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# Leading by Words: A Voluntary Contribution Experiment With One-Way Communication

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## Abstract

In this paper, we study a voluntary contribution mechanism with one-way communication. The relevance of one person's words is assessed by assigning exogenously the role of the 'communicator' to one group member. Contrary to the view that the mutual exchange of promises is necessary for the cooperation-enhancing effect of communication, we find that, compared to a standard voluntary contribution mechanism with no communication, one-way communication significantly increases contributions and renders them stable over time. Moreover, the positive effects of one-way communication persist even when communication is one-shot.

*JEL Classification:* C72; C92; H41

*Keywords:* Public goods experiment; Computer-mediated communication; Cheap-talk; Cooperation

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## 1 Introduction

One of the most consistent experimental findings in the social dilemma literature is that costless, non-binding, non-verifiable communication (i.e., cheap-talk) has a positive effect on cooperation.<sup>1</sup> But what is it about communication that boosts cooperation? Three aspects of communication are suggested in the literature as inductive to cooperation (see, e.g., Dawes et al. 1977): identification, discussion, and commitment. Several experimental studies demonstrate that neither mere identification nor discussion are *sine quibus non* for the occurrence of the communication effect (see, e.g., Bouas and Komorita 1996; Bohnet and Frey 1999; Brosig et al. 2003). Instead, the commitment to cooperate, in the form of a mutual exchange of promises and pledges, is considered crucial for communication to unravel its cooperation-enhancing effects (see Kopelman et al. 2002 and Bicchieri and Lev-On 2007, for surveys of relevant work in the psychology and economics literature, respectively).

Most of the evidence on the role of commitment comes from two kinds of studies. First, experiments that draw a comparison between face-to-face and other forms of communication (e-mails, chat-rooms, audio-conferences, numerical cheap talk; see, for instance, Frohlich and Oppenheimer 1971; Brosig et al. 2003; Bochet et al. 2006). Such experiments find that the strength of the communication effect depends on the communication medium, with a stronger effect of face-to-face discussion compared to any other alternative.<sup>2</sup> Notice, however, that all these communication opportunities do allow

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<sup>1</sup>Sally (1995) offers a meta-analysis of 35 years of social dilemma experiments and shows that enabling people to communicate significantly increases cooperation rates. Balliet (2009), in a more recent meta-analysis, reports similar results. Ledyard (1995), in his survey of public goods experiments, identifies cheap-talk communication as one of the most important variables affecting contribution levels.

<sup>2</sup>According to Bicchieri and Lev-On (2007, pg. 145): “using computer-mediated communication instead of face-to-face communication can hamper the generation of normative

subjects to mutually exchange non-binding promises, thereby encumbering the assessment of the effective merit of commitment for the cooperation-enhancing effect of communication. Second, experiments that draw a comparison between face-to-face and passive communication<sup>3</sup> (e.g., Brosig et al. 2003). This approach is not well suited to question the relevance of the mutual exchanges of promises because, while it makes commitment unfeasible, it renders the source of the messages external to the group.

An unambiguous way of studying whether commitment is necessary for cooperation, in the sense that in its absence the positive effect of communication should vanish, calls for a setting where an in-group communication channel is preserved and mutual pledges to cooperate are ruled out by design. In this paper we provide an experimental study based on such a setting.

We consider a finitely repeated linear public goods game with one-way communication. All group members make their contribution decisions privately and simultaneously, but prior to this, one of them, a group member that is randomly assigned the role of the ‘communicator’, can send a free-form text message to his fellow players. This method of unidirectional messaging precludes the mutual exchange of promises. Hence, if commitment is necessary for the rise in cooperation rates, we should not observe any difference in contribution levels with respect to a no-communication baseline treatment. If, on the other hand, all that is needed in order to overcome the free-riding problem is a “primed” cooperative behavioral rule, and all group members’ preferences are consistent with that rule (see, e.g., Kerr et al. 1997; Bicchieri 2006), then the presence of the communicator could promote contributions towards the public good.

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settings in which promises are perceived as reliable”.

<sup>3</sup>Passive communication means that subjects may attend but not intervene in the communication of outsiders (that is, people that do not belong to their group).

This paper argues that there is more to the impact of communication on cooperation than the behavioral importance of promises to cooperate.<sup>4</sup> The communicator may enhance cooperation by lending salience to other facets of the game (like the efficiency gains obtainable under full contributions of all subjects) or by affecting people's preferences and beliefs (see, e.g., Foss 1999; Bicchieri 2006). To check whether the alleged effectiveness of one-way communication hinges on the frequency of messaging, we consider two treatments that differ only with respect to how often the communicator can send messages.

Another way of looking at our setup is to consider the communicator as a leader who leads by words. It is not difficult to guess the power such words can carry. Susan Brownell Anthony played a pivotal role in the 19th century campaign to introduce women's suffrage into the United States. She travelled the United States and Europe, and gave 75 to 100 speeches every year for 45 years. The 44th President of the United States, Barack Obama, said that his biggest inspiration came from Mahatma Gandhi, who, he declared, ended up doing so much and changing the world just by the power of his ethics.<sup>5</sup>

Previous experiments dealing with communication in social dilemma games testify as well that the presence of a leader who dominates the discussion serves as a means of establishing mutually beneficial cooperation. Orbell et al. (1991), for instance, note that self-selected group leaders encourage a particular strategy and ask the others to conform to it; instead, in leaderless groups, agents find it difficult to reach an agreement and often terminate the

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<sup>4</sup>Gneezy (2005), Charness and Dufwenberg (2006), and Vanberg (2008), among others, have shown that people have a preference for keeping their word.

<sup>5</sup>"I am always interested in people who are able to bring about change, not through violence, not through money, but through the force of their personality and their ethical and moral stances" (The Financial Express, September 10, 2009).

discussion ahead of time. Rocco (1998) focuses on a finitely repeated common pool resource experiment and compares a face-to-face treatment with a ‘mailing list’ treatment (in which everyone could access everyone else’s messages). Rocco finds that while groups communicating face-to-face converge quickly towards cooperation, those communicating through messages fail to reach effective cooperative agreements. She attributes this result to the difficulty of electronic communication to establish leaders who organize and focus discussion. Finally, Simon and Schwab (2006) observe that the emergence of a leader within a group deterred dissent and helped people keep talking.<sup>6</sup> In these studies all members can communicate with each other. Therefore, the actual influence of a leader’s message on the effectiveness of communication remains an open question.

Although the effects of leadership in public goods experiments have captured a lot of attention lately, we are not aware of any empirical study trying to assess the relevance of leading by words in a voluntary contribution mechanism.<sup>7</sup> Except for a few contributions, experimental economists have investigated the effects of leadership in social dilemma games by focusing on leading by example.<sup>8</sup>

Whether and to what extent one-way communication, in the form of leading by words, can affect cooperation levels in social dilemmas could be of interest to group organizers and institution designers. As noted, for example, by Messick and Brewer (1983), multilateral communication in real-world social dilemmas can be very costly, or even unfeasible. Most social

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<sup>6</sup>For an account of the importance of leaders in coordinating the group see also Bicchieri (2006). In a similar vein, but from a theoretical perspective, Foss (1999) observes that somebody who leads via suggesting a strategy can coordinate the actions of many people by making that strategy commonly known.

<sup>7</sup>The study of leadership by words has been pursued in much greater detail in coordination games (see, e.g., Brandts and Cooper 2007 and references therein).

<sup>8</sup>The studies on leadership are discussed in more detail in Section 2.2.

dilemmas are large group problems (e.g., global environmental problems) offering the participants little or no opportunity to communicate or negotiate a solution. Our experimental study allows us to examine whether one-way communication supports cooperative outcomes, and whether this depends on the communication mechanism being provided as a costless one-shot opportunity or on a repeated basis.

The paper is organized as follows. Section 2 reviews the relevant literature. Section 3 details our research questions and describes our experimental design. Section 4 provides results. Section 5 concludes.

## **2 Related literature**

Our paper weaves together two strands of experimental research: communication and leadership. In this section, we review some relevant studies from each strand and discuss their differences with our experiment.

### **2.1 Studies on communication**

Many experimental dilemma games have shown that multi-directional communication (i.e., communication among all involved parties) is effective in enhancing cooperation. Most of the early experiments involve face-to-face discussion (Dawes et al. 1977; Isaac and Walker 1988; Orbell et al. 1988). However, as Roth (1995) points out, face-to-face interactions are difficult to interpret as they bring into play a multitude of cues and social motivations that may affect behavior and outcomes.

Next, in an attempt to delineate the features of face-to-face interactions which are essential for the activation of cooperative behavior, researchers turned to computer-mediated communication. Frohlich and Oppenheimer (1998), for instance, report the comparative results of a repeated public



goods experiment using both face-to-face and electronic communication: the former is more effective than the latter because, following the authors, it promotes a greater sense of community among subjects.

It is now commonly accepted that written messages, either in the form of notes or via computer, are less powerful than face-to-face communication in affecting cooperation levels (see, e.g., Rocco 1998; Bos et al. 2001; Brosig et al. 2003; Bochet et al. 2006; Balliet 2009). The compliance with social norms of cooperation, especially commitment, has been identified as the most likely explanation for this result (see, e.g., Kerr et al. 1997; Bicchieri 2002). Bicchieri and Lev-On (2007) suggest that the norm of promise keeping is less salient in computer-mediated environments, which (1) provide few cues that can be used to evaluate the credibility of others' promises, (2) render the communication noisy, impeding public knowledge of the mutuality of promises, and (3) lack a leader who can coordinate actions.

Since we consider a repeated public goods game with one-way communication, there is, by construction, no process of endogenous leader determination. Instead, the relevance of one person's words is assessed by assigning exogenously the role of the communicator/leader to one group member. In addition, we rely on free-form text communication to isolate the impact of the message content from visual (i.e., body language, eye contact, facial expressions) and verbal cues (tone of voice, phrasing, fluency, manner of expressing moral rhetoric).

There exist some studies exploring the effects of partial communication on cooperation levels, but they deal with face-to-face contexts. Braver and Wilson (1986) find that discussion of the dilemma among subgroup members leads to higher cooperation rates. More recently, Kinukawa et al. (2000) have established that the communication effectiveness is positively correlated with

the connectivity of the communication network, i.e., with the number of others to whom each agent can, directly or indirectly, talk.

There is also a lot of contention about how many communication opportunities subjects should have. More specifically, participants interacting repeatedly have been allowed to communicate (1) prior to the first period only (pre-play communication), (2) prior to a few preselected periods (discontinuous communication), and (3) prior to each and every period (continuous communication). Findings on this issue are mixed. While certain studies find that pre-play and discontinuous communication has a lasting effect on cooperation (Radlow and Weidner 1996; Brosig et al. 2003; Balliet 2009), others find that cooperation rates decline in response to restrictions in communication (Ostrom et al. 1992; Fröhlich and Oppenheimer 1998). Our approach to communication timing resembles that of Voissem and Sistrunk (1971). We examine whether the effect of the communicator's words is transitory or not by comparing the time path of contribution levels under one-shot and repeated communication.

## 2.2 Studies on leadership

In experimental papers, leadership is typically implemented as a sequential public goods game where one group member contributes first and all others follow.<sup>9</sup> Employing a symmetric, complete-information environment, Moxnes and van der Heijden (2003), Gächter and Renner (2004), Güth et al. (2007) find that leaders' and followers' contributions are highly correlated, and that average contributions are often higher in the presence than in the absence of a leader. Güth et al. report that followers follow, albeit they contribute significantly less than their leaders. Consequently, leaders decrease

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<sup>9</sup>The concept of leading by example has been analyzed theoretically by, among others, Rotemberg and Saloner (1993), Hermalin (1998), and Bolton et al. (2008).

their contributions over time bringing down the public good production. These findings have been attributed to peer-pressure (Falk and Ichino 2003; Mohnen et al. 2008) and social preferences (like conditional cooperation; Fischbacher et al. 2001). Levati et al. (2007) show that leadership by example is almost ineffective when information on the distribution of endowments is incomplete. In contrast, leadership effects can be rather strong when the leader has private information on the marginal returns from contributing to the public account, as his contribution decision may serve as a signal to the others (Potters et al. 2007).

A recent experiment by Gürer et al. (2009) focuses on team production in a voluntary contribution setting where the leader chooses between two incentive schemes. Then, having observed the individual contributions of his teammates, the leader is able to either reward or punish them. Gürer et al.'s results indicate that leaders show initially a preference for rewards, yet this preference is diminishing over time. As far as contributions are concerned, they are, on average, higher under punishment incentives.<sup>10</sup>

The experiment most similar to ours is Houser et al. (2007), who consider a repeated linear public goods game with numerical communication by an elected group member. Participants interact (in groups of four) for five periods. Then, prior to the sixth period, they write a message that is delivered to all other co-players. The group members, having read the various messages, vote on who should be their leader. For the remaining ten periods, all group members, before arriving at their decision, receive from their elected leader a non-binding contribution suggestion.

Houser et al. compare this 'human leader' treatment to a 'random' treatment where the same suggestions are sent by an external device. Their

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<sup>10</sup>Rivas and Sutter (2008) report similar findings in a sequential public goods game.

results indicate that contribution suggestions that do not originate with a human leader have no impact on the group members' decisions. Thus Houser et al. focus on the importance of human leaders to leadership effects in social dilemmas. Our research questions deal with the effect of one (randomly selected) group member's words on contributions towards public goods.<sup>11</sup> Both their study and ours conclude that sizeable suggestions by the leaders lead to high levels of cooperation and nearly optimal outcomes.

### 3 The experiment

#### 3.1 The basic public goods game

The basic game is the voluntary contribution mechanism, as introduced by Isaac et al. (1984). Groups of size  $I = \{1, \dots, 4\}$  interact for  $t = 1, \dots, 10$  periods in a partner design (group composition does not change during the experiment). Every participant is endowed at the beginning of each period with 25 ECU (Experimental Currency Units), which can be either consumed privately or contributed to a public good. Denote by  $c_{i,t}$  individual  $i$ 's contribution to the public good in period  $t$ , where  $c_{i,t} \in [0, 25]$ ,  $i \in I$ , and  $t = 1, \dots, 10$ . The monetary payoff of individual  $i$  in period  $t$  is given by:

$$\pi_{i,t}(\mathbf{c}_t) = (25 - c_{i,t}) + 0.4 \sum_{j=1}^4 c_{j,t} \quad \forall i \in I, \quad \forall t = 1, \dots, 10, \quad (1)$$

where  $\mathbf{c}_t = (c_{1,t}, \dots, c_{4,t})$  and  $0.4 \sum_{j=1}^4 c_{j,t}$  are the period  $t$  strategy profile and the income from the project, respectively. Since the marginal per capita return is less than unity, the dominant strategy for a selfish, payoff-maximizer

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<sup>11</sup>Note that in Houser et al.'s (2007) setting, communication is not always one-way: before the sixth period, all group members communicate with each other via written messages.

player is to contribute nothing. Yet, the socially efficient outcome (i.e., the outcome that is maximizing the sum of  $\pi_{i,t}(\mathbf{c}_t)$  over  $i = 1, \dots, 4$ ) is to contribute everything. If all group members free-ride (i.e., contribute zero), then each one of them earns 25 ECU. If, on the other hand, all contribute the Pareto optimal amount, they earn 40 ECU each. The dominance of free-riding extends to the finitely repeated game: it can be shown, by means of backward induction, that free-riding in each period is the unique subgame perfect equilibrium.

### 3.2 Treatments and research questions

We study three treatments that build on the basic game described above. The primary treatment variable is the frequency of communication.

1. *Baseline (B)*. Group members cannot communicate with each other. They decide simultaneously and privately on the number of ECU that they want to contribute to the public good.
2. *Continuous Communication (CC)*. At the beginning of the experiment, one member of each group is randomly selected to be the communicator. The communicator is given, prior to each period, the opportunity to send a message to his co-players (so he can send up to ten messages).
3. *Pre-play Communication (PC)*. The communicator is again selected randomly, but he can send a message only prior to the first period (i.e., before making any contribution decision). Afterward, the groups interact as in the baseline treatment.

Our treatments are expressly designed to address the following three questions.

Question 1: *Does one-way communication affect contributions towards the public good?*

Question 2: *Is the number of communication periods relevant, i.e., does the effect of one-way communication depend on whether it occurs continuously or just once?*

Question 3: *What kind of arguments are invoked by the communicator?*

The correspondence between research questions and tools used for investigating them is displayed in Table 1.

Table 1: Research questions and approach to test for them

Research question	Approach for testing
Is one-way communication effective?	$CC$ vs. $B$ $PC$ vs. $B$
Does the frequency of communication matter?	$CC$ vs. $PC$
What kind of arguments are used?	Messages' content

With regard to Question 1, the relevant theoretical literature points at the effect of augmenting the game with cheap-talk. A number of papers have addressed the theoretical conditions under which cheap-talk effects efficient outcomes (see Farrell and Rabin 1996 and Crawford 1998 for surveys). When interests conflict completely (as it happens in our case), cheap talk is not expected to alter the prediction of full free-riding insofar as people care only about their own monetary payoff. Yet, as emphasized in the previous sections (i) this selfish prediction has been contradicted by decades of experimental research, albeit mostly focusing on communication among all parties, and (ii) the opportunity to make commitments is regarded as the most likely explanation of the effect of communication.

We argue that people's propensity to contribute may increase for reasons other than commitment. For instance, in his theoretical analysis of leadership, Foss (1999, p. 22) maintains that a leader's words can change the payoff structure of a prisoner's dilemma by influencing preferences towards generalized "niceness". In this case, the game becomes a coordination game, where the communicator's cheap-talk may be more effective (see, e.g., Farrell and Rabin 1996).<sup>12</sup> According to Shamir et al. (1993, p. 585), "charismatic leaders engage in communicative processes that affect frame alignment and mobilize followers to action". Such leaders transform the needs, values, preferences and aspirations of followers from self-interests to collective interests (p. 577). Based on these arguments, we conjecture that the answer to Question 1 is positive.

An answer to Question 2 is more difficult to formulate as not only the existing research contrasting pre-play with continuous communication is based on multi-directional communication, but also its findings are mixed. On the one hand, pre-play communication by one group member may (*i*) engender a personal norm of cooperation that persists even in the absence of further messages (Kerr et al. 1997; Balliet 2009) and/or (*ii*) permanently alter preferences so as to transform the original game into a coordination game (Foss 1999; Bicchieri 2006). On the other hand, individuals might need "counter reinforcers," such as the communicator's approval or disapproval, in order to sustain cooperative behavior (Jerdee and Rosen 1974; Frohlich and Oppenheimer 1998).

Finally, we have no preconceptions about Question 3. Previous studies analyzing the content of communication either involve multi-directional communication or consider games where promises to cooperate play a crucial role

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<sup>12</sup>See also Bicchieri (2006) for an analysis of how the establishment of a cooperative social norm can transform a prisoner's dilemma into a coordination game.

(see, e.g., Charness and Dufwenberg 2006; Simon and Schwab 2006; Brandts and Cooper 2007; Sutter and Strassmair 2009). The study by Brosig et al. (2003) analyzes the content of communication in public goods experiments where all group members could communicate to each other via different types of medium. They divide their communication data in nine categories, some of which (like computation of the payoffs for full cooperation) are included also in our categorization. However, as our setting is different from theirs, their results (that the use of promises together with threats enhances efficiency) cannot apply to our study.

### 3.3 Procedures

The experiment was programmed with the software z-Tree (Fischbacher 2007) and conducted in the experimental laboratory of the Max Planck Institute of Economics in Jena, Germany. Subjects were undergraduate students from the Friedrich-Schiller University of Jena. They were recruited using the online recruitment system ORSEE (Greiner 2004). Upon entering the laboratory, subjects were randomly assigned to visually isolated computer terminals. Instructions (reproduced in the Appendix) were distributed and read out loud to establish common knowledge. Questions were answered individually at the subjects' seats. Before starting the experiment, subjects had to answer a control questionnaire testing comprehension of the rules.

In the treatments allowing communication (*PC* and *CC*), the communicator could use a text box on his screen to type and send a message to his group members. The communicator had a maximum of four minutes to write his message, but was permitted to finish writing and send the message ahead of time. In principle, the message was of “free-form”. The only restrictions to its content were that the communicator could not identify himself,



threaten the other group members or promise side-payments. To enforce compliance with these restrictions, all messages were monitored before being sent. All communicators messages were collected, screened, and then delivered simultaneously. Improper messages were not to be delivered, and their sender was supposed to be given a warning for misconduct, but actually this never happened. It was common knowledge that (i) the message was cheap-talk (i.e., costless and non-binding), (ii) each group member received exactly the same message from the group communicator, and (iii) only after reading the communicator's message could all group members decide simultaneously on their contribution.

Regardless of the treatment, at the end of each period, participants got feedback on 1) the number of ECU contributed by each group member, with the individual contributions being sorted in descending order, 2) the income from the project, and 3) their corresponding period payoff.

In total, we ran six sessions (two per treatment). Except for treatment *CC* where 20 participants showed up in one session, all other sessions involved 24 participants. This yields 12 independent observations for *B* and *PC* and 11 independent observations for *CC*. *B* sessions lasted, on average, 45 minutes; *PC* and *CC* sessions about one hour and a quarter. Payoffs were quoted in ECU, where 10 ECU = 50 euro-cents. At the end of period 10, subjects were privately paid their earnings from all periods. The average earnings per subject were €20.43 (including a €2.50 show-up fee), ranging from a minimum of €13.79 (in treatment *B*) to a maximum of €23.6 (in treatment *CC*).

## 4 Results

The results are presented in two subsections. The first subsection focuses on the first two research questions and reports on the effects of one-way communication on contribution levels. The second subsection analyzes the contents of communication.

### 4.1 The effects of one-way communication

Table 2 presents descriptive statistics in the baseline and the two treatments with communication.

Table 2: Summary statistics on contributions by treatment.

Treatment	Mean	Median	Std. Dev.
<i>B</i> (baseline)	12.36	10.00	10.13
<i>CC</i> (continuous communication)	21.59	25.00	7.78
<i>PC</i> (pre-play communication)	22.59	25.00	6.86

Both the mean and the median contributions in treatments *CC* and *PC* differ considerably from those in treatment *B*: as compared to a situation with no communication, the presence of a communicator significantly raises average contributions ( $p < 0.005$  for both *B* vs. *CC* and *B* vs. *PC*; Wilcoxon rank sum tests).<sup>13</sup> Moreover, whether communication is continuous or one-shot does not influence average contributions significantly ( $p = 0.114$ , Wilcoxon rank sum test comparing average contributions in *PC* and *CC*).

Figure 1 shows the time path of average contributions in each treatment. The baseline treatment replicates standard findings (Ledyard 1995): average contributions begin at 57.33% of the endowment and decline with repetition

<sup>13</sup>All statistical tests rely on independent group observations and are two-sided.

(in the last period, contributions are 18.04% of the endowment). In contrast, in the treatments allowing communication average contributions start at very high levels (84.91% and 91.58% of the endowment in *CC* and *PC*, respectively) and are basically stable from the first until the last but one period (in period 9, average contributions are 81.64% in *CC* and 90.00% in *PC*). Wilcoxon signed rank tests comparing average contributions in the first and the ninth period of each treatment detect no significant difference for *CC* and *PC* ( $p \geq 0.588$  in both cases) and a significant difference for *B* ( $p = 0.006$ ).

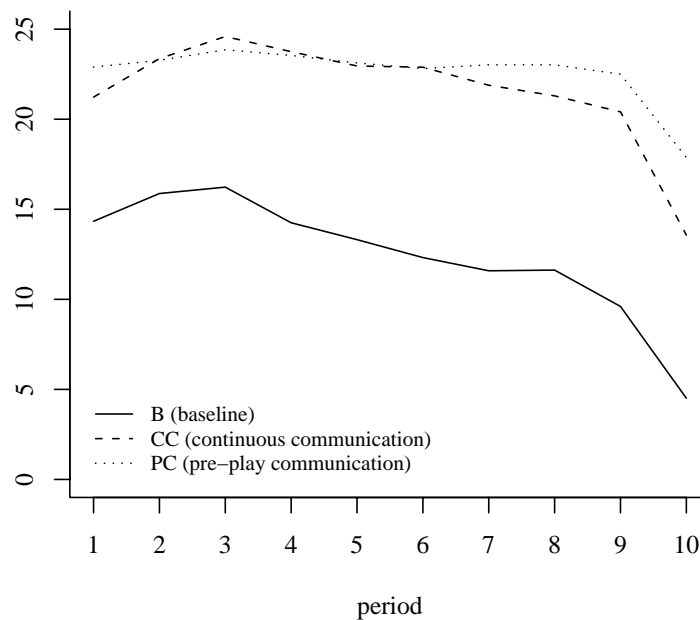


Figure 1: Average contributions over time.

It is remarkable that in the *PC* treatment, out of 12 groups, four are socially optimizing (contribute 100% of their endowment) from period 1 to

10, and five are so until period 9.<sup>14</sup> The numbers are lower, but nevertheless noteworthy, in the *CC* treatment (where the number of groups is 11): one group chooses the Pareto optimal amount over all periods, and four do so up to period 9.

The results of this section can be summarized as follows:

Result 1: *One-way communication significantly increases contributions to the public good and renders them stable until the last but one period.*

Result 2: *Whether the communicator can send a message only prior to the first period or prior to each period has not significant influence on contributions.*

## 4.2 Analysis of communication content

To study what kinds of arguments the communicators invoke and how such arguments influence behavior we analyze the content of the messages sent in the two treatments with communication. Our approach to this analysis closely follows that employed by, e.g, Cooper and Kagel (2005) and Sutter and Strassmair (2009). In a first step, two researchers separately screened the messages and established preliminary categories, which were then reconciled into a final set.<sup>15</sup> The full list of categories including labels and a detailed description is shown in Table 3. In a next step, two student assistants individually coded every message. They assigned a “1” if a particular message entailed the statement of a specific category and a “0” otherwise. Finally, the coders gathered, discussed their individual assessments, and agreed on one common coding for each message. The average cross-coder

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<sup>14</sup>Actually, one subject in one of the almost always socially optimizing groups contributed 24 in period 1 and 25 in periods 2–9.

<sup>15</sup>Notice that since the experiment was conducted in Germany, the categorization was undertaken by one of the authors and one additional researcher who was a German native speaker and familiar with all details of the experiment.

Table 3: Description of the communication content's categories

Category	Label	Description
C1	Concrete Proposal	Proposal (point or interval) about how much to contribute
C2	Conformity	Emphasis on the fact that all group members have to conform to the proposal
C3	Efficient proposal	Proposal is to contribute the full endowment
C4	Proposal's payoff	Payoff (period or overall) calculation according to the proposal
C5	Efficient payoff	Payoff (period or overall) calculation according to efficient solution
C6	Two scenarios' payoffs	Payoff calculation according to two scenarios
C7	Maximization of payoffs	Explicit argument that the proposal maximizes the group payoffs or conjecture that the participants are interested in maximizing total payoffs
C8	Promise	No proposal is made but a specific promise
C9	Trigger	Statement predicting possible dynamics in behavior
C10	Satisfaction argument	Statement arguing that people can be satisfied with predicted or actual results
C11	Free-riders' presence	Communicator notifies free-riders and/or requests something from them
C12	Team-spirit & Socialization	Communicator tries to invoke team-spirit, tries to create some sort of social environment or requests social behavior
C13	Praise	Praise without any reference to team-spirit
C14	Appeal to keep on	Appeal to keep on with previous behavior
C15	Filler	Text written just to fill the text box
C16	Proposal correction up	Upward correction of a previous proposal

correlation turned out to be 0.56 for messages in period 1 across both communication treatments and 0.53 for periods 2–9 in the *CC* treatment.<sup>16</sup>

Table 4 reports the results in relative frequencies. In order to be able to make comparisons across treatments, the results for the *CC* treatment are split up into those for period 1 and those for all subsequent periods. This also makes sense in view of the messages' content, as the purpose of first messages is inherently different from that of all subsequent ones.

The third and fourth columns of Table 4 reveal that the statements invoked by communicators in period 1 are rather similar across our communication treatments. In both treatments, the most frequently mentioned statement refers to category C1, shortly followed by C2. Thus it seems that most of the communicators take the opportunity to propose a specific contribution and they additionally stress the importance of conformity within the group. Category C3 is actually a subset of C1: out of those who make a proposal, 83% (58%) explicitly suggest to contribute the Pareto optimal amount in *PC* (*CC*). Notice that category C8, which refers to unilateral promises and, in our definition, is orthogonal to C1, is used not at all in the *PC* treatment and only once in the *CC* treatment. In both treatments, first period messages quite frequently include payoff calculations, which most often refer to the stated proposal. In some instances (25% in *PC*; 18% in *CC*) communicators even compute payoffs for two scenarios, possibly trying to focus peoples' attention on the achievable gains from cooperation. This conjecture is reinforced by the quite substantial proportions of arguments (42% in *PC*; 45% in *CC*) which refer to overall payoff maximization as a possible behavioral motivation. Sophisticated arguments, suitable to draw peoples' attention to possible consequences of their behavior in future peri-

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<sup>16</sup>These values are comparable to those in Cooper and Kagel (2005) and Sutter and Strassmair (2009).

Table 4: Categories of the communication content: Relative frequencies

Category	Label	Relative frequency of coding "1"		
		PC	CC	
		period 1	period 1	periods 2-10
C1	Concrete proposal	1.00	0.91	0.32
C2	Conformity	0.83	0.82	0.13
C3	Efficient proposal	0.83	0.64	0.25
C4	Payoff acc. to proposal	0.83	0.64	0.03
C5	Efficient payoff	0.75	0.55	0.02
C6	Two scenarios' payoffs	0.25	0.18	0.00
C7	Maximization of payoffs	0.42	0.45	0.01
C8	Promise	0.00	0.09	0.03
C9	Trigger	0.08	0.18	0.02
C10	Satisfaction argument	0.33	0.27	0.04
C11	Free-riders' presence	na	na	0.08
C12	Team-spirit & Socialization	0.75	0.64	0.32
C13	Praise	na	na	0.30
C14	Appeal to keep on	na	na	0.46
C15	Filler	0.00	0.00	0.21
C16	Proposal correction up	na	na	0.09

ods (category C9), are used only once in *PC* and twice in *CC*. In all these cases, the communicators speculate on the likely impact of free-riding on overall behavior. About 30% of all first period messages (33% in *PC*; 27% in *CC*) include some statement trying to rationalize predicted outcomes on grounds of satisfaction. Communicators quite often attempt to generate

some social environment as C12 is coded “1” in 75% and 64% of the cases in the *PC* and *CC* treatment, respectively. It is also instructive to mention that, in period 1, there are no arguments coded as C15. This can be taken as a clear sign that communicators took their task seriously, trying to make convincing arguments for what they deemed reasonable.

Next, we turn to the content of messages in periods 2–10 in the *CC* treatment. How do communicators reinforce cooperation in case of high initial contributions? And how do they react when they realize that free-riding occurs in their group? Of course, in light of our results, the data is more suitable to answer the first, rather than second, question. The results are depicted in the last column of Table 4. They show that only 32% of the messages continue to include specific contribution proposals, and most of these proposals refer to the efficient contribution level. 9% of all messages propose to contribute an amount greater than the one previously proposed, and most of these upward corrections take place in period 2. Moreover, almost no message includes specific payoff calculations any longer. The high proportions of statements referring to categories C12 (32%), C13 (30%), and C14 (46%) suggest that communicators try to reinforce high initial cooperation by focusing on team-spirit, praising observed cooperative behavior, or appealing to the group members to stick to high contributions. The observation that 22% of messages are purely meant to fill the chat-box (category C15) in combination with high average contributions reinforces the finding that once cooperation has been established at a high level, no arguments are needed to stabilize contributions. In fact, for one of the groups which fully contributed during all 10 periods, the communicator stopped writing messages already in period 5.

In the two groups in the *CC* treatment which encountered free-riding in



period 1, communicators focus the others' attention on this fact immediately in their second message.<sup>17</sup> In one group, the communicator mentions trigger strategies (category C9) implicitly threatening the free-rider, and free-riding did not reoccur until the last period. In the other group, the communicator appeals to fairness concerns (category C12), and contributions remained unstable.

## 5 Conclusions

In this paper, we have studied the effects of one-way communication in a voluntary contribution experiment. Contrary to the view that the mutual exchange of promises is necessary for the cooperation-enhancing effect of communication, we have found that enabling one group member to send a free-form text message to his co-players allows to achieve and sustain very high levels of contributions. Fifty-one percent of the participants exposed to the treatments with one-way communication contributed 100% of their endowment from the first to the last period. Moreover, this finding does not appear to depend on how often communication occurs. Indeed, we did not detect any statistical difference in contributions between a treatment where the communicator could send just one message and a treatment where the communicator could send messages repeatedly.

These results suggest that, contrary to what Jerdee and Rosen (1974) or Frohlich and Oppenheimer (1998) maintain, people do not need to receive “counter reinforcers” such as praise or disapproval in response to their cooperative or shirking behavior. A one-shot message before starting the interaction is sufficient to sustain the efficient outcome.

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<sup>17</sup>In one case, the proposal was to contribute 25 ECU and one group member contributed 10 ECU; in the other, the proposal suggested 15 ECU and one group member free-rode.

There are two possible explanations for this finding, which are not mutually exclusive. The first – in line with the argument of, e.g., Kerr et al. (1997) and Balliet (2009) – suggests that communication engenders a personal norm of cooperation that enduringly increases individuals' propensity to contribute, thereby affecting behavior even when there is no possibility of future reproaches. Although Kerr et al.'s (1997) experiment concerns the commitment norm, their reasoning can be applied to any kind of norm the communicator brings forward insofar as the proposed norm is well internalized. An analysis of the contents of the communicator's messages reveals that such a norm may be “efficiency” or pro-social behavior.

The second explanation we propose is in line with the contention that the communicator is able to permanently alter the agents' preferences and beliefs (e.g., Foss 1999; Bicchieri 2006) and to transform the original game into a coordination game with multiple Pareto-ranked equilibria. Previous experimental studies have established the importance of conditional cooperation, meaning that people are willing to contribute more to the public good the more others contribute. If the communicator succeeds in influencing preferences towards perfect conditional cooperation, in the sense that everyone wants to match the average contribution, then every uniform contribution vector becomes an equilibrium of the game with the transformed utility function (see, e.g., Levati 2006).

Our results seem in contrast with those of Brosig et al. (2003) who find that unidirectional communication technologies in which subjects are exposed to speech of out-groups are rather unsuccessful means to enhance cooperation. However, this apparent contradiction is resolved by noting that, in our experiment, the source of the message is internal to the group so that the communicator and the recipients of his message have a common

endeavor and share the same ‘fate’. Social identity theory (Tajfel and Turner 1986) may thus explain why an ingroup, but not an outgroup, communicator is effective.

One important implication of our findings is that a low-cost communication medium like the internet may be a valid platform to maintain long-distance relationships featuring a social dilemma problem. What seems to be needed is that one of the persons involved in the relationship sends a message exhorting the others to cooperate.

## Appendix. Experimental instructions

This appendix reports the instructions (originally in German) we used for the continuous communication (*CC*) treatment. The instructions for the baseline (*B*) and the pre-play communication (*PC*) treatments were adapted accordingly and are available upon request.

### INSTRUCTIONS

Welcome and thank you for participating in this experiment. Please remain silent and switch off your mobile!

You will receive €2.50 for showing up on time. Beyond this you can earn more money. In order to do this, please read these instructions carefully. The €2.50 show up fee and any additional amounts of money you may earn will be paid to you in cash at the end of the experiment. Payments are carried out privately, i.e., without the other participants knowing the extent of your earnings.

During the experiment, we shall not speak of euros but of ECU (Experimental Currency Units). ECU are converted to euros at the following exchange rate: 1 ECU = €0.05.

It is strictly forbidden to speak to other participants. If you have any questions during the experiment please raise your hand.

### DETAILED INFORMATION ON THE EXPERIMENT

#### Group formation

You will be placed in a group of four players. Group composition does *not* change during the experiment, i.e., you will be always interacting with the same participants. You will never learn the identity of the other members of your group.

#### Decisions

The experiment consists of 10 periods. At the beginning of each period, you (as well as the other members of your group) receive an endowment of 25 ECU. You have to decide **how many of these 25 ECU you want to contribute to a**

**project.** The ECU contributed to the project yield income for you as well as for the other members of your group (you will learn more about the “income from the project” below). You can keep the ECU that you do not contribute for yourself (they yield income just for you).

### Period earnings

More specifically, in every period your earnings consist of two parts:

- a) “Income from the project” =  $0.4 \times \text{sum of all group members' contributions}$   
(in words, the income from the project is determined by multiplying the sum of the contributions of all group members by 0.4);
- b) “ECU you keep” =  $25 - \text{your contribution to the project}$ .

Thus, your period-earnings summarized in a formula are

$\begin{aligned} \text{Period-earnings} = & \quad \text{Income from the project} \quad + \quad \text{ECU you keep} \\ & (0.4 \times \text{sum of group's contributions}) \quad + \quad (25 - \text{your contribution}) \end{aligned}$
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*Example:*

Suppose that all four group members contribute 5 ECU. Then both you and your group members receive an “income from the project” of 8 ( $= 0.4 \times 20$ ) ECU. The “ECU you keep” are 20 ( $= 25 - 5$ ). Hence, your period-earnings are  $8 + 20 = 28$  ECU.

### Interaction with your group members in each period

Each period consists of the following two stages:

1. One group member is given the opportunity to communicate with his/her fellow members (how communication is carried out is described below). In the following, we shall refer to the group member who can communicate with the others as the “communicator”.
2. When the communication stage ends, the four group members decide simultaneously and privately on their own contributions.

At the beginning of the experiment, one member of each group is randomly selected to be the “communicator” for all 10 periods. Every participant will be informed whether he or she is going to act as the “communicator” in an “Information Window”.

### Communication

During the communication stage, the communicator can use his/her keyboard to type one message to the others.

The communicator is free to send the message (s)he likes, including what (s)he thinks is the best approach to the experiment, what (s)he plans to do, or what (s)he would like the others to do.

However, *there are two restrictions on the kind of messages that the communicator can send:*

1. First, the communicator is not allowed to identify him/herself to the others. Thus, (s)he cannot reveal his/her real name, nicknames, or any other identifying feature such as gender, hair, or seat number.
2. Second, there must be neither threats nor promises pertaining to anything that is to occur after the experiment.

To enforce compliance with the above restrictions, all messages, before being sent, are checked by a monitor (a member of the experiment team). Improper messages are not be delivered. Instead, the sender receives a warning informing him/her of his/her misconduct.

The communicator has 4 minutes to write his/her message, but (s)he is free to send it ahead of time. A clock will inform the communicator of the remaining time.

The screen-shots that you will see in period 1 if you are the communicator in your group are shown below (*original instructions included two screen-figures here*). In periods 2–10, if you are the communicator, you will see the following screen (*original instructions included a screen-figure here*).

Please, remain quiet during the whole experiment or the session will be terminated and all payments cancelled.

### The information you receive at the end of each period

At the end of each period, you will receive information about 1) the number of ECU contributed by each of your group members, with the individual contributions being sorted in descending order, 2) the income from the project, and 3) your corresponding period-earnings.

### **Your final earnings**

Your final earnings will be calculated by adding up your period-earnings in each of the 10 periods. The resulting sum will be converted to euros and paid out to you in cash, together with the show-up fee of €2.50.

Before the experiment starts, we ask you to answer some control questions, in order to assure that all participants completely and correctly understood the rules of the experiment.

*Please remain quietly seated until the experiment starts. If you have any questions, please raise your hand now.*

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