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Positive, global, and health or environment framing bolsters public support for climate policies

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Public support for climate policies is important for their efficacy, yet little is known about how different framings of climate change affect public support for climate policies around the world. Here we report findings from a conjoint experiment of 7,500 adults in five countries – China, Germany, India, UK, and USA – to identify climate messages that elicit greater support for policies to tackle climate change. Messages were randomly varied on four attributes: positive (opportunity) or negative (threat) framings, theme (health, environment, economy, migration), scale (individual, community, national, global), and time (current, 2030, 2050). We find that a positive frame, health and environmental frames, and global and immediate frames bolster public support. We examine differences between countries, and across groups within countries – particularly focusing on the effect of these frames among individuals that are unconcerned about climate change. Among this group, positive and health frames increase the likelihood of support for climate policies, indicating the relevance of these frames for shifting policy preferences for different audience groups.

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The 2015 Paris Agreement seeks to keep the increase in global temperatures to well below the critical 2 °C threshold[1]. It rests on legally binding commitments made by countries (Parties) within the Agreement to reduce their territorial greenhouse gas (GHG) emissions, with commitments ratcheted up every 5 years. The initial set of commitments fell well short of achieving the Paris goals and global temperatures continue to rise[2,3]. It was critical that the process of revisiting the 2030 targets at the end of 2022, as agreed at the 26th Conference of the Parties (COP26) in November 2021, results in more ambitious commitments[4,5]. The meeting included the world's major GHG emitters—China, the USA, the EU, and India[2]—and the decision to revisit targets at the end of 2022 is widely seen as determining the future stability of our climate system.

While policies are set by governments, public support is key, particularly in areas like climate change[2] and in societies where public opinion influences policy[6]. For the non-binding approach of the Paris Agreement—in which countries set their own contributions—to be effective, it is especially important that the public is engaged, and supports policies to address climate change. Indeed, levels of public support can have an important effect on governments' mitigation targets[7]. This has led to greater attention to the challenge of communicating climate change in ways that build public support for mitigation policies[8]. There has been much focus, in particular, on how different frames used in climate change messages influence public engagement and support[9,10]. In communication science, 'framing' refers to the crafting of messages that gives salience to particular aspects of the issue[11].

In the context of climate change, studies have examined whether positive framings, focusing on opportunities provided by climate initiatives, elicit greater support for climate policies than negative framings that emphasize the threats posed by climate change[12–14]. Studies have also investigated whether focusing on particular areas or themes, such as health and economic impacts, can engage the public and make climate change more personally relevant[6,15–18]. Others have examined spatial and temporal scales, investigating whether climate change policies elicit greater support whether framed around local or global impacts[6,19], and around current or future impacts[20]. To the best of our knowledge, no study has assessed the effects of these different types of frames together at the same time.

We designed a conjoint survey experiment testing the effects of different frames on public support for climate policies. Conjoint experiments ask participants to evaluate different hypothetical scenarios, which randomly vary according to multiple attributes, and to express a preference between the scenarios. They are increasingly used to measure public preferences and to assess the relative importance of multiple components in decision-making[21,22]. In our study, the conjoint design enabled us to incorporate different frames into climate change messaging, which randomly varied, and to assess the causal effect of these different frames on support for climate policies. Surveys were fielded in five countries: USA, China, India and the two highest-emitting European countries, Germany and the UK. We chose these countries to ensure that our survey focused on countries emitting high levels of CO_2[23]. Conducting the analysis in these five countries also enables us to examine how the effect of different frames on public support for climate policies varies across countries that differ in terms of levels of socioeconomic development, political system, culture, geography, climate change exposures and impacts, and climate policies[24]. We used quota sampling to ensure representative samples in terms of age, gender, and region to reflect the demographic characteristics of each country's population (or urban populations for China and India), of at least 1500 participants in each country. Details of the

sample, design, messages, and statistical analysis are provided in the Methods.

We test the effects of four different types of frames, or attributes, on support for climate change policies. The four frames are *valence*, *theme*, *scale*, and *time* (Table S2). *Valence* refers to whether the message has a positive framing in terms of the opportunities of climate action or a negative framing that focuses on the threats posed by climate change. *Theme* refers to the framing of climate change according to different issues and impacts. We test four different *theme* frames: economic, environmental, health and migration. *Scale* refers to framing the effects of climate change at different levels: individual, community, national and global level. *Time* refers to the timeframe at which climate change and climate policies take effect: now, 2030 or 2050. Participants received messages that were randomly varied across these four attributes, resulting in 96 different message profiles. We tested these different messages in earlier pilots conducted in the five countries (see Supplementary Discussion). Further details about the treatment design with examples are provided below (see Methods). Participants were presented with pairs of these randomly generated messages and asked to select which of the two would make them more likely to support policies to tackle climate change.

We also consider how the effects of frames on support for climate policy varies across different groups in society. In recent years, there has been growing attention to how attitudes to climate change and climate policy vary across groups of people. Studies have highlighted the importance of different factors—including ideology, age, and gender—in shaping differences in people's level of support for climate policy[25–27]. We consider how the effect of these frames on people's support for climate policy varies is influenced by different factors, such as people's age, gender, education, and income. In particular, we consider how the effect of these different frames on support for climate policy differs among those respondents that express concern about climate change and those that are unconcerned. In cross-national polls, around a third of adults do not regard climate change as a global emergency[28] or a major threat to their country[29]. Some have also suggested that there is evidence of a growing divide between 'convinced' and 'sceptics', with reduced support among sceptics for policies framed around tackling climate change[30–32]. Others, however, have pointed out that trends in climate scepticism vary considerably across countries, and that general claims about climate scepticism are often based on findings from the US context, where there is a particularly high level of climate scepticism closely related to ideology[33]. This, again, highlights the importance of examining how climate frames impact public support for climate policy across different country contexts.

Results
Effect of different frames on public support for climate policy. Figure 1 presents the analysis of the effects of the different frames on support for climate policies for each of the five countries. The results show that in China, the UK, and the USA, positive frames increase the likelihood of public support for climate policies, while negative frames reduce the likelihood of public support. In other words, focusing on the opportunities that arise through implementing climate policies is more effective at eliciting public support than emphasizing the threats of not implementing these policies. In India, the effect of *valence* on support for climate policies is not statistically significant at the 95% confidence level. In Germany we find the opposite effect, with a negative framing increasing the likelihood of public support and a positive framing lowering the likelihood of support for mitigation policies.
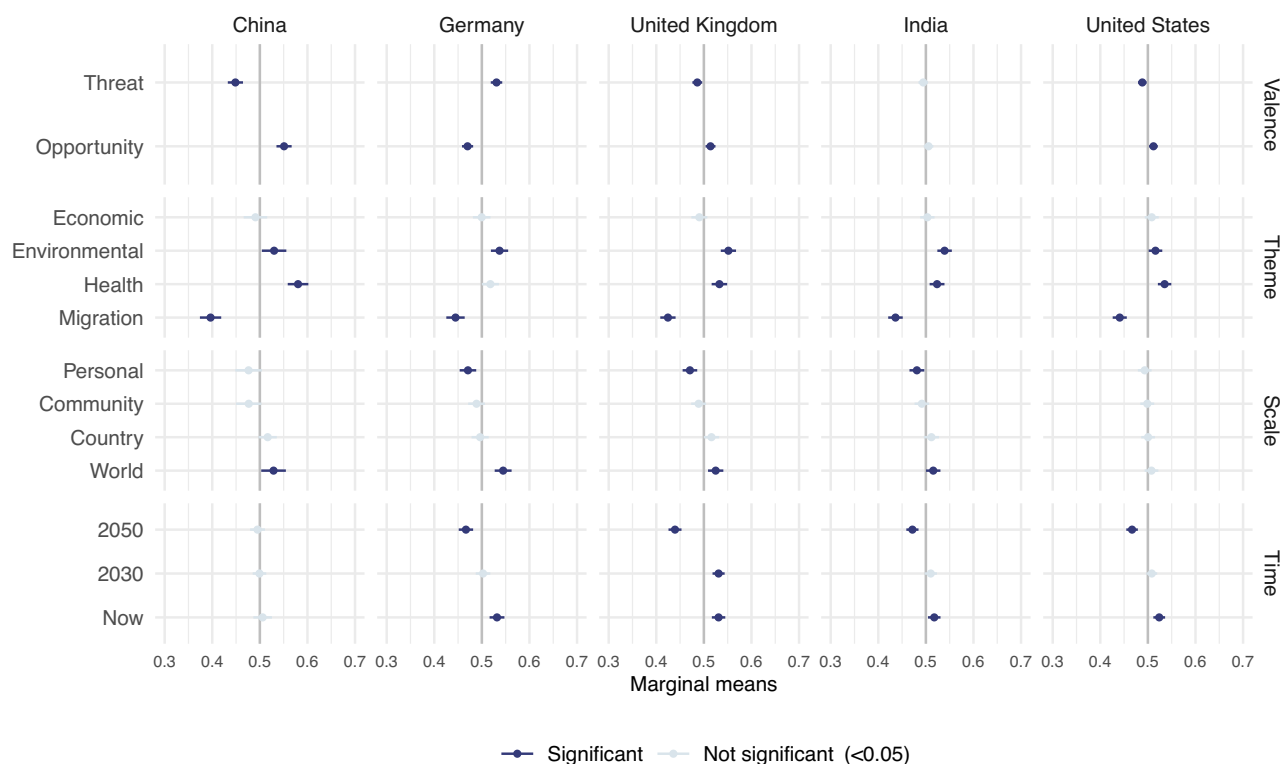
Fig. 1 Effects of different climate frames on respondents' support for climate policies. Sample size: China $n = 1502$, Germany $n = 1501$, United Kingdom $n = 1500$, India $n = 1506$, United States $n = 1503$. Data are weighted to be nationally representative. Fieldwork by Deltapoll, October 2020. Question: Respondents were shown two statements in which the valence, theme, scale, and time frame were varied at random, providing 96 possible permutations. Respondents were asked: Indicate which of the two statements would make you more likely to support policies to tackle climate change. Dots with horizontal lines indicate marginal means with 95% confidence intervals (CI).

The effects of the four different *themes*—economic, environmental, health, and migration—on public support for climate policies are also presented in Fig. 1. The results are highly consistent across the five countries. The environmental frame is more likely to elicit public support for climate policies in all five countries. Similarly, the health frame increases the likelihood of public support for climate policies in China, India, the UK, and the US. In Germany the effect of the health frame falls outside the 95% confidence interval. We find that for all five countries, the economic frame has no statistically significant relationship with support for climate policy. Figure 1 shows that the migration frame reduces the likelihood of public support for mitigation policies in all five countries.

Figure 1 also shows the effects of the *scale* and *time* frames on public support for climate policies. Across the five countries, we find that framing messages about the effects of climate change at a larger scale is more likely to elicit public support for climate policies; messages that say it impacts on the world (a global framing) makes respondents more likely to support climate policies, while an individual framing—i.e. that climate change will affect 'you personally'—makes respondents less likely to support these policies. The results indicate that for China, Germany, India, and the UK, representing climate change at a global (or 'world') level increases the likelihood of support, while in the USA this effect is not statistically significant. In Germany, India, and the UK, using a personal or individual-level framing reduces the likelihood of respondents supporting climate mitigation policies, while in China and the USA the result is not statistically significant at the 95% confidence level. The results of the *time* frame presented in Fig. 1 suggest that in Germany, India, the UK, and USA, there is greater likelihood of public support for climate

policies when the focus in climate messaging is on immediate (now) and near-term (2030) impacts than when longer-term time horizons (2050) are used. However, we find that there is no statistically significant effect of using different *time* frames in China; in the other four countries, the 2050 frame has a negative effect on public support for climate policies, while the present-day frame has a positive effect.

In the Supplementary Information, we include the results from additional analysis that help demonstrate the robustness of these findings. This includes presenting results from earlier pilots conducted in the five countries, which are consistent with the findings here (see Supplementary Figs. S24 and S25). Given conjoint experiments do not allow respondents to indicate opposition to climate policy, we also conducted the analysis on a sample that excluded those most likely to oppose climate policies. We did this by removing those participants who stated they would be unwilling to pay any amount of money to support climate policies from the sample. While there are some minor differences in terms of whether specific frames in the different countries are statistically significant, the results are very similar to those presented here.

Effect of different frames on public support for climate change across different subgroups. How does the effect of these different frames on support for climate policy vary across different groups in society? There has been growing attention to how different attributes and beliefs impact people's attitudes to climate change and climate policy. Our results show that the most important differences are those between those that believe climate change is a global threat and those that do not. Figure 2 presents the results
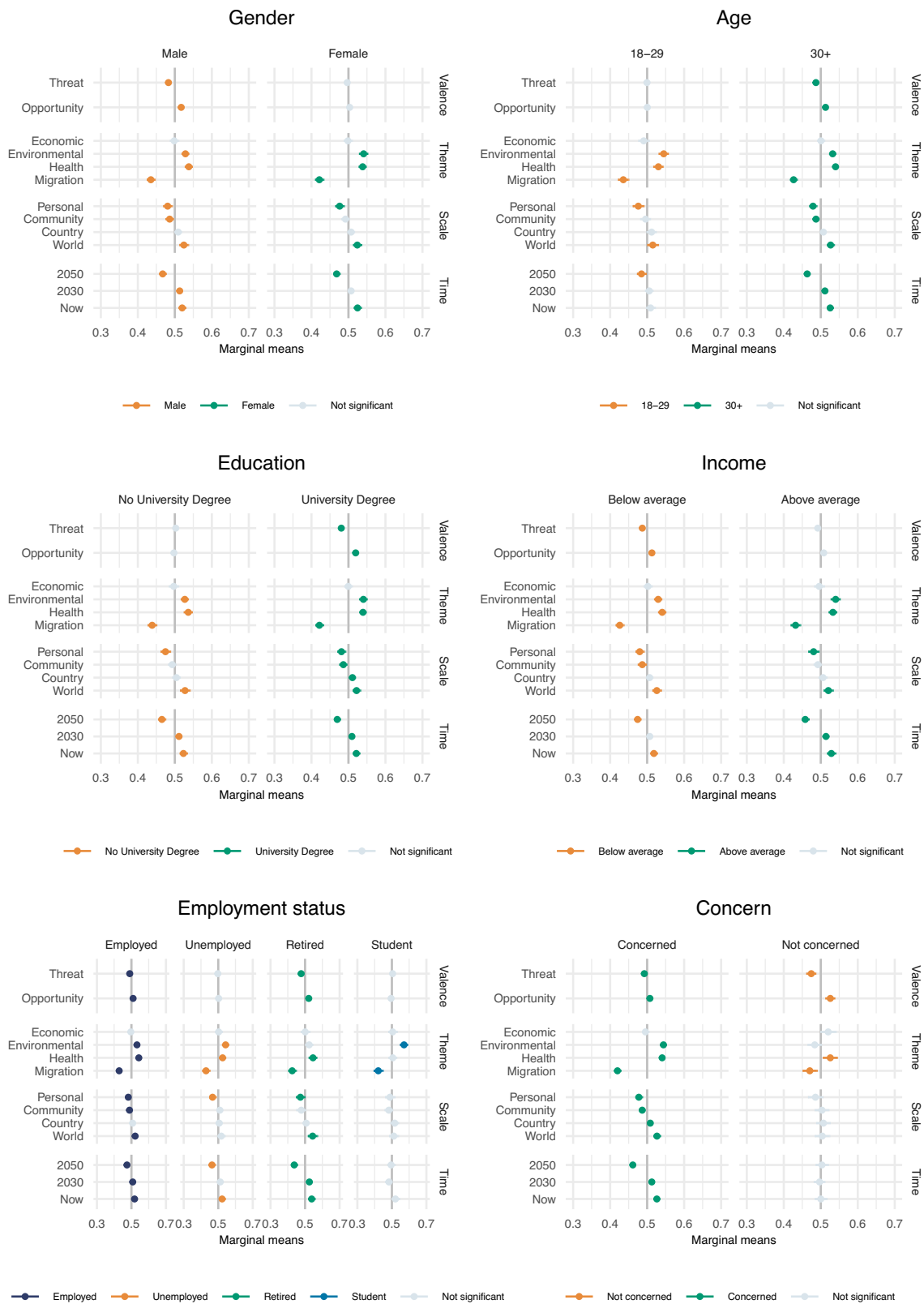
Fig. 2 Pooled results of the effects of different climate frames on support for climate policies across subgroups of respondents. Sample size $n = 7512$. Data are weighted to be nationally representative. Fieldwork by Deltapoll, October 2020. Question: Respondents were shown two statements in which the valence, theme, scale, and time frame were varied at random, providing 96 possible permutations. Respondents were asked: Indicate which of the two statements would make you more likely to support policies to tackle climate change. Dots with horizontal lines indicate marginal means with 95% confidence intervals (CI).

of the conjoint analysis across six subgroups: gender, age, education, income, employment status, and concern for climate change. This is based on a pooled sample from across the five countries; in the Supplementary Information, we provide the results of the subgroup analysis for each country separately, together with results from additional subgroups (see Supplementary Figs. S4–S22).

The results presented in Fig. 2 show that the main differences in the effects of frames on support for climate policy across different subgroups can be observed with the *valence* frames (threat vs opportunity). We find that the previously identified effect of positive frames being more likely to engender support, and negative frames less likely to elicit support, is statistically significant for males, over 30s, those with university degrees, those with lower-than-average incomes, and employed or retired; we find that this effect is not statistically significant at the 95% confidence level for females, under 30s, those without university degrees, those with higher-than-average incomes, and those that are unemployed or students. It is worth noting that while we find differences in terms of whether the effects of the *valence* frames are statistically significant, the results do not show that the negative frame is more effective than the positive frame across any of the subgroups. Across the other frames that we examined; we find few differences across the subgroups. In other words, the findings of the effects of the *theme*, *scale*, and *time* frames are not impacted by respondents' gender, age, education, income level, or employment status. Hence, apart from with the *valence* frame, we find that the effect of the different frames on support for climate policy is not impacted by individuals' socio-demographic background. The results of the subgroup analysis for individual countries indicates that there are examples of the effect of different frames varying according to socio-demographic characteristics—though even for the individual countries, the results are fairly consistent across different subgroups (see Supplementary Figs. S4–S22).

The results in Fig. 2 demonstrate important differences in the effects of the frames on support for climate policies according to individuals' level of concern for climate change (further details on this measure of concern for climate change are provided in the Supplementary Discussion). It is worth noting that those unconcerned by climate change made up a relatively small proportion of our samples in each of the five countries. This group was largest in the USA, constituting 25% of the total sample, and consisted of less than 17% of the sample in the other four countries (see Supplementary Table S1). Most of the frames do not impact support for climate policies among those not concerned by climate change (Fig. 2). However, importantly, we find that there is an effect of the *valence* frames on the likelihood of the unconcerned group supporting climate policies. We find that the opportunity frame increases the likelihood of support for climate policies and the threat frame reduces the likelihood of support—and we find that the effects of these two frames on support for climate policy is larger for those unconcerned with climate change than those that are concerned. We also find that the health frame increases the likelihood of support for climate policies among those unconcerned by climate change, and the migration frame reduces the likelihood of support among this group.

To further unpack the findings among those concerned and unconcerned by climate change, we present the findings of each of the five countries separately in Fig. 3. The results suggest that our findings on the effect of positive valence on support for climate policies among those not concerned by climate change is primarily driven by results in the UK and USA, and the finding on the effects of the health framing is largely driven by results in China and the USA. The results also show that in the USA—the

country with the highest proportion of respondents that are unconcerned by climate change—the environmental frame reduces the likelihood of those unconcerned by climate change supporting climate policies, and the economic frame (like the health frame) increases the likelihood of this group supporting climate policies. It is also worth noting that among those concerned with climate change in Germany, the health frame has a statistically significant positive effect on support for climate policy (this effect is statistically insignificant for the overall sample in Germany). Furthermore, the effect of the *valence* frames on support for climate policies among the concerned group in the UK and USA are statistically insignificant (unlike for the overall samples in these countries), and the effect of the *scale* frames are also statistically insignificant for the concerned group in the USA.

Discussion
This study has examined how different frames impact public support for climate policies using conjoint survey experiments conducted in China, Germany, India, the UK, and USA. We tested the effects of four types of frames—*valence*, *theme*, *scale*, and *time*—on public support for climate policies using conjoint experiments in the five countries. The experimental design of our study enables us to identify the causal effect of different frames on support for climate policies at the same time as each other. Furthermore, focusing on multiple countries enables us to examine the extent to which these effects can be observed across different country contexts. This is especially important given much of the existing evidence on public attitudes to climate change comes from high-income and 'Western' countries[34,35]. Therefore, while we have selected our five countries on the basis that they are all high-emitting countries; they vary considerably in terms of cultural contexts, socioeconomic development, political systems, climate change exposures and impacts, and climate policies (see Supplementary Methods). Conducting the analysis in these five countries enables us to identify common elements in the effects of these frames on public support for climate policy across these different contexts, as well as those that are specific to national contexts.

The results of the analysis indicate that there are differences between the countries in terms of the effectiveness of positive and negative frames in climate messaging in eliciting public support for mitigation policies. In China, the UK, and the USA, we find that a positive framing that highlights the opportunities offered by climate policies makes public support for climate policies more likely, while a negative framing that emphasizes that threats of climate change is less likely to elicit public support. This is consistent with studies that have argued that emphasizing the opportunities of climate action can increase public support[13,36]. Importantly, our analysis also suggests that positive frames can increase the likelihood of those unconcerned by the effects of climate change supporting climate policies. This too is consistent with existing research on promoting pro-environmental behaviour among climate sceptics, which finds that positive framings can increase support among sceptics by helping circumvent ideological issues around climate change belief and denial, and instead emphasize common goals[32]. However, we do not find that positive framing bolsters public support for climate policies in all of the countries. Our results show that the valence of the frames has no statistically significant effect in India, and in Germany we find the opposite effect—the negative framing increases the likelihood of public support for climate policies, while the positive framing is less likely to gain support. A possible explanation for this is the long history of politicians and the media in Germany emphasizing the threat posed by climate change to the public,
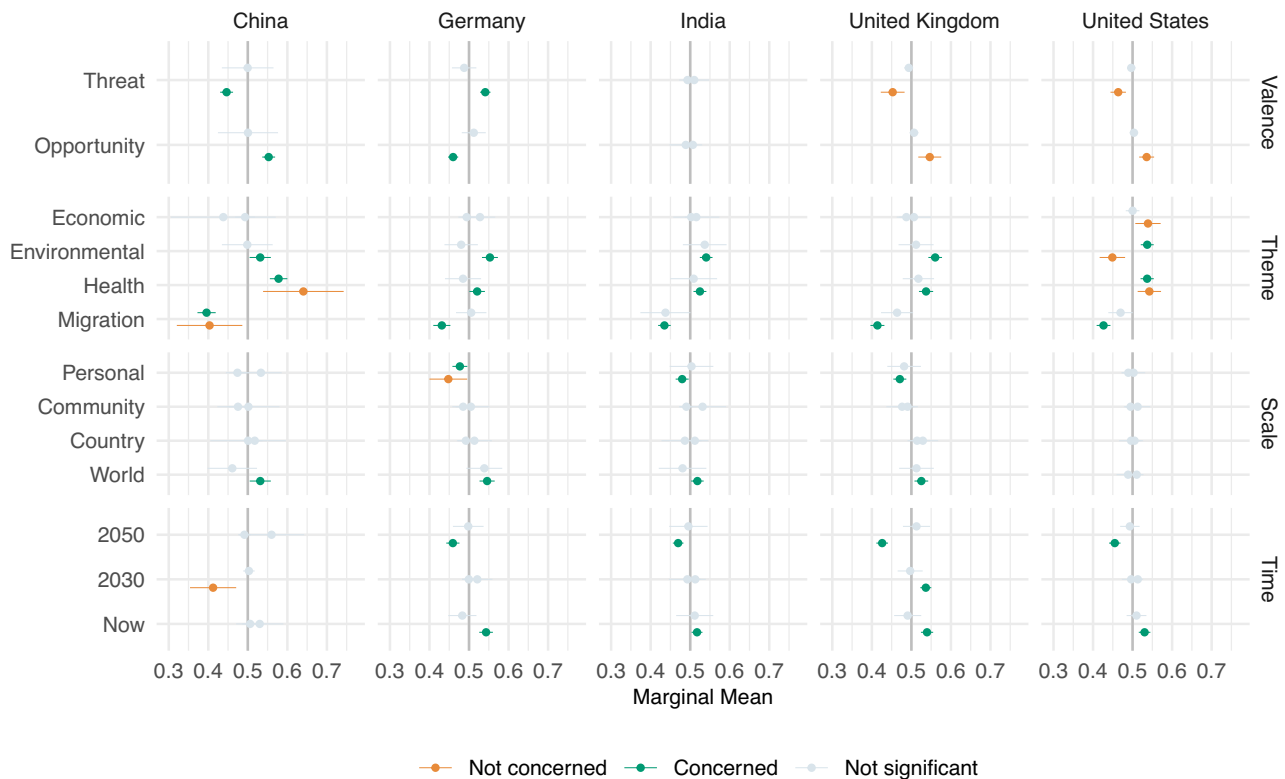
Fig. 3 Effects of different climate frames on support for climate policies for respondents concerned about climate change and respondents not concerned about climate change for individual countries. Sample size: China $n = 1502$, Germany $n = 1501$, United Kingdom $n = 1500$, India $n = 1506$, United States $n = 1503$. Data are weighted to be nationally representative. Fieldwork by Deltapoll, October 2020. Question: Respondents were shown two statements in which the valence, theme, scale, and time frame were varied at random, providing 96 possible permutations. Respondents were asked: Indicate which of the two statements would make you more likely to support policies to tackle climate change. Dots with horizontal lines indicate marginal means with 95% confidence intervals (CI).

with attempts to downplay this threat largely excluded from the political debate[37]. Hence, messaging that focuses on the positives of implementing climate policy may be viewed as undermining this prevailing public discourse on the climate emergency.

Our findings on the effects of the policy theme frames—economic, environmental, health, and migration—are highly consistent across the different countries. In all five countries, the environmental frame increases the likelihood of support for climate policies, the migration frame lowers the likelihood of support, and the economic frame has no significant effect on public attitudes. We find that the health frame increases the likelihood of public support in four of the countries. The negative effect of the migration frame on public support across all five countries provides strong support for the growing consensus that making simplistic linkages between climate change and migration should be avoided, especially given the highlight politicized nature of migration debates in many countries[38]. The ineffectiveness of the economic frame is a little surprising, given the focus on economic frames in the existing literature on public perceptions of climate change[18]. A possible explanation for this is that while an economic framing may elicit support for climate policies among some individuals, it may lead others to instead reflect on the economic costs that such policies may entail[39].

The positive effect of the environmental frame is also a little surprising, given that much of the focus on using alternative framings in climate messaging has been based on the view that a traditional environmental framing fails to engage sectors of society because it portrays climate change as too complex, distant, and lacking in immediate and visible impacts on people's lives[9]. However, our findings suggest that growing public awareness

about climate change in recent years[40] may have fostered greater public understanding and concern about the effects of climate change on the natural environment. Our results also provide strong support for the growing emphasis on using a public health framing of climate change to build public support for climate policy[17]—with climate action in the global policy arena increasingly framed around the protection of planetary and human health[3]. Importantly, our findings suggest that in addition to increasing the likelihood of support for climate policy across the general population, a health framing has the potential to increase support for such policies among those less concerned with climate change (see Fig. 3).

Our analysis also suggests that in terms of the *time* and *scale* frames, a global rather than individual framing of the effects of climate change is more effective in eliciting public support for climate policy, as is framing climate change impacts at the present time rather than in the future. It is worth noting that previous research has found inconsistent findings on whether framing climate change in terms of local and personal impacts or in terms of national and global impacts is more effective in building support for climate policies[10]. The results of our analysis suggest quite clearly that more global framings increase the likelihood of support for such policies, while individual-level framing reduces the likelihood. A possible explanation for this is the inclusion of the different examples of climate change impacts in the messages presented to respondents, which they may feel they had not personally experienced—but could more easily recognize as issues impacting people globally. The effectiveness of using a current rather than future framing of climate to elicit support for climate policies is unsurprising. However, it

is worth noting that the time frame had no effect on support for climate policies in China.

The strength of using a conjoint experiment approach in this study is that it enables us to identify the causal effect of multiple frames on respondents' expressed support for climate policies. However, the approach also has several limitations that are particularly linked to issues of external validity. For example, the analysis involves respondents comparing climate messages side-by-side, which is not how people receive information in the real world. This also meant that respondents had to choose between one of the two messages they were presented with, and so could not express a preference opposing climate policies. While we have sought to ensure that our findings are consistent even when we remove those respondents that state they would be unwilling to pay any amount to support climate policy (see Supplementary Fig. S23), this does not overcome this limitation. A further limitation is that the survey experiment design means that the choice outcome assesses people's perception of the message effectiveness rather than the actual effectiveness of the message. In other words, our analysis is based on asking respondents to indicate which message makes them more likely to support climate policies rather than directly measuring the effectiveness of messages on actual support for climate policies. Finally, it is also important to recognize that the surveys were fielded during the COVID-19 pandemic, which may have influenced the salience of the health frame. Therefore, future research will need to consider the extent to which a health framing continues to bolster public support for climate policies.

Despite these limitations, the analysis provides key insights for actors seeking to build public support for stronger climate policies after COP26. A fruitful area of future research would be to examine interactions between different frames. Indeed, when we consider the message profiles that were most, and least, often selected in each country (see Supplementary Fig. S3)—we find some indication that certain combinations of these different frames may be especially effective (or ineffective) in eliciting support for climate policies in specific countries. Our study suggests that shifts in framing have the potential to elicit greater support for climate policies across different countries and groups. Such public support will be essential for driving more ambitious government commitments to reducing GHG emissions and achieving the goal set out in the Paris Agreement of keeping the increase in global temperatures to well below the critical 2 °C threshold.

Methods

Survey procedure and sample. We fielded our survey in the five countries—China, Germany, India, the UK, and USA—in October 2020 using online panels. We chose these countries to ensure that our survey focused on countries emitting high levels of CO_2[22] with a diversity of national characteristics, including countries in different regions, with different political systems, and countries experiencing different climate change effects. Given much of the literature on public attitudes to climate change has focused on countries in Europe and North America, we sought to address this bias with the inclusion of China and India in the study.

In each of the five countries, the surveys were carried out by the survey company Deltapoll who sampled adult respondents from the population from representative online panels[41]. In Germany, UK, and USA, quota sampling was used to ensure representative samples based on age, gender, and region to reflect the demographic characteristics of each country's adult population. In China and India, quotas were based on age, gender, and region to ensure that samples were representative in terms of the demographic characteristics of urban populations (rather than national populations) as the use of online panels meant that participants tended to be recruited from cities in the two countries. Panellists were asked to complete questions on basic sociodemographic information, before being invited to take part in online surveys. Deltapoll compensates all respondents for participating in the surveys. The precise process for compensation varies from respondent to respondent, reflecting the different methods used for initial recruitment to the panel, as opposed to the specific survey. The survey was conducted under ethical approval granted by the University of Birmingham

(project 766927). Informed consent was obtained from participants at the beginning of the survey.

In addition to the standard recruitment process used by Deltapoll, the recruitment of participants for our survey used sampling quota and weight targets for age, gender, and aggregated region. The targets were derived from the most recent national surveys and census data available for each country (see below). The overall sample size for the study was 7512, with a sample of at least 1500 in each country. The exact sample sizes for each of the five countries was as follows: China, $n = 1502$; Germany, $n = 1501$; India, $n = 1506$; UK, $n = 1500$; and USA, $n = 1503$. Descriptive statistics are reported in Supplementary Table S1.

Experimental design. We embedded a conjoint experiment within the survey, which was designed to measure how different climate change frames affect people's support for policies to tackle climate change. Conjoint experiments, which ask participants to evaluate statements that combine multiple attributes that are randomly assigned, are now widely used in social science research to measure multidimensional preferences. We used a standard randomized paired profiles conjoint design, which has been shown to be especially effective in replicating real world behaviour[22,42]. Based on this approach, participants were shown two statements about climate change displayed side by side (see Fig. 4 for an example).

The statements consisted of four attributes: valence, theme, scale, and timeframe. Valence refers to whether the statement uses a negative frame in terms of highlighting the threats that climate change poses or a positive frame that emphasizes the opportunities that tackling climate change provides. Theme refers to the policy theme that was used to frame the statement. We included four different themes—an economic frame, an environmental frame, a health frame, and a migration frame. Scale refers to whether the statement was framed in terms of the threats/opportunities at the global level, the country level, the community level, or the personal level. Finally, time refers to whether the statement discussed the threats/opportunities occurring at the present time, by 2030, or by 2050. The statement was generated based on a random assignment of these different attributes.

This is illustrated in Fig. 4, which shows the four different attributes that we vary in the statements provided to participants, and provides an example of the pairs of statements that were seen by participants in the UK survey. The two statements were randomly generated, and participants saw and evaluated five pairs of statements. The structure of the statements was kept consistent, whereby each statement starts with a reference to the valence ('climate change is the greatest threat'/'tackling climate change is the greatest opportunity') followed by a reference to the theme (e.g., health or economy). This is followed by a specific example of the threat/opportunity of climate change, which is produced through a combination of the valence and theme (i.e., each valence/theme combination has a unique example). The statement ends with a final sentence that includes reference to the valence ('…better'/ '…worse'), the scale (e.g., world or country—in this case the UK), and the timeframe (e.g., now or 2050). It is worth noting that for the scale attribute, the country option varied according to the name of the country in the survey was being fielded. There are a total of 96 different randomly generated statements that participants could be shown, which are presented in the Supplementary Information (Supplementary Table S2).

In addition to developing climate statements that enabled us to test the effects of these different attributes and frames, we also sought to address concerns with the external validity of the survey experiment by ensuring that our climate messaging reflected real world climate change communications as closely as possible. This was done in several ways. We observed common messaging on climate change in the public sphere, and sought to adopt this language in the statements we produced. We also discussed these climate statements with individuals working in the global climate communications sphere to ensure that the statements we produced were similar to actual climate change messaging. As we note below, for the China and Germany surveys, which were translated into Mandarin and German, we used native speakers with subject expertise to check the quality of the translations—including whether the statements reflected the types of climate messaging used in the two countries. Finally, we also conducted pilots with smaller samples in the five countries to further test the messaging.

Outcome variables. After being shown the pair of climate change messages, respondents were asked to select which of the messages made them more likely to support policies to tackle climate change. We also asked respondents to express their levels of support for each message in the form of how much they would be willing to pay each month. While we do not report those results here, we used the quantitative ratings as a robustness check to see whether respondents' choices matched their preferences as expressed through this alternative measure, which they did.

Survey translations. The survey instrument was designed and produced in English. In the UK, USA, and India, the English language version of the survey instrument was used. The survey instrument was professionally translated into Chinese and German for China and Germany, respectively. Mandarin and German speakers with survey research background and subject matter expertise checked the quality and accuracy of the translated questionnaires.
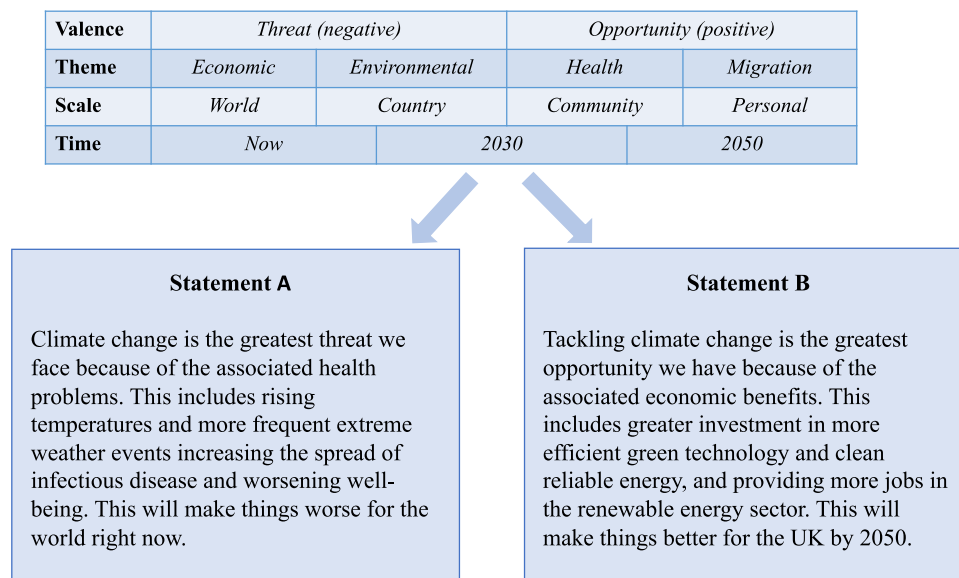
Valence	Threat (negative)		Opportunity (positive)	
Theme	Economic	Environmental	Health	Migration
Scale	World	Country	Community	Personal
Time	Now	2030		2050

Statement A

Climate change is the greatest threat we face because of the associated health problems. This includes rising temperatures and more frequent extreme weather events increasing the spread of infectious disease and worsening well-being. This will make things worse for the world right now.

Statement B

Tackling climate change is the greatest opportunity we have because of the associated economic benefits. This includes greater investment in more efficient green technology and clean reliable energy, and providing more jobs in the renewable energy sector. This will make things better for the UK by 2050.

Fig. 4 List of attributes and frames, and examples of randomly generated paired statements. Table at the top contains the four different attributes (left column) to create the statements—valence, theme, scale, and time frame—using random assignment of the different levels within each (rows). This makes a total of 96 possible permutations, i.e., different statements. Respondents were shown two randomly generated statements and were asked to indicate which of the two statements would make them more likely to support policies to tackle climate change. Statement A and B show two example statements. Note that all statements have contextually appropriate examples added to them in addition to just the four attributes to help respondents understand the framing.

Statistical analysis. Each of the 7512 respondents evaluated 5 pairs of messages, resulting in a total of 75,120 messages being evaluated. All attribute values were randomly assigned across all profiles and respondents without any constraints. Given we are interested in the relative favourability of respondents to profiles, and our experiment is a forced choice conjoint design, our estimand of interest is the marginal mean[43]. The conditional or marginal mean is the mean outcome across all times a particular conjoint feature level is shown, averaging across all other features. To estimate the marginal means we use the 'cregg' package in the R programming language[44]. All estimates use the sampling weights. While we have a rating and a choice outcome, we prefer to use the latter for clarity and explication. The robustness of the results when using the rating outcome is discussed in the Supplementary Discussion.

Reporting summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability
The datafiles used to conduct the analysis and to produce all figures and tables in the main manuscript and the Supplementary Information, are deposited in the public repository, Harvard Dataverse at: https://doi.org/10.7910/DVN/XJ4VEH.

Code availability
The R-language script to conduct this analysis (all figures and tables in the main manuscript and Supplementary Information) is also publicly available at the Harvard Dataverse repository at: https://doi.org/10.7910/DVN/XJ4VEH.

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Author contributions

N.D., H.G., D.H., S.J., J.v.H.-H., and N.W. contributed to the conceptualization and design of the study. N.D. produced the first draft of the manuscript with N.D., H.G., D.H., S.J., J.v.H.-H., and N.W. contributing to revisions. D.H. conducted the data analysis and visualization.

Competing interests

The authors declare no competing interests.

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