A representative survey experiment of motivated climate change denial

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Climate change is arguably one of the greatest challenges today. Although the scientific consensus is that human activities caused climate change, a substantial part of the population downplays or denies human responsibility. In this registered report, we present causal evidence on a potential explanation for this discrepancy: motivated reasoning. We conducted a tailored survey experiment on a broadly representative sample of 4,000 US adults to provide causal evidence on how motivated cognition shapes beliefs about climate change and influences the demand for slanted information. We further explore the role of motives on environmentally harmful behaviour. Contrary to our hypotheses, we find no evidence that motivated cognition can help to explain widespread climate change denial and environmentally harmful behaviour.

Human activities caused the recent warming of the Earth[1]. Despite the near-unanimous scientific consensus on this matter[1–3], a substantial part of the population denies or downplays the contribution of humans to climate change. In a 2019 Pew study, 30% of US adults said humans play only a partial role and 20% said no or a minor role in climate change[4]. The 2022 report Climate Change in the American Mind finds similar results: a third of the respondents said that climate change is due to natural changes and is not caused mostly by human activities[5]. How can this discrepancy be explained? Various factors affecting beliefs on climate change have been proposed in recent literature[6,7]. For this project, we focus on the potential explanation that climate change denial stems from motivated reasoning patterns. The literature of motivated beliefs posits that the belief formation process is often guided by the desire to maintain certain convictions or to hold a positive self-view, rather than by a desire for belief accuracy. In the context of climate change, people's beliefs might be shaped by the need to justify their emitting behaviour (for example, driving a big car, enjoying transcontinental flights, eating a meat-rich diet or being invested in CO_2-intensive industries). Intuitively, actions that harm the climate are easier to live with when one downplays the severity of climate change or the role humans play in it. However, causal evidence

for the connection of motivated cognition and climate change denial is scarce, and the determinants of climate change denial remain poorly understood[8].

In this project, we conducted a tailored survey experiment[9] with 4,000 respondents from the US population to shed light on the following three questions. (1) Does motivated cognition shape beliefs about climate change? (2) Moving beyond beliefs, does motivated cognition influence how people seek out information about climate change? (3) Does environmentally harmful behaviour increase when people anticipate the opportunity to justify their behaviour?

To establish the causal role of motivated reasoning for beliefs about climate change and information demand, our key design idea is to exogenously manipulate the motive to form beliefs or seek out information about climate change in a self-serving way. Specifically, our approach relies on experimentally varying the possibility to behave selfishly at the expense of the climate and then measure beliefs about climate change or the demand for slanted information in an incentive-compatible way. This approach is inspired by the literature on 'moral wiggle room', where the availability of excuses induces people to harm others for their own benefit[10–12]. We first focus on different types of excuses and then move to behavioural consequences.

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The 4,000 participants were randomly assigned to one of five treatment conditions: Belief Main, Belief Control, Demand Main, Demand Control and Behaviour. To answer our first research question, 1,599 study participants were randomly assigned to treatments Belief Main ($N = 800$) and Belief Control ($N = 799$). In Belief Main, participants had the opportunity to earn additional payments by taking away the money from a donation that helps fight climate change and keeping it for themselves. Specifically, in the experiment, there was a $20 donation intended to fight climate change. Subjects were able to decide to take away this donation and instead keep the $20 for themselves. After this decision, and as a surprise, we elicited beliefs about the scientific consensus on the causes of recent global warming in an incentive-compatible way (see 'Design' section in Methods for an overview of the potential payments). Previous literature has identified beliefs as a possible excuse for selfish behaviour[13,14]. In this Registered Report, we test whether climate change denial can serve as an excuse for behaviour that is beneficial to the individual but harmful to the climate. To be precise, we informed participants about a survey conducted among climate scientists. Participants had to guess how many, out of 100 scientists, doubt that human activities are the main cause of global warming. We incentivized this question using the actual results from a survey, making it costly for participants to distort their beliefs. In Belief Control, we elicited the same climate change belief but removed the opportunity to enrich oneself at the expense of the climate. Instead of keeping money for themselves, participants in the control group could decide only how to distribute $20 between two climate nonprofits. Hence, the only difference between the two conditions is the exogenous variation in the 'motive' to manipulate beliefs about the main driver behind climate change. We hypothesize that participants in Belief Main distort their beliefs about climate change in a self-serving way. Thus, compared with Belief Control, they, on average, state that scepticism among experts is significantly more common.

Moving beyond beliefs, treatments Demand Main ($N = 800$) and Demand Control ($N = 801$) study how information demand about climate change can serve as a possible excuse for selfish and environmentally harmful behaviour. Arguably, harming the climate might create a self-serving demand for such slanted information, akin to classical information demand paradigms in the moral wiggle room literature[10,15,16]. The treatments are identical to Belief Main and Belief Control except that we replaced belief elicitation with an information demand paradigm. The paradigm differs from existing motivated information demand paradigms in that participants cannot choose between information and no information, but rather between accurate and slanted information. We opted for such a design because slanted information about climate change pervades both social and traditional media[17-20]. Participants could choose between two short clips about climate change. Participants knew that they have to watch the selected clip at the end of the experiment. The two clips differ substantially in their perspective on climate change. While one video follows the science on climate change, the other is visibly slanted, downplays climate change and disputes established scientific consensus. We hypothesize that participants in Demand Main choose to watch the clip downplaying climate change significantly more often compared with Demand Control.

To investigate whether participants are also altering their behaviour, we conducted treatment Behaviour ($N = 800$). Treatment Behaviour is identical to Demand Main except that we changed the timing of questions. In Demand Main, participants answered the donation decision without being aware of the subsequent question on information demand. In Behaviour, both questions are introduced at the same time and are displayed on a single page. Hence, participants made the donation decision having in mind the option to self-servingly deceive themselves via information demand. Research has shown that having such an opportunity for excuses at hand facilitates moral transgressions[21]. We hypothesize that participants in Behaviour more frequently choose the selfish action compared with participants in Demand Main.

Finally, we gauge potential heterogeneous treatment effects along socioeconomic characteristics, focusing on income. We chose income because the incentive to act selfishly in the donation decision is at the centre of our research design. However, not all participants will experience the same temptation when offered $20 for harming the environment. We hence test how motivated cognition interacts with the household income of the participants. For our first analysis, we dichotomize household income and hypothesize that participants with income below the US median household income distort their climate change beliefs more than participants who are less financially constrained when given the opportunity to take money away from the nonprofit organization. They further exhibit a larger demand for the video downplaying climate change and choose the selfish action more frequently in reaction to our treatment variation. Extending this, we apply a binning estimator and use lasso estimators to address nonlinearities and omitted interaction biases[22-24].

The proposed experiment tests whether motivated cognition can help explain widespread climate change denial and environmentally harmful behaviour. In our experiment, we elicited the participants' belief about the scientific consensus on the role of humans in recent global warming. In a 2020 survey by the Yale Program on Climate Change Communication, only 57% of the respondents agreed with the statement 'most scientists think global warming is happening' when asked about the scientific consensus[25]. Recent literature has also shown that peoples' beliefs about the human role in climate change and the belief about the consensus predict support for climate policies[26,27]. Political interest groups opposing climate legislation frequently tried to raise doubt about the scientific consensus about climate change to undermine the support for climate policies, lending further support for the importance of our measure[28]. Hence, the beliefs about climate change in our study can be a powerful rationalizing story that can have real-world consequences.

In the context of climate change, there exists an abundance of slanted and biased information sources[17-20]. Our study delivers insights into whether people actively choose biased information for motivated reasons. This relates to recent literature that looks at information demand in the context of political news[29].

Finally, our analysis of the role of motivated cognition for the donation behaviour illustrates how motivated reasoning enables climate-damaging acts. The incentivized donation decision captures a central trade-off of climate action; fighting climate change comes at a personal cost. Recent literature showed how economic preferences, moral values and social norms predict climate preferences[30]. We add to this by focusing on how motivated cognition affects climate preferences.

Our results from all five treatments do not reveal a strong role of motivated reasoning in the context of climate change. We note here that these null results were obtained despite the fact that an essential prerequisite underlying our hypotheses is fulfilled: participants indeed enrich themselves at the expense of the climate (41.13% in Belief Main, 41.38% in Demand Main and 4438% in Behaviour take away the $20 from the donation), hence potentially inducing a motive for self-deception. We further note that the donation decision is meaningfully associated with the take-up rate for the slanted video as well as our beliefs measure.

Our study connects with two broader research strands. First, it connects with research on motivated reasoning, which has a longstanding tradition in psychology and economics[31,32]. The central idea of this literature is that the desire for a positive self-view or the preservation of certain convictions drives people to manipulate their beliefs in a self-serving manner. Implications have been studied in diverse contexts; the one most closely related to our paper is moral behaviour. To rationalize selfish behaviour, individuals distort beliefs about other peoples' behaviour[13] and marginalized groups[33]—their risk preferences[34], their fairness preferences[10,35], their investment opportunities[36] or ambiguity preferences[14]. Further, recent evidence suggests that individuals frequently seek out situations in which they have the cognitive flexibility to rationalize selfish behaviour[37]. In contrast to the existing
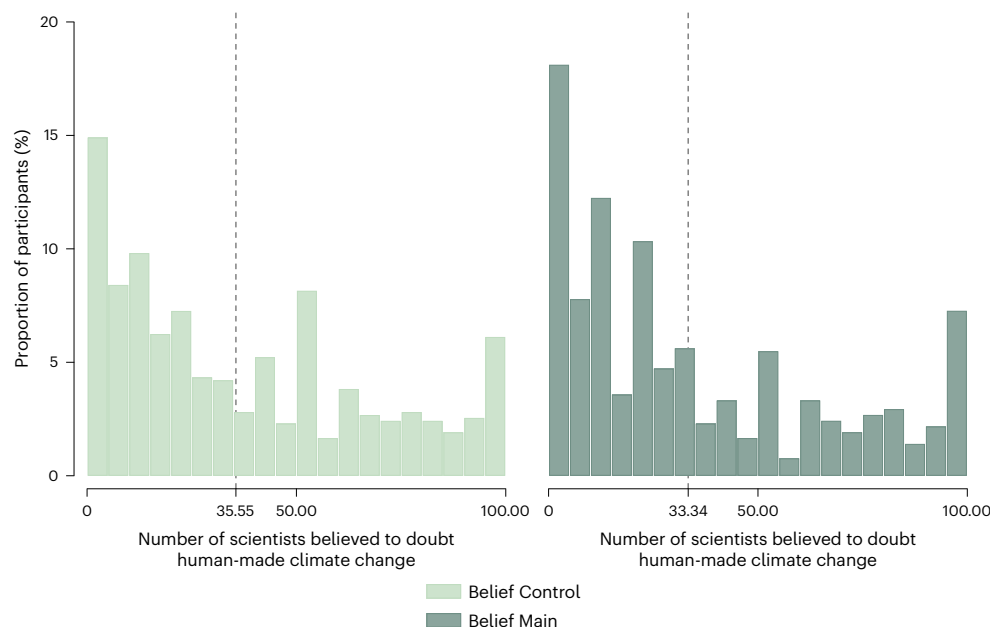
Fig. 1 | Distribution of beliefs about climate change. Distribution of the beliefs about climate change in Belief Main ($N = 784$) and Belief Control ($N = 785$). The answers are binned into 20 intervals of equal size. The dashed vertical line marks the average belief in the respective group. For a definition of the measure, see the 'Design' section in Methods.

literature, we look at beliefs about climate change. As stated before, a prominent explanation for climate change denial in the population is motivated cognition[38,39]. Related to this research strand, our evidence also contributes to the literature on people's demand for information or avoidance of information[16,40–46].

Second, in the sphere of beliefs about climate change, most research focuses on upholding party identity as the dominant driver behind climate denial[47–52]. However, most of the existing evidence cannot distinguish between motivated cognition and other belief formation processes[8,52]. The reason is that party affiliation is not easy to vary exogenously. In contrast to studies on partisanship, we look at a different motive: self-interest. Upholding a positive self-view is a prominent driver of motivated cognition and can be manipulated by exposing participants to situations in which they might behave contrary to their positive self-image.

Results

The data collection process accurately followed the methodology outlined in Methods. Data were collected from 19 May to 6 June 2023. Supplementary Table 1 reports the characteristics of the 4,000 respondents and their distribution in each condition. Our sample is representative of the US population along the following dimensions: age, sex, income, region and education. We employ pre-defined measures to ensure the highest possible quality of answers and run all the analyses as described in Methods.

Beliefs about climate change

We first explore how motivated cognition affects beliefs about the scientific consensus on the causes of recent global warming. Participants had to guess how many, out of 100 scientists, doubt that human activities are the main cause of global warming. We hypothesized that people distort their beliefs in the direction of thinking that many scientists doubt human-made climate change to rationalize selfish and environmentally harmful behaviour. In contrast to our hypothesis, we do not find evidence that self-interest shapes beliefs about the scientific consensus on climate change.

The distribution of beliefs in the treatment conditions Belief Main and Belief Control is illustrated in Fig. 1. Participants in Belief Main

expressed on average a 2.208 percentage points ($P = 0.155$, 95% confidence interval (CI): $(−5.255, 0.839)$) lower belief about the number of scientists doubting human-made climate change compared with participants who had no opportunity to enrich themselves at the expense of the climate. The estimates for the specifications without and with control variables are summarized in Fig. 2 and Supplementary Table 2, illustrating the robustness of this non-result.

Further, we do not find evidence that the participants' reaction to our treatment differs significantly along household income. The results of our median split analysis are reported in Fig. 3 and Supplementary Table 7, and the results of the different binning estimators can be found in Supplementary Fig. 1 and Supplementary Table 8.

Result 1. We do not find evidence that motivated cognition leads to a distortion of climate change beliefs. The average belief about the scientific consensus on the causes of recent global warming is not significantly different between Belief Main and Belief Control.

Information demand

Next we move to the treatment conditions Demand Main and Demand Control, which allow us to study whether motivated cognition influences how people seek out information about climate change. We hypothesized that participants who are given the opportunity to behave selfishly at the expense of the environment seek out slanted information that justifies their behaviour. However, we do not see a significant difference in the take-up of the video downplaying climate change and disputing established scientific consensus between the two treatment conditions.

In Demand Main, 49.74% of participants chose to watch the slanted video, while in Demand Control, the percentage was slightly higher at 51.48%. We present the average treatment effects in Fig. 2 and Supplementary Table 3. In the specification without controls, the dummy coefficient is $−0.017$ ($P = 0.493$, 95% CI: $(−0.067, 0.032)$), and in the specification with controls, it is $−0.018$ ($P = 0.468$, 95% CI: $(−0.067, 0.031)$). Probit results are summarized in Supplementary Table 4.

Our heterogeneity analysis, presented in Fig. 3 and Supplementary Tables 9 and 10, indicates that the interaction between household income and treatment assignment does not significantly influence
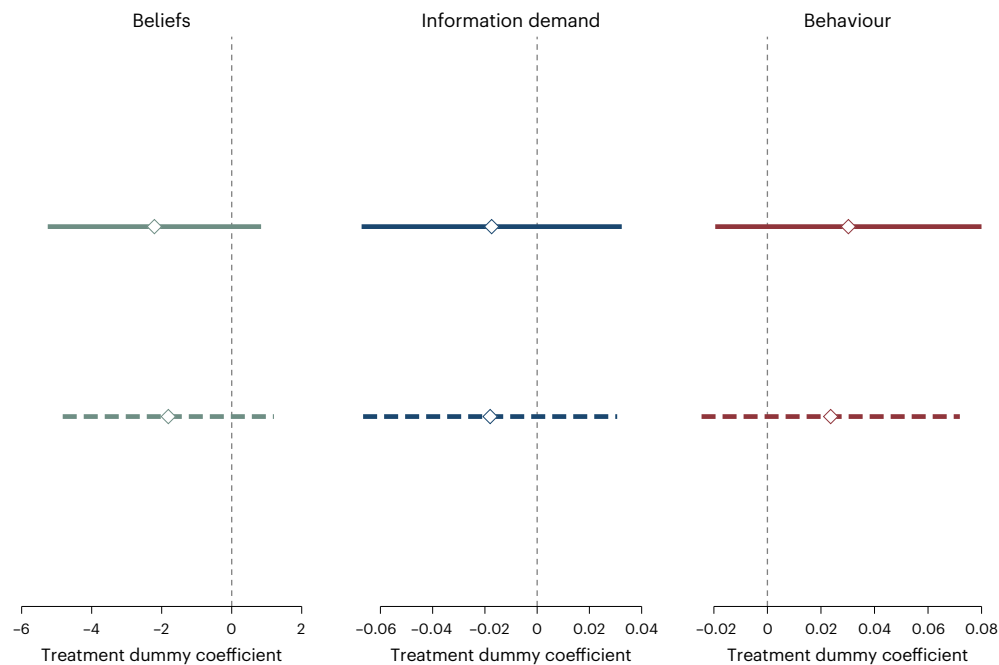
Fig. 2 | Estimated average treatment effects for three comparisons. Diamonds indicate the estimated effect. For all three comparisons, the estimated effect is reported for the specification without (diamond plus solid line) and with (diamond plus dashed line) controls. The lines indicate the 95% confidence interval. Beliefs shows the treatment dummy coefficients for the comparison between Belief Main ($N = 784$) and Belief Control ($N = 785$). A coefficient below zero indicates that the participants in Belief Main stated lower beliefs about climate change. Information demand shows the treatment dummy coefficients for the comparison between Demand Main ($N = 778$) and Demand Control ($N = 775$). A coefficient smaller than zero indicates that participants in Demand Main choose the video that downplays climate change less often. Behaviour shows the treatment dummy coefficients for the comparison between Behaviour ($N = 777$) and Demand Main ($N = 778$). A coefficient smaller than zero indicates that participants in Behaviour took away the money from the donation less often.

the demand for slanted information. These findings were further confirmed through our additional analyses using binning estimators (Supplementary Fig. 2 and Supplementary Table 11).

Result 2. Participants in Demand Main did not choose to watch the clip downplaying climate change significantly more often, compared with Demand Control. Thus we do not find evidence that motivated cognition influences how people seek out information.

Behaviour

While participants in Demand Main answered the donation decision without being aware of the subsequent question on information demand, participants in Behaviour were introduced to both questions at the same time. Comparing the two conditions enables us to test whether environmentally harmful actions increase when people anticipate the opportunity to justify their behaviour. We find that, in contrast to our hypothesis, the take-up rate is not significantly higher in condition Behaviour.

In Behaviour, 44.02% of participants chose to take away the money for the donation and keep the $20 for themselves. The rate is slightly lower in Demand Main, where 41.13% of participants chose to take away the money. Figure 2 plots the coefficients of the two ordinary least squares (OLS) regressions. In the specification without additional controls, the dummy coefficient is 0.029 ($P = 0.250$, 95% CI: (−0.020, 0.078)). In the specification with controls, the coefficient is 0.021 ($P = 0.392$, 95% CI: (−0.027, 0.069)). The results of the OLS and probit regressions are reported in Supplementary Tables 5 and 6.

We do not observe that more financially constrained participants choose the selfish action more frequently in reaction to our treatment variation. The results of our median split analysis are reported in Fig. 3 and Supplementary Tables 12 and 13. Extending this, we apply a binning estimator and use lasso estimators to address nonlinearities and omitted interaction biases. While the treatment dummy coefficient

in all three bins is still not significantly different from zero, our binning estimators show that the interaction effect is nonlinear (Supplementary Fig. 3 and Supplementary Table 14).

Result 3. Participants in Behaviour did not keep the $20 for themselves more frequently than participants in Demand Main. In other words, we find no evidence that anticipating the opportunity to justify one's behaviour encourages environmentally harmful actions.

Discussion

We conducted a tailored survey experiment on a broadly representative sample of 4,000 US adults to provide causal evidence on how motivated cognition shapes beliefs about climate change and influences the demand for slanted information. Contrary to our hypotheses, we find no evidence that motivated cognition can help to explain widespread climate change denial and environmentally harmful behaviour.

In the following, we provide a brief discussion of the presented null finding. We first empirically rule out some possible explanations for our null results that are related to aspects of our survey design and then offer some thoughts about interpretation and implications. Importantly, we stress that the analyses discussed here are explorative in nature and were not part of our Stage 1 report.

We begin with the donation decision. An important prerequisite for our hypothesis is that a substantial fraction of participants decides to enrich themselves at the expense of the climate. Indeed, 41.13% in Belief Main, 41.38% in Demand Main and 44.38% in Behaviour take away the $20 from the donation. Hence, a sizeable fraction of participants in principle could have had a motive to deceive themselves in our survey. We further note that the donation decision is significantly correlated with the take-up rate for the slanted video in Demand Main and Behaviour. Similarly, we do find a positive (although insignificant) relation between the donation decision and beliefs in Belief Main (see Supplementary Tables 17–19 for the correlations).
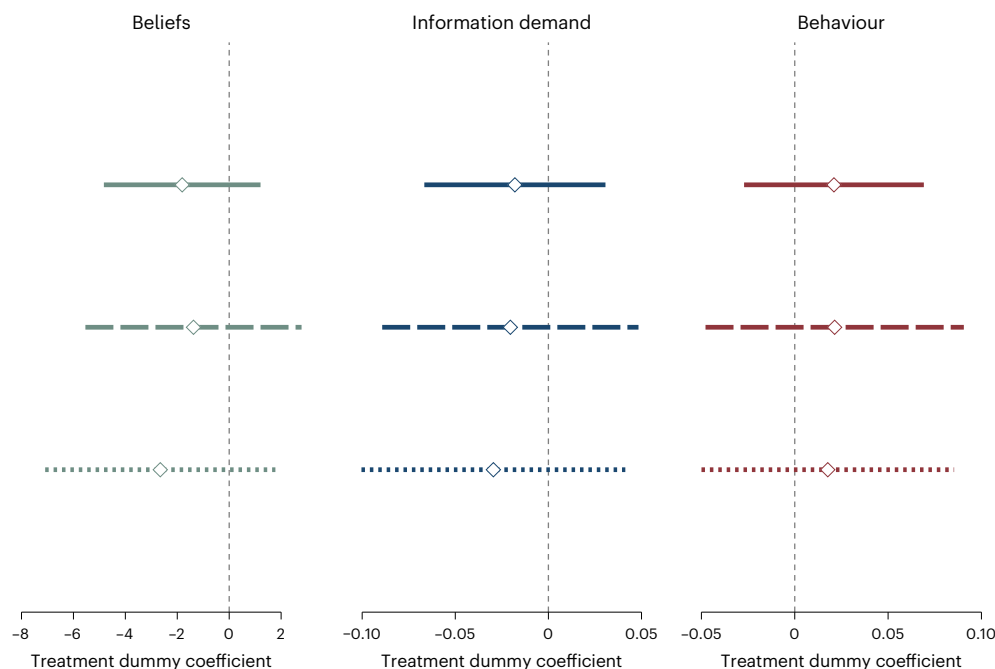
Fig. 3 | Estimated heterogeneous treatment effects for three comparisons (median split income). Diamonds indicate the estimated heterogeneous treatment effect. For all three comparisons, the estimated effect is reported for the whole sample (diamond plus solid line), the subsample of people with a household income below median (diamond plus coarse dashed line) and the subsample of people with a household income above median (diamond plus fine dashed line). The lines indicate the 95% confidence interval. Beliefs shows the treatment dummy coefficients for the comparison between Belief Main ($N = 784$) and Belief Control ($N = 785$). A coefficient below zero indicates that the participants in Belief Main stated lower beliefs about climate change. Information demand shows the treatment dummy coefficients for the comparison between Demand Main ($N = 778$) and Demand Control ($N = 775$). A coefficient smaller than zero indicates that participants in Demand Main choose the video that downplays climate change less often. Behaviour shows the treatment dummy coefficients for the comparison between Behaviour ($N = 777$) and Demand Main ($N = 778$). A coefficient smaller than zero indicates that participants in Behaviour took away the money from the donation less often.

Another potential explanation for our null results is that it was not sufficiently salient to participants who stated beliefs or information demand might serve as a means of self-deception. For example, it might be that the biased nature of the slanted video was not apparent enough from the description we provided. To test this, we provide a validation of our measures by regressing them on political affiliation. To that end, we exploit the fact that party affiliation is a strong predictor of climate change beliefs and attitudes. Therefore, the absence of a significant association of our measures with party affiliation could be interpreted as evidence of a lack of salience. By contrast, we find that the answer behaviour significantly differed along party lines in the expected directions, which validates our measures. The average belief of Democrats in Belief Control is 13 percentage points smaller than that of Republicans; 60% of Republicans and only 39% of Democrats in Demand Control chose the video downplaying climate change and disputing the established scientific consensus.

As summarized in the preceding, while substantial fractions of participants took away the donation, the majority did not. A potential concern that we anticipated and discuss in Methods is that the decision to not take money away might motivate some individuals to be more conscious about climate change, which would be a countervailing force against our hypothesized effect. To shed some light on this, we focus on the left tail of the belief distribution and run quantile regressions (without controls) for the first two quartiles to study whether self-interest motivates participants with already relatively low climate change beliefs to state even lower beliefs. We observe significant differences for the first quartile (coefficient: −2, $P = 0.034$, 95% CI: (−3.85, −0.15)) and the median (coefficient: −5, $P = 0.045$, 95% CI: (−9.88, −0.12)). This can be interpreted as evidence suggesting that resisting the temptation to take away the money from the donation might have led some participants in Belief Main to state lower beliefs. In that interpretation, motivated reasoning would not have a clear average effect on beliefs but would increase belief polarization (Supplementary Table 26).

Taken together, our study does not yield clear evidence that climate denial can be explained by motivated cognition. Given the strong and robust evidence for motivated reasoning in other contexts[10,13], and given that we find that neither beliefs about climate change nor the availability of slanted information served as excuses for harming the climate in our experiments, we see two plausible interpretations of our results. First, these results might simply reflect that motivated reasoning plays only a negligible role in the context of climate change. It is, for example, conceivable that societal or group norms are such that harming the climate is considered okay, hence not even requiring any form of motivated reasoning. If true, then important policy implications would be that prevailing misperceptions about climate change could be tackled by straightforward information campaigns and that the key to changing climate behaviour would be to change existing norms[30]. Second, it could be that other motives dominate the motive we are inducing with our experiment. Specifically, instead of the motive to justify one's own climate-harmful behaviour, group identity motives could be the key driving force; for example, people on the political right might want to deny or downplay climate change because such beliefs are part of their political identity. In fact, existing work in political psychology clarifies that different types of motives exist in politically motivated reasoning and that different types might be active at different points in time[53]. Interestingly, in our comparison between Belief Main and Belief Control, we do observe heterogeneous treatment effects along party affiliation (Supplementary Table 20). While Democrats that are given the opportunity to behave selfishly at the expense of the environment state higher beliefs than Democrats in the control (coefficient and P value for specification with controls: 4.495 ($P = 0.090$)), we observe a negative (but insignificant) treatment

effect for Republicans (coefficient and *P* value for specification with controls: −3.312 ($P = 0.223$)). If protecting one's group identity outweighs other motives, then from a policy perspective, reducing the existing misperceptions will be a difficult task. The key challenge would be to change group identities or weaken them altogether, which seems uncharted territory for policymakers.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41558-023-01910-2.

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Methods

Ethics information

Our research complies with all relevant ethical regulations. We obtained ethics approval from the German Association for Experimental Economic Research e.V., Institutional Review Board Certificate no. m5Jj-fAbk. Informed consent was obtained from all participants

Design

We conducted a large-scale online survey experiment using a broadly representative sample. Supplementary Fig. 4 illustrates the experimental procedure.

Attention check, questionnaire and demographics. Before being randomly assigned to one of the five treatment conditions, each participant had to answer the same set of questions. At the beginning of our experiment, we assured participants that their answers would be anonymized and asked them to sign a consent form. A standard attention check followed (see Experimental Design in Supplementary Information for details). Participants who did not pass this stage could not participate in our survey and were redirected to the survey provider's website.

We next elicited the following demographic information about the participants: age, state of residence, sex assigned at birth, highest level of education, annual household income and area of residency. Participants who passed this first set of questions were randomly assigned to treatment conditions.

At the end of the survey, all participants answered three questions about their political attitudes (party affiliation and self-placement on a political spectrum and the four-item post-materialism index).

Payments. After passing the attention check and the questionnaire, participants received general information about the upcoming decisions and fixed and potential additional payments. We informed participants that they were going to answer questions that could have financial consequences for them. We then explained that a computer programme would randomly choose one out of ten participants for additional payments, independently of the participant's decision and other respondents' choices. Each participant was informed at the end of the survey whether they were randomly chosen or not. If a participant was selected, one of their incentivized decisions was implemented[54]. In Belief Main and Belief Control, participants faced two decisions with real consequences (donation decision and climate change belief). To avoid hedging motives between the two decisions, we randomly selected one decision for implementation[55]. In the other conditions, the donation decision was implemented.

Importantly, the payment regime was identical across the conditions we compared. In Belief Main and Control, participants could receive up to $4 for the belief decision and had to decide how to allocate a $20 donation. As explained in the following, the only difference was that in Belief Main the decision was between a $20 donation and $20 for the participants instead of allocating $20 between two climate nonprofits. If a participant in Belief Main or Belief Control was selected for an additional payment, one of these two decisions would be randomly implemented. In the remaining three conditions, the only payment-relevant choice was the donation decision.

Treatment conditions. Participants were randomly assigned to one of five treatment conditions: Belief Main, Belief Control, Demand Main, Demand Control and Behaviour.

In Belief Main, after completing the questionnaire and receiving general information about the upcoming decisions, participants were introduced to the donation decision. Participants had the opportunity to take all money away from a donation to a nonprofit organization that fights climate change. We informed participants that a computer would randomly select one of two climate nonprofits for a $20 donation

and that the money would help to fight the climate crisis. Participants received information about the two—recommended by Giving Green—climate nonprofits (Clean Air Task Force and Industrious Lab). They were informed that 'both climate nonprofits are very established and are committed to the fight against climate change. They fund projects that reduce human-made greenhouse gas emissions. We will randomly select one of the two organizations for the donation.' However, they could decide to take the money away from the donation and keep the $20 for themselves instead.

We informed participants about two climate nonprofits to keep the number of organizations identical to the control condition (Belief Control), where participants could allocate money between these two nonprofits. Participants in Belief Main were told which organization was randomly selected to be the recipient of the donation before making their choice.

After the donation decision, and as a surprise for participants, we elicited beliefs about the scientific consensus on the human role in climate change. Literature has shown that this belief is an important predictor for peoples' support of climate action[27]. Therefore, we argue that deciding to take away money from a climate nonprofit for personal benefit can be rationalized by a more sceptical outlook on the scientific consensus. We informed participants that an academic journal recently published a paper with findings from a survey conducted among climate scientists[56]. Among other things, they asked the scientists what role humans play in global warming. We asked participants to estimate the beliefs of the scientists who were surveyed: 'What do you think: Out of 100 climate scientists, how many doubt that human activities are the main cause of global warming over the last decades?'

Incentive compatibility was ensured via a quadratic scoring rule. Participants could earn up to $4 for their answers (see Supplementary Information for the exact formula).

The intuition underlying treatment Belief Main is that the choice to take away money from a donation that would have helped to save the environment induces a motive to downplay or doubt climate change. To establish causality in the relation of motivated reasoning and beliefs about climate change, we conducted treatment Belief Control.

Belief Control is identical to Belief Main except that participants cannot receive any money for themselves in the donation task. Specifically, participants in Belief Control had to decide how to distribute $20 between the two climate nonprofits. They could distribute all the money to either of the two organizations. Afterwards, participants stated their belief about the scientific consensus on the human role in climate change.

Hence, while participants in Belief Main could enrich themselves at the expense of the environment, such a motive does not exist in Belief Control. In other words, Belief Control removes the motive for self-deception and measures beliefs absent motivated cognition.

Treatments Demand Main and Demand Control are analogous to Belief Main and Belief Control except that we replaced the belief question with an information demand paradigm. Specifically, after facing the same allocation decisions as in Belief Main and Belief Control, respectively, participants in Demand Main and Demand Control have to decide between two videos to watch. Both videos focus on the extent to which humans are responsible for the recent climate change, but they differ starkly in their perspectives. The participants watched the video at the end of our experiment. While one of the two videos reflects the scientific consensus, the other video plays down the role of humans and provides slanted information (see Experimental Design in Supplementary Information for the exact wording).

The selected video was shown to participants directly after they answered the three political attitudes questions.

We erased all source names and parts that gave away the origin from the two videos and the short descriptions. To mitigate the ethical concern about showing some participants a video casting scepticism

about climate change by presenting factually wrong information, we added a short debriefing for all participants at the end of the experiment (Supplementary Information).

Treatment Behaviour is identical to Demand Main, with one key difference. In Demand Main (and all other treatments introduced so far), participants made the allocation decision without being aware of the content of the subsequent question. In Behaviour, the two questions (donation decision and information demand) were instead introduced simultaneously. Participants received all the relevant information before their two decisions. Both decisions were displayed and answered on the same decision screen.

Hence, in treatment Behaviour, participants knew that they would have a chance to self-servingly deceive themselves when making their donation. In other words, their behaviour in the donation decision might have been affected by the anticipation of a possible excuse, making it easier to act selfishly. Comparing the donation behaviour between Behaviour and Demand Main provides causal evidence on the role of motivated reasoning for behaviour.

The instructions of our survey are available via Open Science Framework (see 'Data availability' and Supplementary Information).

Design discussion

Opportunity versus actual behaviour. It is important to note that our identification rests on an average treatment effect. We do not measure the direct effect of behaving selfishly on beliefs and demand, but instead compare how the opportunity to act selfishly leads to distorted beliefs about climate change and increased demand for slanted information on the group level. This allows us to cleanly identify the causal role of motivated cognition for climate denial. Notice that this type of identification strategy is frequently used in the literature on motivated cognition[13,57].

Lower bound. As stated, not every participant in our Main treatments will behave in a self-interested manner or will feel the need for an excuse for their selfish behaviour. It might be possible that participants who leave the donation untouched in the Main treatments are motivated to reinforce their belief in human-made climate change. While the latter channel seems unlikely given our design, it would work against the proposed hypothesis.

Generalizability. The decisions in our study have real stakes and consequences. We believe that our experimental design mimics real-world decisions in which there exists a fundamental trade-off between actions that might be individually profitable but have negative climate externalities and actions that have a neutral or positive impact on the climate but require individuals to forgo a personal benefit. At the same time, we acknowledge that the stylized nature of our experiment might limit the generalizability of our results for some domains of climate-related behaviour and that more empirical work is needed to fully understand the role of motivated cognition for climate denial.

Representativeness. Respondents are stratified to match the respective US adult population on the following dimensions: age, sex, income, region and education. The survey platform indicated that it is feasible to recruit such a sample for the United States. If the final sample size might not be fully representative of some of these categories, we will explicitly note any deviation in the final results section. Recent work on online panels showed that while they generally support a broad spectrum of most demographics, they sometimes do not support the full distribution of characterizations, for example, extremely high incomes or people in more rural areas[58,59]. Differences in sociodemographics between our sample and the general population will not affect the causal interpretation of our results. We will carefully check for differences and discuss them and their implications in the final results section.

Analysis plan

Average treatment effect: beliefs (Belief Main and Belief Control). Comparing the climate change belief between Belief Main and Belief Control enables us to causally identify the role of motivated cognition for beliefs about climate change. To test whether participants distort their belief about climate change in Belief Main, we first run the following regression:

$$Y_i = \alpha + \beta_1 \text{treat}_{\text{belief}} + \gamma \text{Controls}_i + \epsilon_i \quad (1)$$

where Y_i denotes our dependent variable climate change belief. Our variable of interest, $\text{treat}_{\text{belief}}$, is a dummy variable indicating whether participants were randomly allocated to Belief Main or Belief Control. The dummy variable takes the value of 1 if the participant was in Belief Main and 0 if the participant was randomly assigned to a control condition.

We run two OLS regressions—one without and one with control variables. The controls added to the OLS regression are dummies for age group, sex, education, income, state and area of residence, post-materialism, self-placement on a left–right political spectrum and party affiliation (the construction of these variables is described in the section 'Sampling plan').

Hypothesis I (beliefs): participants distort their beliefs about the scientific consensus on climate change in a motivated manner when previously given the opportunity to act in a selfish manner ($\beta_1 > 0$).

Average treatment effect: information demand (Demand Main and Demand Control). Focusing on the participants in Demand Main and Demand Control, we now want to test whether participants who had the opportunity to act selfishly show a demand for slanted information, analogous to before we run the following regressions:

$$Y_i = \alpha + \beta_2 \text{treat}_{\text{demand}} + \gamma \text{Controls}_i + \epsilon_i \quad (2)$$

This time, Y_i denotes our dependent variable video choice. In addition to the two OLS regressions—one with and one without controls—we run a probit regression with controls.

Hypothesis II (information demand): participants in Demand Main choose to watch the *What They Haven't Told You About Climate Change* video significantly more often ($\beta_2 > 0$).

Average treatment effect: donation behaviour (Demand Main and Behaviour). To show that participants' behaviour towards the environment is affected by the opportunity to justify their decision, we now compare the donation decision between Demand Main and Behaviour. We run the following regressions:

$$Y_i = \alpha + \beta_3 \text{treat}_{\text{behavior}} + \gamma \text{Controls}_i + \epsilon_i \quad (3)$$

where Y_i denotes our dependent variable donation decision and $\text{treat}_{\text{behaviour}}$ is a dummy variable indicating whether participants were randomly allocated to Demand Main or Behaviour. The dummy variable takes the value of 0 if the participant was in Demand Main and 1 if the participant was randomly assigned to Behaviour.

We run two OLS regressions—one without and one with control variables—and a probit regression with controls. The control variables are similar to before.

Hypothesis III (donation behaviour): giving participants the opportunity to excuse their behaviour while making their decision increases the rate of the selfish and environmentally unfriendly decisions in the donation decision; that is, participants take the $20 more frequently in Behaviour ($\beta_3 > 0$).

We will further compare the climate change belief between these two conditions. A significant difference between the beliefs would indicate that ex-post rationalizations are not the same as on-the-spot excuses.

Heterogeneity—income. We explore how the income of the participants affects our results.

Median split. We start by dichotomizing our income variable along the median income of American households in the year 2021. Our sample is going to be representative of income for this split. Thus, the groups are going to be balanced. We run the following three regressions:

$$Y_i = \alpha + \beta_4 \text{treat} \times \text{low income} + \delta\text{treat} + \sigma\text{low income} + \gamma\text{Controls}_i + \epsilon_i \tag{4.1}$$

$$Y_i = \alpha + \beta_5\text{treat} + \gamma\text{Controls}_i + \epsilon_i \text{ if low income} = 0 \tag{4.2}$$

$$Y_i = \alpha + \beta_6\text{treat} + \gamma\text{Controls}_i + \epsilon_i \text{ if low income} = 1 \tag{4.3}$$

where Y_i denotes our dependent variable, treat is a dummy variable indicating to which treatment condition a participant was randomly assigned and low income is a dummy variable indicating whether participants are of low income. See the Experimental Design section in Supplementary Information for a more detailed description. We first run a regression with an interaction term, and in two subsequent regressions, we look at the subsamples separately.

For all three cases, we run two OLS regressions—one with and one without controls. Analogous to before, we run probit regressions (with controls) for our binary outcome variables (video choice and donation decision).

Hypothesis IV (low income): participants with a lower income distort their belief about the scientific consensus on climate change more than participants with a more relaxed financial situation. They further exhibit a larger demand for the slanted information and choose the selfish action more frequently.

Binning estimator and adaptive lasso. We extend our analysis of the interaction between our treatment and income in two ways. We implement a binning estimator to study the nonlinear interaction effect[22]. For the binning estimator, we discretize the income variable into three bins. The three bins correspond to the three terciles of the income distribution in our sample. We estimate two models—one without and one with our controls. In both, we include interactions between the bin dummies and our treatment variable. While the median split analysis is based on the nationwide distribution of household incomes, the binning estimator focuses on the within-sample distribution of income. We further utilize the adaptive lasso estimator to account for covariates that are correlated with income and have a nonlinear impact on our outcome variables[23,24].

Robustness. As described in the section 'Sampling plan', our benchmark sample drops those respondents that simply clicked through the survey. We will run the same regressions using all observations.

Sampling plan
Using the internet panel of PureProfile, we administered a survey to 4,000 respondents. Respondents were stratified to match the respective US adult population on the following dimensions: age, sex, income, region and education. To achieve representativeness along these dimensions, we exploited our initial sociodemographic questions. For each dimension, we obtained quotas based on the American Community Service Survey (Census). We constructed buckets in the following way: age is divided into four intervals (18–24, 25–39, 40–59, ≥60), sex is binary, income is divided on the basis of the median income (below $70,000 and equal or above), education is binary (university/professional degree or not) and region is divided into four intervals (Northeast, Midwest, West, South). If a representativeness quota was already fulfilled, a new participant in this category was redirected to the survey company's website and was not allowed to participate in the survey.

Exclusions and data quality. Ensuring data quality is of utmost importance for survey studies. A key concern is inattentiveness among survey respondents[9]. Our survey includes one attention check that tests whether participants read the instructions. If the attention check was answered incorrectly, the respondent was immediately screened out of the survey. These screen-outs are not included in the sample size stated in the preceding. We further kept track of the time spent by the respondents. In each condition separately, we dropped participants who finished the survey in under one-third of the median duration. Together with the attention check, this should eliminate participants who rush through the survey inattentively. We also did not include respondents in our sample that did not finish the survey, did not consent to our participant information and consent form or started the survey and belonged to an already filled representative quota.

Sample size and power analysis. Our sample size was determined on the basis of a cost–benefit analysis. We aimed to collect the largest sample possible with resources available and ascertain whether this sample would detect effect sizes that are theoretically informative. As our main measures are unique, we cannot derive feasible expected effect sizes from other studies. For this reason, we asked a small number of people to answer the climate change belief question, the information demand and the donation decision. For details and results of the power analysis, see the Experimental Design section in Supplementary Information.

Outcome measures. Climate change belief is a continuous variable that can take values between 0 and 100. A higher number indicates that participants assume more scientists do not think that humans played a pivotal role in recent climate change. Video choice is a binary variable measuring the demand for slanted information: '1' indicates that participants chose to watch the biased video. Donation decision is binary, where '1' indicates that the participants chose to pocket $20. We used the donation decision as an outcome measure when comparing Demand Main and Behaviour.

Control variables. For details on the coding of the control variables, see the Experimental Design section in Supplementary Information.

Implementation. The implementation was successful, with a small deviation at randomization: Belief Control had 799 instead of 800 participants while Demand Control had 801 completes. The reason for the deviation was that participants were assigned to one of the five treatment conditions after the attention check and the first questionnaire. Towards the end of data collection, it was possible that a person went through randomization but was later excluded because a quota had been met in the meantime. In such a case, the randomization counter did not reset.

Protocol registration
The Stage 1 protocol, as accepted by the journal on 10 May 2023, can be found at ref. 60.

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Author contributions

All authors contributed to the paper equally. L.S.S. and F.Z. both formalized and contributed to the research goals, designed the survey experiment and prepared the manuscript with feedback from each other. L.S.S. conducted the power analysis in consultation with F.Z., and F.Z. developed the outcome measures in consultation with L.S.S. L.S.S and F.Z. contributed to data collection, analysed the data and reviewed and approved the final manuscript together.

Competing interests

The authors declare no competing interests.

Additional information

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