Forward-looking belief elicitation enhances intergenerational beneficence

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Abstract

One of the challenges in managing the Earth's common pool resources, such as a livable climate or the supply of safe drinking water, is to motivate successive generations to make the costly effort not to deplete them out of reasons including intergenerational beneficence. In the context of sequential contributions, intergenerational reciprocity dynamically amplifies low past efforts by decreasing successors' rates of contribution. The behavioral literature provides few interventions to motivate intergenerational beneficence. We identify a simple intervention that motivates contributions by decision makers who are not beneficiaries of their predecessors effectively disabling the negative side of intergenerational reciprocity. In a large online experiment with 1378 subjects, we show that asking decision makers to forecast future generations' beneficence considerably increases their rate of contribution (from 46% to over 60%). By shifting decision makers' attention from the immediate past to the future, the intervention is most effective in enhancing intergenerational beneficence of subjects who were not beneficiaries of their predecessors, effectively neutralizing negative intergenerational reciprocity effects. We provide suggestive evidence that the attentional channel is the main mechanism at work.

Introduction

Containing climate change within safe limits is one of the major challenges faced by humanity (IPCC, 2018; Tol, 2009). No matter how it is framed, successful action will require current generations to sacrifice some of their interests for those of future generations. The intergenerational dynamics of the climate change problem have frequently been identified as one of the main reasons why the atmosphere is aggressively exploited as a greenhouse gas sink (Fischer et al., 2004; Mason and Phillips, 1997). The intergenerational dilemma is becoming more widely recognized by the general public as well, as shown by the Fridays for the Future and other civic youth movements. This altruistic motive of providing for future generations can be harnessed to motivate action (Zaval et al., 2015). Here we investigate an intervention designed to enhance such motivation.

Climate change mitigation is especially challenging because it has not only the global public good features, but also the intergenerational features (Sherstyuk et al., 2016). Many experimental studies designed to inform the management of climate change emphasize the global public good dimension of this problem, but give less attention to the intergenerational one (Kube et al., 2018). Experimental studies of this kind generally look into the contribution to a public good, or a threshold public good, that immediately benefits all contributors, in case it is provided (Fischer et al., 2004; Hauser et al., 2014; Milinski et al., 2008; Rockenbach and Milinski, 2006).

The difficulties in raising the public goods are exacerbated by the intergenerational dimension of the climate change problem, as future generations in the climate change problem are passive recipients of preceding generations' actions. The intergenerational feature deactivates powerful incentives to cooperation that are active in public good games within one generation, namely direct and indirect reciprocity, and communication. As a result, sustainability must rely on the non-strategic motivation of intergenerational beneficence, which is usually found insufficient, see previous studies (Hauser et al., 2014; Jacquet et al., 2013; Sherstyuk et al., 2016).

In this paper, we explore this intergenerational dimension, while abstracting from the cooperation/coordination settings typically employed. Our experiment focuses on intergenerational beneficence and how it is shaped by predecessors' behavior as well as beliefs about successors' behavior in the intergenerational dilemmas (Wade-Benzoni and Tost, 2009). We introduce a simple behavioral intervention that asks decision-makers to forecast the decisions of future generations before making their own contribution decision. This new intervention builds on query theory (Johnson et al., 2007; Weber et al., 2007), which suggests that people make decisions by posing a series of queries that retrieve different aspects of the decision and that the order of the queries influences which option is picked. Our study is the first to explicitly include both backward- and forward-looking considerations in an intergenerational setting and to consider how decision makers' attention shifts from one to the other. Using a large online experiment with more than a thousand subjects, we find that this simple intervention considerably increases the rate of intergenerational contribution, from 46% to 60%. In particular, the intervention offsets the reduction in the contribution of subjects who are not beneficiaries of their predecessors' action, effectively neutralizing negative intergenerational reciprocity effects.

Related Literature

The intergenerational dimension of the climate change problem is related to the sequential public goods game (Gächter et al., 2010; Normann and Rau, 2015), but differs in the sense that the current generation's payoff only depends on decisions of previous generation and their own, but not on the decision of future generations. This power asymmetry between the generations (Wade-Benzoni, 2002) completely removes the possibility of direct and indirect reciprocity (Fehr and Fischbacher, 2003). For first movers in a sequential game, it is in their self-interest to care about second or

subsequent movers' payoffs; in contrast, in the intergenerational setting it is not in the self-interest of the current generation to care about the payoffs of future generations.

Some experimental studies have examined the coordination within the same generation, adapting the public goods game in different ways. One influential setting is the collective-risk social dilemma, in which the decision makers need to reach a fixed target sum through monetary contribution to avoid losing their remaining money with a certain probability (Milinski et al., 2008). Whether decision makers reach agreement on the efficient collective decision depends on various factors, such as the probability of losing their endowment in case the target sum is not met (Milinski et al., 2008) and inequality in endowment among the decision makers (Tavoni et al., 2011).

Some other experimental studies use the intergenerational version of the common pool resources dilemma to study the maintenance of resources. There is a high degree of heterogeneity in individual preferences for resource exploitation in the intergenerational common pool problem setting (Chermak and Krause, 2002). Although decision makers in such settings can see the need for restraint in intergenerational resource use, they generally do not take the corresponding actions themselves but falsely expect that others will restrain from overexploitation (Fischer et al., 2004).

One of the factors examined in the literature to promote sustainability in common pool resource dilemmas is communication. Communication among decision-makers substantially increases the likelihood of cooperation and efficiency (Hackett et al., 1994). In case the decision makers' collective decision has a negative externality on out-group members, decision makers incorporate the out-group members' utility in their decision when contact with the out-group members is possible, but almost completely ignore their utility when there is no way of contact, suggesting an attentional mechanism (Delaney and Jacobson, 2014). Our paper does not consider the factor of communication because our setting focuses on the case when the current generation is deciding to benefit or harm a non-overlapping future generation, and communication is absent or minimal.

Other than communication, two other methods have been suggested as candidates to mitigate challenges to sustainability in the literature. One method is to increase the social utility associated with the sustainable option. In an experiment where the public goods are to be invested in, making the altruistic contribution decision publicly visible reinforces altruism. Publicity allows contributors to gain in social reputation, which tends to be rewarded by others, in future social interactions after the contribution (Milinski et al., 2006). The third method is to determine the collective level of exploitation by binding vote for all involved. When deciding based on majority vote, the level of total extraction, as determined by the median, tends to preserve resources that would be destroyed had each one individually made one's own extraction decision (Hauser et al., 2014).

Both methods above, increasing the visibility of altruistic contribution and voting, would induce greater sustainability under one prerequisite: that the majority of the decision-makers are in favor of sustainability. In case this assumption does not hold, other methods are needed to boost individual support for sustainability, which substantially depends on decision-makers' attitudes towards the future generations: their intergenerational beneficence.

A different strand of literature, mostly in psychology, has long been concerned with intergenerational beneficence and the channels through which it might be activated. Indeed, although the material interests of the current generation and future generations are not aligned, there are reasons for intergenerational beneficence to take place. The survival of one's genes (Simon Fan, 2005) and the desire to be remembered positively (Wade-Benzoni et al., 2012, 2010; Zaval et al., 2015) are two examples of possible motives. Increasing the salience of these motivations has been found in these studies to increase intergenerational beneficence, reflected by increased intergenerational contribution. Social considerations such as social norms, fairness of contributing, as well as pure altruism, can also be expected to increase intergenerational beneficence (Bang et al., 2017; Fischer et al., 2004; Hauser et al., 2014; Kamijo et al., 2017; Wade-Benzoni et al., 2008; Wade-Benzoni and Tost, 2009).

All these motivations for intergenerational contribution on the part of the current generation for the benefit of a future generation tend to be forward-focused. What has received less attention is how previous events in the intergenerational chain shape the current generation's intergenerational beneficence and beliefs about the future. A few studies have looked at the impact of the predecessor's choices (Bahr and Requate, 2014; Bang et al., 2017; Hernandez et al., 2015; Wade-Benzoni, 2002) and have identified *intergenerational reciprocity* as a powerful heuristic in intergenerational decisions. Intergenerational reciprocity is the tendency to copy the behavior of the immediate predecessor and its perceived intention to benefit or damage those that follow (Bang et al., 2017; Wade-Benzoni, 2002). Such reciprocity has, by its nature, a backward-looking attentional focus as opposed to a forward focus on the consequences of one's decision on future generations. When the predecessor contributed, no conflict exists between a decision based on backward-focused intergenerational reciprocity and one based on forward-focused motivations as intergenerational efficiency or fairness and both would increase the likelihood to contribute. When the predecessor did not contribute, however, forward-looking considerations clash with backward-focused negative reciprocity, and the likelihood to contribute depends on which focus gets initial (and, according to Query Theory, thus greater) attention.

Negative intergenerational reciprocity could generate long chains of low contribution, effectively disrupting sustainability. In the case of climate change, intergenerational reciprocity often plays against intergenerational beneficence, as countries that could do the most today to limit future greenhouse gas emissions are often the ones that benefited the least from the wealth created by past emissions (Tavoni et al., 2014). Perceiving this intergenerational unfairness, today's high emitting countries and their inhabitants may feel less strongly a moral obligation to mitigate emissions, even

though mitigation in these countries would be most effective and efficient, and their current emissions cause the same amount of future damage as the emissions by other countries (Dubash, 2012).[a] Information interventions giving the decision makers access to the history of previous decisions or to the advice of previous generations, meant to increase the contribution to the public good, may backfire when previous generations have not contribute through the mechanisms of negative reciprocity (Sherstyuk et al., 2016). The threat from negative intergenerational reciprocity is increased by the difficulty to moderate its impact. A few successful moderation intervention involve priming decision makers with death (Wade-Benzoni, 2019; Wade-Benzoni et al., 2012) and their legacy motives (Bang et al., 2017). While effective in specific contexts, such interventions may meet practical and moral challenges when applied at large scales outside of the lab. Our novel setting allows us to consider both the forward- and backward-looking considerations of intergenerational contribution and test how the intervention affects the relative importance of the two.

Forward-looking belief elicitation, the intervention that we propose in this paper, suggests that shifting the public conversation from the traditional narrative that we "should act for the sake of future generations," to a narrative reflecting on "what future generations will do", might increase willingness to increase current climate efforts. In public good game settings, (incentivized) belief elicitation increases contributions of individuals in the same generation (Gächter and Renner, 2010). Whether such type of intervention, with and without incentives, works in the intergenerational settings is what our study sets out to investigate.

In the current paper, we try to break the cycles of negative intergenerational reciprocity with a behavioral intervention based on query theory (Johnson et al., 2007; Weber et al., 2007). Query theory has been shown to explain differences in choice as a result of normatively-irrelevant differences in the

[a] Other arguments are also brought forth in justifying lower rates of contribution to global climate policy by some parties. Here we argue that intergenerational reciprocity is one crucial component.

decision context, such as the endowment effect (Johnson et al., 2007) or the influence of the default options (Weber et al., 2007). Query theory explains these and several other choice anomalies by differences in attention to different choice alternatives that are affected by the order in which internal automatic queries about arguments for choosing each alternative are issued to the decision maker's knowledge base. A query that evaluates the arguments for one option temporarily inhibits evaluation of arguments for the other options and thus results in a larger recall of arguments for choosing the option first considered (Weber and Johnson, 2009).

The behavioral intervention of forward-looking belief elicitation we propose serves as a "nudge," which influences choices without imposing direct costs on decision-makers (Bhargava and Loewenstein, 2015; Hagmann et al., 2019; Thaler and Sunstein, 2009). In particular, we ask subjects the following belief elicitation question before they make their own contribution decisions: "For a moment, look into the future and give us your best guess of how many among the 4 participants who will follow you will contribute 10 cents (i.e., choose Decision B)?" Since the belief elicitation focuses subjects' attention on Decision B, we hypothesize that they will also query their knowledge base for arguments for choosing Option B first, when they make their own contribution decision, resulting in an increased probability of selecting that option, due to the Query Theory first-option-considered boost. Note that this effect of belief elicitation is the same, whether or not there is a monetary incentive for correct belief elicitation.

To summarize, despite the growing knowledge about intergenerational beneficence, there is a lack of effective behavioral interventions applicable to the general public to motivate intergenerational contribution. Building on the existing experimental literature on this topic (Thaler and Sunstein, 2009; Tost et al., 2015; Tversky and Kahneman, 1986; Wade-Benzoni et al., 2012, 2010; Weber et al., 2007; Zaval et al., 2015), we test our intervention in an *intergenerational dilemma*, in which the decision maker's material interests are in conflict with the interests of the future others and the present decision

maker has complete unilateral decision power (Wade-Benzoni and Tost, 2009). That is, since current decision makers will not be affected by any decision of the future others, they have no self-interested motive to contribute.

Method

We study intergenerational beneficence and test the effect of our intervention with an incentivized experiment on Amazon Mechanical Turk. Although experiments cannot replicate all details of influential events such as political elections, international negotiations, and the evolution of social norms, human behavior observed in such stylized and structured settings has provided useful insights into the mechanisms governing human cooperation (Calzolari et al., 2018; Morton and Williams, 2010; Rockenbach and Milinski, 2006; Schotter and Sopher, 2003).

Experimental Design

In this experiment, each decision maker is endowed with an amount of money and can decide either to keep the full amount (decision A); or to forego a fixed amount, *d*, out of this endowment (decision B) in order to make a contribution to the next decision maker, who then receives an endowment incremented by an amount α. The intergenerational contribution is socially efficient, i.e., α is greater than *d*. The decision in the intergenerational dilemma is formulated through a dichotomous choice (i.e., are you willing to leave amount *d* so that the next generation will benefit from increment α, or not?). As a result, the endowment *E* of each decision maker can be either high, $E_H = \underline{E} + \alpha$, or low, $E_L = \underline{E}$, depending on whether the previous generation did or did not contribute. Possible take-home payoffs are then $\underline{E} + \alpha$, $\underline{E} + \alpha - d$, $\underline{E}$, and $\underline{E} - d$. A sequence of payoffs equal to E_L, resulting from the extreme case of a sequence of generations each choosing not to contribute, would be socially inefficient; on the other extreme, if every generation contributes *d*, this would generate a sequence of payoffs equal to $E_H - d$, which would be socially efficient. In the lab, we expect to see any sequence between these two extremes. Figure 1 illustrates a possible sequence of 5 payoffs realized in the experimental setting (in bold) and its counterfactual at each generation. In the implementation of the experiment, a **non-beneficiary** decision maker receives the low endowment $E_L = \underline{E} = 50\ cents$. A **beneficiary** decision maker receives a high endowment, $E_H = \underline{E} + \alpha = 70\ cents$, where the contribution of the previous generation cost them *d =10*. We chose the parameters to have *α /d = 2*, as

previous studies suggest that this should support a balanced set of selfish and altruistic decisions in the control treatment.[b]

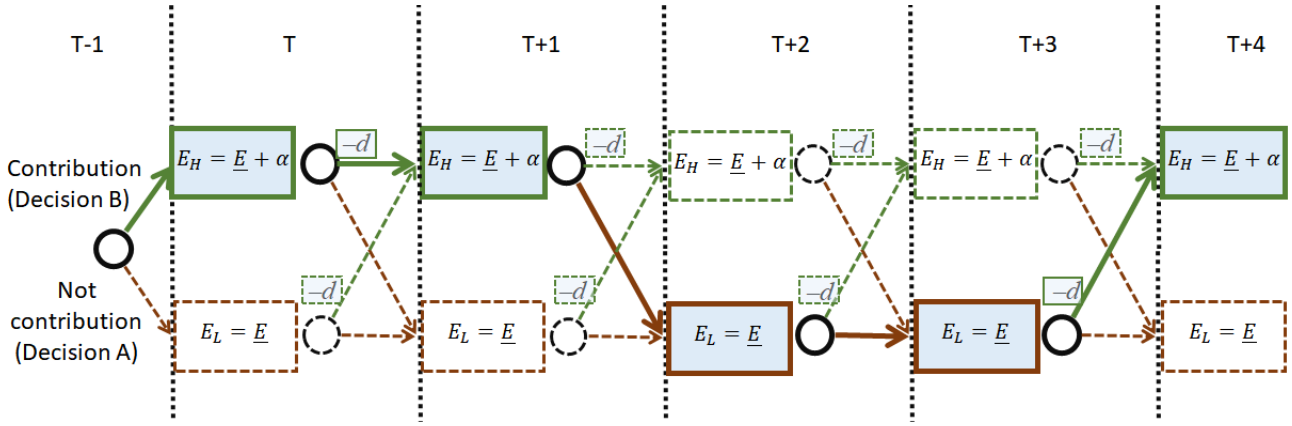


Fig. 1. A flow of the intergenerational dilemma. The nodes and arrows represent the decisions to choose between Decisions A and B at different times. The rectangles represent the resulting endowment for the decision maker in each generation living at each time point, at which she knows before her own contribution decision is made. Green (red) arrows and rectangles correspond with the decision of contribution (not contribution) and the resulting endowments of the beneficiary and non-beneficiary decision makers in the next generation. Nodes, arrows, and rectangles with bold solid lines are the ones of one path that could take place while the ones with dashed lines show the counterfactuals.

This experimental setup undoubtedly simplifies real-world intergenerational dilemmas but has the advantage of simplicity and of isolating intergenerational beneficence as the single motive for contributing.[c] In the basic structure of the game described above, we introduce three treatments to test the effectiveness of eliciting decision makers' forecasts about future contributions before they decide on their own contribution, described next.

[b] Studies that explored donations in a dictator game with different α /d ratios find that, when α /d =2, the average contribution increases to somewhat above 50%, from 27% in the case of α = d (Andreoni and Vesterlund, 2001). In a field experiment on matching in a charitable contribution (Karlan and List, 2007), the effect of the multiplier appears to asymptote at about 2. Having received α from the previous generation might induce an income effect, although the literature suggests the effect unlikely to be influential, e.g., one study shows that the effect of stakes is not a significant determinant of donations (Carpenter et al., 2005). For the sake of caution, we chose a small α (20 cents) to constrain any potential income effect.

[c] A closely related practice in the literature is to keep the endowment of the decision maker constant after generous and non-generous predecessors to provide decision makers with the same ability to leave money for the future (Bang et al., 2017; Wade-Benzoni, 2002). To achieve this, the generous and non-generous predecessors have different endowments and contribute different proportions but the same amount (e.g., a generous predecessor contributes $6 out of $8 while a non-generous one contributes $6 out of $24). This practice keeps the same endowment for decision makers while the endowments differ between generations ($9 vs. $8 or $24) and differ between predecessors of different decision makers ($8 vs. $24). Our setting has the same two levels of endowments, high and low, in all generations, to increase comparability across generations and decision makers. To limit the impact of the endowment on the decision maker's ability to contribute, we set the contribution to be a dichotomous decision with a modest amount.

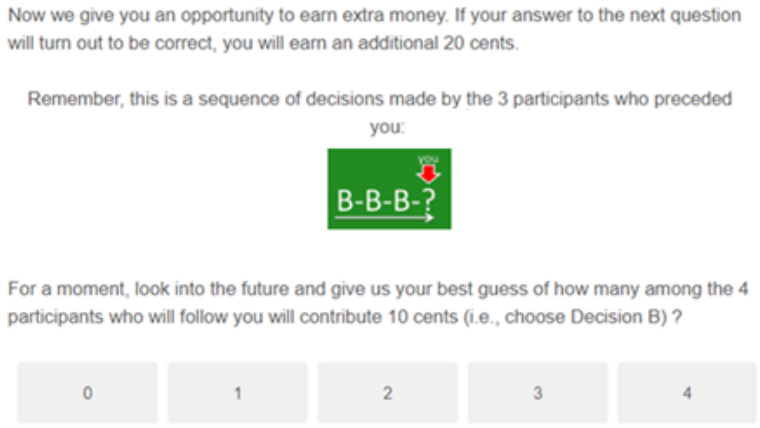
Forecast Treatments

In addition to the contribution decision, we asked all subjects to forecast how many of the subsequent four decision-makers in the sequence would contribute (see snapshots in Fig. 2). The forecast question is asked either before or after the contribution decision.

Each subject is randomly assigned to one of the three treatments. In the control treatment, the forecast elicitation takes place after the contribution decision (**Forecast After**). Since the forecast is made after the contribution decision, the contribution rate is not affected by the forecast elicitation. In the second treatment (**Forecast Before**), the forecast elicitation comes before the contribution decision. The treatment effect of forecasting was estimated by comparing the contribution rate in treatments Forecast After and Forecast Before. Orthogonally to the treatments, each subject was randomly assigned to be either a beneficiary or a non-beneficiary.

We incentivize truthful forecasting by paying the subject 20 cents for a correct forecast. One possible confounding factor in this comparison between Forecast Before and Forecast After treatments is that a decision maker in the Forecast Before treatment may consider the expected payoff from the forecast elicitation question when making the contribution decision, creating a possible income effect. If the forecast intervention only works when subjects are paid according to their accuracy, it would be very difficult to implement in the real world since the current generation could not observe the future generations' decisions, let alone being paid now according to their estimation of those decisions. Furthermore, our QT explanation for the effectiveness of the intervention suggests that financial incentives are incidental. We test the role of incentive for estimation in our third treatment (**Forecast Before without Incentives**), in which everything was the same as in the Forecast Before treatment, except that there was no financial payment incentive for a correct forecast.

(a) Contribution



(b) Forecast estimation

Fig. 2: snapshots of the contribution and forecast estimation pages in the experiment of Treatment Forecast After.

"Contribution" and "forecast estimation" are the two central tasks for each subject. Fig. 2 shows an example of the screens that our subjects saw in treatment Forecast After. Order of the two tasks is reversed, i.e., the forecast (either incentive or not) comes before the contribution in treatments Forecast Before and Forecast Before without Incentives (see Fig. S1 in the appendix). As shown in the example, each subject is given information concerning the contribution choice of her predecessor (or a sequence of predecessors). Although only the direct predecessor's decision affects the player's endowment, information given to the player can include also a longer chain of decisions, depending on the condition. The information about previous generations' actions, can be any among the following six

sequences and is assigned randomly. The sequences in the six information conditions are: **B**, **A,** BB**B**, AA**A**, BBB**A**, AAA**B**. The first two represent condition without sequence information but the predecessor's decision (i.e. information on the preceding player's choice, either A or B, is given); the second two represent consistent sequences of choices, either positive (with three consecutive B) or negative (with three consecutive A); the two remaining sequences explore the situation of a positive (negative) sequence followed by a negative (positive) choice made by direct predecessor. All treatments and information conditions are summarized in Table 1.

After making their contribution and forecast decisions, subjects provide demographic information. We asked the subjects at the end of the experiment to rate (on a 3-point Likert scale, "not relevant," "somewhat relevant," and "highly relevant") how much the following three factors affected their contribution decision:

(a) "the decision of the previous participant" (intergenerational reciprocity),[d]

(b) "doing what is the fair thing to do" (fairness), and

(c) "the fact that the next participant gains more than I contribute" (social efficiency).

In addition, we asked three questions regarding their altruism traits, two questions (altruism 1 and altruism 2), positively, and one question (altruism 3), negatively, measure the altruistic tendency (detailed information on this final set of questions is provided in the codebook in the Appendix).

Experiment Implementation

Experiment Recruitment

We tested the effect of this behavioral intervention using an online experiment. Subjects of the experiment were recruited from Amazon Mechanical Turk, an online labor market, in the period

[d] The labels in the brackets were not shown to the subjects, the same for (b) and (c).

between April 27 and June 7, 2017. We recruited online workers located in the United States to facilitate the comparison of demographic information with the general population. Following the literature on online experiments (Peer et al., 2014), in order to collect high-quality data, we filtered the worker sample to have *a)* completed more than 50 Human Intelligence Tasks (HITs) and *b)* an approval rate higher than 95 percent from past employers. Each subject was introduced to the general rules of the experiment, including the relationship between her decision and the subsequent person's endowment, as well as her own endowment and its relationship to the predecessor's decision.

Recruiting subjects to complete the tasks in actual sequences would make their responses dependent to each other within a sequence and, more importantly, the conditions (endowments, historical information) endogenous. To allow for a clear distinction between the effects of treatments and conditions and keep the implementation of our experiment simple, all treatments and conditions shown in Table 1 are randomly assigned to each subject. To avoid deceiving subjects with the information provided, we made sure, ex-post, that the sequence of decisions presented to each subject existed in the study. In particular, we made sure that for each beneficiary in the experiment, there existed a subject who contributed.

To determine the bonus for accurate forecasts in the treatments where forecasts were incentivized (Forecast After and Forecast Before), we simulated the future generations' decisions using p_A and p_B estimated from all observations. The accuracy of prediction was not significantly affected by our treatment. For treatments Forecast After, Forecast Before, Forecast Before without Incentives, the accuracy rates are 20.04%, 21.72%, 23.75%, all low, given that a random guess would have a 20% accuracy. The predictions (M=1.90, Standard deviation=1.14) biased towards underestimating the probability for intergenerational contribution to take place compared to the simulated answers (M=2.49, Standard deviation=1.08), $t=13.92$, $p<0.01$.

Randomization and Attrition

We recruited 1378 subjects on Amazon Mechanical Turk (AMT) to be in the Forecast After, Forecast Before, and Forecast Before without Incentives treatments, with 464, 455, and 459 subjects, respectively. Our sample was more representative than the previously more typical one for experiments of this sort, mainly consisting of university students, although still younger and with lower average income than the general US population (see Table S5 in the appendix).

Preceding sequence (information condition)	Sequence type	Endowment	Forecast After	Forecast Before	Forecast Before without Incentives
BB**B**	Positive	High	73	76	76
AAA**B**	Negative	High	81	81	78
B	None	High	75	75	76
BBB**A**	Positive	Low	80	75	75
AA**A**	Negative	Low	78	73	76
A	None	Low	77	75	78

Table 1: Number of observations in each treatment with each information condition.

In total, 1696 respondents started the experiment, and 1378 of them completed it. Being aware of the hazard of attrition, we kept the experimental session short, with a median time of 6 minutes. To examine potential bias from attrition (Rand, 2012; Zhou and Fishbach, 2016), we tested for a treatment-dependent attrition rate. The attrition rate of our experiment was 18.75% (318/1696), which is lower than usually found in experiments on Amazon Mechanical Turk. Besides, most (215/318) of the incomplete responses dropped out before treatments were assigned to them. The attrition rate after treatment being assigned was 6.95%, with the attrition rate of 31/495, 38/493, and 34/493 for the

Forecast After, Forecast Before, and Forecast Before without Incentives treatments respectively, which were not distinguishable (Chi-square = 0.80, p = 0.67).

Results

To estimate the effects of different conditions on the subjects' decisions, we aggregate the three information conditions (i.e., information about contribution history preceding the consequential most recent one) and only evaluate them separately when analyzing the forecast estimates. (For detailed summary statistics of each information condition, please see Table S1 in the Appendix). We will start off by discussing the strength of intergenerational reciprocity and its influence on contribution rates in our data. Next, we will describe the treatment effects in neutralizing the negative effect of intergenerational reciprocity on contribution. Subsequent sections will detail the channels through which the treatment effects take place.

Contribution rate and Intergenerational reciprocity

We find strong evidence for intergenerational reciprocity in our data, consistent with the literature. The probability of intergenerational contribution, all treatments pooled together, is 70% for the beneficiaries, but only 55% for the non-beneficiaries of a previous contribution (Chi-square = 30.74, $p < 0.001$). In the baseline treatment (Forecast After), intergenerational reciprocity has an even stronger influence on the contribution rate, which is 68% among the beneficiaries, and it is reduced to 46% among the non-beneficiaries. As we discuss in the next section, the Forecast Before treatments nullify the negative effect of intergenerational reciprocity.

To better understand the individual tendency to act as predicted by intergenerational reciprocity, we examine subjects' answer to the survey question concerning the importance of the contribution of the predecessor. The overall proportions of individuals reporting that the predecessor's decision was "not relevant," "somewhat relevant," and "highly relevant" were 33%, 36%, and 31%, respectively.

We find that self-reported importance of predecessor's decision is highly correlated with actual behavior: for those who report that the predecessor's decision is "highly relevant" to their own contribution decision, the correlation between their contribution decision and that of their predecessor is 0.56 (95% CI = [0.49, 0.62]); for those who report "somewhat relevant", the correlation is 0.20 (95% CI = [0.11, 0.28]); and for those who report "not relevant," the correlation is −0.30 (95% CI = [−0.38, −0.22]). All three coefficients are significantly different from 0 and from each other at a confidence level of 95%. The data show that this answer indeed reflects the subjects' attitudes towards the predecessor's decision, as attitudes are correlated with decisions. It is noteworthy that those who report that the previous generation's contribution behavior is "not relevant" show instead a contribution behavior that is negatively correlated with that of their predecessor (i.e., they tend to do the opposite to the predecessor's decision) rather than no correlation.

Table 2 shows the influence of intergenerational reciprocity and other considerations on the contribution decision. Other considerations include fairness, social efficiency, and altruism (altruism 3 is a reverse index of altruism), as self-reported by subjects. The coefficients are all positive, both in the regression with the full sample and in the ones with the beneficiary or non-beneficiary sub-samples. The effect of intergenerational reciprocity, in line with the correlational analysis above, depends on whether or not the decision maker is a beneficiary.

Table 2: Effects of intergenerational reciprocity, fairness, efficiency concerns, and three altruism measures on intergenerational contribution. Standard errors are in brackets. ***, p<0.01; **, p<0.05.

DV: contribution=1 (DM chooses B) or 0 (choice of A)	Full sample	Non-beneficiaries sub-sample	Beneficiaries sub-sample
Endowment	−1.74 *** (0.25)		
intergenerational reciprocity	−0.70*** (0.08)	−0.72*** (0.08)	0.48*** (0.09)
intergenerational reciprocity × endowment	1.13*** (0.12)		
Fairness	1.02*** (0.07)	0.97*** (0.09)	1.10*** (0.10)
Social Efficiency	0.15** (0.06)	0.26*** (0.09)	0.02 (0.09)
Altruism1	0.13*** (0.02)	0.18*** (0.03)	0.07** (0.03)
Altruism2 (/1000)	0.82*** (0.30)	0.98** (0.39)	0.53 (0.47)
Altruism3 (non-altruism)	−0.05*** (0.02)	−0.01 (0.02)	−0.10*** (0.02)
Constant	−1.64*** (0.26)	−2.27*** (0.34)	−2.84*** (0.31)
N	1362	678	684

Belief Elicitation treatment effects on contribution rate

Aggregated over the two sub-groups of beneficiaries and non-beneficiaries, the proportion of contribution when the forecast task takes place before the contribution decision (**Forecast Before treatment**) is 64%, notably higher than that in the **Forecast After treatment**, 57% (Chi-square = 4.50, p = 0.03). Figure 2 unpacks this result, showing that the effect is mostly driven by the change in the behavior of the non-beneficiaries. Being asked to forecast the behavior of successors substantially increases the proportion of contributors from 46% (Forecast After treatment) to 57% (Forecast Before treatment) (Chi-square = 5.10, p = 0.02). For beneficiaries, there is no significant difference in the rates

of contribution between the Forecast Before and Forecast After treatments, with the proportion of contribution being 68% and 70%, respectively (Chi-square = 0.25, p = 0.62).

The positive effect on contribution persists even when the forecast is not incentivized (Pooling both beneficiaries and non-beneficiaries, Chi-square = 10.66, $p < 0.01$; for the non-beneficiaries subgroup, Chi-square = 14.12, $p < 0.01$), confirming that the treatment effect is not coming from the incentives.[e]

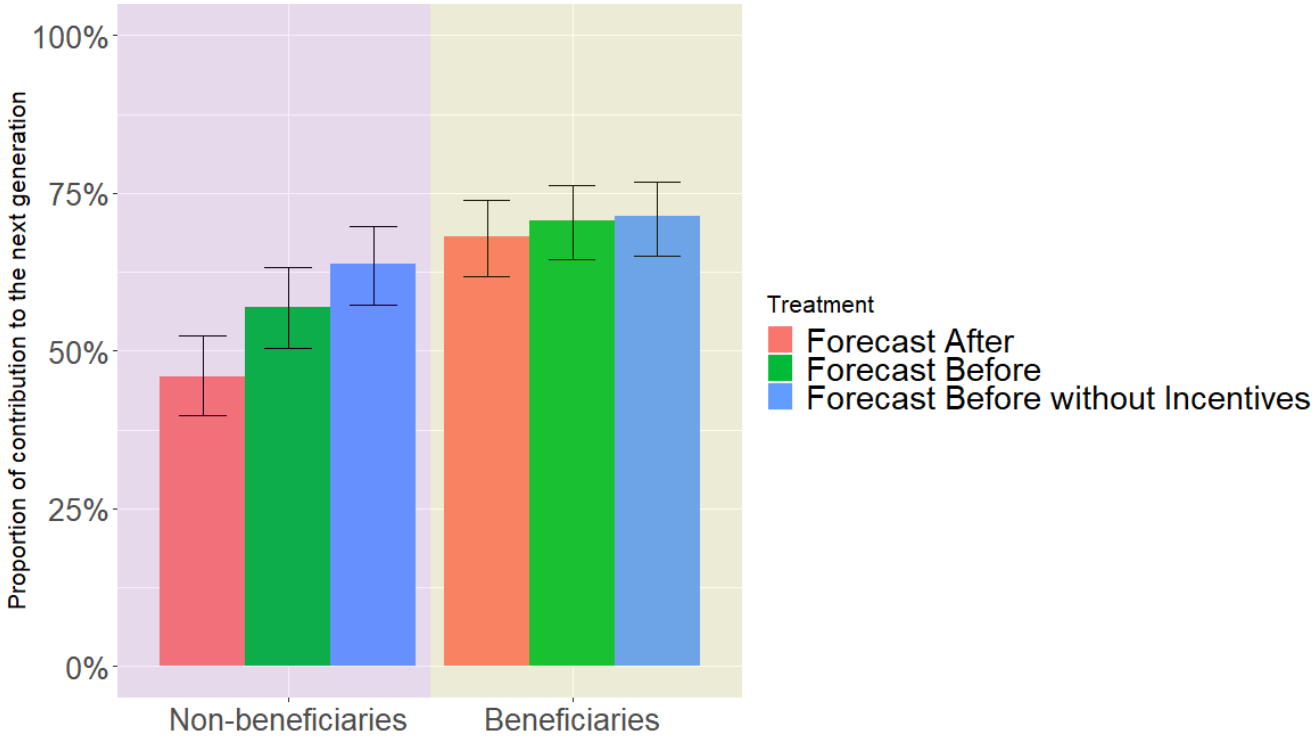


Fig. 2. The Proportion of contribution to the next generation as a function of being beneficiaries or non-beneficiaries and treatments (error bars show the 95% confidence interval).

How much influence does the treatment have on contribution rate in the long run? A straightforward model of contribution, capturing intergenerational reciprocity, would pose that the probability of contribution only depends on whether or not the predecessor contributed: p_B after a previous contribution and p_A after no previous contribution, with $p_B > p_A$. In such a simple

[e] The proportion of contribution is greater if the forecast is not incentivized though the difference is not statistically different (Chi-square = 1.15, p = 0.28).

"Bernoulli" style model with two probabilities of contribution, p_B and p_A, the expected long-run proportion of contributions can be shown to be $p_A/(1-(p_B-p_A))$. Compare this to a basic Bernoulli trial, in which by the law of large numbers the long-run proportion is given by the (single) probability of success: $p = p_A = p_B$.

If we were to estimate these probabilities from our data, we would get p_B =69% and p_A = 46% when subjects are *not* asked to evaluate future generations' decisions before their own decision (as in treatment Forecast After). When, instead, they are asked for their forecasts about the future *before* their own decision (as in treatment Forecast Before), p_B increases slightly from 69% to 71%, but it is p_A that is strongly affected growing from 46% to 57%. Thus, the intervention raises the expected long-run proportion of contributions by six percentage points from 60% to 66%.

The attentional channel

Grounded in query theory, we propose the attentional channel as the main channel through which our treatment neutralizes the negative side of intergenerational reciprocity. Query theory posits that our treatments, by affecting the order of the queries our subjects use in valuing contributing to the next generation would affect the contribution decision. Without the treatment intervention (in treatment Forecast After), the decision maker's query would likely start from considering the decision of the predecessor, since that information is just provided to her as the explanation of her endowment. Such a query order would increase the possibility of decisions in line with intergenerational reciprocity, a pattern that we clearly documented above. The forecast elicitation interferes with such ordering as the forecast task induces decision makers to consider the behavior, and the existence, of future generations, and in its framing (to judge the number of future participants who *will* contribute) also focuses attention on the contribution option. When it is time for their own contribution decision, the forecast task has primed decision makers to start with the query that considers arguments for Option B first.

The predictions of query theory are in line with what we observed (see Figure 2). In addition, we also can use data on self-reported motives and their importance. Table 3 shows the results of linear regressions of the reported relevance of the three concerns (Intergenerational reciprocity, Fairness, and Social Efficiency) as a function of providing the forecast about future contributions before (Forecast Before or Forecast Before without Incentives) in contrast to baseline treatment (Forecast After) for the two sub-samples of beneficiaries and non-beneficiaries.

Table 3: Effect of eliciting Future Contributions Forecasts before vs. after the Contribution Decision on three self-reported Justifications for the Contribution Decision for different experimental groups. Standard errors are in brackets. ***, p<0.01; **, p<0.05.

DV	Intergenerational Reciprocity		Fairness		Social Efficiency	
Sample	**Non-beneficiaries**	**Beneficiaries**	**Non-beneficiaries**	**Beneficiaries**	**Non-beneficiaries**	**Beneficiaries**
Forecast Before	−0.27***	−0.13	0.13	0.09	0.13	0.07
	(0.08)	(0.07)	(0.08)	(0.07)	(0.08)	(0.07)
Forecast Before without Incentives	−0.20***	−0.08	0.09	−0.08	0.22***	−0.1
	(0.08)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)
Constant	2.20***	2.78***	2.10***	3.15***	1.68***	2.86***
	(0.61)	(0.49)	(0.60)	(0.50)	(0.60)	(0.48)
N	686	691	686	691	686	691

Reported relevance of the Intergenerational Reciprocity motive is strongly reduced by both future-focusing treatments (Forecast Before and Forecast Before without Incentives). As predicted, the treatment effects are significant only for the non-beneficiaries. Note that the treatments also increase the efficiency motivation of the non-beneficiaries (although the effect is statistically significant only for the Forecast Before without Incentives treatment).

Query theory predictions about changes in attentional processes and resulting differences in initial internal queries (Johnson et al., 2007; Weber et al., 2007; Weber and Johnson, 2009) are just one of multiple, non-mutually exclusive reasons for the effectiveness of our treatment of forecasting future

generations' beneficence to neutralize the negative side of intergenerational reciprocity. Subjects may also be reminded by the forecasting task of the power that they have over future generations, and the sense of power boost intergenerational beneficent (Tost et al., 2015). Another explanation is that the question could make them feel that their decision will be judged by future generations, resulting in increased legacy motivation (Wade-Benzoni, 2019).

In light of the evidence presented, we postulate that it is a shift in attention away from the most recent decision in an intergenerational chain and the resulting neutralization of (negative) intergenerational reciprocity as the primary explanatory mechanism for the success of our treatment. Our results allow us to rule out three alternative mechanisms: a change in perceived social norms, an increase in altruism, and strategic considerations.

Unsupported alternative channels

Perceived social norm

To test the hypothesis that the perceived social norm is a channel through which our forecast elicitation works, we can leverage on results obtained by changing information on the history of previous generations. The positive (negative) sequences substantially increased (decreased) the subjects' forecast of future generations' generosity (Table S2, left column), but the sequences do not show consistent effects on contribution. As shown in the right column of Table S2, the positive sequence does not affect contribution, [f] and the negative sequence increases contribution. Hence the mechanism of priming with a social norm does not provide a clear explanation of our treatment effect from forecast elicitation.

It could still be that eliciting forecasts about future contributions before the decision maker's own contribution increases the attention that the decision maker pays to the perceived social norm, and

[f] This finding is consistent with a previous study (Wade-Benzoni, 2002), showing that information suggesting decision norms has little impact when the decision maker is not materially affected by the information.

this, in turns, affects the contribution decisions. However, it would still be the attentional channel that plays a role, rather than norms per se.

Altruism

Not surprisingly, altruism is positively correlated with intergenerational contributions (see Table S3), but we find that altruism is a stable trait, not affected by the experimental intervention (see Table S4). As a result, the treatment effect is unlikely to be through the channel of altruism.

Strategic consideration

If subjects in the Forecast Before treatment thought that contributing could increase their chance of receiving the forecast bonus, the increased contribution might be an artifact of strategic thinking. If so, the policy implication of our treatment would be substantially undercut. This is partially why we designed a specific arm of the study, Forecast Before without Incentives treatment, in which the subjects have no monetary incentive to manipulate the future generations' decision. The increased intergenerational beneficence of the Forecast Before treatment is entirely replicated in the Forecast Before without Incentives one, ruling out that the Forecast Before treatment's increase in contribution rate is due to the decision makers' strategic self-interest to increase their chance in winning forecast bonus.

It is true that we cannot rule out all possible strategic reasons, such as changing one's contribution, which involves real money, just to be right about the forecast without monetary incentives. We are not very concerned about such alternative strategic motives because these motives would not undercut the effectiveness of the policy intervention.

Conclusion

Our experiment reveals that one of the big challenges to sustaining intergenerational contributions, namely overcoming the tendency to reciprocate selfish decisions by predecessors, can be at least partially overcome by a simple (median time spent on the forecast before contribution was

merely 26 seconds) but effective intervention. Eliciting subjects' forecasts about the future generations' decisions increases the contribution rates amongst decision makers who themselves had received lower endowments. This treatment promotes beneficent intergenerational decisions by reducing the negative emotional effects of not receiving a contribution from the preceding generation and redirecting attention away from a past that suggests reasons for not contributing towards the future which instead prompts reasons for contributing, including the fairness and efficiency of intergenerational beneficence.

Applying this insight to investments in climate change mitigation, it may prove fruitful to emphasize future impacts of global collective action in formulating reasons for countries currently bearing the brunt of climate change to still contribute to the global mitigation effort. While there are many reasons for countries that are currently experiencing substantial negative impacts from past greenhouse gas emissions to persist in using cheap and polluting energy sources, negative intergenerational reciprocity need not be one of them. This is not to say that intergenerational inequities should not be addressed, perhaps in the form of current-generation transfer payments or low-interest loans that redress inequities. The point is that a focus on a negative past can unnecessarily reduce individuals' or countries' willingness to engage in socially beneficial solutions.

When conveying information to the general public concerning climate change, it is unavoidable to discuss the causes of the current situation: human activities of multiple preceding generations. In many cases, in order to convince people that climate change is a result of human behavior, we need to show overwhelming evidence of how past human behaviors have caused the current situation. Our research shows that it is important to be aware of the potential adverse effect of emphasizing past non-cooperative behavior, because the tendency to apply intergenerational reciprocity could result in a lower willingness to sacrifice for the future generation when emphasis is placed on the fact that the past generations have failed to do so. It appears that decision makers' tit-for-tat instinct is triggered by the behavior of the past generation, even though such a strategy is clearly misapplied in the

intergenerational context, where their response is not fed back to the past generation. The forecasting intervention tested in the current paper counters such effect, by inducing people to consider aspects related to the future generation, shifting their focus away from past, unsustainable behaviors. Providing information about the positive consequences that current action to mitigate climate change will have on future generation at the very end of information campaigns, might increase the public's engagement and willingness to act for the benefit of the future.

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Data availability

The authors declare that data supporting the findings of this study are available online. Further information regarding the code used and the data produced are available from the corresponding author upon reasonable request.

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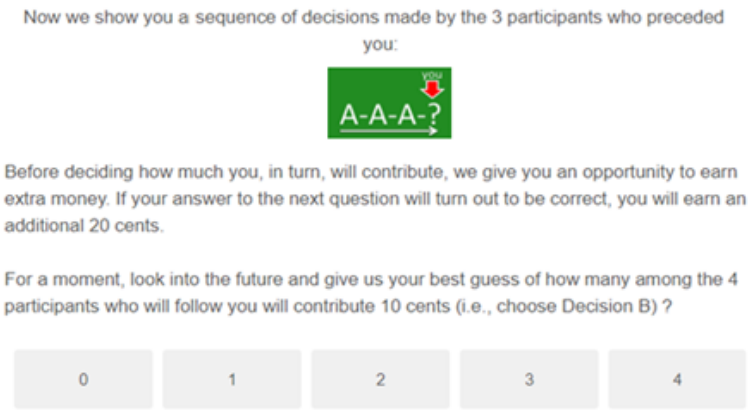
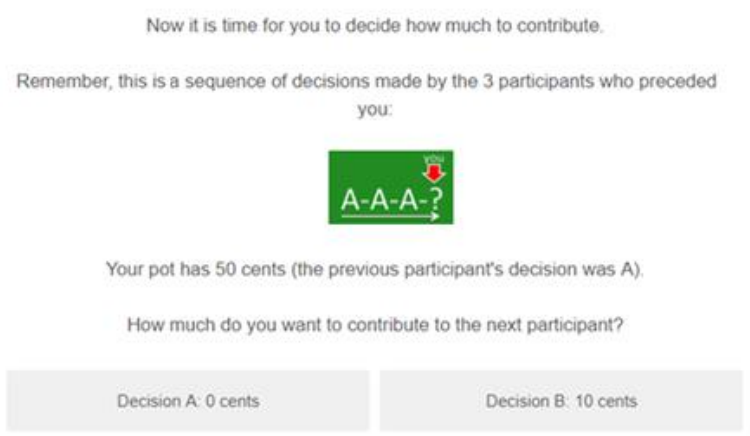
Appendix

Codebook

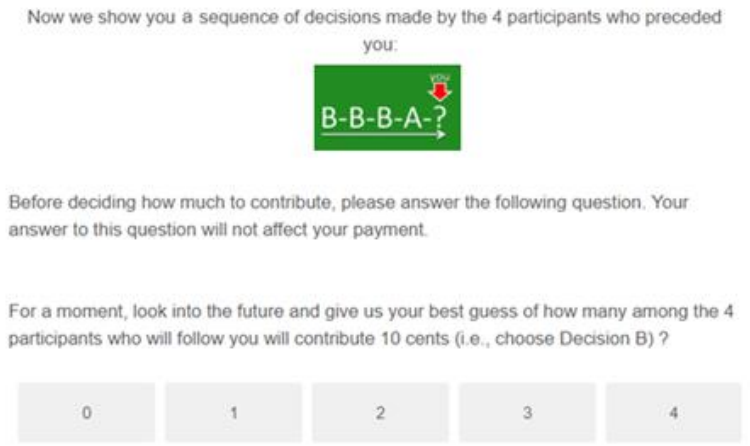
Name	*Explanation and Value*
Treatment	"post" – Forecast After; "pre" – Forecast Before; "preNP" – Forecast Before without Incentives
endowment	0, endowment =50c; 1, endowment=70c
history	info on history sequence, being one of the following six values: BBB, BBBA, AAAB, AAA, B, A
Reason	Please indicate how well each of the reasons below explains the decision of how much to contribute to the next player's stake that you made
Reason1	How relevant is "the decision of the previous participant" with your decision to contribute
Reason2	How relevant is "doing what is the fair thing to do" with your decision to contribute
Reason3	How relevant is "the fact that the next participant gains more than I contribute" with your decision to contribute
Altruism1	How would you assess your willingness to share with others without expecting anything in return, for example, your willingness to give to charity?
Altruism2	Today you unexpectedly received 1000 dollars. How much of this amount would you donate to charity?
Altruism3	I do not understand why people spend their lifetime fighting for a cause that is not directly beneficial for them.



(a-1) Treatment Forecast Before, forecast estimation



(a-2) Treatment Forecast Before, contribution



(b-1) Treatment Forecast Before without incentives, forecast estimation

(b-2) Treatment Forecast Before without incentives, contribution

Fig. S1: snapshots of the forecast estimation and contribution pages in the experiment of treatments Forecast Before and Forecast Before without incentives.

Preceding sequence (information condition)	Sequence type	Endowment	Forecast After	Forecast Before	Forecast Before without Incentives
BBB	Positive	High	67% (2.51)	72% (2.57)	72% (2.61)
AAAB	Negative	High	67% (1.93)	70% (1.72)	82% (1.65)
B	None	High	71% (2.08)	69% (2.01)	59% (2.04)
BBBA	Positive	Low	48% (1.81)	59% (2.33)	60% (2.31)
AAA	Negative	Low	51% (1.22)	55% (1.32)	72% (1.26)
A	None	Low	39% (1.56)	57% (1.69)	59% (1.64)

Table S1: percentages of contribution and forecast number (out of 4) in brackets in each treatment with each information condition.

Table S2: Intervention effects on intergenerational contribution across histories. Standard errors are in brackets. ***, p<0.01; **, p<0.05.

	DV: Forecast of future beneficence (number of contribution in the following 4 DMs)	DV: contribution=1 (DM chooses B), 0 (chooses A)
Good history (BBB)	0.51*** (0.07)	0.10 (0.08)
Bad history (AAA)	−0.31*** (0.07)	0.20** (0.08)
Constant	1.84*** (0.05)	0.23*** (0.06)
N	1378	1378

Table S3: Effects of the three altruism measures on decision maker's probability to contribute across different treatments; *** p<0.01, ** p<0.05, * p<0.1; Standard errors are reported in brackets.

DV: contribution=1 (DM chooses B), 0 (chooses A)	Full data	Forecast After	Forecast Before	Forecast Before without Incentives	Full data pooled together
Last choice = A		−0.68*** (0.13)	−0.53*** (0.13)	−0.34** (0.13)	−0.51*** (0.08)
Three B choices in history		0.02 (0.16)	0.06 (0.16)	0.21 (0.16)	0.09 (0.09)
Three A choices in history		0.18 (0.16)	−0.02 (0.16)	0.58*** (0.16)	0.24*** (0.09)
Altruism 1	0.21*** (0.02)	0.24*** (0.03)	0.21*** (0.03)	0.20*** (0.03)	0.22*** (0.02)
Altruism 2	0.0011*** (0.0003)	0.0007 (0.0004)	0.0016*** (0.0005)	0.0016*** (0.0005)	0.0012*** (0.0003)
Altruism 3 (non-altruism)	−0.03** (0.01)	−0.03 (0.02)	−0.06** (0.02)	−0.02 (0.02)	−0.04** (0.01)
Intercept	−1.06*** (0.14)	−1.09*** (0.25)	−0.75 *** (0.26)	-1.04 *** (0.27)	−0.96*** (0.15)
Sample size	1378	464	455	459	1378

Altruisms can explain choices to contribute to the next generation, in a consistent way across the treatments without affecting the treatment effects.

Table S4: Regressions on measures of altruism; *** p<0.01, ** p<0.05, * p<0.1; Standard errors are reported in brackets.

DV: altruism measure	Altruism1 willingness to give to charity	Altruism 2 Out of 1000 unexpected windfall, how much to give to charity	Altruism 3 Do NOT understand why fight without self-interest
Last choice = A	0.08 (0.12)	16.76* (9.09)	0.02 (0.15)
Treatment = Forecast Before	0.05 (0.15)	2.52 (11.14)	−0.19 (0.19)
Treatment = Forecast Before without Incentives	0.11 (0.15)	6.68 (11.10)	0.04 (0.19)
Three B choices in history	0.07 (0.15)	7.47 (11.16)	0.05 (0.19)
Three A choices in history	0.10 (0.15)	2.54 (11.11)	0.27 (0.19)
Intercept	6.49 *** (0.15)	124.57 *** (0.09)	3.82*** (0.19)
N	1378	1378	1378

These three regressions show that the three altruism measures are not affected by any of our treatments. It seems that they are quite stable traits against our treatments.

Table S5 — Summary of demographic variables (in percentages).

Income	Experimental Online workers	2016 American population
<5000	12.92%	13.71%
5000-10000	7.91%	9.12%
10001-15000	8.35%	8.40%
15001-25000	14.08%	14.54%
25001-35000	13.57%	11.93%
35001-50000	16.18%	13.48%
50001-65000	12.19%	9.26%
65001-80000	6.82%	5.75%
80001-100000	4.14%	4.71%
>100000	3.85%	9.10%
Total	1378	246325
mean income	37171.63	47347

Marital Status	Online workers	American National Election 2013 Panel Study
single	39.07%	17.98%
dating	1.96%	5.02%
relationship	18.37%	0.00%
married	35.80%	55.66%
separate	0.58%	1.59%
divorced	3.27%	12.66%
widow	0.09%	7.09%
Total	1377	1635

age	Online workers	American National Election 2013 Panel Study
18-24	17.50%	5.02%
25-34	47.20%	10.40%
35-44	20.62%	11.01%
45-54	9.08%	18.84%
55-64	3.99%	26.48%
65-74	1.53%	19.69%
75+	0.01%	8.56%
Total	1377	1635

Education	Online workers	American National Election 2013 Panel Study
Less than high school	1.02%	5.57%
High school	12.99%	24.65%
attended college	26.42%	32.17%
Bachelor's degree or higher	55.44%	37.61%
Total	1378	1635