Voluntary contributions in cascades: The tragedy of ill-informed leadership

Béatrice Boulu-Reshef, Nina Rapoport

Documents de Travail du
Centre d'Economie de la Sorbonne

CES Working Papers

Voluntary contributions in cascades: The tragedy of ill-informed leadership

Béatrice BOULU-RESHEF, Nina RAPOPORT

2020.23

Maison des Sciences Économiques, 106-112 boulevard de L'Hôpital, 75647 Paris Cedex 13
https://centredeconomiesorbonne.univ-paris1.fr/
ISSN : 1955-611X

Voluntary contributions in cascades: The tragedy of ill-informed leadership

Béatrice Boulu-Reshef* Nina Rapoport†

October 20, 2020

Abstract

Voluntary contributions are often solicited in sequential and public settings where information on the quality of the fundraising project unfolds with the sequence of decisions. This paper examines how the different sources of information available to potential donors in such settings influence their decision-making. Contrary to most of the leadership literature, neither leaders nor followers in these settings have certainty about the quality of the fundraising project. We explore whether leaders remain influential, the extent to which they use their influence strategically, and the consequences on followers when leaders are misinformed. We combine an information cascade method with a modified public goods game to create a "Voluntary Contributions in Cascades" paradigm. Participants sequentially receive private signals about the state of the world, which determines the potential returns from the public good, and take two public actions: an incentivized prediction about the state of the world and a contribution to the public good. We find that participants' predictions mostly align with Bayesian predictions, and find no evidence for strategic or misleading predictions. Leaders' contributions are positively correlated with followers', suggesting they remain influential despite their limited informational advantage. This influence takes a tragic turn when leaders happen to be misinformed, as most misinformed leaders end up unintentionally misleading followers. We find that having a misleading leader is associated with a reduction in gains from contributions roughly twice as large as the reduction that stems from dividing the marginal-per-capita-return by two. Our results stress the significance of having well-informed leaders.

Keywords: voluntary contribution, information cascade, fundraising, sequential public good game, leadership
JEL Codes: C92, D80, D82, H41

*Université d'Orléans, Laboratoire d'Economie d'Orléans, FRE2014, Faculté de Droit d'Économie et de Gestion, Rue de Blois - BP 26739, 45067 Orléans Cedex 2, France, + 33 (0)2 38 41 70 37, beatrice.boulu-reshef@univ-orleans.fr

†Université Paris 1 Panthéon-Sorbonne, Centre d'Economie de la Sorbonne, Paris School of Economics. Address: Centre d'Economie de la Sorbonne - UMR 8174, Maison des Sciences Économiques, 106-112 bd de l'Hôpital, 75642 Paris Cedex 13, France, +33 (0)1 44 07 81 00, nina.rapoport@psemail.eu.

1 Introduction

The act of contributing publicly and sequentially has become a prevalent way to raise funds in contemporary economies. One interesting consequence of this fundraising framework is that information about the quality of a project unfolds as contributions take place. In such settings, potential contributors must infer the posterior-probability of the fundraising project being successful, given the private information they possess together with what they infer from others' behavior. In traditional fundraising campaigns, the first ones to contribute (the "leaders") typically have more information about the quality of the project, and donors are thus often composed of a small group of influential leaders followed by a large group of uninformed followers. In contrast, other campaigns, such as crowd-funding campaigns, may be better represented by assuming a long sequence of contributions decisions by individuals who all have limited information, and for whom the information regarding the quality of the project unfolds as contribution decisions take place in a sequential fashion.[1] This setting raises several questions in the realm of leadership. First, to what extent are leaders (i.e., the first potential donors to be solicited) in such settings influential? Second, if leaders are influential, might they behave strategically in attempt to increase their expected earnings? Lastly, if followers do follow such leaders, what is the cost of having a leader who is ill informed?

Traditionally, experimental studies on the informational aspects of sequential decisions have made use of the information cascades framework, and the decision-making process regarding sequential contribution behavior has been studied via sequential public good games. In this paper, we design a "Voluntary Contributions in Cascades" (VCC) paradigm combining the information cascade method with that of a modified public goods game to study how informational and behavioral aspects impact the diffusion of information about the quality of the public good as well as the contributions to this public good. Under this framework, potential donors possess private information about the quality of the good, observe previous contributions made by others, and decide whether and how much to contribute. To control for their beliefs, they also make a public, incentivized prediction about the quality of the good, framed and simplified in our setting as predicting whether "the project will be successful". As such, their actions may be influenced both by their private signals as well as by the behavior (predictions and contributions) of upstream individuals. In turn, they may influence the behavior of downstream individuals through their predictions and contribution decisions.

This framework allows to examine leadership and sequential effects in groups of potential contributors where no one has certainty about the quality of the economic endeavor, answering the

[1] While reward-based crowdfunding initiatives represent threshold public good games, where the public good is provided if and only if total contributions towards its provision are sufficiently high, other types of crowdfunding, such as donation-based crowdfunding, do not possess this characteristic, while retaining the components of interest for our study, namely the sequential and public aspect of contributions. One important difference that remains is that only decisions at the intensive margins are typically observed in crowdfunding platforms, as potential donors can see the amounts chosen by previous donors but not the proportion of donors who chose (not) to donate. Nonetheless, the current study does not aim to replicate a crowdfunding environment but rather was inspired by the sequential and public nature of crowdfunding in designing the 'Voluntary Contributions in Cascades' paradigm.

questions outlined above and addressing an important gap in the leadership literature. Moreover, by comparing behavior in periods where participants play the VCC procedure described above to periods where a classic information cascade task is administered, the setting allows to examine whether the strategic environment introduced with the contribution component of the VCC yields biased predictions.

We find that participants behave in a rational-like fashion in that their predictions are driven by their expected payoffs, resulting in the absence of strategic predictions. Participants contribute more to the public good when they believe the project will be successful than when they believe it will not succeed, and more when they are assigned to sessions where returns to contributions are high than when assigned to sessions where these returns are low. Concerning leadership, leaders in our setting are influential in the sense that their contributions are positively correlated with the contributions of followers. Nevertheless, contributions do not seem to be driven by their diminishing returns (if players believe that increasing their contributions will lead subsequent players to contribute more to the public good, marginal expected gains would decrease as the place in the sequence increases). Rather, players contribute more (with respect to themselves) the later they play in the sequence. The influence of the leaders takes a tragic turn when these happen to be misinformed, as most misinformed leaders end up misleading followers. We find that having a misleading leader is associated with a reduction in gains from contributions roughly twice as large as the difference that stems from dividing the MPCR by two,[2] stressing the significance of having well-informed leaders. The remainder of the paper is structured as follows: Section 2 describes the relevant literature. Section 3 describes the VCC paradigm in greater detail, describes a simple analytical framework for our setting and outlines the specific hypotheses in this framework. Section 4 describes the procedure of the lab experiment conducted to test these hypotheses, and section 5 describes the results from the lab. Section 6 further discusses these results and their possible interpretations, and concludes.

2 Related experimental literature

This paper contributes to the literature on leading by example in fundraising. In the past years, many studies have investigated the impact of leadership on donation decisions, and have sought to identify the mechanisms driving it. Some have attempted to demonstrate the general existence of leadership effects by comparing behavior in sequential and simultaneous voluntary contribution games, obtaining mixed results. Güth et al. (2007) and Qiu et al. (2018) report a strong positive effect of such leadership, while Moxnes and Van der Heijden (2003) report a negligible (but significant) effect, and Gurerk et al. (2018) find no significant effect. Theoretically, Andreoni (1998) demonstrates how the existence of a lead donation could improve donation outcomes in cases of capital projects with large fixed costs. Using a threshold public goods Game, Bracha et al. (2011) find experimental support for Andreoni's theory for projects with sufficiently high fixed costs. In

[2]In our high MPCR sessions, contributions to the public good are multiplied by 3, and in low MPCR sessions they are multiplied by 1.5

the field, an experiment by Huck et al. (2015) with the Bavarian-state opera finds that the simple announcement of a lead-donation increases contributions more than matching donors' contributions to those of the same influential individual (with various matching ratios). Similar observations were made by Shang and Croson (2009) and Martin and Randal (2008). In terms of the drivers of such "leadership effects", several mechanisms have been outlined by the literature.

Conditional cooperation In a seminal work, Clark and Sefton (2001) found in a sequential prisoner's dilemma that cooperation is conditional on first-mover choice, which support the argument that cooperation reflects reciprocation rather than unconditional altruism. In the context of sequential public good games, Moxnes and Van der Heijden (2003), Güth et al. (2007), Levati et al. (2007), Arbak and Villeval (2013), Dannenberg (2015), Pogrebna et al. (2011), McCannon (2018) find that first movers tend to make larger contributions than later movers, and that later movers' contributions are strongly correlated to first movers' contributions, suggesting that the effect is driven by reciprocity. Gächter and Renner (2018) use repeated experimental public goods game with and without a leader and they find that leaders strongly shape their followers' initial beliefs and contributions. Figuieres et al. (2012) find that average contributions are higher when made sequentially than simultaneously, and that the contributions decline with the position in the sequence. They attribute the first result to the combined effect of leadership and reciprocity, and the second one to the combination of a vanishing leadership effect and imperfect reciprocity. Cartwright and Lovett (2014) find in a sequential public good game a prevalence of conditional cooperation that remains relatively stable to changes in the MPCR and game timing.

Leader characteristics Others have investigated different characteristics of leaders that impact both leaders' own behavior as well as followers' tendency to follow them. Rivas and Sutter (2014) find that endogenous leadership is more efficient than exogenously imposed leadership. Sahin et al. (2015), who differentiate between two types of leaders - "exemplar" leaders who are the first movers who commit to a level of contribution, and "managers" who are the first movers who make cheap talk suggestions to the team members, find that both types of leaders reduce coordination failures as compared to a simultaneous move, baseline scenario with no leader. Angelova et al. (2019) study the effects of having the first contribution being made by a permanent member while the second contribution is made by a temporary member and vice versa. Permanent members are those who may benefit from reciprocity as they stay together, while temporary members switch to different new groups after each period, and participants are aware of this group restructuring. They find that for the permanent members the place in the sequence impacts the amount contributed to the public good. Gaechter et al. (2012) find that groups perform best when led by those who are cooperatively inclined. Cooperative leaders are found to be more optimistic than noncooperators about the cooperativeness of followers and cooperative leaders contribute more than noncooperative leaders even after controlling for optimism. Their results show that cooperativeness and beliefs lead to differing types of leader and that they impact contributions of followers.

Information transmission Another strand of research highlights the importance of leaders in transmitting information. In Hermalin (1998), on possible explanations for why followers follow the leader, argues that *"they believe the leader has better information about what they should do than they have"*. In a public good's game setting, the impact of interactions between leaders and followers depends on the available information on the returns from the public good, and on how this information is distributed. Andreoni (2006) proposes that "leadership giving" (or "leading by example") impacts contributions by providing a signal to following donors that the charity is of high quality, rather than by leveraging social factors such as reciprocity or conformity. Experimental work by Potters et al. (2005) supports this claim: they find that when some donors do not know the true value of the good in a public good game, the donors predominantly choose to contribute sequentially, meaning that informed donors contribute first and uninformed donors follow. They further find that sequential moves result in a larger provision of the public good, even when externally imposed, as followers tend to mimic the actions of the leader and thus choose to contribute when it is efficient to do so. Potters et al. (2007) additionally find that the ability to lead-by-example has no effect on total contributions and earnings when such returns are commonly known, supporting the view that the effect of leadership on contributions is driven by signaling rather than reciprocity. This view is reinforced by studies in other settings reporting absence of conforming behavior when leaders have no informational advantage. For example, in a setting similar to an information cascade, but where players have no private information, Corazzini and Greiner (2007) find that, when exposed to previous players' decisions, participants did not exhibit conformity in their choices, and actually tended to favor the less popular choice.

Another question this literature poses is whether leaders may try to use their informational advantage strategically, and how followers react to this possibility. Thus, as argued by Hermalin, *"a leader must then convince followers that she is transmitting the correct information; that is, she must convince them that she is not misleading them"*. Komai et al. (2007) study leaders via their ability to get exclusive access to information and the possibility that they may retain parts of it if it serves their interests. Komai and Stegeman (2010) further investigate the role that informational advantage plays in followers' decision to follow the leaders. In asymmetric informational settings in which leaders are better informed than followers, a leader who is not credible will be ignored by followers, and resulting equilibria will be inefficient. This literature investigates the mechanisms via which leaders may strategically use information to get followers to follow their lead.

In this paper, we create a setting in which neither leader nor follower has certainty about the value of the public good,and where information is provided to leaders using a probabilistic device that allows to control for followers' beliefs concerning the propensity of the leader to have correct information. We find that leaders' behavior in this setting has an impact on contributions further down the sequence, addressing an important gap in the leadership literature. The tragic consequence of this influence is that followers are significantly harmed when leaders are ill-informed, as most misinformed leaders end up unintentionally misleading their followers.

3 The Experiment

The "Voluntary Contributions in Cascades" (VCC) paradigm is a setting in which players face a fundraising project of unknown quality. They receive a private signal about its quality, hereafter referred to as the state of the world, and are asked to simultaneously predict the state of the world and decide if and how much to contribute to the project. Both predictions and contributions are made publicly, such that individuals have access to previous players' prediction and contribution decisions when making their choices. Moreover, returns from the fundraising project depend on the state of the world. If the project is of high quality ("successful"), a public goods game is implemented and players receive their per-capita return. If the project is of low quality ("unsuccessful"), contributions are multiplied by zero and players incur a loss. Note that the success of a project does not depend on the level of contributions required to carry out the project (as in a threshold public goods game) but rather is defined by the utility the project provides; low for low quality projects and high for high quality projects. This setting allows us to examine how the different sources of information individuals face - the private signal, previous players' predictions about the state of the world, and previous players' contributions - influence their predictions about the state of the world and their decisions whether and how much to contribute.

3.1 Information Cascades Component

We rely on the symmetric model developed by Bikhchandani et al., as used by Anderson and Holt (1997). According to the model, information cascades are defined by five conditions: (1) there is a decision to be made (adopting a new technology, contributing to a fundraising project, etc.), (2) the action space is limited to a binary decision (e.g. adopt or reject), (3) decisions are made sequentially, and each decision-maker observes others' previous choices, (4) each person has some private information (draw/signal) and (5) these private signals cannot be directly observed, but under some assumptions (such as that decision-makers are rational), and in circumstances where behavior is informative, can be inferred from decision-makers' choices.

In this canonical framework, there are two possible states of the world, A and B, represented by the two urns in Figure 1 and containing different proportions of *a* and *b* balls. One by one, participants are approached in a random order to receive a signal (either *a* or *b*) and make a prediction about the state of the world (A or B). These predictions (but not the signals) are made public. Thus, everyone (except for the first participant) relies on two sources of information when making their prediction - their private signal and the predictions of previous participants. If correct predictions are rewarded with higher payoffs than incorrect ones, expected-utility maximizers will choose the urn with the highest posterior probability. As the first participant relies only on his or her private signal, they will predict A if the signal is *a* and B if the signal is *b*, revealing their private signal through their prediction. When the second participant receives their signal, there are two possible options. If the signal is identical to the one received by player 1, their prediction will be identical as well. If, however, the first person predicted A and the second person receives *b*,

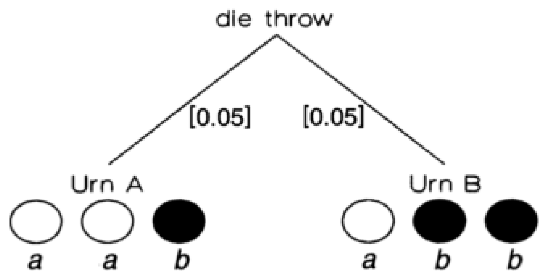


Figure 1: The Symmetric Model (Source: Anderson and Holt (1997)

they will be facing a signal distribution of a (inferred from 1's decision) and b (their own signal), resulting in equal posterior probabilities for events A and B. In such cases, we assume (in line with Anderson and Holt (1997)) that players will follow their own signal, a reasonable assumption where exists a positive probability that the previous player made a mistake. Lastly, let us suppose that each player assumes the other players base their predictions on Bayesian calculations.[3] This allows later players to infer the private signals of players 1 and 2, implying that, in cases where the first two players make the same decision (say, A), the third player faces a higher posterior probability for A regardless of her signal. The rational decision in this case is thus to predict A as well, even when having received a signal of b, triggering an information cascade. As decisions that are part of identical sequences become less and less informative, rational individuals will ignore these in their assessment of posterior probabilities. If however a cascade is broken by a player predicting the other event (say, B), it is reasonable to infer that she possesses a corresponding private signal.

3.2 Donations Component

We use the paradigm of information cascades to analyze situations where individuals must decide whether to contribute to projects of uncertain quality. As such, we attach meaning to the two possible states of the world in the information cascade ('A' - the project is successful, 'B' - the project is unsuccessful), and introduce a contribution decision in addition to the prediction decision. The VCC paradigm thus combines the information cascade framework with that of a public goods game, and consists of individuals receiving a private signal, making a public prediction and deciding on a public contribution.[4] The state of the world (successful or unsuccessful) determines the marginal per-capita return (MPCR) of the public goods game, which is high (low) if the project

[3]Relevant signals, that should be used to assess posterior probabilities, are those inferred from decisions before the start of a cascade, the two decisions starting a cascade, and non-Bayesian deviations from cascades. Let n be the number of relevant a signals and m the number of relevant b signals. We can then calculate the posterior probability of event A given any sequence of draws (private and inferred):

$$Pr(A|n,m) = \frac{Pr(n,m|A)Pr(A)}{Pr(n,m|A)Pr(A) + Pr(n,m|B)Pr(B)}$$

$$= \frac{(2/3)^n(1/3)^m(1/2)}{(2/3)^n(1/3)^m(1/2) + (1/3)^n(2/3)^m(1/2)} = \frac{2^n}{2^n + 2^m}$$

[4]For details on its implementation in the lab see Section 4.

is successful (unsuccessful).[5] In the current experiment, we introduce the simplifying assumption that contributions are lost if the project is unsuccessful, obtaining the following profit function for individual i:

$$E(\pi_i) = P_i^A[R_i + e_i - c_i + \frac{\alpha}{n}\Sigma_{i=1}^N c_i] + (1 - P_i^A)[R_i + e_i - c_i] =$$

$$P_i^A[\frac{\alpha}{n}\Sigma_{i=1}^N c_i] + R_i + e_i - c_i, \text{ where:}$$

P_i^A is the posterior probability for a successful state of the world from the point of view of i, i.e., the probability that the chosen state of the world was A given the information i observes from her private signal and from previous players' predictions and contributions.[6] R_i is the reward for i's prediction Pr_i, which can take two values, depending on whether or not the player's prediction matches the state of the world or not, defined as:

$$R_i = \begin{cases} 10, & \text{if } Pr_i = S \\ 2.5, & \text{if } Pr_i \neq S \end{cases}$$

Where S is the state of the world which can be either "successful" (A) or "unsuccessful"(B): $S \in \{A, B\}$ and Pr_i is the prediction of player i. Let us denote the first case as R^T (reward for true predictions) and the second as R^F (reward for false predictions). e_i is i's endowment for the given period, c_i is i's chosen contribution for the given period, n is the number of players, $\frac{\alpha}{n}$ is the marginal per-capita return, and $\Sigma_{i=1}^N c_i$ is the sum of the group members' contributions.

If a player predicts A ($Pr_i = A$), she faces the following expected gains:

$$E(\pi_i|Pr_i = A) = P_i^A[\frac{\alpha}{n}\Sigma_{i=1}^N c_i|Pr_i = A] + e_i - c_i + P_i^A R^T + (1 - P_i^A)R^F$$

If a player predicts B ($Pr_i = B$), she faces the following expected gains:

$$E(\pi_i|Pr_i = B) = P_i^A[\frac{\alpha}{n}\Sigma_{i=1}^N c_i|Pr_i = B] + e_i - c_i + P_i^A R^F + (1 - P_i^A)R^T$$

Note that, under the assumption that the contribution stays constant regardless of the prediction, there can exist cases where players with a larger subjective probability for B than A will nevertheless predict A if they expect the difference between the sum of contributions given the prediction being A or B to be larger than the difference between the payoffs from a (true) prediction for B and a (false) prediction for A. Formally:

[5] As do Potters et al. (2007)

[6] Calculated as follows given the relevant a and b signals:

$$Pr(A|n,m) = \frac{Pr(n,m|A)Pr(A)}{Pr(n,m|A)Pr(A) + Pr(n,m|B)Pr(B)}$$

$$= \frac{(2/3)^n(1/3)^m(1/2)}{(2/3)^n(1/3)^m(1/2) + (1/3)^n(2/3)^m(1/2)} = \frac{2^n}{2^n + 2^m}$$

$$(Pr_i = A | P_i^A \leq 0.5) \iff [\Sigma_{i=1}^N c_i | Pr_i = A] - [\Sigma_{i=1}^N c_i | Pr_i = B] \geq (R^T - R^F) - R^T P_i^A$$

Let us examine a numerical example in line with our experimental parameters.[7] We set the value of the reward for correct predictions to 10 and that of the reward for incorrect predictions to 2.5, and assume that player i ($i < N$ as this strategic reasoning is irrelevant for the last player) believes that the state of the world is such that the project is successful with probability 0.4: $R^T = 10, R^F = 2.5, P_i^A = 0.4$. For the condition above to hold, the player must expect an increase of at least 1.5 in the sum of the group's contributions. Given the contributions levels we report in section 5, we cannot a priori rule out such strategic lying.

3.3 "Voluntary Contributions in Cascades"

This novel task allows to examine how players' prediction and contribution decisions depend on the different sources of information they possess (their private signal and previous players' predictions and contributions), and investigate the influence of leaders on the sequence of decisions made by players. By varying the signal received by first players such that about one third of signals are misleading, it further allows to document the impact of ill-informed leadership. We also test whether the introduction of social and strategic context that occurs when adding the donation component to the information cascade influences the way players make predictions about the state of the world. To assess how predictions and contributions depend on the height of potential gains, we vary the size of the multiplier α such that half of the sessions have high value of α and the other half a low one. The design also enables us to test how the two decision variables (predictions and contributions) interact, and how players' behavior changes depending on their place in the sequence and over the course of the game.

3.3.1 Theoretical hypotheses

Beyond the exploratory questions outlined above, the framework allows us to formulate the following theoretical hypotheses:

Hypothesis 1a - Unbiased predictions, in the absence of contributions - Baseline: We expect players to process the information from their private signals and others' predictions in a rational-like fashion such that their predictions maximize their profits from predictions.

Hypothesis 1b - Strategic lying, in the presence of contributions - Treatment: We hypothesize that the introduction of the strategic environment with the introduction of the contributions will lead players to make predictions that are biased towards the successful state of the world. This would be reflected by this part of the game having biased predictions with respect to the baseline periods.

[7] Detailled in section 4.

Hypothesis 2 - Contribution Determinants: We hypothesize that players' contributions will be driven by the following:

1. Their beliefs about the state of the world (elicited through their predictions) such that contributions will be higher when players predict the successful state of the world.

2. The MPCR, such that contributions will be higher in the sessions with the high MPCR.

3. Contributions of previous players: Beyond the cascades that are expected given the impact of the predictions of the first players on latter predictions, we hypothesize that a similar impact will occur for contributions, such that first players play a leadership role via their contributions on latter contributions.

4 Experimental Procedure

4.1 Participants and Design

120 participants (66 women, 54 men), aged 18-44 (mean=23.35, st.dev.=3.81) were recruited through the pool of voluntary participants of the LEEP laboratory at Paris 1/PSE, where the experiment was also conducted. We excluded participants who had alreadu participated in a public goods experiment.

The experiment consisted of two components - a baseline of 8 periods of a standard information cascade paradigm, and an experimental variation with 8 periods of the "voluntary contributions in cascades" paradigm. Groups were randomly assigned to one of 4 2*2 conditions depending also on MPCR and order of play, as illustrated in Table 1. All participants completed both the baseeline and VCC components, and their order was randomized to avoid order effects. MPCR could be either high ($\alpha = 3$) or low ($\alpha = 1.5$), and the order of play was either first 8 periods of baseline (standard information cascade) and then 8 periods of VCC (**B+VCC**) or first 8 periods of VCC and then 8 periods of baseline (**VCC+B**). We conducted 20 sessions in the lab, each lasting about 45 minutes and consisting of a group of six participants. Before the start of every session, and after participants had given their informed consent, the experimenter read the instructions[8] aloud and ensured comprehension. On average, sessions lasted for an hour and 15 minutes, including the time required for reading the instructions, answering questions, and paying participants at the end of the session. Participants' earnings ranged from €12.46 to €34.92, with average earnings of €29.69 for the high MPCR sessions and of €22.69 for the low MPCR sessions.

4.2 Experimental Interface

The interface allowed for both private and public information to be available to players, as required for information cascades. An administrator interface was used by the experimenter to reveal the state of the world at the end of each period. After completing the experimental tasks detailed

[8] See appendix C

Table 1: Design

Low MPCR ($\alpha = 1.5$) 10 groups ($n = 6$)	High MPCR ($\alpha = 3$) 10 groups ($n = 6$)
5 groups: Information Cascade 1st, Voluntary contributions in cascades 2nd (8 periods each)	5 groups: Information Cascade 1st, Voluntary contributions in cascades 2nd (8 periods each)
5 groups: Voluntary contributions in cascades 1st, Information Cascade 2nd (8 periods each)	5 groups: Voluntary contributions in cascades 1st, Information Cascade 2nd (8 periods each)

Figure 2

below, participants were instructed to answer questions related to the frequency of participation in charitable projects, demographic information,[9] and loss-aversion,[10] and then received their total earnings in cash from the experimenter.

4.3 Baseline - Information Cascade

Participants were informed that there were two possible states of the world, A and B, represented by the two envelopes in Figure 2. Envelope A contained two yellow cards labeled "a" and one pink card labeled "b", and envelope B, contained two pink cards labeled "b" and one yellow card labeled "a". Each period, the experimenter randomly determined the envelope to be used in the upcoming period.

After selecting the envelope and removing the three cards, participants were chosen in a (predetermined) random order and approached by the experimenter to privately draw a card, record its label in a private cell and return it to the stack. Then, they were asked to record their prediction for the chosen envelope in a public cell that revealed it to the rest of the participants. Before the start of the game, participants were informed that they would receive 10 tokens (each worth €0.11) for each correct prediction, and 2.5 tokens for each incorrect prediction. This process continued until all six players had made their decisions. Then, the chosen envelope was revealed to participants, and their corresponding gains were automatically calculated. The game continued in this manner for 7 more periods, each time with a different playing order.

[9]See Appendix A.
[10]See Appendix B.

4.4 Experimental Variation - Voluntary Contributions in Cascade

In this component, participants played 8 periods of a variation of the task described in Section 3. They received 10 experimental tokens for each period in this stage of the game. After the experimenter had determined the envelope and playing order, she approached the first player to draw a card from the envelope, record its label on the spreadsheet in a private cell and return it to the stack. The player was then asked to make two public decisions: (1) a prediction about the chosen envelope; (2) decide whether to contribute to the public good, and if so how many tokens (between 0-10). The period continued in a similar manner until all six players had played. Every player (except for player 1) thus had access to both a private signal as well as the observed behavior of others when making their decisions. At the end of each period, the chosen envelope was revealed and earnings were automatically calculated for the current period. The game continued in this manner for 7 more periods, each time with a different playing order.

5 Results

5.1 Descriptive Statistics

5.1.1 Illustrative example

Table 2 describes the outcomes of a sequence of periods. Consider the period represented in the upper left square. The chosen envelope was B, implying that the state of the world was an unsuccessful project (i.e., the group's contributions were lost). Player 1 received a "b" signal and predicted B. The next decision maker (player 2) received an "a" signal, and predicted B. Player 2's decision of giving more weight to previous players' decisions than her private signal is categorized as over-weighing.[11] Next, player 3 received a "b" signal and predicted B. As we cannot know if this was the result of a Bayesian calculation taking into account the private signals inferred from the previous predictions, or the result of predicting in accordance with his private signal, such decisions are categorized as indeterminate. Next, player 4 received an "a" signal, but predicted B, consistent with Bayesian calculations as she faces the following sequence of (inferred and private signals): b, b, b, a, and a corresponding higher posterior probability for envelope B. This decision is consistent with Bayesian calculations, but not with private information. Player 5 goes through a similar process. Lastly, player 6 receives a "b" signal, and predicts B, consistent both with Bayesian calculations and private information. In this period, all players chose not to contribute any of their endowed tokens, consistent with a belief in a state of the world in which the chosen envelope was B.

[11] See categorization details in section 5.1.2. While it could be inferred from player 1's prediction that she received a "b" signal, resulting in player 2 facing equal occurrences of (private and inferred) "a" and "b" signals, the Bayesian prediction in such a case (as defined by A&H) is to go with one's signal. Even if player 2 assumes that player 1 is rational, there is still a positive probability that she made a technical error.

Table 2: Sample Periods

SOW	B						A						A					
Player	1	2	3	4	5	6	6	5	4	2	3	1	5	6	4	2	1	3
Draw	b	a	b	a	a	b	a	a	a	a	b	a	a	a	b	a	a	b
Prediction	B	B	B	B	B	B	A	A	A	A	A	A	B	A	A	A	A	A
Contribution	0	0	0	0	0	0	2	2	2	5	10	8	4	0	1	5	0	2
SOW	B						B						B					
Player	2	3	1	5	4	6	3	4	1	6	5	2	5	6	3	2	1	4
Draw	b	a	b	a	b	a	a	b	a	b	b	b	b	b	a	b	b	a
Prediction	B	A	B	B	B	A	A	B	B	B	B	B	A	A	A	A	A	A
Contribution	0	2	0	0	0	2	2	0	2	10	0	0	2	10	10	10	0	2

5.1.2 Predictions

In order to analyze players' decision making, we use the following definitions, based on Anderson and Holt (1997). A *cascade* occurs when an imbalance of previous inferred signals causes a person's optimal decision to be inconsistent with his or her private signal. *Reverse cascades* occur if the aforementioned decision turns out to be mistaken (ex-post). Decisions consistent with private information, but not with Bayesian updating are defined as *private information*. We define three additional categories: Decisions consistent with neither private information nor Bayesian updating are defined as *mistakes*[12], and decisions where individuals give more weight to others' decisions than their own private signal are denoted *overweight*. Decisions that do not fall under any category are denoted as *indeterminate*. Table 3 details the proportions of predictions in each of these categories.[13] Overall, in rounds with cascade potential, behavior is mostly consistent with Bayesian updating as in Anderson and Holt (1997).[14]

5.1.3 Contributions

Participants' contributions ranged from 0 to 10, with a mean of 3.896 tokens (SD=3.66) and a median of 3. The mean contribution of participants who predicted the successful state of the world was 5.46 tokens (SD=3.38), and for those who predicted the unsuccessful state of the world 2.32 tokens (SD=3.22). The mean contribution of participants with the high MPCR was 4.47 tokens

[12] The label mistake (as well as other labels) functions here merely as a label and is not intended to carry over any judgmental opinion on participants' behavior

[13] We analyze behavior by round, and not by period, enabling us to categorize decisions of individual players.

[14] In terms of efficiency, the average actual efficiency is 82.3% and average private-information efficiency (the efficiency that would have been obtained if players had always followed their signal) is 47.7% (with respect to 91.4% and 72.1% in Anderson and Holt (1997)). In terms of potential, 17.2% of rounds had the potential for a cascade. Out of these 193 rounds with cascade potential, 91 were cascades (47.15%), 47 (24.35%) were reverse cascades (adding up to 71.5% of cascades, compared to the 72% as reported by A&H), and 55 were private-information decisions (28.5%), very similar to A&H's findings of 26% percent. In other words, in about 70% of the time when the potential for a cascade existed, participants behaved consistently with Bayesian updating, and the rest of the time according to their own signal.

Table 3: Behavior Categorization

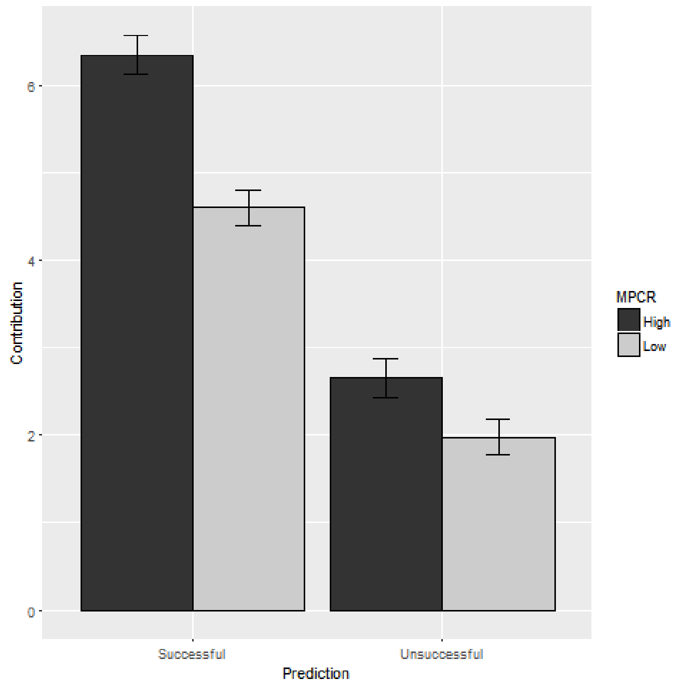
	Behavior	Frequency	Percentage
1	Cascade	143	7.57
2	Mistake	297	15.71
3	Inderterminate	1241	65.66
4	Overweight	57	3.02
5	Private Information	76	4.02
6	Reverse Cascade	76	4.02
7	Total	1890	100.00

(SD=3.89), and 3.29 tokens (SD=3.28) for the low MPCR.

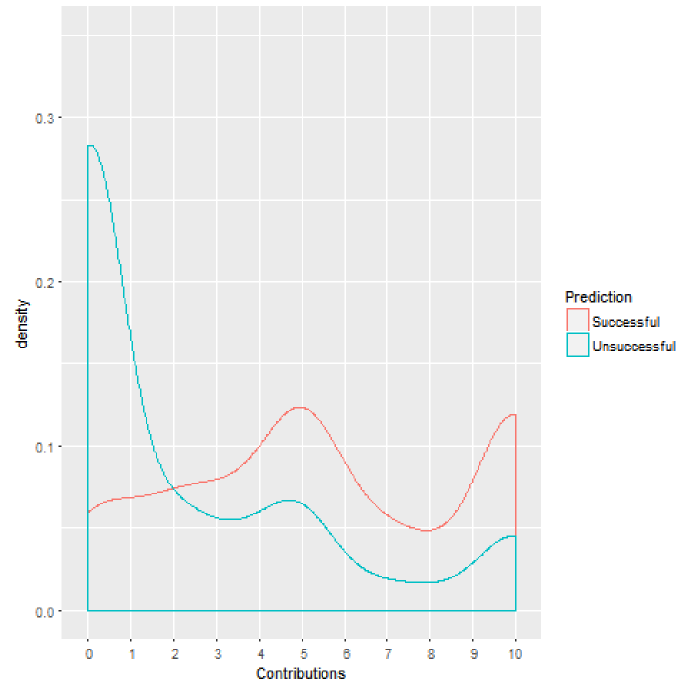
Impact of MPCR and relationship with predictions Figure 3b depicts the distribution of contributions between 0 and 10 tokens as a function of the predicted state of the world. When predicting the unsuccessful state of the world, contributions peak at 0. When predicting the successful state of the world, contributions peak at 5 and 10. Figure 4 shows the effect of the marginal per-capita return on contributions. When predicting the successful state (Figure 4a), contributions in sessions with the low MPCR peak at 5, and contributions in sessions with the high MPCR peak at 10. When predicting the unsuccessful state (Figure 4b), there is a higher proportion of zero contributions in sessions with the low MPCR. The two main effects of MPCR and predicted state of the world are illustrated in Figure 3a.

Table 4 summarizes the results concerning contribution determinants. Column 1 reports the regression of players' contributions on the marginal per-capita return (MPCR), which we varied between sessions. Lowering the MPCR from 3 to 1.5 reduces the average contribution by 1.14 tokens (p-value < 0.01). In the high (low) MPCR periods, players who predicted the successful state of the world contributed on average 3.7 (2.6) tokens more than those who predicted the unsuccessful state of the world (p-value < 0.01) (column 2). When controlling for the predicted state of the world, the effect of the low MPCR is significant only in the cases where participants predicted the successful state of the world ($\beta = -1.07$, p-value < 0.05). When VCC is played in the second half of the game, the average contribution holding all else equal is 1.15 tokens lower than when playing VCC in the first half of the game (p-value < 0.05, column 3).

Figure 3: Mean Contributions

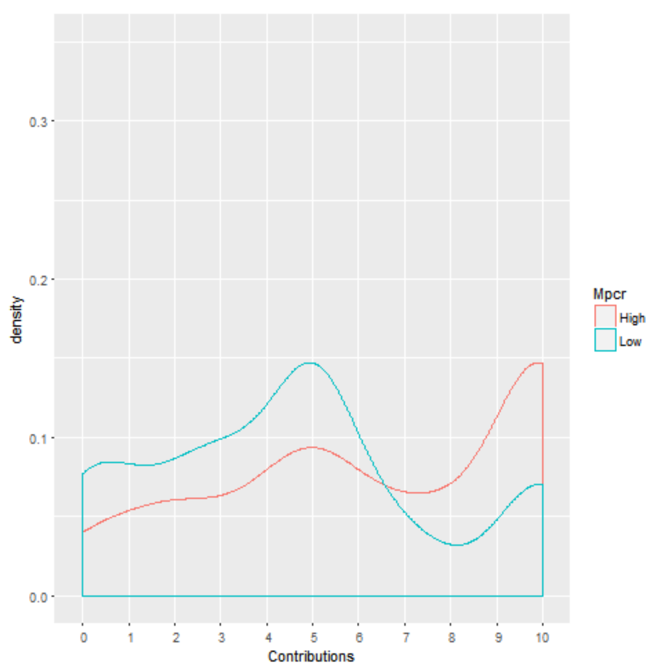


(a) Contributions by Prediction and MPCR

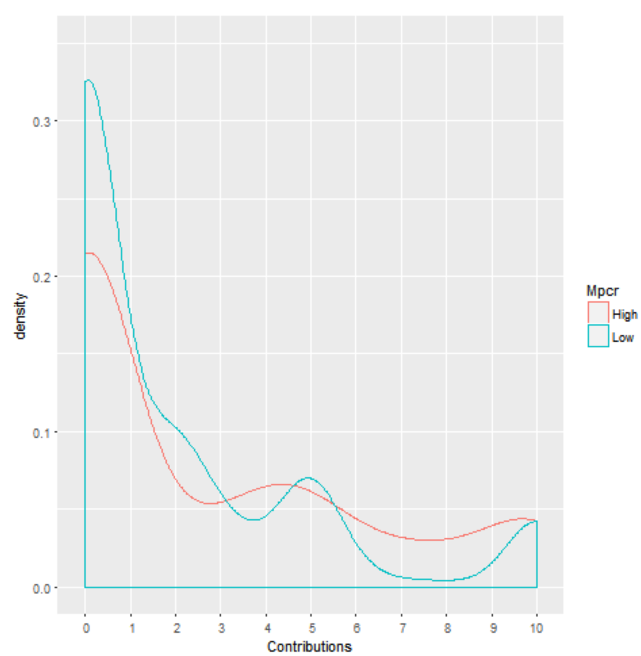


(b) Distribution of Contributions by Prediction

Figure 4: Contributions by MPCR



(a) When predicting successful state



(b) When predicting unsuccessful state

Table 4: Determinants of contributions

	Contribution		
	(1)	(2)	(3)
Low mpcr	-1.14^{***}	-0.67	-0.32
	(0.40)	(0.50)	(0.73)
Predicting successful SOW		3.70^{***}	3.51^{***}
		(0.47)	(0.53)
2nd half			-1.15^{*}
			(0.66)
Low mpcr*Predicting successful SOW		-1.07^{*}	-1.09^{*}
		(0.58)	(0.58)
Predicting successful SOW*2nd half			0.39
			(0.58)
Low mpcr*2nd half			-0.58
			(0.74)
Constant	4.47^{***}	2.66^{***}	3.23^{***}
	(0.29)	(0.40)	(0.59)
Observations	930	930	930
Adjusted R^2	0.02	0.22	0.24
F Statistic	23.10^{***} (df = 1; 928)	86.29^{***} (df = 3; 926)	51.08^{***} (df = 6; 923)
Notes:	Standard errors clustered at the individual level. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$		

Table 5: Leadership Effects on Contributions

	Contribution		
	(1)	(2)	(3)
Leader's contribution	0.45^{***}	0.83^{***}	0.77^{***}
	(0.03)	(0.05)	(0.08)
Player		0.48^{***}	0.30^{***}
		(0.08)	(0.07)
Predicting successful SOW			0.63
			(0.46)
Leader's contribution*Player		-0.11^{***}	-0.13^{***}
		(0.01)	(0.01)
Leader's contribution*Predicting successful			0.04
			(0.07)
Predicting successful SOW*Player			0.48^{***}
			(0.11)
Constant	2.26^{***}	0.59^{***}	0.37
	(0.22)	(0.23)	(0.23)
Observations	930	930	930
Adjusted R^2	0.18	0.22	0.33
F Statistic	210.19^{***} (df = 1; 928)	86.27^{***} (df = 3; 926)	77.78^{***} (df = 6; 923)
Notes:	Standard errors clustered at the individual level. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$		

Descriptive statistics 5.1.3 - Contribution determinants: *Players' contributions are in line with our hypothesis and are highest when predicting the successful SOW in the high MPCR condition (S,H), followed by predicting the successful SOW in the low MPCR condition (S,L), then when predicting the unsuccessful SOW in the high MPCR condition (U,H), and lowest when predicting the unsuccessful SOW in the low MPCR condition (U,L).* $C_{(S,H)} > C_{(S,L)} > C_{(U,H)} > C_{(U,L)}$

Intra-individual variation - order of play in a period For a given individual, we find a positive relationship between contributions and the randomly assigned order of play in a period, or "position in the sequence", indicating that players tend to contribute more the more "downstream", or close to the end of the sequence, they are positioned. In cases where players predicted the successful state of the world, a linear regression of the difference between a given contribution and the individual's mean contribution over the entire session on the position in the sequence (1-6) yields a positive and significant coefficient ($\beta = 0.15$, p-value < 0.05), indicating an average increase of .15 tokens for every "downstream shift". This is not the case for periods where the unsuccessful state of the world was predicted (p-value $= 0.88$). Figure 5 illustrates these results.[15]

Descriptive statistics 5.1.3 - Position in the sequence: *With respect to themselves, players contribute more the further down the sequence they are. This is contrary to a scenario in which players would strategically contribute more earlier in the sequence to try and influence subsequent contributions, or freeride on previous players' contributions when playing later in the sequence.*

Individual characteristics Players who reported contributing more to charitable causes had significantly higher average contributions (see Figure 6). With respect to loss aversion, participants with lower loss aversion had higher average contributions ($\beta = 0.4595$, $p < 0.001$) and did not differ in their propensity to predict the successful state of the world.

5.2 Unbiased predictions

Table 6 summarizes the results of a linear probability model where the dependent variable is a binary variable equal to 1 if players predicted the successful state of the world (denoted A) and 0 if they predicted the unsuccessful state of the world (denoted B). In column 1, it is regressed on the difference in expected gains from predictions $\pi_A - \pi_B$, a binary variable equal to 1 if the period relevant to the prediction was one of the 8 VCC periods where players make contribution decisions

[15] When not accounting for the predicted state of the world, we find that upstream players do not contribute more than downstream players, nor have a higher probability to predict the successful state of the world. The difference between the average contribution of first (1) to last (6) players is insignificant both in the low MPCR sessions (p-value $= 0.9540$) and in the high MPCR sessions (p-value $= 0.1717$). The difference between the average contributions of players 1 and 2 to players 5 and 6 is also not significant in the low MPCR sessions (p-value $= 0.8121$) nor in the high MPCR sessions (p-value $= 0.7574$). Similar results are obtained when comparing the decisions of first players to those of players 2-6.

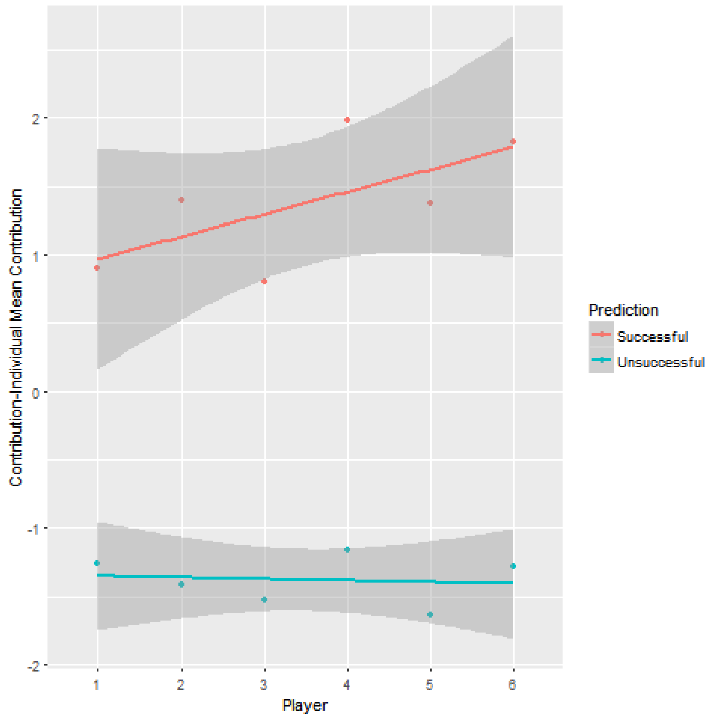


Figure 5: Deviation from individual mean contribution in sequence

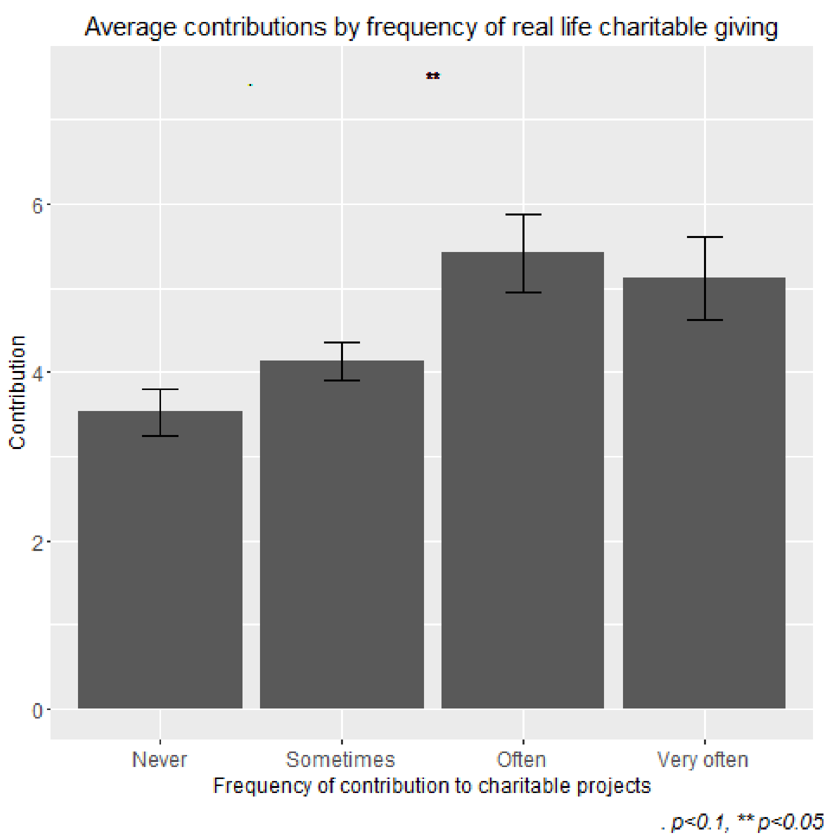


Figure 6

in addition to predictions and 0 if the prediction was made in a baseline period, and the interaction between the two. As hypothesized, the greater the distance between the expected payoffs from predicting the successful state and the unsuccessful state, the more likely individuals are to predict the successful state of the world. The coefficient on the distance in expected payoffs $\pi_A - \pi_B$ remains significant and positive (β=0.37, p-value < 0.001) when introducing a dummy for the low MPCR sessions and its interactions with the VCC dummy and the difference in expected payoffs (column 2). Players process the information from their private signals and others' predictions in a rational-like fashion in that their predictions reflect their expected payoffs.

Table 6: LPM: - Determinants of predicting the successful state of the world

	Probability to predict the succcesful state of the world		
	(1)	(2)	(3)
$\pi_A - \pi_B$	0.07***	0.07***	0.07***
	(0.00)	(0.00)	(0.01)
VCC	0.01	0.03	0.02
	(0.02)	(0.03)	(0.03)
Low mpcr		0.01	0.01
		(0.03)	(0.03)
2nd half			−0.01
			(0.02)
$\pi_A - \pi_B$*VCC	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)
$\pi_A - \pi_B$*Low mpcr		0.00	0.00
		(0.01)	(0.01)
VCC*Low mpcr		−0.03	−0.03
		(0.04)	(0.04)
$\pi_A - \pi_B$*2nd half			0.01**
			(0.00)
VCC*2nd half	0.49***	0.49***	0.49***
	(0.01)	(0.02)	(0.02)
Observations	1,890	1,890	1,890
Adjusted R^2	0.33	0.33	0.33
F Statistic	309.97*** (df = 3; 1886)	154.94*** (df = 6; 1883)	116.86*** (df = 8; 1881)
Notes:	Standard errors clustered at the individual level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$		

This behavior, which we refer to as unbiased predictions, improves with time, suggesting that players learn with experience. The coefficient on the difference in expected payoffs remains significant when controlling for whether the prediction was made in the first or the second half of the game (column 3).[16] The coefficient on the interaction term between $\pi_A - \pi_B$ and a dummy for periods in the second half of the game is positive and significant (β=0.29, p-value < 0.05), implying that the accuracy of players' predictions improves with respect to the first half of the game - see Figure 7.

[16] Sessions consisted of two 8-period "chunks" that were either P or VCC.

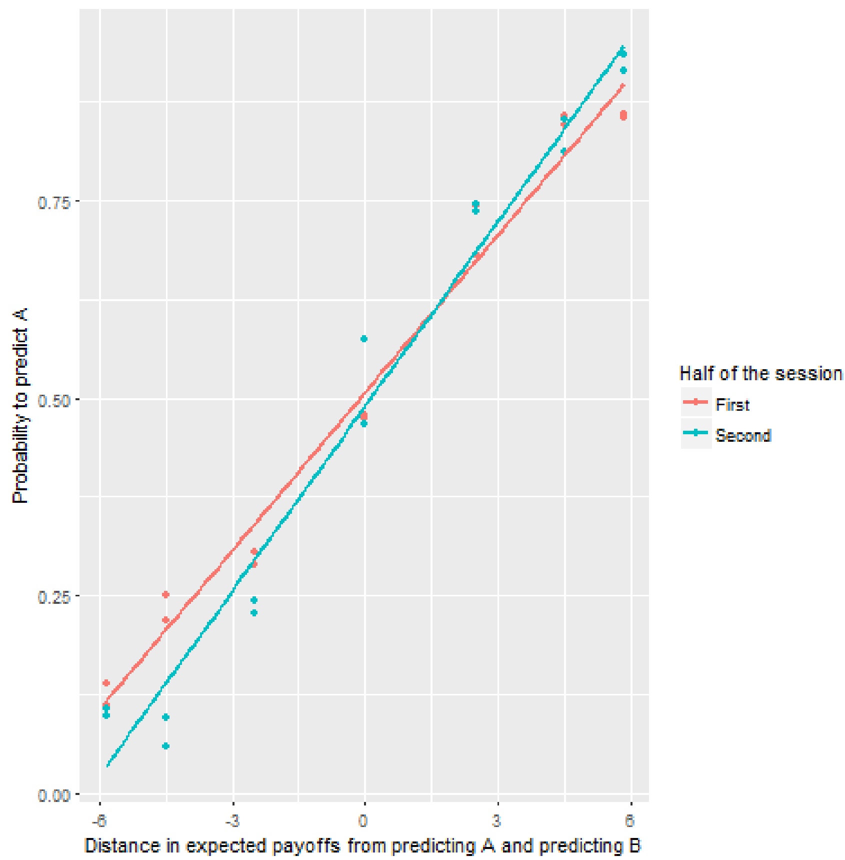


Figure 7: Probability to predict successful SOW given difference in expected payoffs

Results 5.2

(a) **Unbiased predictions** *Players process the information from their private signals and others' predictions in a rational fashion in that their predictions are driven by their expected payoffs. This behavior, which we refer to as unbiased predictions, improves with time, suggesting that players learn with experience.*

(b) **No evidence of strategic predictions** *Ex-ante accuracy is not impacted by the introduction of the strategic environment that is present when players are asked to make a contribution decision on top of their predictions, i.e., we find no evidence of players trying to influence others by making untruthful predictions.*

5.3 Main Results: The influence of leaders and the consequences of ill-informed leadership

5.3.1 The influence of leaders

Table 5 reports the result of a regression of players' contributions on the contribution of the first player (leader) in the relevant period, the place in sequence (player 1 to 6), the predicted state of the world, and the relevant interaction terms. We find that, even when controlling for players' predictions concerning the state of the world (successful or unsuccessful), the contribution of the first player in a period is positively correlated (p-value $p < 0.01$) with that of the remaining players (column 3), suggesting a sort of "leadership effect". Indeed, on average, players in the same place in the sequence contribute .45 tokens more for every additional token contributed by the first player (column 1). This effect decreases as the sequence proceeds, as we can see from the negative coefficient on the interaction term between player 1's contribution and the placement in the sequence ("player") (column 2). Interestingly, this relationship does not depend on the predicted state of the world, i.e., players are as much influenced by the contribution of the first player when predicting the successful state of the world (accompanied on average by higher contributions overall) than when predicting the successful state of the world (accompanied on average by lower overall contributions, see Figure 8), as shown in column 3. Moreover, controlling for the contribution of the first player reveals additional sequential effects. Firstly, players contribute more the further they are in the sequence (p-value < 0.01) given player 1's contribution. Secondly, once we control for first players' contribution and for players' place in the sequence, players' actual prediction is no longer significantly correlated with their contribution. Lastly, controlling for first players' contribution shows that when players predict the unsuccessful state of the world, the increase in contributions throughout the sequence is less steep than in the case of players who predict the successful state of the world.

More generally, conditional on the information available to players from the prediction decisions of previous players (captured by the distance in expected payoffs between predicting the two states of the world), increases in the mean contribution at a given point in the sequence are significantly associated both with an increase in contributions and an increase in the probability to predict the successful state of the world (see Table 7). The latter is especially interesting, as the fact that players are more likely to predict the successful state of the world the more previous players have contributed (holding their predictions equal) suggests that contribution decisions hold informational value. Nevertheless, the previous results presented in this section suggest that though this informational value is used by players to make their own decisions, they do not try to influence others through their choices of predictions or contributions.

Table 7: Impact of upstream behavior on contributions and predictions

	Contribution	Prediction	Contribution	Prediction	Contribution	Prediction
	(1)	(2)	(3)	(4)	(5)	(6)
Mean contribution	0.53***	0.05	0.45***	0.01*	0.41***	0.01*
	(0.05)	(0.06)	(0.06)	(0.01)	(0.01)	(0.01)
$\pi_A - \pi_B$			0.06	0.07	0.07***	0.07***
			(0.06)		(0.01)	(0.01)
Mean contribution*$\pi_A - \pi_B$			0.02	0.00	0.02***	0.00
			(0.01)		(0.00)	(0.00)
Constant	1.93***	0.32	2.16***	0.47***	1.51***	0.48***
	(0.28)	(0.27)	(0.34)	(0.03)	(0.03)	(0.04)
Period	No	No	No	No	Yes	Yes
Observations	775	775	775	775	775	775
Adjusted R^2	0.17	0.08	0.19	0.35	0.20	0.35
F Statistic	158.74*** (df = 1; 773)	67.28*** (df = 1; 773)	60.98*** (df = 3; 771)	140.76*** (df = 3; 771)	49.62*** (df = 4; 770)	105.54*** (df = 4; 770)

Notes: Standard errors clustered at the individual level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

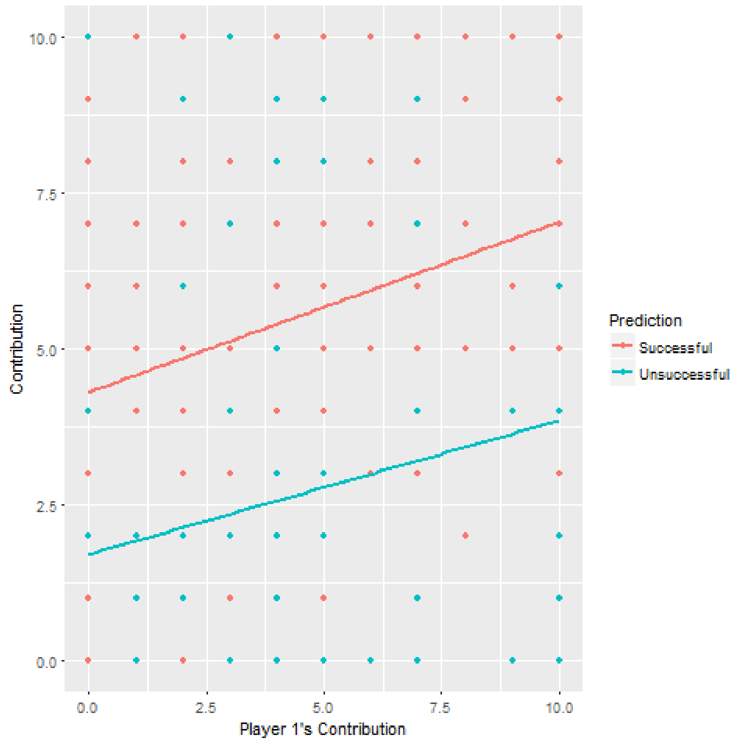


Figure 8: Effect of Player 1's Contribution on Contributions Given Prediction

Results 5.3.1

(a) **Leaders are influential** *First players exert leadership in that, for both types of predictions, their contributions are positively correlated with later contributions, an effect which decreases throughout the sequence.*

(b) **Conditional reciprocity** *Players contribute more when others have contributed more, holding expected payoffs from predictions constant.*

(c) **Informational value of contributions** *Holding expected payoffs constant, players are more likely to predict the successful SOW when others have contributed more, suggesting contributions are perceived as holding informational value*

5.3.2 The consequences of ill-informed leadership

The random occurrence of misleading signals on the state of the world allows to measure the cost of having a leader who is misinformed. Given that the state of the world is randomly determined as successful or unsuccessful, and the private signals that players receive are randomly drawn from the envelope as described in Section 3, the combination of the two creates two randomly assigned conditions in terms of the informational quality of leadership. In around one third of periods, first players receive a misleading signal that portrays the unrealised state of the world as more likely than the true state of the world.

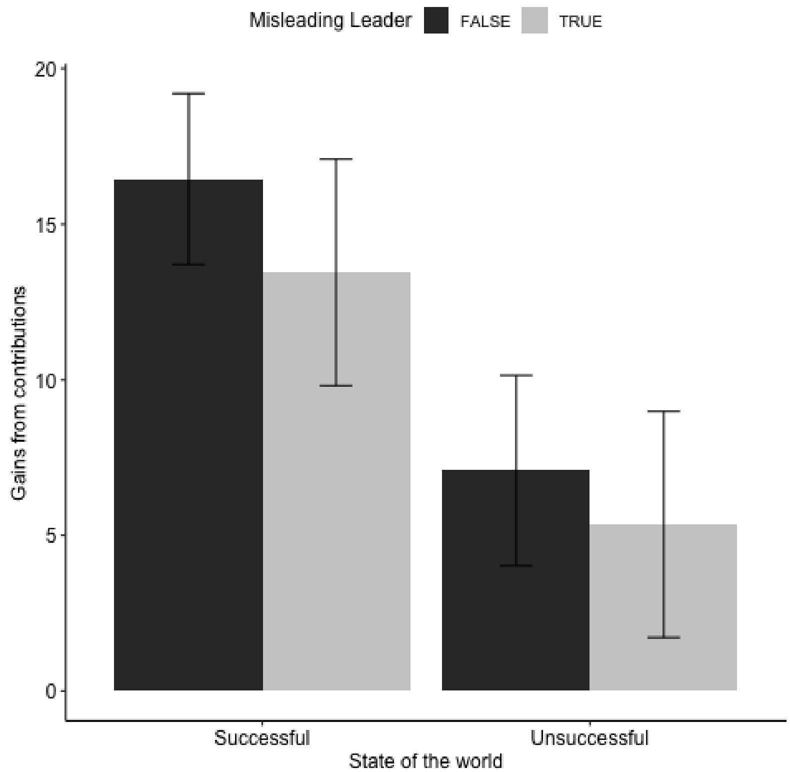


Figure 9: Effect of misleading leader on gains from contributions by state of the world

To document the impact of having misinformed leaders on the gains from the voluntary contributions, we report the following results only for the periods with voluntary contributions. 70.3% of leaders receiving misleading information behaved "rationally" and made a prediction in line with their signal, potentially setting in place a reverse cascade. We refer to leaders that make a wrong prediction as "misleading leaders", as they are (unknowingly) making their followers more likely to form false beliefs about the state of the world, and accordingly make decisions that are in their disadvantage.[17]

What is the cost of having a misleading leader? When considering gains from contributions,[18] players in periods with a misleading leader earn on average around 2.25 tokens less (p-value < 0.001) than in periods where the leader drew the correct signal. In periods where the successful state of the world was realized, this difference rises to almost 3 tokens less (p-value < 0.01), and in periods where the unsuccessful state of the world was realized, the difference is just under 2 tokens (p-value < 0.01).[19] The state of the world (SOW) determines the mechanism underlying these costs

[17] This term also captures leaders who make wrong predictions about the state of the world although they received the true signal, which happens for around 20% of cases. We explore this issue further below and address the heterogeneity issue of misleading predictions by instrumenting the endogenous variable of making a misleading prediction with the exogenously determined variable of drawing a misleading signal. See Table 10.

[18] Note that having a misleading leader also negatively impacts gains from predictions - for details see section 5.3.3

[19] When considering misinformed rather than misleading leaders, i.e., leaders who received a misleading signal regardless of whether their prediction was aligned with it, the difference between gains from contributions in periods with and without misleading leaders is significant only in periods where the unsuccessful state of the world was

Table 8: Summary statistics for misleading leaders

Misleading leader	SOW	gains	N	se	contributions
FALSE	Successful	16.45	42	0.15	5.20
TRUE	Successful	13.45	29	0.14	2.95
FALSE	Unsuccessful	7.08	50	0.07	2.91
TRUE	Unsuccessful	5.35	34	0.11	4.65

from misinformed leadership, as illustrated in Table 8 and Figure 9.[20] In the unsuccessful SOW, having a misleading leader leads players to form beliefs biased towards the successful SOW (where contributions are multiplied by $\alpha > 0$), and thus to be more likely to contribute than in cases when the SOW is unsuccessful and the leader is not misleading. Indeed, average contributions are about 2 tokens higher in the former than the latter (p-value < 0.01). As contributions are lost under the unsuccessful SOW, increased contributions imply decreased gains. In the successful SOW, having a misleading leader has the opposite effect. Players in such periods contribute less (about 1.5 tokens on average) with respect to the counterfactual where the leader is well informed (p-value < 0.01). Under the successful SOW, decreased contributions imply decreased gains, as there is less money in the "common pot" than would have been under the aforementioned counterfactual scenario.

Table 9: Impact of misleading leader by SOW and MPCR

Misleading leader	State of the world	MPCR	Contribution gains	N	Contributions
FALSE	Successful	High	22.69	17	6.34
			(0.40)		(0.32)
TRUE	Successful	High	16.36	12	3.18
			(0.49)		(0.36)
FALSE	Unsuccessful	High	6.67	30	3.33
			(0.29)		(0.28)
TRUE	Unsuccessful	High	4.67	21	5.33
			(0.36)		(0.36)
FALSE	Successful	Low	12.21	25	4.42
			(0.20)		(0.26)
TRUE	Successful	Low	11.40	17	2.79
			(0.24)		(0.30)
FALSE	Unsuccessful	Low	7.70	20	2.30
			(0.29)		(0.29)
TRUE	Unsuccessful	Low	6.46	13	3.54
			(0.38)		(0.38)

This setting can be analyzed as an encouragement design setting. Giving the first player a misleading signal can be thought of as the encouragement to take the treatment ("mislead followers"), and leaders who (do not) make predictions in line with their signal can be thought of as (not) com-

realized (p-value < 0.05)

[20]Table 9 and Figure 10 in 5.3.2 includes the same table and graph broken down with the additional dimension of MPCR

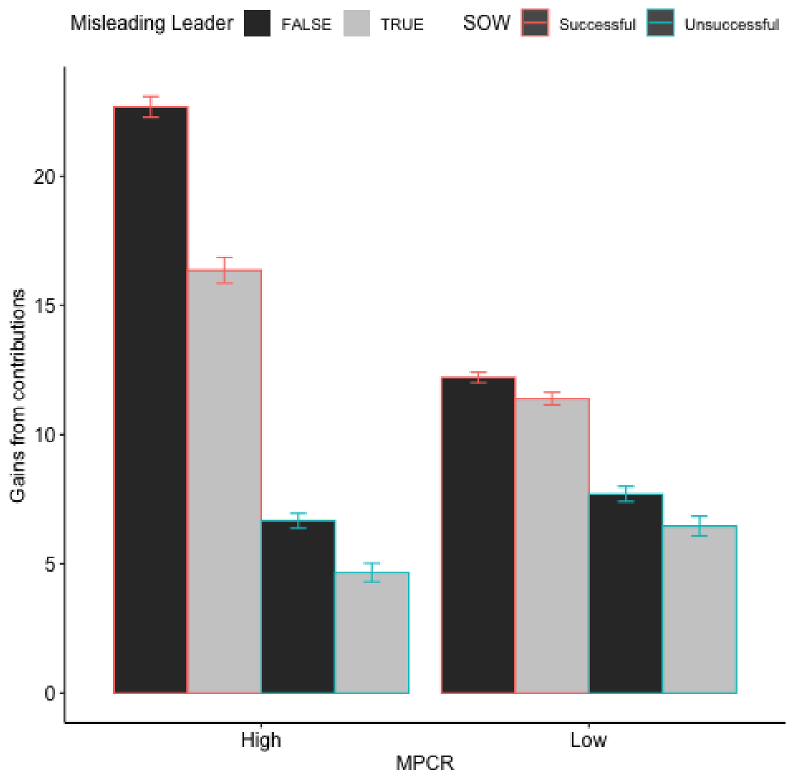


Figure 10: Effect of misleading leader on gains from contributions by MPCR and SOW

plying with the treatment. This framework is helpful in allowing to perform a more precise analysis of the impact of misinforming first players on all players' gains from contributions. Table 10 reports the results of this analysis. Misleading leader is a binary variable equal to 1 for players for whom the first player in their group in the relevant period made a wrong prediction about the state of the world, and zero otherwise. Misinformed leader is a binary variable equal to 1 for players for whom the first player in their group in the relevant period received a misleading private signal, and zero otherwise. Column 1 is a linear probability model regressing misleading leader on misinformed leader. The coefficient on misinformed leader is positive and significant (p-value < 0.01), indicating that misinforming a leader (providing them with a a misleading signal) significantly increases the probability that this leader will make a misleading prediction. As the value of 'misinformed leader' is determined by the random signal the first player draws and the randomly determined state of the world, it is completely exogenous. Misinformed leader thus satisfies the two conditions for a valid instrumental variable.

The dependent variable in columns 2 - 4 is the gains from contributions for a given player in a given period. Column 2 is the OLS regression of gains from contributions on misleading leader, using the following specification: $contributions\_gains_{i,p,s} = \beta_0 \cdot mislead\_leader_p + \beta_1 \cdot SOW_p + \beta_2 \cdot mislead\_leader * SOW_p + \beta_3 \cdot MPCR_s + \beta_4 \cdot mislead\_leader * MPCR_{p,s} + \beta_5 \cdot mislead\_leader * SOW * MPCR_{p,s} + \epsilon_{i,p,s}$ Column 3 uses the same specification as column 2, replacing misleading leader by misinformed leader. Column 4 is an instrumental variable regression in which misleading leader is instrumented by misinformed leader. All specifications give similar results in terms of both magnitude and statistical significance. In high MPCR sessions, and in periods in which the successful state of the world is realized, having a misleading leader leads to a reduction of about 5 tokens in the gains from contributions (p-value < 0.01). If the unsuccessful state of the world is realized, this reduction is closer to 3 tokens (p-value < 0.01). In low MPCR sessions, the impact of having a misleading leader is much less pronounced. In periods in which the successful state of the world is realized, having a misleading leader leads to a reduction of about 0.73 tokens in the gains from contributions (p-value < 0.01). If the unsuccessful state of the world is realized, the reduction is 2.31 tokens (p-value < 0.01). To put these results into perspective, the average loss of gains due to misleadership (2.27 tokens, p-val¡0.001) is equivalent to almost twice the difference in average gains between high MPCR sessions and low MPCR sessions (1.76 tokens, p-val ¡ 0.01).[21]

5.3.3 Misleadership on gains from predictions

Not surprisingly, being matched with a misled leader also leads to lower gains from predictions, as depicted in figures 11 and 12.

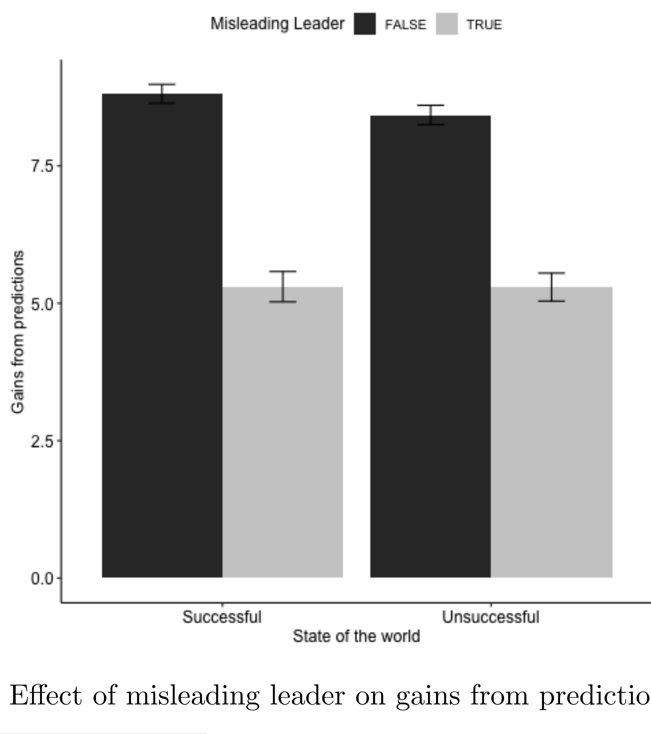


Figure 11: Effect of misleading leader on gains from predictions by SOW

[21]This is also equivalent to roughly one quarter of the difference in gains between the high MPCR sessions and the low MPCR sessions in periods where the successful state of the world is realized.

Table 10: Impact of misleading leader on gains from contributions by SOW

	Misleading leader	Gains from contributions		
	OLS	*OLS*		*instrumental variable*
	(1)	(2)	(3)	(4)
Misinformed leader	0.51***		−3.32***	
	(0.74)		(0.56)	
Misleading leader		−6.33***		−5.01***
		(0.54)		(0.81)
Unsuccessful SOW		−16.01***	−15.44***	−15.15***
		(0.43)	(0.49)	(0.61)
Low mpcr		−10.48***	−9.76***	−9.97***
		(0.45)	(0.50)	(0.59)
Misinformed leader*Unsuccessul SOW		4.32***		2.22*
		(0.67)		(1.24)
Misinformed leader*Low mpcr		5.51***		4.28***
		(0.70)		(1.15)
Misleading leader*Unsuccessul SOW			2.11***	
			(0.71)	
Misleading leader*Low mpcr			2.90***	
			(0.75)	
Unsuccessful SOW*Low mpcr		11.50***	10.65***	10.22***
		(0.61)	(0.67)	(0.90)
Misinformed leader*Unsuccessul SOW*Low mpcr		−4.75***		−1.58
		(0.95)		(1.89)
Misleading leader*Unsuccessul SOW*Low mpcr			−1.73*	
			(1.02)	
Constant	0.20***	22.69***	21.79***	22.14***
	(0.49)	(0.35)	(0.41)	(0.43)
Observations	930	930	930	930
Adjusted R^2	0.26	0.71	0.67	0.70
F Statistic	320.29*** (df = 1; 928)	319.65*** (df = 7; 922)	266.43*** (df = 7; 922)	
Notes:	Standard errors clustered at the individual level. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$			

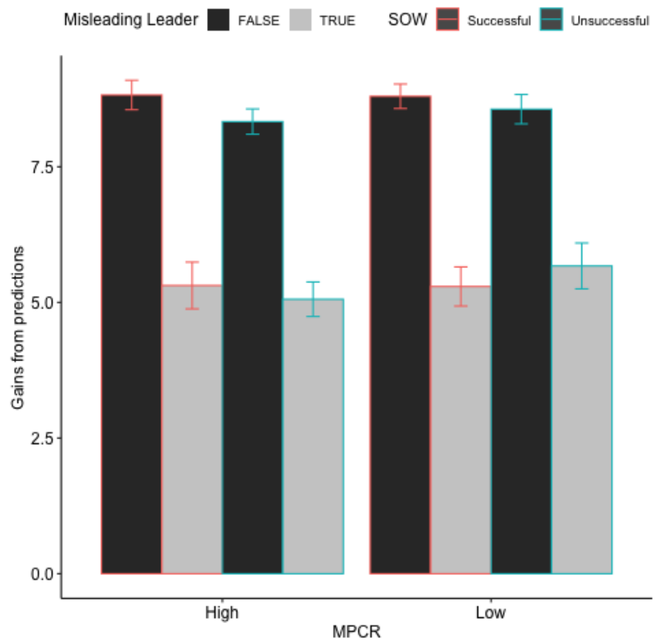


Figure 12: Effect of misleading leader on gains from predictions by MPCR and SOW

Result 5.3.3 - The tragedy of ill-informed leadership *Being matched with an ill-informed leader leads to lower overall earnings, driven both by a reduction in gain from contributions as well as from a reduction in gains from predictions.*

6 Conclusion

By combining the information cascade method with that of a modified public goods game, the "Voluntary Contributions in Cascades" paradigm put forth in this paper allows to document how information and behavior interact to impact voluntary contributions to public goods of uncertain quality. It allows to investigate how participants use the different sources of information they possess, their private signal as well as upstream predictions and contributions, to form beliefs about the state of the world and to decide whether and how much to contribute to the public good. The combination of the features of the sequential public good game with that of an information cascade provides a unique outlook on whether predictions and contributions are strategically motivated, and on how the position in the sequence impacts predictions and contributions. Finally, the occurrence of misleading signals on the state of the world allows to measure the cost of having a leader who is misinformed, highlighting the arbitrary nature of leadership quality and the importance of the information received by first movers in a sequence of potential donors in which no one has certainty about the returns from contributions.[22]

We find contribution behavior to be aligned with the theoretical predictions in that participants contribute more after predicting the successful state of the world than after predicting the

[22] In contrast to Potters et al. (2007) where leaders are always informed, and followers can be either informed or uninformed.

unsuccessful state of the world. Increasing incentives to contribute via a higher marginal per-capita return leads to higher overall contributions, which are even higher for participants who predict the successful state of the world. With respect to themselves, participants contribute more the further down the sequence they are. This is contrary to a scenario of strategically contributing more earlier in the sequence to try and influence subsequent contributions, and free-riding on previous contributions when playing later in the sequence.

Prediction behavior is aligned with Bayesian models and sensitive to the sources of information available to participants. The introduction of an information cascade baseline treatment in which there are no contribution decisions allows to test whether introducing a strategic dimension in the VCC paradigm has an impact on the *ex ante* accuracy of predictions. The presence of this strategic environment does not lead to biased predictions, even when increasing the incentives to mislead with the introduction of a higher marginal per-capita return. This suggest to the results are relatively robust to the introduction of incentives to mislead. Thus, the findings are not aligned with the hypothesis that participants may be willing to mislead others through their predictions with the prospect of benefiting from their contributions if the successful state of the world were to materialize. Our findings support an interpretation of predictions as representative of beliefs on quality. We also find that contributions are extremely sensitive to these beliefs: participants with a high quality prediction contribute significantly more than those predicting low quality.

Our results suggest the presence of learning. Participants act more in line with theoretical predictions as they gain more experience in the game. First, average contributions decrease when the "Voluntary contributions in cascades" component takes place in the second half of the game. Second, predictions in the second half of the game are more sensitive to expected payoffs, suggesting that prediction accuracy improves with experience.

Results on leadership show that participants are sensitive to the contributions of the leader in each period - the average contribution of a given period is correlated with that of the first player, a correlation that decreases with position in the sequence. This suggests that leaders are in an influential position. However, leaders do not use this influence to establish high norms of contributions or to mislead followers. On the contrary, average contributions increase with place in the sequence, in line with a conditional reciprocity hypothesis. The fact that no "end of game" effect is observed, which would materialize as a decrease in the contributions of participants in the 6th and last position, strengthens this interpretation. Moreover, predictions and contributions decisions are sensitive to sequence dynamics in that increases in the mean contribution at a given time are associated with increases in contributions as well as in the probability to predict the successful state of the world. Contributions are thus found to have an informational value as, holding expected payoffs constant, participants are more likely to predict the successful SOW when others have contributed more. Results on leadership also show that there is a tragedy of ill-informed leadership as being matched with an ill-informed leader leads to lower overall earnings, driven both by a reduction in gain from contributions as well as from a reduction in gains from predictions. In terms of the magnitude of this effect, the reduction in gains from contributions due to misleadership is roughly twice as large as the difference between high and low MPCR sessions.

Further work could investigate the robustness of these results to the parametrizations of the incentives at stake. The incentives in the current study were chosen to be tied in a satisfactory fashion to the information cascade literature on the one hand, and the public good game literature on the other hand. However, it would be interesting to explore whether a different incentive scheme would have driven leaders to strategically try and manipulate followers by behaving less truthfully. For example, providing a lower ratio between gains from predictions and gains from contributions by lowering rewards for correct predictions or increasing the MPCR even further, could potentially drive leaders to intentionally mislead followers, and unveil more complex strategic behavior than that which is reported in the current results.

Acknowledgement

The financial support of the "Département des études, de la prospective et des statistiques du ministère de la Culture (DEPS)" for the project "Développement des ressources propres des établissements culturels" is gratefully acknowledged.

References

L. R. Anderson and C. A. Holt. Information cascades in the laboratory. *The American Economic Review*, pages 847–862, 1997.

L. R. Anderson and C. A. Holt. Risk aversion and incentive effects. *The American Economic Review*, (5):1644–1655, 2002.

J. Andreoni. Toward a Theory of Charitable Fund-Raising Toward a Theory of Charitable Fund-Raising. *Source Journal of Political Economy*, 106(6):1186–1213, 1998.

J. Andreoni. Leadership Giving In Charitable Fund-Raising. *Journal of Public Economic Theory*, 8(1997):1–22, 2006.

V. Angelova, W. Güth, and M. G. Kocher. Leadership in a Public Goods Experiment with Permanent and Temporary Members. Ihs working paper series, Institute for Advanced Studies, Nov. 2019.

E. Arbak and M. C. Villeval. Voluntary leadership: motivation and influence. *Social Choice and Welfare*, 40(3):635–662, 2013.

S. Bikhchandani, D. Hirshleifer, and I. Welch. A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades. *Journal of Political Economy*, (5).

A. Bracha, M. Menietti, and L. Vesterlund. Seeds to succeed?: Sequential giving to public projects. *Journal of Public Economics*, 95(5):416–427, 2011.

E. J. Cartwright and D. Lovett. Conditional cooperation and the marginal per capita return in public good games. *Games*, 5(4):234–256, 2014.

K. Clark and M. Sefton. The sequential prisoner's dilemma: evidence on reciprocation. *The economic journal*, 111(468):51–68, 2001.

L. Corazzini and B. Greiner. Herding, social preferences and (non-) conformity. *Economics Letters*, 97(1):74–80, 2007.

A. Dannenberg. Leading by example versus leading by words in voluntary contribution experiments. *Social Choice and Welfare*, 44(1):71–85, 2015.

C. Figuieres, D. Masclet, and M. Willinger. Vanishing leadership and declining reciprocity in a sequential contribution experiment. *Economic Inquiry*, 50(3):567–584, 2012.

S. Gaechter, D. Nosenzo, E. Renner, and M. Sefton. Who makes a good leader? cooperativeness, optimism, and leading-by-example. *Economic Inquiry*, 50(4):953–967, 2012.

O. Gurerk, T. Lauer, and M. Scheuermann. Leadership with individual rewards and punishments. *Journal of behavioral and experimental economics*, 74:57–69, 2018.

W. Güth, M. V. Levati, M. Sutter, and E. Van Der Heijden. Leading by example with and without exclusion power in voluntary contribution experiments. *Journal of Public Economics*, 91(5-6): 1023–1042, 2007.

S. Gächter and E. Renner. Leaders as role models and 'belief managers' in social dilemmas. *Journal of Economic Behavior & Organization*, 154(C):321–334, 2018.

B. E. Hermalin. Toward an economic theory of leadership: Leading by example. *The American Economic Review*, (5):1188–1206, 1998.

S. Huck, I. Rasul, and A. Shephard. Comparing charitable fundraising schemes: Evidence from a natural field experiment and a structural model. *American Economic Journal: Economic Policy*, 7(2):329–369, 2015.

M. Komai and M. Stegeman. Leadership based on asymmetric information. *RAND Journal of Economics*, (1):35–63, 2010.

M. Komai, M. Stegeman, and B. E. Hermalin. Leadership and information. *American Economic Review*, (3):944–947, 2007.

M. V. Levati, M. Sutter, and E. Van der Heijden. Leading by example in a public goods experiment with heterogeneity and incomplete information. *Journal of Conflict Resolution*, 51(5):793–818, 2007.

R. Martin and J. Randal. How is donation behaviour affected by the donations of others? *Journal of Economic Behavior and Organization*, 67(1):228–238, 2008. ISSN 01672681. doi: 10.1016/j.jebo.2007.08.001.

B. C. McCannon. Leadership and motivation for public goods contributions. *Scottish Journal of Political Economy*, 65(1):68—-96, 2018.

E. Moxnes and E. Van der Heijden. The effect of leadership in a public bad experiment. *Journal of Conflict Resolution*, 47(6):773–795, 2003.

G. Pogrebna, D. Krantz, C. Schade, and C. Keser. Words versus actions as a means to influence cooperation in social dilemma situations. *Theory and Decision*, 2011.

J. Potters, M. Sefton, and L. Vesterlund. After you–endogenous sequencing in voluntary contribution games. *Journal of Public Economics*, 89(8):1399–1419, 2005.

J. Potters, M. Sefton, and L. Vesterlund. Leading-by-example and signaling in voluntary contribution games: an experimental study. *Economic Theory*, 33:169–182, 2007.

H. Qiu, Y. Zhang, G. Hou, and Z. Wang. The integrative effects of leading by example and follower traits in public goods game: A multilevel study. *Frontiers in psychology*, 9:1687, 2018.

M. F. Rivas and M. Sutter. Leadership, reward and punishment in sequential public goods experiments. In B. R. P.A.M. Van Lange and T. Yamagishi, editors, *Reward and punishment in social dilemmas*. Oxford University Press, Oxford, 2014.

S. G. Sahin, C. Eckel, and M. Komai. An experimental study of leadership institutions in collective action games. *Journal of the Economic Science Association*, 1(1):100–113, 2015.

J. Shang and R. Croson. Field experiments in charitable contribution: The impact of social influence on the voluntary provision of public goods. *Economic Journal*, 540:1422–1439, October 2009.

A Post-experiment questions

Age:

Gender:

Do you contribute to charitable projects? Never, sometimes, often, very often.

B Loss aversion decision task

As in a Anderson and Holt (2002) risk-aversion task, in this task, one option (A to F) was selected at random. The decision was then implemented.

Instructions: For each option, choose "I accept" or "I reject".

Option	If you roll a 1-3 on the die, then you lose	If you roll a 4-6 on the die, then you win	Your decision	
A	1 euro	3 euros	"I accept"	"I reject"
B	1.5 euro	3 euros	"I accept"	"I reject"
C	2 euros	3 euros	"I accept"	"I reject"
D	2.5 euros	3 euros	"I accept"	"I reject"
E	3.5 euros	3 euros	"I accept"	"I reject"
F	3.5 euros	3 euros	"I accept"	"I reject"

C Sample instructions[23]

[23]These are the instructions translated from French for the high MPCR sessions that did the VCC first and the baseline second.

Part One

The experiment consists of a sequence of "rounds". Since you are six players, the six rounds during which you play one after the other constitute a "period". In total, you will participate in 8 periods during the first part of the experiment. In each period, the order of play will be drawn at random.

We have prepared two envelopes, containing different mixes of colored cards. The first (denoted by a large "A") contains two yellow cards, labeled with a small "a" and a pink card labeled "b", and the second (denoted by a large "B") contains one yellow ("a") and two pink ("b") cards. In each period, one of the envelopes will be drawn at random and used for that period.

In each round, one player will draw a card from the envelope (according to the order of play for that period), and must guess which envelope is being used (A or B). After you draw this card on your turn, select "a" or "b" in the box labeled "draw" (For example, if your card is yellow with a small "a", select "a"). Then put the card back in the envelope. Your draw will not be revealed to other group members.

Première période - vous etes le joueur no1

	prédictions							
tirage	votre prédiction	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	enveloppe utilisée	gains
a								
b								

After you have marked your draw, you will be asked to make two decisions:

1. A prediction about the envelope used ("A" or "B") - enter your choice in the pink box under "prediction".

Première période - vous etes le joueur no1

	prédictions							
tirage	votre prédiction	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	enveloppe utilisée	gains
a								
	A							
	B							

- Each time a prediction is made, it will be revealed to the other players, unlike your draw, which will remain private.
- Once all players have made their prediction, the envelope used will be revealed, along with your earnings. A correct prediction will bring you 10 tokens (worth 11 cents each), and an incorrect prediction will bring you 2.5 tokens.

	predictions							
tirage	votre prediction	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	enveloppe utilisée	gains
a	A	B	A	B	A	B	B	2.5

2. A contribution decision - You receive 10 tokens per period (worth 11 euro cents). You have the possibility to contribute between 0 and 10 tokens to a common fund.
   - If the envelope used is A, the contributions of all members of the group will be multiplied by three and equally distributed among all members, regardless of their contribution.
   - If the envelope used is B, no one will receive anything, and contributions will be lost.

Every period will therefore proceed as follows:
Each player will in turn draw a card, mark the result in the designated box, and make a prediction about the envelope used. In addition to this, you will be asked to make a contribution choice:

Première période - vous etes le joueur no1														
	prédictions						contributions							
tirage	votre prédiction	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	votre contribution	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	enveloppe utilisée	gains
a	A													
							0							
							1							
							2							
							3							

Once everyone has played, the envelope used will be revealed, and your earnings will be calculated. This time, your earnings will consist of two parts: the earnings for correct predictions (10 tokens) or incorrect predictions (2.5), but also the earnings related to the contributions of the members of your group.

Première période - vous etes le joueur no1														
	prédictions						contributions							
tirage	votre prédiction	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	votre contribution	joueur no2	joueur no3	joueur no4	joueur no5	joueur no6	enveloppe utilisée	gains
a	A	A	B	A	A	A	5	5	6	4	3	5	A	29

We will continue this way for seven more periods, before moving on to the second part of the experience.

<u>Part Two</u>

In this second part, you only make the prediction regarding the envelope. As before, one envelope (A or B) will be drawn at random for each period.

We will continue in this way for seven more periods.

Then, all of your earnings will be calculated and you will receive their cash equivalent before leaving the laboratory