatments. It is possible that writing about the threats of climate change and writing about what one knows about climate change make climate change salient in the minds of the participants in the same way as Shrum's letter and essay writing task, and all four treatments increase donations to mitigation compared to writing about daily tasks. The results are consistent with the interpretation that salience of climate change in the minds of the participants affects climate change donations. The more subtle differences in the stimuli related to threat appraisals and emotions studied here do not appear significant.

Availability of data and materials

The registration, dataset, materials, and analysis code supporting the conclusions of this article are available in the Effects of Fear on Donations to Climate Change Mitigation repository, DOI 10.17605/OSF.IO/PVSRA, https://osf.io/pvsra/.

Declaration of Competing Interest

None.

Data availability

The location is given in the manuscript: DOI 10.17605/OSF.IO/PVSRA, https://osf.io/pvsra/

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesp.2022.104422.

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