

# Leading by words: a voluntary contribution experiment with one-way communication

## **Abstract**

We use experimental methods to study the power of leading by words. The context is a voluntary contribution mechanism with one-way communication. One group member can send a free-form text message to his fellow players. Contrary to the commonly-accepted wisdom that the cooperation-enhancing effect of communication requires the mutual exchange of promises, we find that the introduction of one-way communication increases contributions substantially and decreases their variation. When communication is one-shot, its effect on contribution levels persists over time. Moreover, one-way communication is effective even in the absence of strategic concerns.

*JEL Classification:* C72; C92; H41

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

# 1 Introduction

One of the most consistent experimental findings in the social dilemma literature is that costless, non-binding, and 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 have been suggested in the literature as inductive to cooperation (see, e.g., Dawes, McTavish and Shaklee 1977): identification, discussion, and commitment. Several experimental studies demonstrate that neither mere identification nor discussion is *sine qua non* for the communication effect to take place (see, e.g., Bouas and Komorita 1996; Bohnet and Frey 1999; Brosig, Weimann and Ockenfels 2003). Instead, the commitment to cooperate, in the form of a *mutual* exchange of promises and pledges, is considered crucial for the cooperation-enhancing effect of communication (see Kopelman, Weber and Messick 2002 and Bicchieri and Lev-On 2007 for surveys of relevant work in the psychology and economics literature, respectively).<sup>2</sup>

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; 1998; Brosig et al. 2003; Bochet, Page and Putterman 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. The crucial factor here is that face-to-face discussion facilitates the exchange of mutual promises.<sup>3</sup> Notice, however, that all these communication methods do allow subjects to exchange non-binding promises. Second, experiments that draw a comparison between face-to-face

---

<sup>1</sup>Sally (1995) offers a meta-analysis of 35 years of social dilemma experiments and shows that enabling people to communicate increases cooperation rates significantly. Balliet (2010), in a more recent meta-analysis, reports similar results.

<sup>2</sup>A notable exception is Bochet and Putterman (2009).

<sup>3</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 settings in which promises are perceived as reliable”.

and passive communication<sup>4</sup> (e.g., Brosig et al. 2003). This approach prevents commitment at the cost of rendering the source of the messages external to the group.

An unambiguous way of studying whether commitment is necessary for cooperation, in the sense that the effect of communication vanishes in its absence, calls for a setting where mutual pledges to cooperate are ruled out by design while the in-group communication channels remain intact. In this paper we provide a series of experimental studies based on such a setting.

We consider a 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 “communicator”, can send a free-form text message to his fellow players. In this sense, the communicator is a leader who leads by words.<sup>5</sup> More importantly, such a unidirectional messaging precludes the mutual exchange of promises. Hence, if the latter were necessary for the rise in cooperation rates, we would not observe any difference in contribution levels in comparison to a no-communication baseline treatment. If, on the other hand, giving someone the chance to suggest and rationalize cooperative play suffices to alleviate the free riding problem, then the communicator’s presence should promote contribution towards the public good.

We would like to stress that we are not questioning the importance of verbal commitment.<sup>6</sup> We are testing instead whether commitment is strictly necessary for the cooperation-enhancing effect of communication. One other plausible explanation for this effect is *coordination* (see, e.g., Charness 2000;

---

<sup>4</sup>Passive communication means that subjects may attend but not intervene in the communication between outsiders (that is, people that do not belong to their own group).

<sup>5</sup>With a few exceptions, experimental economists investigating the effects of leadership in social dilemma games focused on leading by example (see, e.g., Güth, Levati, Sutter and van der Heijden 2007; Levati, Sutter and van der Heijden 2007). Pogrebna, Krantz, Schade and Keser (2009) consider a public goods game where first the leader can promise to contribute a certain amount and then all group members make binding contribution decisions. The authors compare leading by pre-game communication with leading by example and find no dependence of contributions on the leadership style.

<sup>6</sup>Gneezy (2005), Charness and Dufwenberg (2006), and Vanberg (2008), among others, show that people have a preference for keeping their word. Ellingsen and Johannesson (2004) provide experimental evidence that promises can mitigate the hold-up problem.

Mohlin and Johannesson 2008). Public goods experiments are usually parameterized so that the dominant strategy of a homogeneous population of monetary-payoff maximizers is to free ride. The systematic finding of positive contributions has therefore led researchers to assume that people exhibit social preferences. Preferences for conditional cooperation (in the sense that people prefer to cooperate as long as all others cooperate),<sup>7</sup> in particular, can transform social dilemmas into coordination games.<sup>8</sup> Whenever there are multiple equilibria, as it is the case with coordination games, the communicator may affect the others' play by drawing their attention to a specific equilibrium (e.g., Cooper, DeJong, Forsythe and Ross 1992; Farrell and Rabin 1996; Crawford 1998; Brandts and Cooper 2007).

We investigate how effective the communicator is in fostering contributions by means of a series of finitely repeated games where the number of communication opportunities acts as the primary treatment variable. The baseline treatment involves no communication at all. The participants in the other treatments can communicate either prior to each and every period (continuous communication) or exclusively prior to the first period (pre-play communication). We compare the results of these treatments to assess not only the effectiveness of one-way communication but also its dependence on the frequency of messaging.

In a repeated context, a rational course of action for a selfish forward-looking player would be to start by cooperating, in order to build a good reputation, and free ride later on (Kreps, Milgrom, Roberts and Wilson 1982). Strategic reputation building might interact with the communicator's potential to affect behavior. To assess the importance of reputation in the workings of one-way communication, we run a series of one-shot games where people have no strategic incentives to contribute.

Whether and to what extent one-way communication, in the form of

---

<sup>7</sup>Following Fischbacher, Gächter and Fehr (2001), conditional cooperation can be considered as a motivation in its own or as a consequence of some fairness preferences like reciprocity or inequity aversion (see, e.g., Sugden 1984; Rabin 1993; Fehr and Schmidt 1999; Bolton and Ockenfels 2000).

<sup>8</sup>This has been shown by, among others, Sen (1967), Levati and Neugebauer (2004), and Levati (2006).

leading by words, affects 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.<sup>9</sup> Yet, if – as our results indicate – one-way communication increases cooperation and one-shot communication is as effective as communication on a repeated basis, then the required organizational cost may be lower than presumed.

The paper is organized as follows. Section 2 lays out our experimental design and details our research questions. Sections 3 and 4 provide analytical results on the finitely repeated and one-shot treatments, respectively. Section 5 concludes.

## 2 The experiment

### 2.1 The basic public goods game

The basic game is the voluntary contribution mechanism (e.g., Isaac, Walker and Thomas 1984). Let  $I = \{1, \dots, 4\}$  stand for a group of four participants who interact for  $t = 1, \dots, T$  periods in a partner design (that is group composition does not change throughout the experiment). At the beginning of every period, each individual  $i \in I$  is endowed with 25 ECU (Experimental Currency Units) which he can either consume privately or contribute to a public good. Denoting  $i$ 's contribution level by  $c_{i,t}$ , where  $0 \leq c_{i,t} \leq 25$ , his monetary payoff per period is given by:

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

where  $\mathbf{c}_t = (c_{1,t}, \dots, c_{4,t})$  and  $0.4 \sum_{j=1}^4 c_{j,t}$  represent the period  $t$  strategy profile and income from the project, respectively.

Since the marginal per capita return is less than unity, the dominant

---

<sup>9</sup>Most social dilemmas are large group problems (e.g., global environmental problems) affording participants little or no opportunity at all to either communicate or negotiate a solution.

strategy for a monetary payoff maximizer is to contribute nothing. If all group members free rided, then each one of them would earn 25 ECU. On the other hand, 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 made the socially efficient choice, then each one of them would earn 40 ECU. 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.

## 2.2 Treatments and research questions

Using a between-subjects design, we study five treatments that build on the basic game described above. The treatments differ with respect to the number of repetitions and, in the case of repeated games, the frequency of communication.

### 2.2.1 Finitely repeated games

In the first three treatments, participants interact for ten periods. The characteristics of these treatments are as follows:

*Baseline* ( $B_{10}$ ): Group members cannot communicate with each other. In each period, they decide simultaneously and privately on the number of ECU that they want to contribute to the public good.

*Continuous Communication* ( $CC$ ): At the beginning of the experiment, one member of each group is randomly appointed communicator (a role which he retains throughout the experiment). Prior to each period, the communicator is given the opportunity to send a message to his co-players.

*Pre-play Communication* ( $PC$ ): The (randomly selected) communicator can send just one message prior to the first period (i.e., in advance of any decision making). Afterward, group interaction follows  $B_{10}$ .

These treatments are expressly designed to address the following 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 written messages are sent repeatedly or just once?*

Question 3: *What kind of arguments are invoked by the communicator and how do they influence behavior?*

The correspondence between these research questions and the methods used to address them is displayed in the upper panel of Table 1.

[Table 1 about here.]

With regard to Question 1, a number of papers have addressed the theoretical conditions under which augmenting the game with cheap talk assists in the achievement of efficient outcomes (see Farrell and Rabin 1996 and Crawford 1998 for surveys). Whenever individual and group interests conflict completely (as 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. However, this prediction has been contradicted by decades of experimental research, with commitment being regarded as the most likely explanation for the effect of communication.

We argue that there is more to the communication's impact on cooperation than the behavioral importance of promises to cooperate. More precisely, the communicator may enhance cooperation by providing a mechanism that allows for coordination on the socially efficient outcome. Previous experimental work indicates that people are often motivated to contribute to the public good provided that others do the same (see, e.g., Keser and van Winden 2000; Fischbacher et al. 2001; Levati and Neugebauer 2004; Croson 2007; Gächter 2007; Fischbacher and Gächter 2010). This kind of conditionally cooperative preferences can transform the social dilemma game into a coordination game

with multiple Pareto-ranked equilibria.<sup>10</sup> That the communicator’s cheap talk increases the amount of efficient play in coordination games is consistent with theory and experimental evidence (Farrell and Rabin 1996; Cooper et al. 1992; Crawford 1998; Charness 2000; Blume and Ortmann 2007). On the basis of these arguments we conjecture a positive answer to Question 1.

As to Question 2, the existing research contrasting pre-play with continuous communication in social dilemma experiments, albeit founded on multi-directional communication, yields mixed results. While certain studies conclude that pre-play communication has a lasting effect on cooperation (Brosig et al. 2003; Balliet 2010), others find that cooperation rates decline in response to limitations in the opportunities to communicate (Ostrom, Walker and Gardner 1992; Frohlich and Oppenheimer 1998).

With one-way communication, two conjectures point to a negative answer to Question 2: (i) the communicator is able to coordinate actions on the efficient outcome at the outset of the game; and (ii) high first-period contributions are critical for future contribution levels. The first conjecture is plausible provided that, as mentioned earlier, preferences for conditional cooperation can transform the social dilemma into a coordination game. Blume and Ortmann (2007), among others, claim that in games with multiple Pareto-ranked equilibria, communication reduces the first-period variance of play by concentrating action near the unique efficient equilibrium. Empirical support for the second conjecture is provided by, e.g., Keser and van Winden (2000), who, having compared partners with strangers conditions, document the importance of first-period play on the whole game. Based on (i) and (ii), we expect the communicator to serve as an enduring coordination device, in other words to have a lasting positive effect on contributions.

---

<sup>10</sup>Sen (1967) shows that if players are conditional cooperators a prisoner’s dilemma in material payoffs can turn into an assurance game in subjective payoffs. Distributional preferences à la Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) predict similar results.

Finally, we have no preconceptions about Question 3.<sup>11</sup> However, we would expect from a communicator interested in coordinating his co-players' actions to make an effort to persuade them of the advantages of the socially efficient contribution.

### 2.2.2 One-shot games

Here, participants interact just once.

*Baseline ( $B_1$ ):* The group members cannot communicate with each other. They make a one-shot contribution decision.

*Communication ( $C$ ):* Before the one-shot interaction, one member of each group is randomly appointed communicator and can send a message to his co-players.

These two treatments are designed to address the following question (see as well the lower panel of Table 1):

Question 4: *What is the effect of one-way communication when subjects are denied the opportunity to play strategically?*

In finitely repeated games, if the information about types is incomplete, strategic reputation building may by itself bring about more cooperation. For example, suppose that a selfish player believes that some other players in his group are conditional cooperators and that the communicator's message could coordinate them on a specific contribution. Then, it may be optimal for him to make that same contribution early in the game (so as to induce these conditional cooperators to contribute) but free ride later on (Kreps et al. 1982; Andreoni 1988; Sonnemans, Schram and Offerman 1999). With one-shot interaction there are no incentives for such a forward-looking behavior. However, the coordination role of the communicator is active in treatment  $C$ . Hence, by comparing contributions in  $B_1$  and  $C$ , we can assess whether one-way communication is effective in the absence of strategic reasoning.

---

<sup>11</sup>Previous studies analyzing the content of communication either involve multi-directional communication or consider games where promises to cooperate play a crucial role (see, e.g., Charness and Dufwenberg 2006; Brandts and Cooper 2007; Sutter and Strassmair 2009).

## 2.3 Procedures

The experiment was programmed in z-Tree (Fischbacher 2007) and conducted in the experimental laboratory of \_\_\_\_\_. The subjects were undergraduate students from \_\_\_\_\_. They were recruited using the ORSEE (Greiner 2004) software. Upon entering the laboratory, the subjects were randomly assigned to visually isolated computer terminals. The instructions (which are reproduced in the supplement) were distributed and then read aloud to establish common knowledge. All subjects' questions were answered individually at their seats. Before starting the experiment, subjects had to answer a control questionnaire which tested their comprehension of the rules.

Whenever communication was allowed, the communicator could use a text box to type in his message.<sup>12</sup> He had a maximum of four minutes to compose the message, but it was at his discretion to send it ahead of the deadline. In principle, the form of the message was free, the only restrictions to its content being that the communicator could neither identify himself, nor threaten the other group members, nor promise side-payments. To enforce compliance with these restrictions, all messages were screened before being sent.<sup>13</sup> Then, all of them were delivered simultaneously. It was common knowledge that (a) the messages were cheap talk (i.e., costless and non-binding), (b) all group members received exactly the same message from the group communicator, and (c) only after having read the communicator's message could the group members decide simultaneously on their individual contributions.

---

<sup>12</sup>We prefer free-form text messages to face-to-face communication so as to isolate the impact of the message's content from visual (i.e., body language, eye contact, facial expressions) and verbal cues (tone of voice, phrasing, fluency, manner of expressing moral rhetoric). We prefer free-form to pre-specified messages so as to allow subjects to express freely their thoughts and views of the game. Lundquist, Ellingsen, Gribbe and Johansson (2008) notice that "using pre-fabricated messages in experiments will not capture the full effect of communication".

<sup>13</sup>Improper messages were to be screened out and their sender was supposed to be given a warning for misconduct, but as a matter of fact such a thing never happened.

### 2.3.1 Finitely repeated treatments

Participants in the repeated treatments got at the end of each period feedback on (a) the number of ECU contributed by each group member (with the individual contributions being sorted in descending order), (b) the income from the project, and (c) their corresponding payoff. Payoffs were quoted in ECU, where 10 ECU = 50 euro cents. At the end of the last period participants were paid in private their accumulated earnings. Average earnings per subject were €20.60 (inclusive of a €2.50 show-up fee), ranging from €13.8 in treatment  $B_{10}$  to €23.6 in treatments  $CC$  and  $PC$ .

### 2.3.2 One-shot treatments

One-shot treatments started with six training periods that involved neither interaction (the others' decisions were selected randomly by the computer) nor communication. The sole aim of these periods was to familiarize the participants with the game and its incentives (no payments were associated with them).

Participants in these treatments received the same information as in the repeated treatments at the end of the experiment. The exchange rate was 10 ECU = 400 euro cents. Participants earned on average €15.12, inclusive of a €2.50 show-up fee.

## 3 Results on the finitely repeated treatments

We ran three sessions per treatment ( $B_{10}$ ,  $CC$ , and  $PC$ ). Each session involved 24 participants. With group size equal to 4, we have 18 independent observations per treatment. The results are presented in two parts: first, the effects of one-way communication on contribution levels; and second, the communication's content and its relation to contribution choices.

### 3.1 The effects of one-way communication

Table 2 presents descriptive statistics of average group contributions.<sup>14</sup> The mean and median of the series in the *CC* and *PC* treatments are notably larger than their respective values in the  $B_{10}$  treatment. In addition, the standard deviation is smaller, which should not be surprising given that for *CC* and *PC* the median average group contribution is equal to the maximum contribution, namely 25.<sup>15</sup> The disparity in dispersion between the baseline and the communication-allowing treatments becomes more pronounced once we consider robust measures of scale like the median absolute deviation about the median (MAD) and Rousseeuw and Croux's  $Q$  statistic.<sup>16</sup>

[Table 2 about here.]

Figure 1 shows how the time series of measures of location of the average group contributions respond to changes in our treatment variable. In panel A, the baseline treatment replicates standard findings (e.g., Ledyard 1995): the mean of the average group contributions begins at 57.1% of the endowment and declines with repetition (in the last period it stands at 18.8% of the endowment). In contrast, in the communication-allowing treatments the mean starts at very high levels (89.6% and 90.0% of the endowment in *CC* and *PC*, respectively) and remains fairly stable in all periods but the last (its period 9 value is 85.4% of the endowment in *CC* and 83.3% of the endowment in *PC*). This stability is clearer if we acknowledge that in the communication-allowing treatments the distributions of the average group contributions in each period are skewed to the left (i.e., they have relatively few low values, see

---

<sup>14</sup>The *CC* and *PC* independent observation series contain outlying observations at the lower tail of their distributions. Thus, in what follows, besides the conventional descriptive statistics (mean and standard deviation) we also report measures of location and scale which are robust to the presence of outliers.

<sup>15</sup>In fact, 73.33% (72.78%) of the average group contributions in the *CC* (*PC*) treatment equal the subjects' endowment. The corresponding percentage in the  $B_{10}$  treatment is 20.56%.

<sup>16</sup>If  $\{x_1, \dots, x_n\}$  is a set of numbers,  $\text{MAD} = b \text{med}_i|x_i - \text{med}_j x_j|$  (where  $\text{med}$  stands for median and  $b$  is a correction factor for consistency) is the most frequently used robust estimate of scale. However, MAD is aimed at symmetric distributions. The  $Q$  estimator, defined as the 0.25 quantile of the distances  $\{|x_i - x_j|; i < j\}$ , besides being suitable for asymmetric distributions, is more efficient than the MAD.

Figure 2), and opt for their median values as better indicators of their central tendency. In periods 1 to 9, the medians of the average group contributions in the *CC* and *PC* treatments equal 25 (see Figure 1B). Furthermore, it is in period 9 that the difference between the median series of the baseline and communication-allowing treatments reaches its maximum value (that is 19.1 ECUs, or, alternatively, 76.5% of the endowment).

[Figure 1 about here.]

One-sided Wilcoxon rank sum tests with group contributions averaged over all 10 periods as independent observation units confirm that the communicator's presence raises contribution levels significantly ( $p < 0.01$  in both *CC* vs  $B_{10}$  and *PC* vs  $B_{10}$  comparisons). The same holds if we compare average group contributions in any particular period; all  $p$ -values are well below the conventional significance levels (the largest of them, equal to 0.003, is associated with the sixth period comparison between  $B_{10}$  and *PC*). On the other hand, the frequency of communication opportunities does not appear to have any significant effect: it is not possible to reject the null hypothesis that the *CC* and *PC* groups of independent observations have identical distributions ( $p = 0.32$ ; two-sided Wilcoxon rank sum test). The same result holds for individual periods (the smallest  $p$ -value is 0.30 in the third period).

Figure 2 draws for each individual treatment boxplots of the average group contributions observed in each period, and illustrates the participants' tendency in the communication-allowing treatments to contribute their entire endowment.<sup>17</sup> More specifically, in the *CC* treatment, 10 out of 18 groups are socially optimizing in periods 1 to 9 (one of them in periods 1 to 10). An equal number of groups are socially optimizing in *PC* in periods 1 to 9 (five of them in periods 1 to 10). In  $B_{10}$ , in contrast, two thirds of the groups never choose the socially efficient amount.

[Figure 2 about here.]

---

<sup>17</sup>The boxplots corresponding to periods 2 to 9 (2 to 8) in *CC* (*PC*) collapse to a single value as all five statistics that they typically depict (lower non-outlier value, first quartile, median, third quartile, and higher non-outlier value) equal 25.

The aforementioned behavioral stability is corroborated by the results of Wilcoxon signed rank tests comparing the distributions of average group contributions in the first and ninth periods of each treatment. These tests detect no location shift different from zero in the case of *CC* and *PC*, but a significant period effect in the case of  $B_{10}$  ( $p = 0.53$  for *CC*;  $p = 0.36$  for *PC*;  $p = 0.005$  for  $B_{10}$ ; the reported significance levels correspond to the two-sided version of the test).

To conclude, the results of this section are consistent with our predictions and can be summarized as follows:

Result 1: *One-way communication significantly increases contributions to the public good and renders them relatively stable in all periods but the last.*

Result 2: *Whether the communicator can send a message prior to the first period only or prior to all periods bears no influence on contribution behavior.*

### 3.2 The communication content

Our categorization scheme of the communicators' arguments is described in Table 3 (the methodological details are given in Appendix A). The relative frequencies of observing the argument(s) implied by each category are reported in Table 4. To facilitate between-treatment comparisons, relative frequencies for *CC* are calculated separately for the first and then all subsequent periods.

[Table 3 about here.]

[Table 4 about here.]

All first-period messages can be classified into at least one of our categories, which we interpret as a sign that the communicators took their task seriously. A comparison between the third and fourth columns of Table 4 reveals that the choice of first-period arguments is only marginally affected by the communication conditions. The vast majority of communicators propose a specific contribution (category 1), mainly the efficient one (category 2),

and stress the importance of conformity within the group (category 3). In line with our conjectures, suggestion and conformity are always concurrent: the communicator seems to understand that if there are conditionally cooperators in the group, contributing the suggested amount favors cooperation.

In both treatments, first-period suggestions are often accompanied by calculations of the associated payoffs (category 4). Communicators also try to motivate the others by drawing their attention to the payoffs that can be achieved under full cooperation (category 5). Arguments that rationalize suggestions on the grounds of either satisfaction (category 6) or fairness (category 7) are infrequent. The same applies to arguments that draw peoples' attention to the possible repercussions of their actions (category 10), in particular the likely effects of free riding on overall behavior. Notice that unilateral promises (category 9) occur just twice in *CC* and never in *PC*.

In *CC*, the first-period messages in all ten groups that start with and retain (at least till period 9) an average group contribution of 25 entail both the efficiency *and* the conformity argument.<sup>18</sup> These arguments do not appear in tandem in the first-period messages sent within groups numbered 2, 3, and 8, but each one of these groups achieves full contribution once its communicator has jointly invoked them. Hence, in *CC*, the conjunction of efficiency and conformity arguments seems to drive group contribution to the maximum.

In *PC*, the arguments of categories 2, 3 *and* 4 are mentioned in all groups where average group contribution remains fixed at 25 for (at least) the first nine periods.<sup>19</sup> In groups that do not consistently cooperate fully (that is groups 8, 9, 15 and 17), the communicators do not make an efficient suggestion and/or do not calculate the associated payoff.<sup>20</sup> Thus, in *PC*, the

---

<sup>18</sup>These are the groups numbered 4, 5, 6, 7, 9, 12, 14, 16, 17 and 18. The same holds for group 11 where average group contribution equals 25 for periods 1 to 8, and group 13 where deviations from maximum average contribution are (with the exception of period 6) no larger than 0.25 ECU.

<sup>19</sup>These are groups 1, 2, 4, 6, 7, 10, 11, 12, 14 and 16. The same happens with groups 5 and 13, where one group member deviates from maximum contribution in the first period ( $c_{24,1} = 24$  in group 5 and  $c_{53,1} = 20$  in group 13).

<sup>20</sup>Here we provide a general description rather than exact rules. For example, even if the criteria of categories 2 to 4 are satisfied, the members of group 18 contribute fully just

efficiency argument needs to be supplemented not only by conformity suggestions but also by payoff calculations in order that one-way communication has a strong impact on contribution levels.

The analysis of messages in the remaining periods of *CC* aims to answer two questions. The first is what communicators do in the face of initially high contribution levels. Our data indicate that once the efficient outcome has been achieved, the communicator sooner or later understands that group contribution will remain maximum even with minimal correspondence effort from his part. So most of the messages, if any, suggest to keep on with the same behavior (category 1), and/or praise past behavior (category 12).

The second question of interest is how communicators react to low contributors. In the three groups where first-period contributions are less than suggested, this is communicated to the other group members in the second period (category 11). In group 10, the communicator uses a trigger strategy (category 10) and his threats prevent free riding in all but the final period. In group 1, the communicator's appeal to fairness (category 7) fails to stabilize contributions. Finally, the communicator of group 15 undercuts (in the first period) his own suggestion. The group achieves full contribution in the following three periods, but average contribution declines dramatically following a second attempt by the communicator to free ride.

## 4 Results on the one-shot treatments

We ran one session per treatment ( $B_1$  and  $C$ ). Each session involved 32 participants. Since there is no path dependence, we consider the individuals' contributions independent observations.<sup>21</sup>

Figure 3A draws histograms of the two data sets of contributions. While the distribution of the  $B_1$  data is skewed to the right, that of the  $C$  data is bimodal (with more than 50% of the data points falling into the two extreme

---

in periods 2 to 6. And the absence of payoff calculation does not prevent the members of group 3 to contribute fully in periods 1 to 8.

<sup>21</sup>The analysis of the effects of one-way communication can be replicated using average group contributions, with the results remaining qualitatively the same.

classes).

[Figure 3 about here.]

Figure 3B graphs empirical estimates of the cumulative distribution functions for the distributions that generated the two treatments' contribution data.<sup>22</sup> The  $B_1$  treatment probability function rises steeply for  $c_i \leq 15$  (over 90% of the observations are less than or equal to 15) and levels off for the remaining values. In the  $C$  treatment, in contrast, less than 50% of the observations are lying within the  $[0, 15]$  range. Following the introduction of one-way communication, the mean (median) contribution rises from 6.9 (5.0) to 14.6 (17.5). Formal testing confirms that the two underlying probability distributions are stochastically different (the  $p$ -value of the two sample Kolmogorov-Smirnov test is less than 0.01), implying that strategic play can not be the driving engine of the effectiveness of one-way communication.

Thus, the answer to the fourth question of Table 1 can be formulated as follows:

Result 3: *One-way communication stimulates contributions even when subjects are denied the possibility to play strategically.*

Finally, Table 5 reports the occurrence frequencies of the arguments that apply to one-shot communication.<sup>23</sup> Among all groups with an average group contribution at least equal to 65% of the endowment (the groups numbered 1, 2, 3, 4, 7 and 8), all but two communicators (in groups 3 and 7) mention the arguments pertaining to categories 2, 3, and 4. The absence of the efficiency suggestion in the messages sent within groups 5 and 6 is associated with lower average group contributions. Unilateral promises are again infrequent: 3 out of the 8 communicators promise to contribute a specific amount. These results parallel our findings for the  $PC$  treatment, and confirm the importance of advancing the efficiency and conformity arguments, as well as of exemplifying payoff computations, to contribution levels.

---

<sup>22</sup>The empirical cumulative distribution function  $F(c_i)$  gives the proportion of observations in a sample which are less than or equal to  $c_i$ .

<sup>23</sup>All messages can be classified into at least one category, attesting once again the communicators' commitment to reasoned arguments.

[Table 5 about here.]

## 5 Conclusions

Contrary to the widespread view that, in public goods games, the mutual exchange of promises is necessary for the cooperation-enhancing effect of communication, we find that one-way communication, in the form of leading by words, increases contributions significantly. Our interpretation of this result is that the communicator acts as an efficient coordination device, as preferences for conditional cooperation can transform the original game into a coordination game with multiple equilibria (e.g., Sen 1967).

The rise in contributions does not depend on the frequency of communication and holds even if there are no prospects of future interactions. Our analysis of the messages' content reveals that unilateral promises are rather infrequent. Most communicators successfully invoke the consequences of efficient behavior and stress the importance of conformity within the group: in the presence of conditional cooperators, the efficient outcome can be achieved only if all group members follow the suggestion of the leader. Thus, while decades of experimental research have shown that Hobbes was wrong in holding that “covenants without swords are nothing but words” (as people keep their promises even in the absence of sanctions), our experimental results suggest that covenants are not needed to establish mutually beneficial cooperative relationships.

Understanding exactly how coordination contributes to the effectiveness of one-way communication is beyond the scope of this paper and may provide a fruitful avenue for future research. Yet, the practical implications of our results are worth pointing out: a low-cost communication medium, like the internet, may be a suitable platform for addressing issues raised in social dilemma problems. Even with projects where many individuals interact via long distance, what seems to do the trick is the presence of a collaborator who sends a timely message to the others exhorting them to cooperate.

## A Categorization methodology

Our categorization methodology follows Cooper and Kagel (2005) and Sutter and Strassmair (2009). Initially, two researchers examined independently a sample of the messages and established their own distinct sets of preliminary categories.<sup>24</sup> Each category represents one or more arguments that the communicator is likely to invoke, and each message may belong to more than one category. After consultations, the two researchers agreed upon the final set of categories shown in Table 3.

Then three undergraduate research assistants coded (once again separately) the total of the messages one by one: if one message contained the argument(s) specified by some category, then that category was assigned the value of 1 (otherwise, it was assigned the value of 0). The average correlation coefficient between the assistants' codings ranged from 0.70 to 0.80 (0.81 to 0.89) for the first-period messages sent in *CC* (*PC*), and from 0.75 to 0.79 for the messages sent in periods 2–10 in *CC*.<sup>25</sup> We can not compute such correlations coefficients in the case of *C*, as the assistants often coded with the same value all the available messages. As an alternative we report that the number of times all coders agreed on 1 relative to the number of times that at least one of them decided on 1 equals 0.85.<sup>26</sup>

Finally, the coders gathered, discussed their individual assessments and arrived at a common coding (the results are reported in Tables 4 and 5 for the repeated and one-shot treatments, respectively).

---

<sup>24</sup>Since the experiment was conducted in German, the categorization was undertaken by Johannes Weisser and Matthias Uhl, a German native speaker familiar with all details of the experiment.

<sup>25</sup>The correlation coefficient values reported by Cooper and Kagel (2005) and Sutter and Strassmair (2009) are somewhat smaller, implying that our categorization procedure was more clear-cut.

<sup>26</sup>The corresponding ratios for the *PC*, *CC* (period 1) and *CC* (periods 2–10) treatments are 0.79, 0.83 and 0.61, respectively.

## References

- Andreoni, J. (1988). Why free ride? Strategies and learning in public goods experiments, *Journal of Public Economics* **37**(3): 291–304.
- Balliet, D. (2010). Communication and cooperation in social dilemmas: A meta-analytic review, *Journal of Conflict Resolution* **54**(1): 39–57.
- Bicchieri, C. and Lev-On, A. (2007). Computer-mediated communication and cooperation in social dilemmas: An experimental analysis, *Politics, Philosophy & Economics* **6**: 139–168.
- Blume, A. and Ortmann, A. (2007). The effects of costless pre-play communication: Experimental evidence from games with Pareto-ranked equilibria, *Journal of Economic Theory* **132**(1): 274–290.
- Bochet, O., Page, T. and Putterman, L. (2006). Communication and punishment in voluntary contribution experiments, *Journal of Economic Behavior & Organization* **60**(1): 11–26.
- Bochet, O. and Putterman, L. (2009). Not just babble: Opening the black box of communication in a voluntary contribution experiment, *European Economic Review* **53**(3): 309–326.
- Bohnet, I. and Frey, B. S. (1999). The sound of silence in prisoner’s dilemma and dictator games, *Journal of Economic Behavior & Organization* **38**(1): 43–57.
- Bolton, G. E. and Ockenfels, A. (2000). ERC: A theory of equity, reciprocity, and competition, *American Economic Review* **90**(1): 166–193.
- Bouas, K. S. and Komorita, S. S. (1996). Group discussion and cooperation in social dilemmas, *Personality and Social Psychology Bulletin* **22**(11): 1144–1150.
- Brandts, J. and Cooper, D. J. (2007). It’s what you say, not what you pay: An experimental study of manager-employee relationships in over-

- coming coordination failure, *Journal of the European Economic Association* **5**(6): 1223–1268.
- Brosig, J., Weimann, J. and Ockenfels, A. (2003). The effect of communication media on cooperation, *German Economic Review* **4**(2): 217–241.
- Charness, G. (2000). Self-serving cheap talk: A test of Aumann’s conjecture, *Games and Economic Behavior* **33**: 177–194.
- Charness, G. and Dufwenberg, M. (2006). Promises and partnership, *Econometrica* **74**(6): 1579–1601.
- Cooper, D. J. and Kagel, J. H. (2005). Are two heads better than one? Team versus individual play in signaling games, *American Economic Review* **95**(3): 477–509.
- Cooper, R., DeJong, D. V., Forsythe, R. and Ross, T. W. (1992). Communication in coordination games, *Quarterly Journal of Economics* **107**(2): 739–771.
- Crawford, V. (1998). A survey of experiments on communication via cheap talk, *Journal of Economic Theory* **78**(2): 286–298.
- Croson, R. T. A. (2007). Theories of commitment, altruism and reciprocity: Evidence from linear public goods games, *Economic Inquiry* **45**(2): 199–216.
- Dawes, R. M., McTavish, J. and Shaklee, H. (1977). Behavior, communication, and assumptions about other peoples’ behavior in a commons dilemma situation, *Journal of Personality and Social Psychology* **35**(1): 1–11.
- Ellingsen, T. and Johannesson, M. (2004). Promises, threats and fairness, *The Economic Journal* **114**: 397–420.
- Farrell, J. and Rabin, M. (1996). Cheap talk, *Journal of Economic Perspectives* **10**(3): 103–118.

- Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation, *Quarterly Journal of Economics* **114**(3): 817–868.
- Fischbacher, U. (2007). Zurich toolbox for readymade economic experiments, *Experimental Economics* **10**(2): 171–178.
- Fischbacher, U. and Gächter, S. (2010). Social preferences, beliefs, and the dynamics of free riding in public good experiments, *American Economic Review* **100**(1): 541–556.
- Fischbacher, U., Gächter, S. and Fehr, E. (2001). Are people conditionally cooperative? Evidence from a public goods experiment, *Economics Letters* **71**(3): 397–404.
- Frohlich, N. and Oppenheimer, J. A. (1971). *Political Leadership and Collective Goods*, Princeton University Press, Princeton.
- Frohlich, N. and Oppenheimer, J. A. (1998). Some consequences of e-mail vs. face-to-face communication in experiment, *Journal of Behavior & Organization* **35**(3): 389–403.
- Gächter, S. (2007). Conditional cooperation. Behavioral regularities from the lab and the field and their policy implications, in B. S. Frey and A. Stutzer (eds), *Economics and Psychology: A Promising New Cross-Disciplinary Field*, The MIT Press, Cambridge, MA, pp. 19–50.
- Gneezy, U. (2005). Deception: The role of consequences, *American Economic Review* **95**(1): 384–294.
- Greiner, B. (2004). An online recruitment system for economic experiments, in K. Kremer and V. Macho (eds), *Forschung und wissenschaftliches Rechnen 2003. GWDG Bericht 63*, Gesellschaft für Wissenschaftliche Datenverarbeitung, Göttingen, pp. 79–93.
- Güth, W., Levati, M. V., Sutter, M. and van der Heijden, E. (2007). Leading by example with and without exclusion power in voluntary contribution experiments, *Journal of Public Economics* **91**(5–6): 1023–1042.

- Isaac, R. M., Walker, J. M. and Thomas, S. H. (1984). Divergent evidence on free riding: An experimental examination of possible explanations, *Public Choice* **43**(2): 113–149.
- Keser, C. and van Winden, F. (2000). Conditional cooperation and voluntary contributions to public goods, *Scandinavian Journal of Economics* **102**(1): 23–39.
- Kopelman, S., Weber, J. M. and Messick, D. M. (2002). Factors influencing cooperation in commons dilemmas: A review of experimental psychological research, in E. Ostrom, T. Dietz, N. Dolsak and P. C. Stern (eds), *The Drama of the Commons*, National Academy Press, Washington, D.C., pp. 113–157.
- Kreps, D. M., Milgrom, P., Roberts, J. and Wilson, R. (1982). Rational cooperation in the finitely repeated prisoners' dilemma, *Journal of Economic Theory* **27**(2): 245–252.
- Ledyard, J. O. (1995). Public goods: A survey of experimental research, in J. Kagel and A. E. Roth (eds), *The Handbook of Experimental Economics*, Princeton University Press, pp. 111–194.
- Levati, M. V. (2006). Explaining private provision of public goods by conditional cooperation, *Metroeconomica* **57**(1): 68–92.
- Levati, M. V. and Neugebauer, T. (2004). An application of the English clock market mechanism to public goods games, *Experimental Economics* **7**: 153–169.
- Levati, M. V., Sutter, M. and van der Heijden, E. (2007). Leading by example in a public goods experiment with heterogeneity and incomplete information, *Journal of Conflict Resolution* **51**(5): 793–818.
- Lundquist, T., Ellingsen, T., Gribbe, E. and Johannesson, M. (2008). The aversion to lying, *Journal of Economic Behavior & Organization* **70**: 81–92.
- Messick, D. M. and Brewer, M. B. (1983). Solving social dilemmas: A review, in L. Wheeler and P. Shaver (eds), *Review of Personality and Social Psychology*, Vol. 4, Sage, Beverly Hills, CA, pp. 11–44.

- Mohlin, E. and Johannesson, M. (2008). Communication: Content or relationship?, *Journal of Economic Behavior & Organization* **65**: 409–419.
- Ostrom, E., Walker, J. and Gardner, R. (1992). Covenants with and without a sword: Self-governance is possible, *American Political Science Review* **86**(2): 404–417.
- Pogrebna, G., Krantz, D. H., Schade, C. and Keser, C. (2009). Leadership by example and by pre-game communication in social dilemma situations. URL: <http://ssrn.com/abstract=1247262>; accessed December 5, 2010.
- Rabin, M. (1993). Incorporating fairness into game theory and economics, *American Economic Review* **83**(5): 1281–1302.
- Sally, D. (1995). Conversation and cooperation in social dilemmas: A meta-analysis of experiments from 1958 to 1992, *Rationality and Society* **7**(1): 58–92.
- Sen, A. K. (1967). Isolation, assurance and the social rate of discount, *Quarterly Journal of Economics* **81**(1): 112–124.
- Sonnemans, J., Schram, A. and Offerman, T. (1999). Strategic behavior in public goods games: When partners drift apart, *Economics Letters* **62**(1): 35–41.
- Sugden, R. (1984). Reciprocity: The supply of public goods through voluntary contributions, *The Economic Journal* **94**(376): 772–787.
- Sutter, M. and Strassmair, C. (2009). Communication, cooperation and collusion in team tournaments – An experimental study, *Games and Economic Behavior* **66**(1): 506–525.
- Vanberg, C. (2008). Why do people keep their promises? An experimental test of two explanations, *Econometrica* **76**(6): 1467–1480.

Table 1: Research questions and appropriate methodology

Research question	Answering approach
1) Is one-way communication effective?	Compare $CC$ with $B_{10}$ Compare $PC$ with $B_{10}$
2) Does communication frequency matter?	Compare $CC$ with $PC$
3) What kind of arguments are used?	Study the messages' content
4) Does strategic play matter?	Compare $C$ with $B_1$

*Note:* Questions 1 to 3 are addressed in the context of finitely repeated games, question 4 in the context of one-shot games.

Table 2: Summary statistics of average group contributions across our finitely repeated treatments

Treatment	Mean	Std. dev.	Median	MAD	$Q$
$B_{10}$	12.27	8.73	11.62	11.68	8.16
$CC$	22.15	5.94	25.00	0.00	0.00
$PC$	21.75	6.68	25.00	0.00	0.00

*Note:* 180 observations per treatment.

Table 3: Description of the communication content categories

Category	Argument	Description
1	Suggestion	Suggestion (point or interval) of how much to contribute to the project (period 1), or appeal to keep on with the same behavior (periods 2-10). The suggestion, whether implicitly or explicit, must be unambiguous.
2	Efficient suggestion	Implicit or explicit suggestion to contribute the whole endowment.
3	Conformity	Emphasis on the need that all group members conform to the suggestion.
4	Payoff calculation	Calculation of the (period or overall) payoff associated with the proposal.
5	Group payoff maximization	Explicit argument that the suggested amount maximizes the group payoff, or conjecture that participants are interested in maximizing the group payoff.
6	Satisfaction	Explicit argument that people should be content with following (or with having followed) the communicator's suggestion.
7	Fairness	Explicit reference to fairness or just behavior.
8	Team spirit	Statement promoting the willingness to cooperate as part of a team.
9	Promise	Pledge to contribute some specific amount.
10	Trigger	Warning on the possible consequences of low contributions (e.g. "If one of us does not contribute, others may follow").
11	Notification of low contributors	Implicit or explicit notification of those who contributed less than suggested and/or request to increase their contribution.
12	Praise	Praise of observed actions.

Table 4: Relative frequency of the arguments' presence in *PC* and *CC*

Category	Argument	<i>PC</i>			<i>CC</i>		
		$t = 1$	$t = 1$	$t > 1$	$t = 1$	$t > 1$	$t > 1$
1	Suggestion	0.94	0.94	0.57			
2	Efficient suggestion	0.83	0.78	0.51			
3	Conformity	0.94	0.94	0.13			
4	Payoff calculation	0.78	0.67	0.04			
5	Group payoff maximization	0.50	0.78	0.01			
6	Satisfaction	0.28	0.11	0.03			
7	Fairness	0.22	0.17	0.02			
8	Team spirit	0.44	0.28	0.09			
9	Promise	0.00	0.11	0.03			
10	Trigger	0.06	0.17	0.01			
11	Notification of low contributors	-	-	0.09			
12	Praise	-	-	0.31			

Table 5: Relative frequency of the arguments' presence in  $C$

Category	Argument	Frequency
1	Suggestion	1.00
2	Efficient suggestion	0.75
3	Conformity	0.88
4	Payoff calculation	1.00
5	Group payoff maximization	0.50
6	Satisfaction	0.00
7	Fairness	0.12
8	Team spirit	0.62
9	Promise	0.38

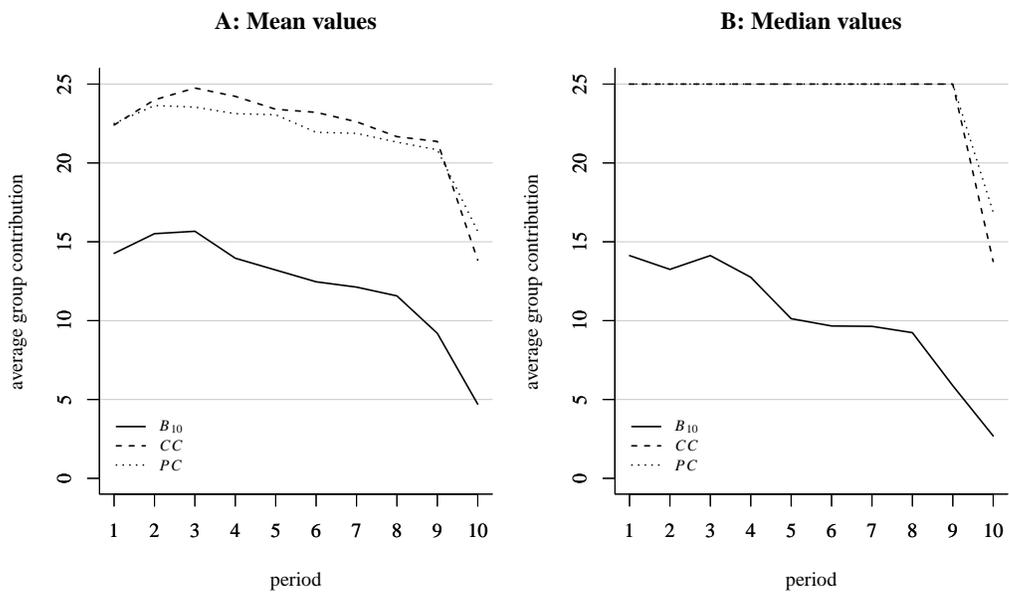


Figure 1: Mean and median of average group contributions over time (finitely repeated treatments; 18 observations per period).

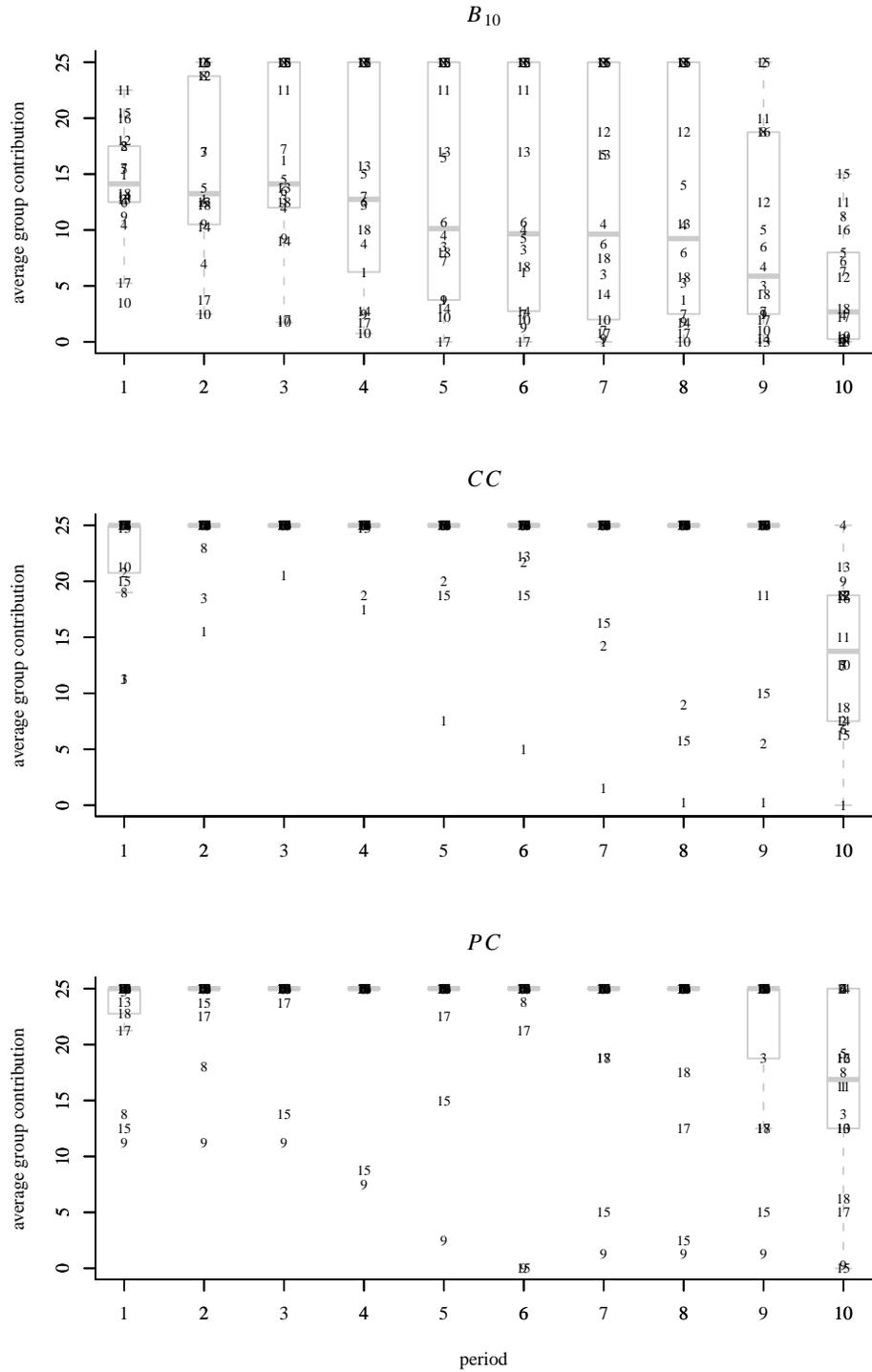


Figure 2: Average group contribution in all periods (finitely repeated treatments; the observations are represented by the corresponding group numbers).

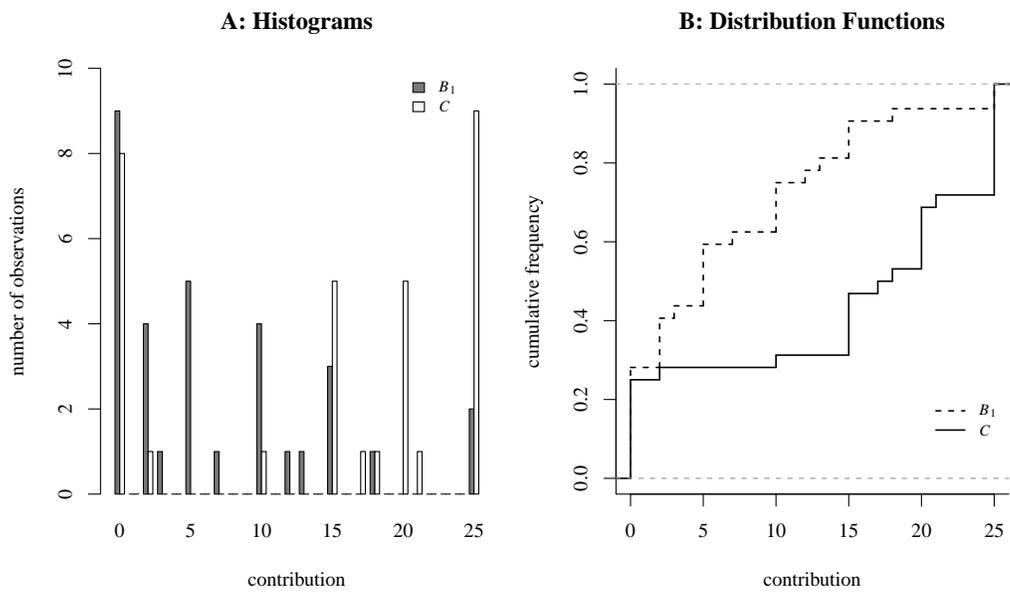


Figure 3: Histograms and empirical cumulative distribution functions of individual contributions in the one-shot treatments.