We care, but delegate: Climate disasters and climate migration trigger concern, normative beliefs, and altruism — but not cooperation

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Abstract

Despite growing awareness of climate change, individual action remains limited. We conducted two pre-registered experiments—an online study with a representative sample and a laboratory experiment with incentivized decisions—to examine whether framing climate risks as natural disasters or climate-induced migration fosters pro-environmental behavior, and to identify the mechanisms underlying the intention–action gap. Exposure to nature risks increased personal normative beliefs, concern, and donations to environmental causes, but did not promote cooperation in collective-action settings prone to free-riding. Climate-migration risk primarily increased donations to migration-related causes. Hormonal data revealed a defensive 'flight' response, suggesting risk avoidance in strategic contexts. Altruism emerged in non-strategic decision settings, yet collective action remained limited by fear that others would not cooperate. This pattern was especially pronounced among participants with high institutional trust, who responded to climate risks by increasing donations while reducing contributions and expectations in strategic settings, suggesting a tendency to delegate responsibility to institutions.

Keywords: Climate change, Climate migration, Cooperation, Personal normative beliefs, Pro-environmental attitudes and behaviors, Risk perception, Physiological responses.

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Introduction

Despite the growing urgency of addressing climate change, shifts toward more sustainable behavior remain limited[1]. Widespread awareness has not translated into consistent action, likely because climate risks are perceived as distant or abstract, and because individuals face psychological, social, and institutional barriers. These include fear-driven avoidance responses, pessimism about others' willingness to cooperate, cognitive biases in risk perception, and a tendency to delegate responsibility to institutions, especially when individual actions are seen as ineffective or vulnerable to free-riding.

To better understand how such barriers could be reduced, the present study investigates the effects of two types of climate threats on pro-environmental beliefs and behavior: a less distant threat characterized by sudden-onset events, and a more abstract, gradual threat. Across two pre-registered experiments, informational video podcasts activated the awareness of climate change by framing climate risks either as natural disasters (an immediate threat) or as climate-induced migration flows (a more distant threat), both presented as affecting one's own country in the future. Although distinct, natural disasters and climate migration represent interconnected pathways through which climate change unfolds. Comparing these two framings allows us to explore how different types of climate threats can shift pro-environmental attitudes, beliefs, and cooperative behavior. Natural-disaster framings may increase pro-environmental behavior by making climate risks immediate and emotionally salient, while climate-migration framings may do so by emphasizing downstream human consequences and the potential of environmental action to reduce future climate-induced displacement pressures. As a result, climate–migration framings are likely to influence behavior indirectly, through social and contextual factors, and their effects may vary substantially depending upon individuals' views and beliefs.

The two experiments – one online survey with a representative sample, one in the laboratory with university students – were run in Italy, a country increasingly vulnerable to migration and natural disasters[2]. We test the effects of natural-disaster and climate-migration threat on these outcomes: pro-environmental attitudes, attitudes towards immigrants and redistribution, risk preferences, trust and behavioral choices, i.e., participants' cooperation in a Collective Risk Social Dilemma (CRSD) game, their personal (normative and descriptive) beliefs about others' behavior, and their donations to pro-environmental organizations. We also shed light on potential physiological, psychological, and attitudinal barriers to pro-environmental action when informational video podcasts are ineffective, by exploring mechanisms and heterogeneity of the effects.

To shed light on the environmental intention-action gap, we compare behavioral choices across individual decision-making contexts, where strategic interaction is absent (i.e., the

[1] For example, global carbon emissions reached an all-time high of 36.8 billion tons in 2022, showing little sign of decreasing despite international agreements. A 2021 survey by the European Investment Bank found that while 75% of Europeans recognize climate change as a serious threat, only 40% have taken steps to reduce their personal carbon footprint, such as reducing air travel or changing energy consumption habits.

[2] In the past five years, Italy has experienced a 57% rise in extreme weather events, including the record 48.8°C heatwave in Sicily (2021) and catastrophic flooding in Emilia-Romagna (2023). At the same time, migration has surged, with over 130,000 refugees arriving in 2023—a 300% increase since 2019.

donation task), and collective-action settings, where outcomes depend on others' choices (i.e., the CRSD game). In our experiments, this gap may arise when individuals, despite endorsing pro-environmental norms and prioritizing environmental protection in non-strategic settings, choose to maximize immediate personal payoffs in response to free-riding risks in group settings. The CRSD provides a stylized representation of collective climate mitigation problems, in which individual actions are costly, benefits are shared, and outcomes depend on others' cooperation. If informational framings shape how individuals perceive climate risks, social norms, or others' willingness to act, these perceptions should be reflected not only in non-strategic decisions and stated preferences, but also in contribution decisions within such collective-risk contexts.

Consistent with Szekely et al. (2021), our results from both studies show that both climate and migration risks influence personal normative beliefs – i.e., how much individuals think others ought to contribute. However, we find that exposure to information on climate change risks produces only limited changes in personal behavior. While the natural-disaster (but not the climate-migration) treatment increases concern for environmental issues and strengthens personal normative beliefs, these shifts only partially translate into behavioral change. They boost donations (as in Dechezleprêtre et al., 2024) to pro-environmental organizations, but do not increase contributions in cooperative settings where free-riding is possible.

These results suggest: (a) that individuals are more likely to engage in pro-environmental behavior when climate risk is perceived as immediate and tangible, compared with a more distant, gradual, or predictable threat (climate migration); (b) a gap between environmental beliefs and the collective actions required for effective climate mitigation; (c) altruistic individual choices in non-strategic – but not in competitive – settings; (d) a tendency to delegate responsibility to institutions, such as pro-environmental organizations. Points (b), (c), and (d) are likely driven by the participants' expectation that others will not contribute – even though they think they should.

We also investigate potential mechanisms of our results. At the physiological level, the lab study revealed that participants exposed to nature-related risks exhibited a decrease in their testosterone-cortisol (T/C) ratio. This physiological change indicates a shift toward fearful and avoidant behavior, a defensive response (e.g., Nierman et al., 2017; Nofsinger et al., 2018; Romanova et al., 2022) that appears particularly relevant in social contexts where others' behavior can pose a threat to one's own payoff (Terburg and van Honk, 2013). This pattern supports the idea that the perceived threat of natural disasters triggers an instinctive self-preservation response, selectively dampening social risk-taking while preserving prosociality in low-risk environments. A second mechanism involves cognitive biases in risk perception (Berkebile-Weinberg et al., 2024). We find that exposure to nature-related risks leads to probability distortion—insensitivity to intermediate probabilities and the overweighting of low and underweighting of high loss probabilities. However, the gap between normative beliefs and individual contributions is primarily driven by the social risk of free-riding, as probability distortion does not predict contributions in the CRSD game.

Lastly, we examine heterogeneity in treatment effects. The tendency to delegate is stronger among individuals with high institutional trust, who donate more—particularly in response to climate-related migration. However, their empirical expectations, and to a lesser extent their

contributions, decline over time in group settings, indicating greater sensitivity to free-riding dynamics. Similar pessimism about others' willingness to act has been documented in prior work (Andre et al., 2024a, 2024b; Welsch, 2022).

Background literature

A growing body of research explores the effects of different information treatments on environmental attitudes (see Rode et al., 2021, for a meta-analysis) and pro-environmental behavior (see Grilli and Curtis, 2021, for a review). Messages on climate change generally have limited effectiveness in changing environmental attitudes, especially policy views. Informing the public on how climate change works, also using statistical facts, increases acceptance of the phenomenon (Ranney & Clark, 2016). Prospective information on local climate change is more effective than retrospective information in promoting pro-environmental actions, particularly for people who trust the central government (Binelli and Loveless, 2024).
Grilli and Curtis (2021) show that pure information treatments, as well as telling people what to do, have little impact on sustainable behavior, whereas tailored information, public pledges and comparative feedback result to be effective. Dechezleprêtre et al. (2024) find that information on the impact of climate change increases willingness to engage in pro-environmental actions (donation to deforestation cause), while not altering environmental policy views. Bernard et al. (2023) shows that information on ways to reduce emissions has an impact on willingness to pay to offset emissions, suggesting that focusing on peer behavior is the most effective way to present this information. A meta-analysis reports that environmental messages invoking emotions, decreasing psychological distance and involving religion are the most effective in changing climate change attitudes (Rode et al., 2021). However, emotional effects are bounded: fear appeals can promote pro-environmental intentions, but when fear is too strong, defensive responses emerge, and perceived collective efficacy becomes key to sustaining higher intentions (Chen et al., 2016).
. Concerning climate migration, which is relevant for our studies, Raimi et al. (2024) suggest that framing climate migration as the consequence of exogenous shocks rather than individual choice, a distinction known to shape support for redistribution and refugee assistance (e.g., Alesina et al., 2001; Hainmueller et al., 2015), can shift public perceptions.

Another strand of literature highlights the complexities of the gap between climate change attitudes and behavior. For instance, Berkebile-Weinberg et al. (2024) reveal that political polarization affects climate beliefs, with conservatives sometimes engaging in climate-friendly behavior that contradict their skepticism. Lorenzoni et al. (2007) suggest that the perception that one's own actions have little impact in the absence of cooperation from others and institutions contributes to the intention–action gap in climate change.. Andre et al. (2024a) emphasize that, despite widespread support for climate action, individuals often underestimate others' willingness to act, leading to "pluralistic ignorance". Similarly, Gupta et al. (2009) show that expectations on others' cooperation are an important factor in green purchase decision. Following this line, Andre et al. (2024b) demonstrate that correcting misperceptions about social norms can increase pro-climate donations, especially among sceptics. This interplay between social norms and conditional cooperation underscores the potential for leveraging social norms to enhance climate action, as shown by Szekely et al.

(2021). Additionally, Mason et al. (2024) highlight the importance of framing climate initiatives as vital for core societal values to engage diverse audiences. Understanding these dynamics is crucial for developing strategies to effectively influence pro-environmental behavior.

The present studies

Our studies build on this existing literature by examining behavioral shifts from two complementary perspectives: individual preference settings, where strategic interaction is absent (i.e., the donation task in our experiments), and collective action contexts, where personal payoffs depend on strategic interactions with others (i.e., the CRSD game). This dual approach helps identify whether reluctance to adopt sustainable behavior in collective settings is driven by concerns about free-riding, which do not arise in isolated, non-strategic contexts. Although some individuals possess strong pro-environmental preferences and are willing to incur personal costs, expectations that others will not cooperate tend to dampen individual contributions to collective environmental action (Bohr 2014; Doyle, 2023; Gupta et al., 2009).
By uncovering these inconsistencies, we provide insights into the environmental intention-action gap. In the context of our study, this gap manifests when individuals, despite holding strong pro-environmental intentions, fail to act on them in group settings due to the appeal of maximizing immediate personal payoffs in the presence of free-riding risks. Additionally, we suggest that trust in institutions is an important factor influencing the emergence of the intention-action gap.

We rely on two experiments that are designed to be complementary rather than identical, deliberately trading off external validity, realism, and experimental control (see Table 1 in the "Methods" section for a detailed comparison among the two studies). Both studies expose participants to the same core informational framings—emphasizing either sudden-onset and uncertain climate risks (natural disasters) or climate risks unfolding through socially and demographically mediated processes (climate-induced migration)—and measure a common set of outcomes capturing beliefs, norms, and behavior in individual and collective decision contexts. In both studies, non-strategic behavior is captured through donation-type decisions[3], while strategic, collective behavior is measured through cooperation in a CRSD game. In this framework, natural disasters are framed as sudden-onset shocks with a direct and locally observable impact, whereas climate-induced migration is framed as a structurally mediated consequence of climate change, through which environmental shocks elsewhere ultimately affect the country via a socio-demographic process (migration), involving a longer attribution chain.

In Study 1, we additionally include a combined "nature + migration" treatment, which simultaneously presents information on natural disasters and climate-induced migration. This condition allows us to explore whether jointly emphasizing immediate and mediated

[3] More specifically, in Study 1, non-strategic behavior is elicited through unincentivized participants' allocation of the collectively accumulated resources across alternative causes at the end of the hypothetical CRSD game (which aims to capture delegation preferences under a fixed resource constraint), whereas in Study 2 it is measured through a standard, money-incentivized Charity Dictator Game (CDG).

climate risks generates additive or reinforcing effects. As this combined framing does not produce strong or systematic behavioral effects in the representative sample, it is not included in Study 2, where we focus on the two core framings to preserve statistical power and sharpen the identification of mechanisms.

At the same time, the studies differ along key dimensions in a deliberate way. Study 1, conducted on a nationally representative sample of the Italian population, serves three main purposes. First, it provides large-scale validation of the informational stimuli, including comprehension and salience across heterogeneous socio-political groups. Second, it allows us to examine treatment heterogeneity, particularly along political orientation. Third, it explores (hypothetical) behavioral responses in a CRSD game under ambiguity about the probability of a collective loss, a feature intended to approximate real-world climate decision-making, where individuals typically rely on subjective and heterogeneous beliefs rather than objectively known probabilities[4].

Study 2 complements this approach in a controlled laboratory setting with a more homogeneous sample characterized by a left-leaning political orientation and higher baseline awareness of environmental issues. The collection of pre-experimental measures in Study 2 enables heterogeneity analyses based on characteristics unaffected by the treatments. All behavioral outcomes are money-incentivized, enhancing response validity and facilitating comparison with the existing experimental literature. In particular, Study 2 employs a multi-round CRSD game with exogenously specified high and low probabilities of loss, allowing us to assess whether the absence of cooperative responses persists when objective risks and equilibrium predictions are well defined. Beyond these design differences, Study 2 incorporates incentivized measures of risk preferences, probability weighting, and physiological responses to the treatments, providing deeper insight into the mechanisms underlying individual reactions and the persistence of the intention–action gap. Further details on the experimental design are reported in the "Results" and "Methods" sections below.

Conceptual framework and hypotheses

In this section, we outline our conceptual framework and present the pre-registered hypotheses for the two studies. A subset of outcomes, identified as "R," is reported in the main paper, while all remaining pre-registered analyses are presented in detail in Sections 1 and 2 of the Online Appendix (OA). The hypotheses were preregistered at OSF both for Study 1 (https://osf.io/yzdmr) and 2 (https://osf.io/emfh7).

[4] Unlike standard implementations of the CRSD game with known probabilities, our design in Study 1 introduces ambiguity about the probability of a collective loss. This implies that equilibrium predictions are not uniquely pinned down and depend on participants' higher-order beliefs. We deliberately exploit this feature to study behavior under the type of strategic uncertainty that characterizes *real-world* climate decision-making, where risks and others' beliefs are rarely transparent. Because preferences, beliefs, and equilibrium strategies cannot be separately identified under ambiguity, we interpret all results as treatment-induced changes relative to the control condition, rather than as levels of cooperation or efficiency. Besides behavioral choices, we directly elicit participants' perceived probability of a collective loss in the CRSD game, which allows us to account for individual heterogeneity in beliefs under ambiguity and to examine whether climate-risk framings affect not only behavior and social beliefs, but also subjective assessments of the likelihood of the shock.

In collective risk dilemmas, higher perceived probabilities of collective loss and stronger personal normative beliefs are typically associated with higher individual contributions, as individuals face stronger incentives to help the group reach the threshold that avoids catastrophic outcomes (Milinski et al., 2008; Szekely et al., 2021; Andre et al., 2024a). Climate-risk narratives that increase risk salience and moral concern may therefore be expected to promote cooperation, both by increasing the perceived urgency of collective action and by strengthening norms of contribution that sustain conditional cooperation (Gupta et al., 2009; Van der Linden, 2015). In parallel, heightened risk salience and pro-environmental norms are expected to translate into a greater willingness to allocate financial resources toward environmental causes in non-strategic settings, where decisions are unilateral and not directly exposed to free-riding concerns, such as donation or allocation tasks (Grilli & Curtis, 2021; Dechezleprêtre et al., 2024).

Climate-risk narratives may also shape broader social and political attitudes by highlighting the downstream human consequences of environmental shocks. In particular, framing climate change as a driver of migration can increase support for preventive actions aimed at mitigating environmental damage, insofar as such actions are perceived as reducing harm to populations in more vulnerable regions who are forced to relocate as a consequence of climate disasters. From this perspective, pro-environmental contributions and donations can be interpreted not only as expressions of environmental concern, but also as responses to the negative externalities generated by polluting activities in wealthier countries, which disproportionately affect populations with fewer resources and lower adaptive capacity (Raimi et al., 2024; Mason et al., 2024).
At the same time, climate-migration narratives may activate a prevention-oriented channel, whereby individuals support environmental mitigation as a means to reduce the likelihood of future climate-induced migration flows toward their own country. These two mechanisms—solidarity-based responses to shared responsibility and prevention-oriented responses to anticipated downstream pressures—are not mutually exclusive and may jointly contribute to observed increases in pro-environmental behavior.
Finally, attributing migration flows to exogenous environmental shocks—rather than to individual choices—may foster more favorable attitudes toward immigrants, as migrants are perceived as victims of climate-related externalities rather than as voluntary movers. Consistently, this framing may also increase support for redistributive policies, which become salient as instruments to address shared responsibility for climate-induced displacement and to manage the social and economic costs borne by displaced populations (Alesina et al., 2001; Hainmueller et al., 2015).

Building on this logic, for Study 1, *H1a* posits that the video podcast manipulations, designed to emphasize immediate and unpredictable risks from natural disasters ('nature risk'), distant and gradual threats induced by climate migration ('migration risk'), or both ('nature and migration risk'), are expected to increase the following outcomes: subjective probability of the shock (OA), cooperation in the CRSD game (R), charitable giving to climate-related accounts (R), environmental concern (R), attitudes toward climate change (OA), attitudes towards immigrants (OA) and redistribution (OA), and risk perception (OA).
H2a hypothesizes that moderator variables —such as social trust (OA), level of prejudice toward migrants (OA), and past voting behavior (R/OA)—will interact with the main effects. Specifically, anti-immigration participants will exhibit heightened sensitivity to the climate

migration manipulation.
A corollary hypothesis ensures that manipulation checks validate our stimuli, demonstrating that respondents correctly identify the video podcast topics. Validation results are detailed in the fourth section of the Online Appendix.
In addition to these pre-registered hypotheses, and for consistency with Study 2, we also examine the moderating role of social media exposure (OA).
Furthermore, in Study 1, we explore the role of institutional trust, both as an outcome (R) and as a moderator (OA). This analysis offers deeper insights into the discrepancies between behaviors observed in the CDG and CRSD contexts. It also highlights preferences for delegation, where individuals, when confronted with the threat of natural disasters, may choose to rely on trusted institutions to address climate challenges rather than adopting personal behavioral shifts. This tendency may become particularly pronounced in collective action contexts, such as those replicated in our CRSD game, where the risk of free-riding by others diminishes the perceived efficacy of individual actions. Based on the observed results, we later pre-registered (pre-experimental measures of) institutional trust as a moderator in Study 2 to better capture its moderating role.

For Study 2, consistent with *H1a*, *H1b* proposes that the 'nature risk' and 'migration risk' conditions will increase self-reported pro-environmental attitudes, concern, and beliefs (OA) as well as behavioral outcomes, including donations in the Charity Dictator Game (CDG) and contributions in the CRSD game (R).
H2b suggests that participants in the 'nature risk' and 'migration risk' conditions, compared to the control condition, will exhibit increased physiological activation, as measured by pre-to-post video podcast changes in testosterone and cortisol levels (R).
H3 predicts that the effects outlined in H1b and H2b will be moderated by pre-experiment survey variables, which are unaffected by the manipulations. These variables include institutional trust (R/OA), environmental attitudes and knowledge (OA), political preferences (OA), risk and time preferences (OA), prejudice toward immigrants (OA), and social media use (OA).
H4 addresses the impact of the 'nature risk' and/or 'migration risk' conditions, compared to the control condition, on participants' risk preferences, particularly through changes in probability weighting. More specifically, *H4a* posits that the probability weighting function shifts upward (elevation effect), leading to greater overweighting of low-probability events and reduced underweighting of high-probability events (R). *H4b* anticipates that the slope of the probability weighting function changes (slope effect), suggesting heightened insensitivity to intermediate probabilities, as well as increased overweighting of low-probability events and underweighting of high-probability events (R). The overall effect of these manipulations on probability weighting will depend on the relative strength of these elevation and slope effects, both of which predict a greater overweighting of low-probability events compared to the control condition.
Finally, *H5* replicates the finding from Milinski's CRSD game that contributions will be higher in high-risk scenarios than in low-risk scenarios across all conditions. It further predicts that the 'nature risk' and/or 'migration risk' conditions will increase contributions in both high- and low-risk scenarios, with these effects mediated by changes in probability weighting[5] (R).

[5] More specifically, we hypothesized that: H5a) because of increased (decreased) overweighting (underweighting), the elevation effect implies, in all risk scenarios of the CRSD game, larger contributions in 'nature risk' and/or 'migration risk' conditions compared to the control condition; H5b) because of increased

To account for multiple hypothesis testing, we report Romano–Wolf–adjusted p-values throughout the Results section.

Results

Study 1

The first experiment was conducted as an online survey with a representative sample of the Italian population, recruited by the polling company Demetra. This study did not include incentivized measures. The experiment assessed the impact of two informational video podcasts on climate change, as well as a third video combining both types of information, using a neutral video podcast as a benchmark. Regarding the outcomes, we measured pro-environmental behavior through two experimental tasks. First, participants engaged in a one-shot, unincentivized (i.e. hypothetical) version of the CRSD game (Milinski et al., 2008), where the shock probability was set at 50%, though described in ambiguous terms as to replicate the *real-world* general lack of precise information on the probability distribution of extreme events. We recorded participants' contribution decisions, their personal normative beliefs (how much they believed people *should* contribute), and their empirical expectations (how much they believed others *would* contribute). Additionally, participants were asked to estimate the likelihood of the shock, providing an exact perceived probability only if it fell within the 40%-59% range. Second, at the end of the game, participants—who were not informed about this task beforehand—decided hypothetically how to allocate the common pool resources across a predefined set of projects of non-profit organizations, including environmental mitigation and migration-related initiatives. Following exposure to the treatments and the game, the survey also measured respondents' environmental concerns, attitudes toward risk and ambiguity, and trust in institutions.

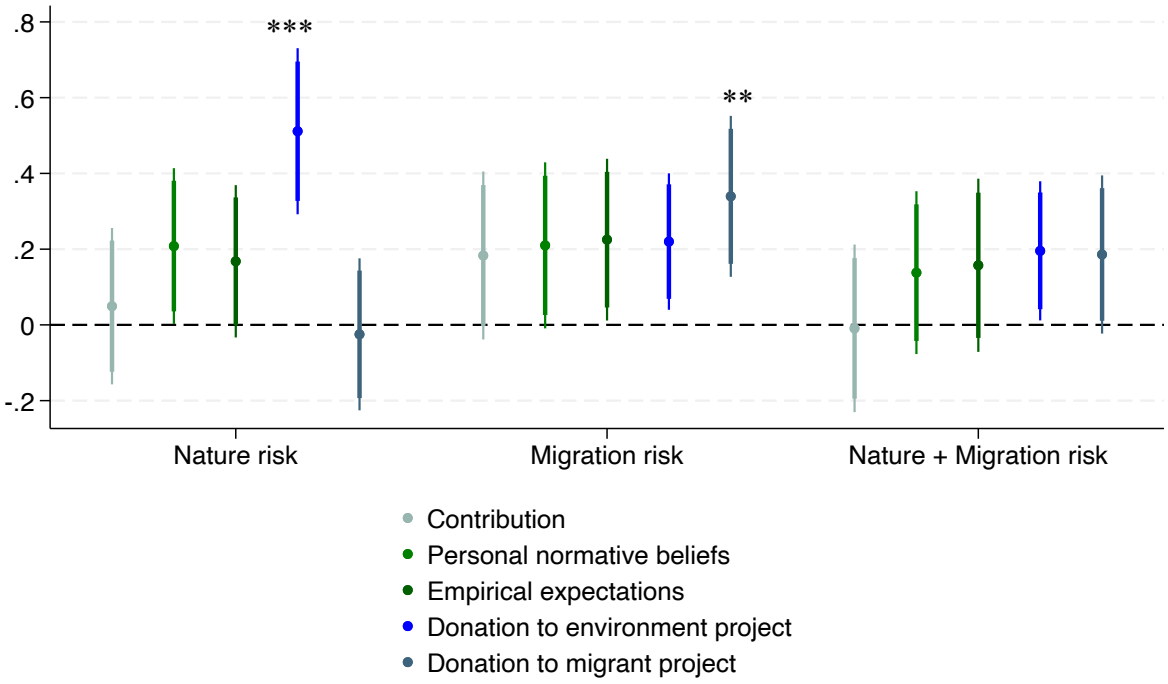
Results for the key outcomes indicate that the three treatments do not have a statistically significant impact on contributions in the CRSD game, as shown in Figure 1. However, the 'nature risk' video podcast increases personal normative beliefs of contributions by 0.21 standard deviations, and it also raises the likelihood of donating more resources to the environmental project by approximately 0.51 standard deviations. As expected, the 'migration risk' video podcast increases personal normative beliefs and empirical expectations by 0.21/0.22 standard deviations, donations toward the migration project (by 0.40sd), with a marginal effect on donations to the environmental project too (0.22sd). When combining both treatments ('nature risk' + 'migration risk'), only the effects on donations replicates but with substantially lower magnitudes (0.2sd for the environmental project and 0.19sd for the migration project). This attenuation is likely due to the increased length and information density of the combined video podcast, which may have reduced the effectiveness of the individual messages. Our hypothesis H1a is, therefore, only partially confirmed by the data with respect to only some variables (personal norms, empirical expectations, donation) and

overweighting and underweighting, the slope effect implies larger (smaller) contributions in the low-risk (high-risk) scenario of the CRSD game in 'nature risk' and/or 'migration risk' conditions compared to the control condition. The overall probability-weighting effect on contributions in the CRSD game will be determined by which of the two mechanisms (elevation vs slope) prevail.

some treatments (complete treatment has low efficacy). Table A1b (OA - Section 1) shows that the only results robust to Romano-Wolf multiple hypothesis testing correction are the positive effect of the 'nature risk' treatment on donations to the environmental project, and the 'migration risk' treatment increase of donations to the migration project.

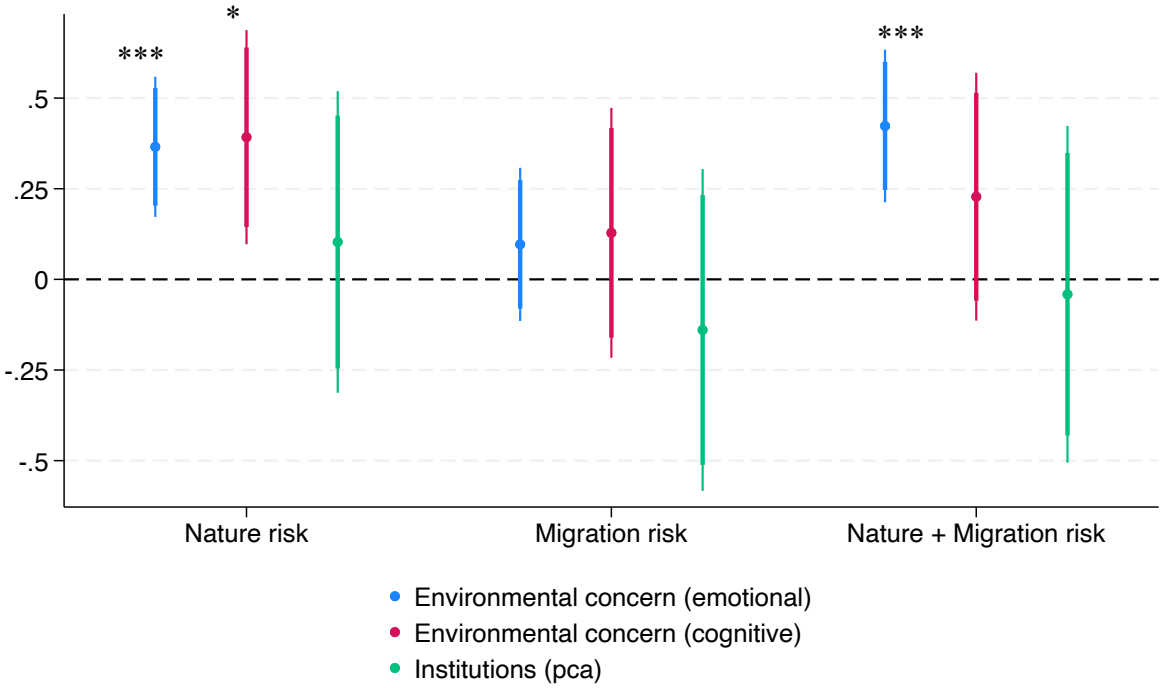
Figure 2 shows the impact of the three treatments on environmental concern – divided into cognitive and emotional components – and institutional trust. Our findings show that Hypothesis H1a is still partially confirmed: only the 'nature risk' information significantly increases both emotional and cognitive environmental concern by 0.37 and 0.39 standard deviations, respectively. The effect on emotional concern remains effective when combined with the 'migration risk' treatment (0.42sd). Moreover, all these results are robust to Romano-Wolf p-value correction (Table A2b in OA - Section 1). Increased concern in response to the 'nature risk' treatment also mirrors the increase in climate change knowledge by participants exposed to this video podcast (Fig. A2 in OA - Section 1). The complete (nature + migration risk) treatment has a positive impact on support for environmental public spending (Fig. A2 in OA - Section 1). H1a is not confirmed on perceived probability of shock in the CRSD game, risk and ambiguity aversion, climate change responsibility, immigration and redistribution attitudes as the three treatments do not have an impact (Fig. A1-2 in OA - Section 1).

Figure 1. Impact of the treatments on contribution, personal normative beliefs, empirical expectations and donations in the CRSD game.



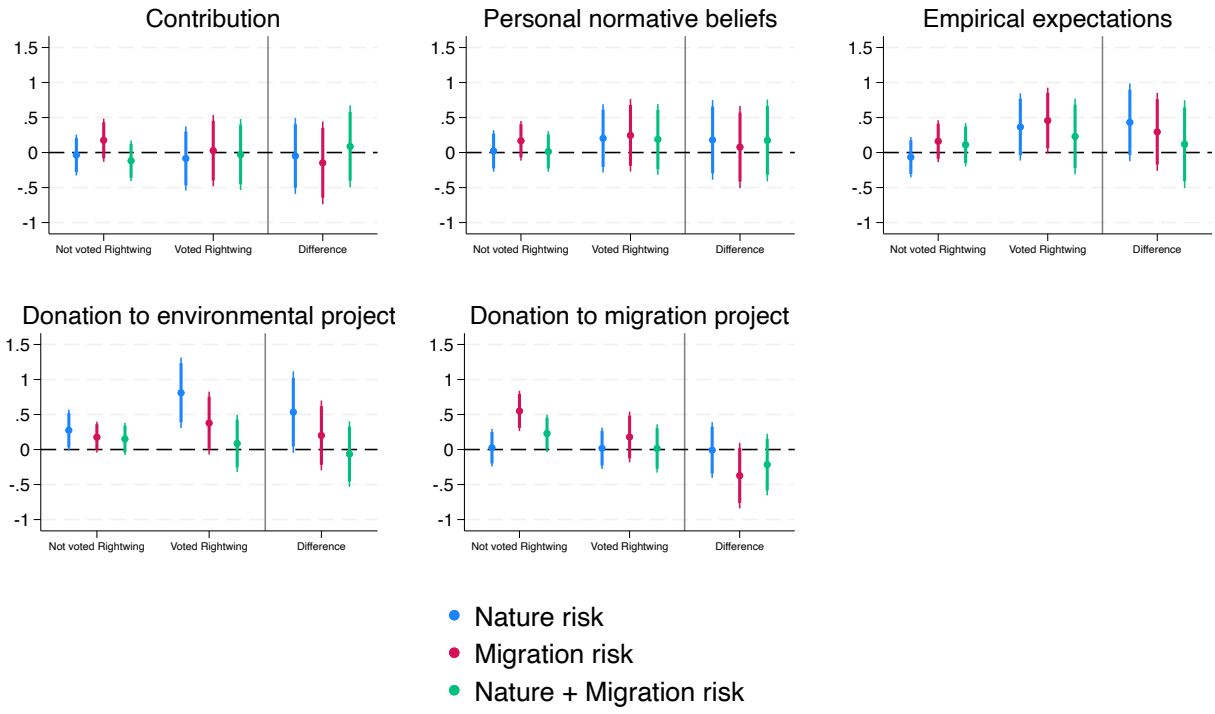
Notes: Figure shows coefficients from regressions controlling for age, gender, education and duration of the survey. Outcome variables are standardized. Robust standard errors. *** p<0.01, ** p<0.05, * p<0.1 identify the Romano-Wolf p-values.

Figure 2. Impact of the treatments on environmental concern and institutional trust.



Notes: Figure shows coefficients from regressions controlling for age, gender, education and duration of the survey. Outcome variables are standardized. Robust standard errors. *** p<0.01, ** p<0.05, * p<0.1 identify the Romano-Wolf p-values.

Figure 3. Impact of the treatments on contribution, personal normative beliefs, empirical expectations and donations in the CRSD game for right-wing respondents.



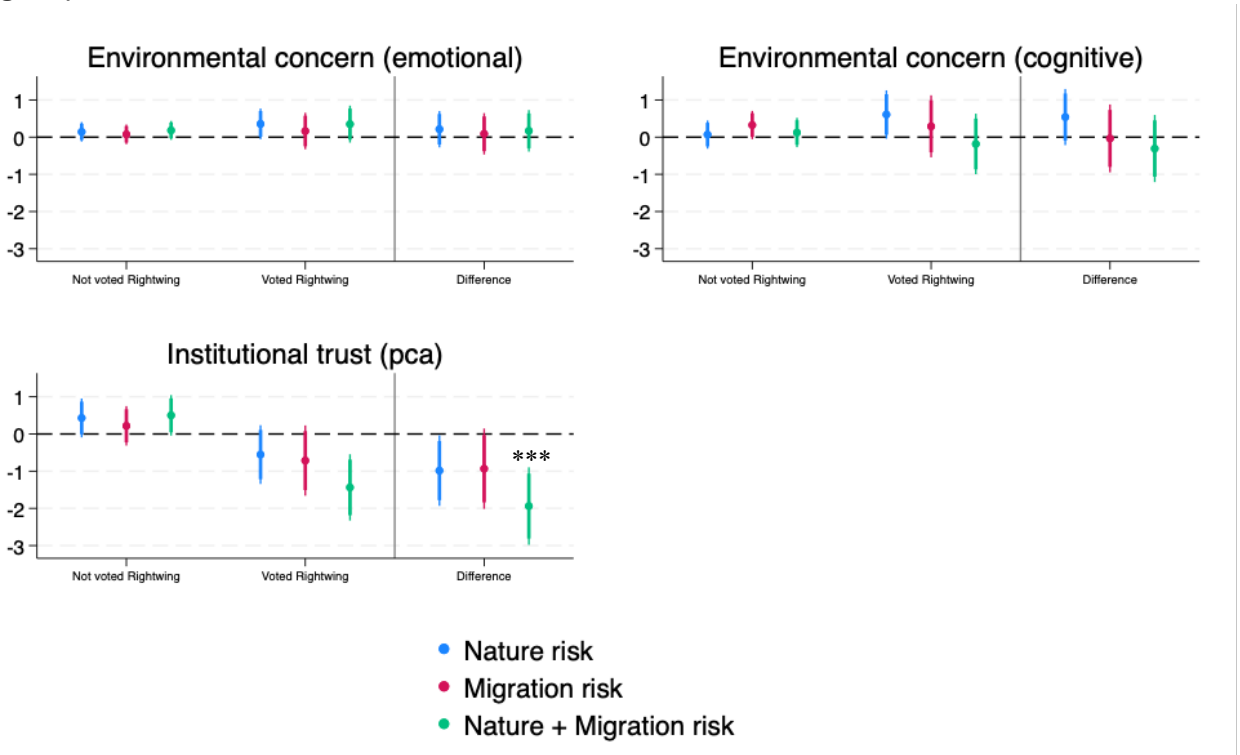
Notes: Figure shows the marginal impact of the treatment from regressions controlling for age, gender, education and duration of the survey. Outcomes variables are standardized. Robust standard errors. Right-wing

respondents are those who reported to have voted a right-wing party in the last national elections. Differences are not significant considering Romano-Wolf p-values.

The impact of these treatments varies across participants, as predicted by H2a. In particular, we observe distinct reactions among participants positioned at the right of the political spectrum. As shown in Figure 3, respondents who voted a right-wing political party in the last national elections increase donations to the environmental projects after the 'nature risk' treatment more than left-wing respondents (difference significant at 10% level – not robust to Romano Wolf correction), whereas we do not observe this difference for the other two treatments. Moreover, while left-wing and moderate respondents increase donations to the migration project as a consequence of 'migration risk' treatment, right-wing participants do not respond to it (although the difference between the two groups is not significant).

H2a, concerning past voting behavior, remains supported when examining trust outcomes. Figure 4 highlights that right-wing voters exhibit a decline in institutional trust after viewing the 'nature + migration risk' video podcast (the difference between the two groups of voters is significant at the 1% for the complete treatment and robust to Romano Wolf as Table A4b shows). These results hold considering self-reported political orientation instead of past voting behavior (Figures A3-4 in OA - Section 1).

Figure 4. Impact of the treatments on environmental concern and institutional trust for right-wing respondents.



Notes: Figure shows marginal effects of treatments from regressions controlling for age, gender, education and duration of the survey. Outcome variables are standardized. Robust standard errors. Right-wing respondents are those who reported to have voted a right-wing party in the last national elections. Romano-Wolf p-values are included only on differences and are identified by *** p<0.01, ** p<0.05, * p<0.1.

To summarize the key findings, emphasizing nature-related risks is more effective in fostering personal normative beliefs about cooperation, increasing environmental concern, and raising donations to environmental projects, but does not translate into higher cooperative behavior in strategic settings. In addition, despite their theoretical relevance, we do not find robust average treatment effects on attitudes toward immigrants or redistribution. By contrast, climate-risk framings primarily affect behavior through targeted allocation decisions—such as donations—rather than through short-run changes in broader social and political attitudes. Finally, information combining climate-induced migration and natural disasters does not generate strong or systematic behavioral responses[6].

Study 2

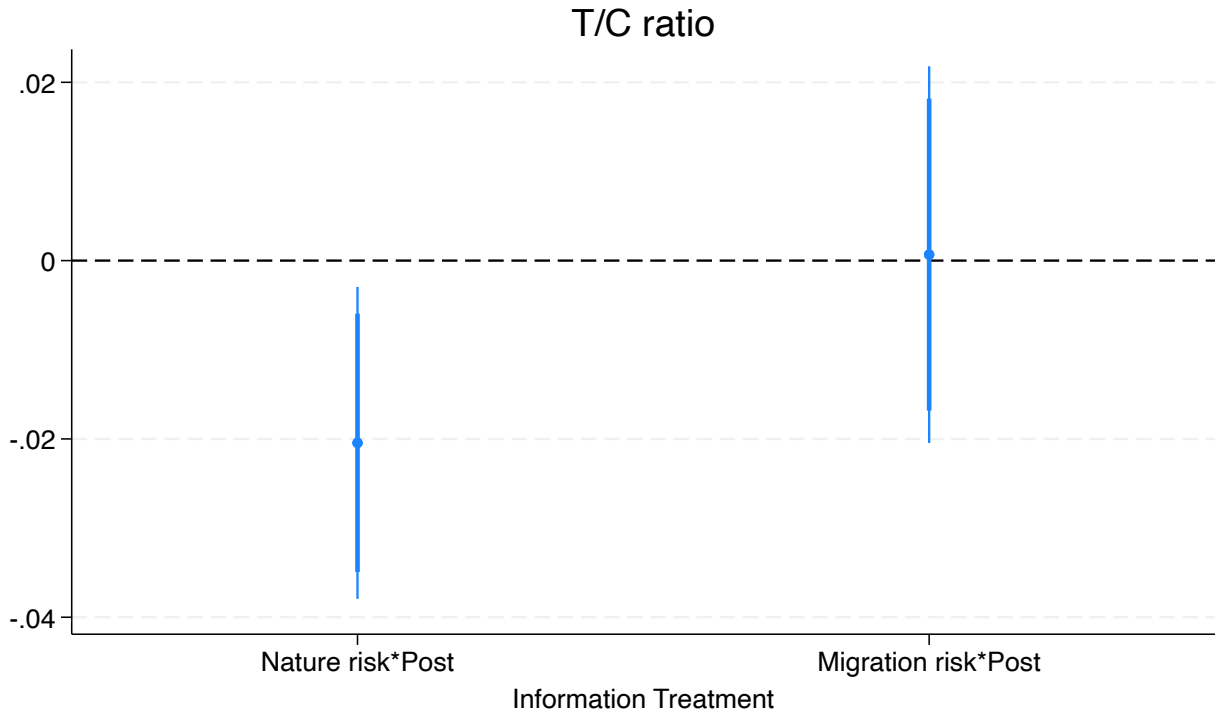
The study employed: (a) a pre-experimental survey questionnaire including socio-demographic information, time preferences, and attitudes toward the environment, immigration, and risk, administered two weeks before the experiment; (b) a 3x2 between-subject experiment, varying the type of video podcast viewed ('nature risk', 'migration risk' or control condition) and the probability of a shock in the CRSD game (high: 90% vs. low: 10%), and. The joint 'nature and migration risk' treatment was excluded to i) reflect its limited impact in Study 1 and ii) enhance statistical power. During the lab sessions, participants watched one of the climate change information video podcasts or an active control video. They then participated in a money-incentivized Charity Dictator Game (CDG), deciding how much of their endowment to donate to Greenpeace. Participants also played ten rounds of the CRSD game in groups of four, with anonymous rematching. Unlike the first experiment, risk probabilities in this study were explicitly defined as either 10% or 90% and remained consistent throughout the game, and the CRSD game was incentivized. Also in this CRSD game, we elicit participants' contributions, personal normative beliefs and empirical expectations. Additionally, participants completed tasks measuring time preferences, risk attitudes (using incentivized lottery choices in the loss domain), and attitudes toward environmental and migration issues. Importantly, saliva samples were collected both before and after the video podcast manipulation to assess hormonal (cortisol and testosterone) responses to information on climate change risk.

The first outcome of interest we analyze is hormonal variation. We examine the testosterone-to-cortisol (T/C) ratio, a measure associated with risk-taking behavior and social aggression (Mehta and Joseph, 2010; Mehta et al., 2015; Nofsinger et al., 2018; Nierman et al., 2017; Terburg et al., 2009), both before and after the manipulation for each participant. To account for time-invariant individual characteristics—such as gender, age, and the time of day when the sample was collected—that could influence hormonal levels, we employ a fixed-effects regression model.

[6] Additional analyses in Section 1 and 2 of the Online Appendix show the other pre-registered heterogeneous treatment effects. Notably, donations to the environmental project induced by the 'nature risk' treatment are primarily driven by non-intensive social media users (SMU) (Figure A5 in OA – Section 1). Conversely, intensive SMU exhibit a backlash effect: when exposed to the 'migration risk' podcast, they show reduced levels of environmental concern and worse climate change attitudes (i.e., environmental concern, both emotional and cognitive; knowledge of climate change anthropogenic causes; feeling responsible of climate change and support for environmental spending), as shown in Figure A6-7 in OA – Section 1.

Results shown in Figure 5 reveal that the 'nature risk' treatment is the only one to significantly reduce the testosterone/cortisol (T/C) ratio. This reduction, of 0.02 standard deviations, suggests a physiological response consistent with a "flight" mechanism—characterized by heightened avoidance, cautiousness, and defensive behaviors in the face of perceived threats.

Figure 5. Hormonal response to the treatments.



Notes: Coefficients from the FE model representing the change in T/C after watching any of the two treatments. The outcome variable is standardized. Standard errors are clustered at the session level.

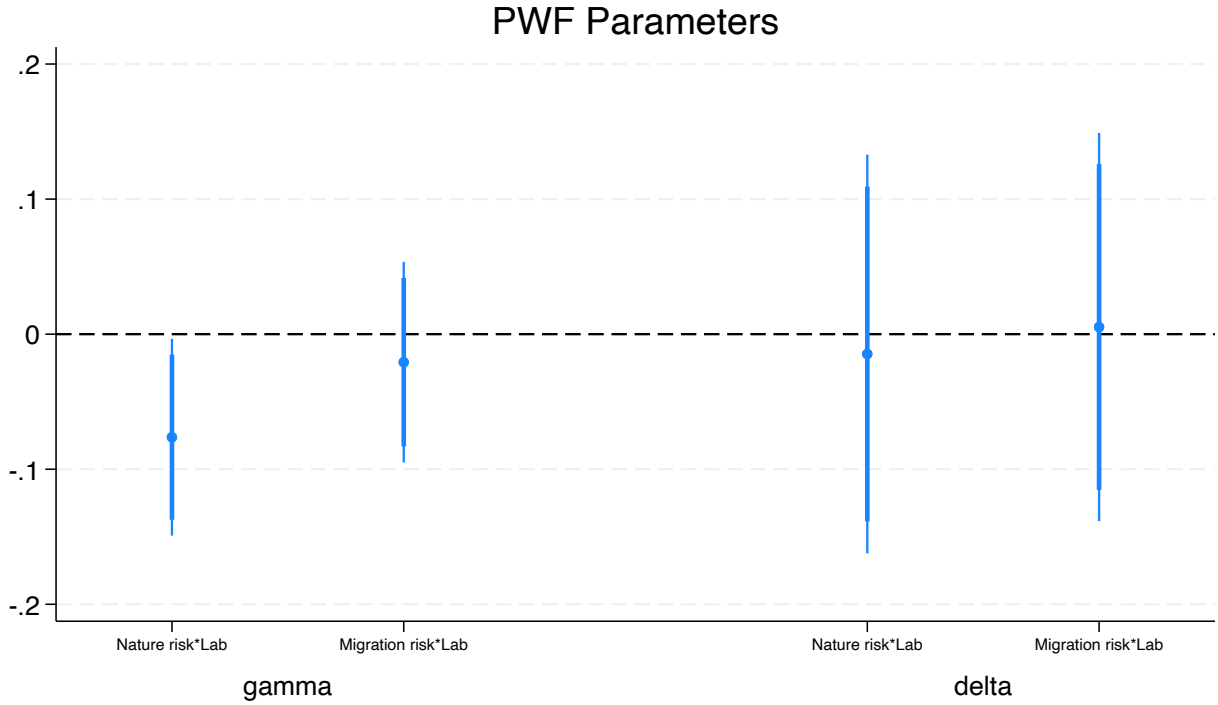
Secondly, we analyze the impact of the two treatments on risk attitudes in the context of prospect theory probability weighting functions (PWF). Risk attitude measures enable us to study a possible mechanism through which the two information treatments can influence behavior in the CRSD game. Moreover, some literature associates T/C ratio to risk-taking behavior (Nofsinger et al., 2018; Terburg et al., 2009). We collected risk attitudes measures both in the pre-experimental survey and in the lab, using lotteries in the loss domain from Choi et al. (2022), which enable us to estimate prospect theory probability weighting functions (PWF).

We use the functional form proposed by Goldstein and Einhorn (1987) in which the perceived probability follows the following functional form: $w(p) = \frac{\delta p^{\gamma}}{\delta p^{\gamma} + (1-p)^{\gamma}}$, where $\gamma, \delta \geq 0$. This function has a clear psychological interpretation. The parameter γ is the slope of the probability weighting function and captures likelihood insensitivity. The smaller is γ, the more curved the function is, the less sophisticated the agent is in distinguishing between probabilities closer to 0.5. Another consequence of a small γ is that the agent is going to perceive extremely low (high) probabilities as higher (lower) than they are. On the other hand, the parameter δ is the crossing point between the function and the 45-degree line, it

represents the degree of optimism the agent has. As we chose the loss domain to mimic real-world natural disasters, the higher δ the more the agent is pessimistic about probabilities.

We estimate probability weighting functions in the pre-experimental survey and in the lab (after video-treatment exposure). Figure 6 shows that the 'nature risk' treatment is the only one to have an impact on PWF: exposure to information on climate change induced natural disasters increases probability distortion, partially confirming H4b. H4a is not confirmed as we do not observe any impact of the two treatments on the degree of optimism. Graphical representations of PWFs are reported in Figure A9 in OA - Section 1. Tables with regression results are reported in Table A6 in OA - Section 1[7].

Figure 6. Impact of treatments on PWF parameters.



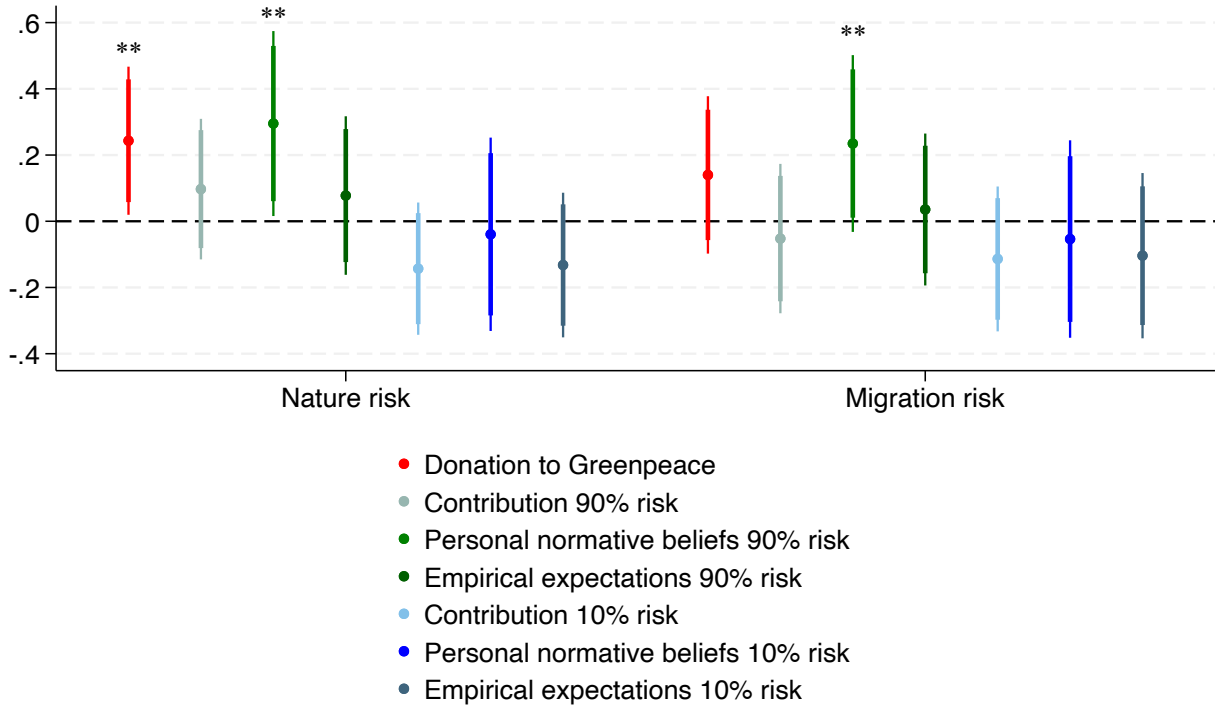
Notes: Marginal effects of the treatments from regression consider lotteries asked in the pre-experimental survey and in the lab. Standard errors are clustered at the individual level.

Similarly to the findings of Study 1, the 'nature risk' treatment exhibits a stronger impact on behavioral outcomes. Information on natural risks of climate change significantly increases donations to Greenpeace in the CDG by approximately 0.24 standard deviations. Furthermore, both treatments influence personal normative beliefs in the high-risk version of the CRSD game, with the 'nature risk' treatment showing a more pronounced effect (0.3sd vs 0.24sd). However, no treatment induces behavioral changes in the low-risk (10%) version of the CRSD game, nor for contribution and empirical expectations in the high-risk scenario. Therefore, H1b results confirmed only for normative beliefs in the high-risk (90%) game and for donations in the CDG. Moreover, these results are robust to Romano-Wolf correction for multiple hypothesis testing (Table A7b in OA - Section 1).

[7] It is possible to observe that in the lab participants tend to have lower probability distortion (higher gamma) and to be more pessimistic (higher delta).

Figures A11 to A13 in OA - Section 1illustrate the dynamics of contributions, as well as normative and empirical expectations throughout the game. Fixed-effects regression models (Figure A10 in OA - Section 1) reveal no significant treatment effects on contributions or beliefs and expectations between rounds, suggesting that the treatments do not alter the dynamics of the CRSD game. H1b is not confirmed on environmental attitudes or support for environmental policies as no significant impact is observed (OA - Section 1, Figure A14).

Figure 7. Treatments impact on CDG and CRSD game.



Notes: CDG model controls for environmental responsibility, emotional concern, climate change knowledge, age and gender. CRSD game models are random effect models including controls for age, gender, previous round payoff, game instructions randomization and time fixed effects. Outcome variables are standardized. Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1 identify the Romano-Wolf p-values.

Finally, to test whether any impact on contribution is mediated by risk perception (H5), we observe first whether probability distortion in the lab, measured by the estimated γ using models from Figure 6, is correlated with contribution in the CRSD game. Correlation between these two variables is extremely low -0.028 (pwcorr of 0.244) for the 90% risk game, and -0.034 (pwcorr of 0.134) for the 10% risk game. This result, together with the absence of a direct impact of the treatments on the collective game contributions, provides no support for H5.

Overall, Study 2 confirms that climate change-related 'nature risk' information was generally more effective than 'migration risk' in influencing personal norms and behavior. Specifically, we observe that information regarding climate change-induced natural disasters increases donations in the CDG and bolsters personal normative beliefs in the CRSD game. Moreover, information on the threat of climate migrants has only a slightly significant effect on personal

norms of cooperation in the CRSD game. However, these positive impacts are not strong enough to translate into higher cooperation in the CRSD game[8].

Discussion

Across two complementary experiments, we examine how alternative, ecologically realistic framings of climate-related risks—one emphasizing sudden-onset and uncertain events, the other highlighting slow-moving risks unfolding through social and demographic dynamics—affect pro-environmental beliefs and behavior.

An important clarification concerns the meaning of "immediacy" and "distance" in our framing. These terms do not refer exclusively to geographic proximity or personal exposure. Rather, they capture differences in the cognitive and causal structure through which climate risks are experienced. Natural disasters are framed as sudden-onset shocks with a direct and locally observable impact, whereas climate-induced migration is framed as a structurally mediated consequence of climate change, involving a longer causal chain that links environmental shocks elsewhere to social and economic outcomes in one's own country. In this sense, migration risks may be salient and familiar to many European respondents, yet still cognitively more indirect than local natural disasters, as their link to climate change relies on attribution across space, time, and social processes. As a result, climate-migration framings are expected to operate through more mediated and socially contingent channels, and their behavioral impact may depend more strongly on individual beliefs, trust in institutions, and political orientation than framings centered on immediate natural disasters.

Both studies indicate that framing climate change as an immediate risk of natural disasters within one's own country increases environmental awareness and prosocial engagement in non-strategic settings—reflected in heightened environmental concern in Study 1, stronger personal normative beliefs and increased donations to environmental causes in both Study 1 and Study 2. heightened awareness does not translate into greater cooperative behavior in strategic contexts, highlighting a persistent gap between environmental beliefs and the collective action required for effective climate mitigation. By contrast, when the climate threat is perceived as more indirect or mediated, it does not appear, on average, sufficiently salient to elicit a physiological response.

The heterogeneity by political orientation observed in Study 1 suggests that natural-disaster framings do not operate uniformly across ideological groups. Among right-wing respondents, exposure to nature-related risks increases environmental concern and donations, but does not translate into greater cooperation in strategic settings. At the same time, these

[8] Additional analyses in Section 1 and of the Online Appendix show the other results on the pre-registered heterogeneous treatment effects. In line with Study 1, we observe that the two treatments are more effective for non-intensive SMU. This group of respondents reacts to information on natural disasters in their country with an increase in contributions, normative and empirical expectations, the latter are also affected by 'migration risk' treatment (Figure A15). Moreover, we observe a backlash effect for intensive social media users. They reduce contributions (because of 'nature risk' treatment) and empirical expectations (because of 'migration risk') over rounds in the 10% risk CRSD game (Figure A16). Intensive social media participants are also induced by the 'nature risk' treatment to reduce feelings of being responsible for climate change and environmental policy support (Figure A17).

respondents exhibit a decline in institutional trust—an effect that also emerges, and in some cases intensifies, following exposure to climate-migration narratives (Figure 4). Taken together, this pattern indicates that heightened risk awareness may redirect engagement toward non-strategic channels perceived as more immediate and effective, such as grassroots environmental organizations, when confidence in institutional or collective solutions is limited (see, e.g., Conzo et al. 2025).

Our findings indicate that risk perception does not mediate the association between the treatments and cooperation in the collective game, and therefore cannot account for the observed discrepancy between cooperative norms and actual behavior in the CRSD game.

Study 2 instead points to social uncertainty, in particular the risk of free-riding, as a potential underlying mechanism. Exposure to information about natural disasters likely triggered a sense of vulnerability and an instinctive shift away from confrontation ("fight") and toward withdrawal or risk aversion. Importantly, this response may not only reflect a general withdrawal from risk but also a specific reaction to social uncertainty—particularly in contexts involving potential free-riding or strategic exploitation. In such settings, a lowered T/C ratio has been linked to defensive freezing and reduced social engagement (Terburg et al., 2009; Terburg and van Honk, 2013). Participants may have interpreted the climate threat as overwhelming and uncontrollable, leading to an emotional and physiological state in which individualized, non-strategic forms of prosociality (e.g., donations) were maintained or increased, while cooperative behaviors in interdependent group settings were suppressed. These findings align with stress research showing that perceived environmental risks often elicit protective behaviors over collective engagement or risk-taking (Mehta & Josephs, 2010; Mehta et al., 2015; Nierman et al., 2017).

The physiological evidence is not intended to establish a causal pathway from hormones to behavior, but to help interpret why climate-risk salience may increase generosity and personal environmental norms in non-strategic settings while simultaneously suppressing engagement in collective action under social uncertainty.
Consistent with prior evidence that defensive “freezing” responses—often indicated by a lowered testosterone–cortisol ratio—are especially pronounced under strategic uncertainty or the risk of exploitation, exposure to natural disasters appears to activate self-preservation instincts that foster prosocial behavior toward third-party causes without translating into greater cooperation in group settings where outcomes depend on others’ contributions.

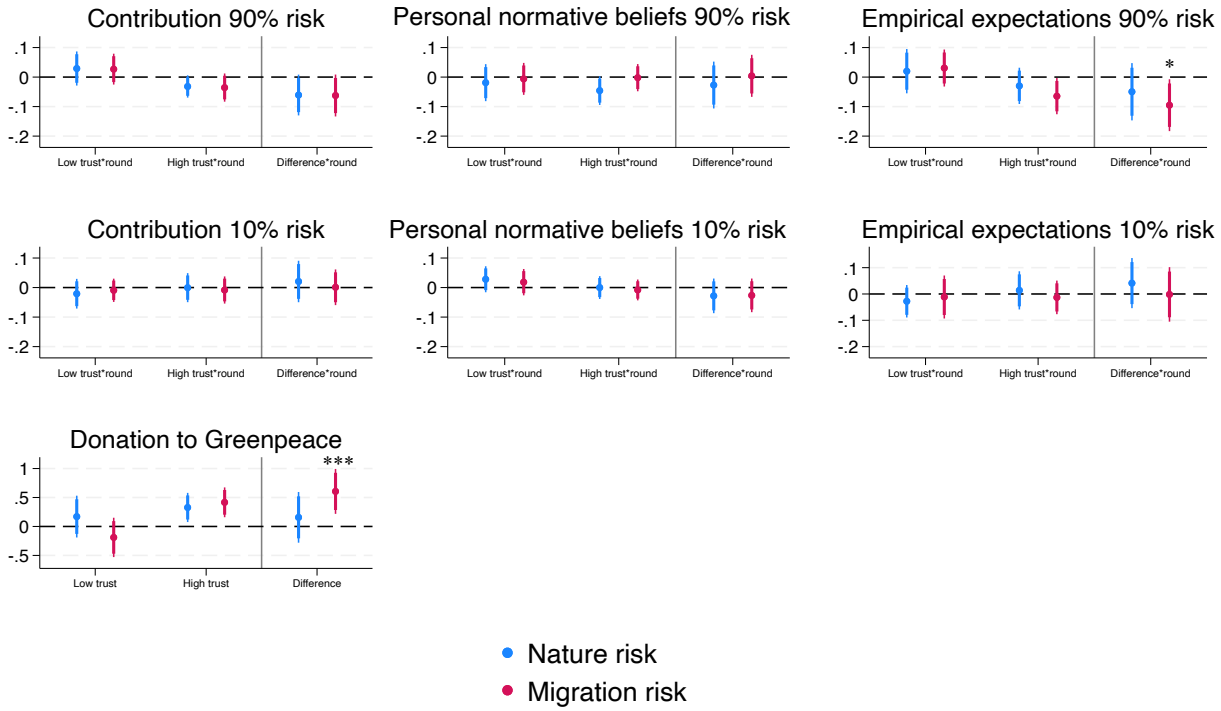
The idea that exposure to climate change risks could trigger pessimism on other’s behaviors is further supported by the fact that the gap between normative beliefs and cooperation in the group task is driven by individuals with high pre-experimental levels of institutional trust. As shown in Figure 8, when exposed to climate migration risks, these individuals tend to reduce their expectations on other players’ contributions over repeated rounds of the 90% risk CRSD game in Study 2, suggesting heightened sensitivity to free-riding (the difference relative to low-trust individuals significant at 5% level). At the same time, high-trust participants increase donations to Greenpeace in response to climate challenges. In particular, under the “migration risk” treatment, the difference in donations between high- and low-trust respondents is statistically significant at the 1% level.

These results, which are robust to Romano-Wolf corrections (Table A8b in OA, Section 1), emphasize the interplay between institutional trust, aversion to free-riding risk in strategic interactions, and the shift from personal efforts in collective action toward delegating responsibility for mitigation to institutional actors. Consistently, when exposed to both treatments, high-trust participants tend to reduce their contributions over time relative to low-trust respondents, further supporting the delegation mechanism (Figure 8)[9]. In cases where exposure to climate risks coincides with declining trust in formal institutions—as observed in Study 1 among right-wing participants—delegation may also take the form of increased support for non-governmental organizations, which can be perceived as a "third way" between formal institutions and individual action, signaling competence, motivation, and immediacy of response (Conzo et al., 2025).

These findings suggest that the intention–action gap in sustainable behavior may emerge when social norms are shifting, but individuals do not perceive a critical mass adopting sustainable practices (Centola et al., 2018; Efferson et al., 2020; Granovetter, 1978; Macy, 1991; Welsch, 2022). In such contexts, the perceived lack of collective action can increase demand for coordinating institutions, prompting individuals to delegate responsibility for addressing climate risks to coordinating institutions.
Two empirical results support this mechanism. First, in Study 2, we find no statistically significant differences in the dispersion of personal normative beliefs across groups (OA – Section 1, Table A11), suggesting that nature risks do not lead to convergence towards stronger cooperative norms, and may therefore dampen expectations that others will act. Second, we observe clear signs of delegation among individuals with high institutional trust, who appear particularly sensitive to the lack of coordination in the CRSD game.
Consistent with this interpretation, Study 1 and recent research (e.g., Aassve et al., 2024) show that individuals with low social trust—who tend to be sceptical of others' cooperation—exhibit increases in institutional trust following exposure to climate-related disasters (OA – Section 1, Figure A8). This pattern points to a substitution mechanism, whereby declining confidence in others' behavior is compensated by greater reliance on institutional actors to address collective risks.

[9] The result on contributions is, however, not robust to Romano-Wolf correction for multiple hypothesis testing.

Figure 8. Treatments impact on CDG and CRSD game by institutional trust.



Notes: CDG model controls for environmental responsibility, emotional concern, climate change knowledge, age and gender. CRSD game models are fixed effect models controlling for previous round payoff. Respondents with high (low) institutional trust are those that have levels of institutional trust above (below) the sample median. Outcome variables are standardized. Standard errors are clustered at the individual level. Romano-Wolf p-values are included only on differences and are identified by *** p<0.01, ** p<0.05, * p<0.1.

Another possible explanation for the divergence between normative beliefs and actual contributions is the experimenter demand effect (EDE). Participants may recognize that higher contributions are expected from the experimenters after everyone's exposure to climate change information—as indicated by the observed increase in normative beliefs—and may therefore opt to free-ride on others' anticipated cooperation in the CRSD game. If participants expect others to behave similarly, this could help explain the absence of effects on contributions and empirical expectations.

We can reasonably rule out this mechanism for several reasons. First, prior research shows that EDEs have limited influence on incentivized tasks and attitudinal outcomes (De Quidt et al., 2018; Haaland et al., 2023; Mummolo and Peterson, 2019), suggesting that longstanding concerns about demand effects in survey experiments may be overstated (Mummolo and Peterson, 2019). In line with this, we find similar results in both Study 1 (non-incentivized) and Study 2 (incentivized), indicating that EDE is unlikely to be a key driver of our findings. Second, several features of our design reduce the likelihood that experimenter demand effects drive our results, including the anonymity of decisions, the use of incentivized tasks in Study 2, and the absence of explicit links between the informational content and the subsequent decision tasks (Haaland et al., 2023; Stantcheva, 2023)[10]. While we cannot rule

[10] It is also worth noting that, while the provision of information by an experimenter in a position of authority could in principle trigger EDE, this element of the design in fact strengthens our study's external validity. Since our objective is to assess the impact of institutional information on environmental attitudes, presenting the information in an authoritative manner mirrors real-world communication channels and thus reinforces the relevance of our findings (Tisserand et al., 2022; Zizzo, 2010).

out demand effects entirely, it is difficult to reconcile them with the divergence we observe between increased normative beliefs and unchanged or declining cooperation in strategic settings.
Third, for Study 2, we examine participants' perceptions of the study's goals and how these relate to behavior in the CDG and CRSD games. Only 6.32% of respondents correctly identify the study's objective (i.e., to provide information to influence donations and cooperation), with rates of 2.31% in the control group, 7.75% in the 'nature risk' group, and 9.09% in the 'migration risk' group. Excluding these participants from the analysis does not alter the main results (see Table A12 and Figures A18–A19)[11].

Finally, although our experiments capture short-term responses to information, understanding these immediate reactions is substantively important. Climate communication in the real world is often episodic—triggered by disasters, media coverage, or political events—and such moments can shape beliefs, norms, and expectations that influence longer-term behavior and institutional demand. Our findings indicate that even when short-term exposure increases concern and altruism, it may fail to generate collective action if social uncertainty and free-riding concerns remain unresolved.

Overall, our results uncover a central paradox: climate risks, especially when framed as immediate threats, heighten concern and prosocial engagement but do not foster cooperation in collective-action settings. Rather than mobilizing coordinated action, heightened risk salience can induce withdrawal and delegation—particularly among individuals with high institutional trust. Bridging the gap between intention and action will therefore require not only informing individuals about climate risks, but also strengthening confidence that others—and the institutions responsible for coordination—will act as well.

[11] With the exception of contributions in the 90% risk condition shown in Figure 8, which were already not robust under the Romano-Wolf correction.

Methods

This section covers the experimental protocol of the two studies, focusing on experimental manipulations[12], physiological measures, Common Resource Social Dilemma (CRSD) game, Charity Dictator Game (CDG) and risk attitudes.

To improve readability, we report in the main text only the essential elements of the experimental design and results. All additional analyses and materials are collected in a single Online Appendix, organized as follows. Section 1 reports all main regression tables corresponding to the figures presented in the paper, together with Romano–Wolf corrections and baseline robustness checks. Section 2 contains the full set of pre-registered heterogeneity analyses that are not discussed in the main text. Section 3 provides additional details on the experimental design and procedures, including the scripts of the informational video podcasts and the collection and analysis of physiological measures. Section 4 documents the validation of the informational stimuli, including detailed topic-recognition and comprehension checks for Study 1 and Study 2, as well as the construction of treatment-specific comprehension indicators. Finally, Section 5 reports the full questionnaires used in Study 1 and in the pre-experimental and laboratory phases of Study 2.

Table 1 provides an overview of the main design features of Study 1 and Study 2, which are described in greater detail in the following subsections, highlighting their complementarity in terms of samples, incentives, strategic environments, and behavioral measures.

Table 1. Overview of experimental design and key features

Dimension	Study 1 (Online survey)	Study 2 (Laboratory experiment)
Sample	Nationally representative sample of Italian adults	University students (left-leaning, higher baseline environmental awareness)
Recruitment	Professional polling company (Demetra)	University of Turin subject pool
Sample size (analysis)	N = 693	N = 451 (hormonal analysis: N = 372)
Preregistration	Yes (OSF)	Yes (OSF)
Incentives	No behavioral incentives; fixed participation fee (€3.3)	Fully incentivized behavioral tasks plus show-up fee
Information treatments	Nature risk; Migration risk; Nature + Migration risk; Active control	Nature risk; Migration risk; Active control
CRSD game	One-shot CRSD	Multi-round CRSD (10 rounds)
Probability of loss	Ambiguous (Ellsberg-type description)	Exogenously specified (10% / 90%)
Non-strategic behavior	Allocation of collectively accumulated resources across causes after CRSD (hypothetical)	Charity Dictator Game (donations to Greenpeace, incentivized)
Belief elicitation	Normative beliefs; empirical expectations; perceived probability of loss	Normative beliefs; empirical expectations
Risk preferences	Self-reported risk and ambiguity attitudes	Incentivized lotteries; probability weighting
Physiological measures	No	Salivary cortisol and testosterone (pre/post)
Main moderators	Political orientation; institutional trust; prejudice toward migrants; social media use	Institutional trust; political orientation; risk and time preferences
Main purpose	External validity, stimulus validation, heterogeneity	Mechanism identification, internal validity

Study 1

[12] The video podcast used as information treatments can be found at the following link: https://drive.google.com/drive/folders/1Utwz6ucUd9tfzuvJ8mt_e0XeYZOMgfvw?usp=sharing

For the first study, we contracted the polling firm Demetra to recruit a nationally representative sample of the Italian population. The survey was administered through Qualtrics, with respondents taking on average 33 minutes to complete it. Participants received a fixed participation fee of €3.3, independent of their decisions. The initial sample, excluding responses which did not passed the quality checks, is composed of 1,036 individuals. Quality checks exclude respondents who did not have access to audio, failed to watch the video podcast in full, or did not pass at least one of the three embedded attention checks. Additionally, we exclude participants who demonstrated poor understanding of the video podcast or completed the survey in times below the 5th and above the 95th percentiles. Lastly, participants with poor comprehension of the CRSD game instructions are excluded from the game analysis.

The survey began with general instructions and informed consent, followed by a check of participants' device audio quality. Respondents then completed: (i) socio-demographic questions, (ii) exposure to one of the three climate change risk video podcast or to an active control video podcast on Earth's motion. They were asked (iii) what information was contained in the podcast (as to check their comprehension of the treatment) and if they were already aware of this information. They received (iv) instructions on how to play the CRSD game with an example (the example they received was randomized among three possible alternatives) and answered to one game comprehension question. They (v) played the CRSD game, were asked their opinion on (vi) the environment and (vii) migration, as well as their attitudes towards (viii) redistribution, (ix) ambiguity and risk, (x) social and institutional trust. Finally, respondents were also asked their (xi) prejudice towards immigrants, (xii) political orientation, voting intentions and past voting behavior, and (xiii) media use. At the end, (xiv) an open-ended question invited comments on the study's aims and suggestions for improvement. Environmental concern is measured using two distinct variables, one capturing its emotional dimension and one assessing its cognitive component. Institutional trust is derived from principal component analysis (pca), aggregating trust in various national and international institutional actors.

The four video podcasts included one active control condition on Earth movements (lasting 2:50 minutes) and three treatment conditions combining the same opening and concluding segments on climate change, and one middle segment which changed depending on the condition. The topic of the middle segment could be environmental disasters (nature risk condition, total video duration 3:31 minutes), or environmental migration (migration risk condition, total video duration 3:42 minutes) or the sum of the two (nature + migration risk, total video duration 5:29 minutes). The opening segment of treatment conditions started with footage of the Marmolada glacier collapse in July 2022 and discussed the link between human activity and climate change. The middle segment of nature risk condition described natural disasters related to climate change such as desertification across Italy, and other similar events in specific regions of the country, i.e., droughts in Piedmont in summer 2022, and floods in Emilia-Romagna in May 2023. The middle segment of migration risk condition stated that African countries are disproportionately affected by climate change and as they are significant sources of migration to Europe, climate change is likely to lead to increased migration flows. The 'nature + migration risk' video combined both sets of information. All treatment conditions concluded by asking participants to envision the future impacts of current trends of natural disasters and/or climate migration.

The CRSD game was a single-round game where participants were given a hypothetical initial endowment of €40 and played in groups of six. If the group collectively contributed at least €120 to a common pool, participants could keep the remainder of their endowment; otherwise, they risked losing their remaining endowment with a specified probability. The probability of loss was described ambiguously using an Ellsberg urn containing an unknown ratio of white and orange balls. Respondents were also informed that the common pool would be invested in a common project.

Note that when probabilities are objectively known, the CRSD admits clear benchmark equilibria, including full contribution equilibria under sufficiently high risk. Under ambiguity, however, optimal behavior depends on participants' subjective beliefs about both the likelihood of the loss and others' expectations. With ambiguous probabilities, multiple behavioral benchmarks are compatible with equilibrium reasoning, including zero-contribution and threshold-reaching outcomes, depending on higher-order beliefs. Rather than testing equilibrium play, our aim in Study 1 is to assess whether heightened climate-risk salience shifts behavior even when strategic uncertainty remains unresolved. Importantly, our focus in that Study is not on identifying stable preferences or equilibrium strategies in the collective risk game. Instead, we are interested in how individuals adjust their beliefs and behavioral choices in response to exogenous information about climate risks.

Participants were also asked about their *perceived* probability of the loss in the CRSD (provided the 120€ threshold is not reached), their contribution to the pool, their personal normative beliefs (how much people *should* contribute), and their empirical expectations (how much they thought others *would* contribute).

After these questions, they are asked to allocate the hypothetical funds from the common pool (€120) across five causes/non-profit institutions: blood cancer research, Medicins sans Frontiers, pro-migrants organization, pro-environmental organization, and animal protection organization. These causes were chosen to be broadly recognizable and specific in their objectives. This task is intentionally embedded in the same collective-risk environment as the CRSD, and it aims to capture delegation/earmarking—i.e., how individuals prioritize competing public causes when allocating a fixed collective budget—rather than pure altruism from private income. This complements the strategic contribution decision in the CRSD, which is directly shaped by free-riding incentives and beliefs about others' cooperation.

Before the CRSD, and after reading the game instructions for the first time, respondents were asked randomly one (out of three) game comprehension question. If they answered correctly, they proceeded; otherwise, they reviewed the instructions, potentially with a randomized alternative example, and were asked the same comprehension question. This process was repeated up to four times. After four unsuccessful attempts, participants were allowed to continue the survey regardless of their answer. We excluded from the analysis of game outcomes respondents that made three or more mistakes out of four attempts of the same game comprehension question.

Table A13 (OA – Section 1) shows a summary of the variables used in the analysis of Study 1, whereas Table A14 reports summary statistics on the analysis sample (N=693 participants).

To assess whether participants processed the informational content of the video podcasts as intended, we implemented detailed manipulation and comprehension checks in Study 1. After viewing the video, respondents were asked to identify all topics covered in the video podcast from a list of ten possible items. This approach allows us to verify topic recognition and to distinguish between core content and information that was only loosely mentioned. Results show very high recognition accuracy in the control condition and systematic, treatment-consistent patterns in the three information treatments. Most misclassifications concern abstract concepts (e.g., causality between climate change and disasters) or secondary references, rather than the main topics of the videos. Based on these responses, we construct a treatment-specific comprehension indicator that focuses on correct identification of the core information delivered in each video podcast. Using this measure, exclusion rates due to poor comprehension are substantially reduced and remain comparable across treatments. All validation results are reported in the Online Appendix (Section 4). Importantly, the validation results from Study 1 informed minor revisions to the comprehension items used in Study 2; in the laboratory experiment, recognition accuracy is correspondingly very high.

The regression models we used for analysis in Figure 1, 2, A1, A2 are based on the following specification:

$$y_i = \alpha + \beta treat_i + \mathrm{X}_i\pi + \varepsilon_i$$

where: y_i is the outcome of interest (i.e. contribution to the CRSD game, donation to environmental project, etc.), $treat_i$ is a categorical variable expressing whether the individual falls into the control group or any of the three treatment groups, X_i is a set of control which is specified in the notes for each set of results, ε_i is the error term, β is the parameter of interest.

Regression models used for heterogeneity analysis (i.e. Figure 3, 4, A3-8) are as follows:

$$y_i = \alpha + \beta treat_i + \phi w_i + \tau treat_i \times w_i + \mathrm{X}_i\pi + \varepsilon_i$$

where w_i is a dummy variable indicating whether the individual belongs to a specific subpopulation (i.e. rightwing voter, high trust, intensive SMU, etc.). In this case the parameters of interest are $\beta, \tau, \beta + \tau$. Where β captures the impact of the treatments on the outcome for respondents who do not belong to the group identified by w_i, $\beta + \tau$ captures the impact of the treatment for respondents in that group and τ captures the differential treatment effect for the group.

Study 2

The second study is a lab experiment conducted in two phases. We recruited 600 University of Turin students through the CLOSER lab online platform. Participants completed an online pre-experimental survey 10–21 days before attending the lab session. Of these, 459 students attended the experimental sessions at CLOSER lab, along with an additional 14 students, resulting in 473 participants. We exclude participants with poor understanding of the information treatment, yielding a final analysis sample of 451 students. For the hormonal analysis, we further reduce the sample to 372 observations due to safety measures (e.g., participants with flu symptoms or those engaged in activities affecting hormonal responses are excluded). Additionally, for the CRSD game outcomes, participants with poor comprehension of the game instructions are excluded.

The pre-experimental survey was distributed through Qualtrics, taking respondents an average of 32 minutes to complete. We conducted 24 lab sessions from the 26th of February

2024 to the 20th of March 2024. Lab sessions hosted from a minimum of 12 participants to a maximum of 24 and lasted on average 65 minutes.

In the pre-experimental online survey, after general instructions and informed consent, respondents were asked to create an alphanumeric code that is used to match their responses to those of the lab session while ensuring anonymity. The survey included: (i) socio-demographics, (ii) un-incentivized lottery tasks à la Choi et al. (2022), (iii) one attention check, (iv) environmental attitudes questions, (v) social and institutional trust, (vi) prejudice towards immigrants, (vii) time preferences, (viii) numeracy, (ix) political orientation and past voting behavior.
In the lab, participants were provided general instructions and informed consent, as well as they were asked to generate their alphanumeric code. They proceeded with the collection of their first saliva sample using oral swab, supervised by chemistry lab experts[13]. After checking the audio of their lab device (pc), they were (i) exposed to either the 'nature risk' treatment, the 'migration risk' treatment or to the active control condition (as reported in the Methods of Study 1). Randomization was at the session level, meaning that all participants in the same lab session viewed the same video podcast. They completed (ii) incentivized lottery tasks à la Choi et al. (2022) and non-incentivized time preference elicitation tasks. Students were asked (iii) what information was contained in the video podcast (as to check their comprehension of the treatment) and if they were already aware of this information. They played the incentivized (iv) Charity Dictator Game (CDG) before receiving (v) Collective Risk Social Dilemma (CRSD) game instructions and comprehension questions. At this point students were asked to collect their second saliva sample (approximately 15-20 mins after exposure to the video podcast, to be able to observe any hormonal response). They played (vi) 10 rounds of the incentivized CRSD game with stranger matching. Finally, participants were asked to answer questions on (vii) environmental attitudes, (viii) immigration attitudes and (ix) perceived goal of the study.

The information treatments featured the same information to those in Study 1 (we excluded the complete treatment). In the CDG, participants were endowed 15€ and decided how much to keep for themselves and how much they wanted to donate to Greenpeace. The CRSD game differed slightly to Study 1: participants played in groups of four with stranger matching. They received €15 each and collectively needed €30 in the common pool to secure their savings with 100% probability. Otherwise, their savings could be lost with either a 10% or 90% probability. This probability manipulation allows us to distinguish a low and high risk scenario, and it was kept constant for all 10 rounds. Each round, participants decided how much to contribute, their normative beliefs (how much others should contribute), and their empirical expectations (how much others would contribute). Feedback on contributions, payoffs, and whether the group avoided the shock was provided after each round. Endowments were reset after each round, and the common pool contributions were donated to climate change research.

Lottery tasks derived from Choi et al. (2022) were implemented as follows in the pre-experimental survey, participants completed 15 hypothetical lottery tasks in the loss domain, varying in loss probability (5%, 25%, 50%, 75%, 95%) and payoffs. The elicitation of the certain equivalent was done through Multiple Price Listing (MPL). We used one block question for each lottery task. Each decision block involved 11 choices between a risky lottery (left

[13] See OA – Section 3 for further details and Conzo et al. (2021) for a similar procedure.

column) and a safe option (right column). The safe option becoming progressively more attractive (lower) going down the matrix. Participants were asked to choose a unique switching point between the two options, resulting in the left column chosen before the switching point, and the left column after it. In the lab students played 5 lottery tasks with same payoffs and varying probabilities of loss (5%, 25%, 50%, 75%, 95%). Certain equivalent was elicited following a three steps staircase approach (similar to the GPS, Falk et al., 2023, 2016). Respondents were first asked to choose between a risky and safe option. If they chose the safe (risky) choice, they were asked to choose between the same lottery and a lower (higher) safe option, narrowing down their certain equivalent range.
Payments included a €5 participation fee, the payoff of one randomly selected lab lottery task from the 15 choices (5 tasks * 3 steps), and the payoff of one random round from the 10 CRSD rounds or the CDG. Payments ranged from €5 to €25, with an average of €15.85. Payment and debriefing were conducted outside the lab.

Table A15 (OA – Section 1) shows a summary of the variables used in the analysis of Study 2, whereas Table A16 reports summary statistics on the analysis sample (N=451 participants).

In the analysis of hormonal data in Study 2, we estimate the following equation:

$$tc_{it} = \alpha + \theta post_t + \rho treat_i \times post_t + \mu_i + \varepsilon_{it}$$

where: tc_{it} is the testosterone to cortisol ratio for respondent i measured at time t (before or after podcast exposure), $treat_i$ is a categorical variable indicating whether the respondent was exposed to the 'nature risk', 'migration risk' treatment or control, $post_t$ is a dummy variable that takes value of 1 for the post-exposure observation, μ_i is an individual fixed effect, ε_{it} is the error term, ρ is the parameter of interest.
In order to evaluate the differential treatment impact on T/C ratio the model used is:

$$tc_{it} = \alpha + \theta post_t + \rho treat_i \times post_t + \tau post_t \times w_i + \lambda treat_i \times post_t \times w_i + \mu_i + \varepsilon_{it}$$

w_i is a dummy variable indicating whether the individual belongs to a specific subpopulation (i.e. high trust, intensive SMU, etc.). In this case the parameters of interest are $\rho, \lambda, \rho + \lambda$. While ρ represents the treatment impact on respondents who do not belong to the group specified by w_i, $\rho + \lambda$ captures the treatment effect on this specific subgroup, and λ represents the difference between the two.

To analyze lottery outcomes, as in Choi et al. (2022), we follow the estimation procedure proposed by Bruhin et al. (2010) and l'Haridon and Vieider (2019). The observed certain equivalent $\widehat{CE(L)}$ of lottery L, elicited from the lottery task, is equal to the one predicted by our model $CE(L)$ using risk probabilities w(p) = $\frac{\delta p^{\gamma}}{\delta p^{\gamma} + (1-p)^{\gamma}}$, assuming linear utility, plus an error term $\varepsilon(L)$. The error term is normally distributed $N(0, \mu(L)^2)$, where the error term $\mu(L)$ is called Fechner error (Hey and Orme, 1994; Loomes and Sugden, 1995; Loomes, 2005). The error depends on the difference between the high and low outcome of the lottery. The full set of parameters γ, δ, μ is estimated through ML[14]. In order to estimate the impact of the treatments on PWF parameters we specify these parameters in the following linear form:

$$par_{it} = \alpha + \beta treat_i + \theta lab_t + \rho treat_i \times lab_t + \mathrm{X}_i + \varepsilon_{it}$$

where: par_{it} is one of the parameters for respondent i at time t (in the pre-experimental survey or in the lab), $treat_i$ is a categorical variable indicating whether the respondent was exposed to the 'nature risk', 'migration risk' treatment or control, lab_t is a dummy variable

[14] See Choi et al. (2022) for more details on the estimation procedure.

that takes value of 1 for the lab observation, X_i are individual time invariant controls, ε_{it} is the error term, ρ is the parameter of interest.
To evaluate the impact of moderators in this relationship we specify PWF parameters with this linear form:
$par_{it} = \alpha + \beta treat_i + \theta lab_t + \phi w_i + \rho treat_i \times lab_t + \sigma treat_i \times w_i + \tau lab_t \times w_i + \lambda treat_i \times lab_t \times w_i + \mathrm{X}_i + \varepsilon_{it}$
as w_i is a dummy variable indicating whether the individual belongs to a specific subpopulation (i.e. high trust, intensive SMU, etc.), the parameters of interest are $\rho, \lambda, \rho + \lambda$. While ρ represents the treatment impact on respondents who do not belong to the group specified by w_i, $\rho + \lambda$ captures the treatment effect on this specific subgroup, and λ represents the difference between the two.

To estimate the treatment effect on outcomes of the CRSD game we used two different models: either a random effect model or a fixed effect model. In the random effect we used the following regression specification, which allows us to capture the average impact of treatments over rounds:

$$y_{it} = \alpha + \beta treat_i + \mathrm{X}_{it}\pi + U_i + \varepsilon_{it}$$

where: y_{it} is the outcome of interest in round t (i.e. contribution to the CRSD game), $treat_i$ is a categorical variable expressing whether the individual falls into the control group or any of the two treatment groups, X_{it} is a set of controls, U_i is the individual random error, ε_{it} is the error term, β is the parameter of interest.
Estimating heterogeneous treatment effect the model becomes:

$$y_{it} = \alpha + \beta treat_i + \phi w_i + \tau treat_i \times w_i + \mathrm{X}_{it}\pi + U_i + \varepsilon_{it}$$

where: w_i is a dummy variable indicating whether the individual belongs to a specific subpopulation (i.e. high trust, intensive SMU, etc.), the parameters of interest are $\beta, \tau, \beta + \tau$. While β represents the treatment impact on respondents who do not belong to the group specified by w_i, $\beta + \tau$ captures the treatment effect on this specific subgroup, and τ represents the difference between the two.
In the fixed effect model, which allows us to capture the impact of the treatments on the dynamic behavior of respondents, the regression specification reads as follows:

$$y_{it} = \alpha + \theta round_t + \rho treat_i \times round_t + \mathrm{X}_{it}\pi + \mu_i + \varepsilon_{it}$$

$round_t$ is a continuous variable indicating the round of the CRSD game the observation refers to. μ_i is the individual fixed effect. The parameter of interest is ρ.
$y_{it} = \alpha + \theta round_t + \rho treat_i \times round_t + \tau round_t \times w_i + \lambda treat_i \times round_t \times w_i + \mathrm{X}_{it}\pi + \mu_i + \varepsilon_{it}$
is the specification used to estimate the differential treatment effects for subpopulations. w_i is a dummy variable indicating whether the individual belongs to a specific subpopulation (i.e. high trust, intensive SMU, etc.), the parameters of interest are $\rho, \lambda, \rho + \lambda$. While ρ represents the treatment impact on respondents who do not belong to the group specified by w_i, $\rho + \lambda$ captures the treatment effect on this specific subgroup, and λ represents the difference between the two.

For all other outcomes we use the same regression models as in Study1.

Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

The entire research was approved by the Ethical Committee of the University of Turin (protocol no. 0452970, date: 28/07/2023).

Consent to participate

Informed consent was obtained from all individual participants included in the study.

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