DEPARTMENT OF ECONOMICS

WORKING PAPER SERIES

2009-09

McMASTER UNIVERSITY

Department of Economics
Kenneth Taylor Hall 426
1280 Main Street West
Hamilton, Ontario, Canada
L8S 4M4

http://www.mcmaster.ca/economics/

Reducing Efficiency through Communication in Competitive Coordination Games[*]

Timothy N. Cason[a], Roman M. Sheremeta[b], and Jingjing Zhang[c]

[a]Department of Economics, Krannert School of Management, Purdue University,
403 W. State St., West Lafayette, IN 47906-2056, U.S.A.
[b]Argyros School of Business and Economics, Chapman University,
One University Drive, Orange, CA 92866, U.S.A.
[c]Department of Economics, McMaster University,
1280 Main Street West, Hamilton, ON L8S 4M4, Canada

October 2009

Abstract

Costless pre-play communication has been found to effectively facilitate coordination and enhance efficiency by increasing individual payoffs in games with Pareto-ranked equilibria. We report an experiment in which two groups compete in a weakest-link contest by expending costly efforts. Allowing group members to communicate before choosing efforts leads to more aggressive competition and greater coordination, but also results in substantially lower payoffs than a control treatment without communication. Our experiment thus provides evidence that communication can reduce efficiency in competitive coordination games. This contrasts sharply with experimental findings from public goods and other coordination games, where communication enhances efficiency and often leads to socially optimal outcomes.

1. Introduction

The early literature on coordination games with Pareto-ranked equilibria documents that coordination failure is common in the laboratory (Van Huyck et al., 1990, 1991; Cooper et al., 1990, 1992). This important finding has been interpreted as relevant for environments ranging from individual organizations to macroeconomies, and has led to an active research agenda to investigate possible mechanisms to resolve this coordination failure. Experiments have studied whether coordination improves through repetition and fixed-matching protocols (Clark and Sefton, 2001), full information feedback (Brandts and Cooper 2006), introduction of between group competition (Bornstein et al., 2002; Riechmann and Weimann, 2008), sequential play (Camerer et al., 2004), the use of entrance fees (Cachon and Camerer, 1996), and gradual increases in group size (Weber, 2006). One of the most effective solutions to the coordination failure problem is communication, even when it is merely nonbinding "cheap talk."

Many experimental studies have shown that cheap talk can facilitate coordination on the efficient equilibrium in experimental games with Pareto-ranked equilibria (Cooper et al., 1992; Van Huyck et al., 1993; Charness, 2000; Charness and Grosskopf, 2004; Blume and Ortmann, 2007; Duffy and Feltovich, 2002, 2006; Riechmann and Weimann, 2008). For example, Van Huyck et al. (1993) demonstrate that pre-play communication is efficiency-enhancing in coordination games. Blume and Ortmann (2007) find that costless nonbinding messages, even when they have minimal information content, can facilitate quick convergence to the Pareto-dominant equilibrium. Communication also enhances efficiency in intergenerational coordination experiments (Chaudhuri et al., 2005). One reason that communication is so effective is that it apparently significantly reduces strategic uncertainty about other players' behavior (Riechmann and Weimann, 2008). Since many economic interactions can be modeled

as coordination games, if this finding is general then it has a very important implication: improving communication in coordination games can increase efficiency and social welfare.

This paper departs from the conventional coordination game literature by embedding the coordination game in a competition between groups, and studying the impact of nonbinding and costless communication. In this experimental environment, two groups compete in a lottery contest by expending costly efforts in order to win a prize. The framework is based on the widely-studied and classical Tullock (1980) model of rent-seeking. One key characteristic of this type of group contest is that coordinating on higher efforts can increase the probability of winning the prize but does not necessarily increase the competitors' payoffs. Excessive efforts can be socially wasteful in contexts ranging from R&D competitions and political or advertising campaigns to war battles. In the experimental literature on the Tullock lottery contest, wasteful efforts that even exceed the equilibrium level are common, as first observed in Millner and Pratt (1989). This previous literature, however, has almost exclusively considered individual contestants. We study contests between groups when efforts are aggregated within each group with a weakest-link production technology, so the effective group effort equals the lowest effort expended by an individual in the group. We investigate whether group competition in these conditions mitigates the excessive efforts often observed in previous studies.

The weakest-link feature of this contest competition resembles many real life competitions where the performance of the entire group depends on the worst performer within a group (Hirshleifer, 1983). For example, in many teamwork competitions each member of the team is responsible for a specific task. If any of the members performs their task poorly then the team loses the competition. Certain R&D competitions have such characteristics. In many sports, such as football and basketball, the weakest player on the team is likely to be a point of attack by

the opponents. Also, in terrorist attacks and in some military battles, the attacker's objective is often to successfully attack one target, rather than a subset of targets (Shubik and Weber, 1981; Clark and Konrad, 2007).

The weakest-link contest combines features of a cooperative minimum effort game (Van Huyck et al., 1990) and a competitive contest (Tullock, 1980). Many experimental studies have shown that the introduction of competition between groups significantly increases individual efforts (Nalbantian and Schotter, 1997; Van Dijk et al., 2001; Sutter and Strassmair, 2009; Croson et al., 2009). Recent experiments have also documented that competition between groups can improve coordination within each group (Bornstein et al., 2002; Myung, 2008; Sheremeta, 2009).

Although it has strong coordination incentives, the key difference in this competitive coordination game is that contributions are socially wasteful so efficiency increases when players coordinate on lower contribution levels. Without communication, we find that group members are able to achieve a modest level of coordination within each group. Allowing group members to communicate before expending any efforts leads to significantly greater coordination, but also results in more aggressive competition and substantially lower payoffs.[1] Group efforts actually exceed the highest equilibrium level in this communication treatment; by contrast, efforts are not significantly different from this equilibrium level in a non-group baseline treatment with individual competing agents. Our experiment thus provides evidence that communication can reduce efficiency in competitive coordination games. This result contrasts with experimental findings from public goods and other coordination games, where communication enhances

---

[1] The fact that higher contributions lead to lower efficiency is the key feature of our experiment that differentiates our study from Nalbantian and Schotter (1997) and Sutter and Strassmair (2009). Although, Sutter and Strassmair (2009) also document that communication within groups increases individual contributions, such contributions lead to higher payoffs and higher efficiency. In contrast, in our experiment higher contributions lead to lower efficiency.

efficiency and often leads to socially optimal outcomes. We conclude that communication only helps improve coordination, not efficiency. Therefore, communication should be thought of as a coordination-enhancing rather than efficiency-enhancing mechanism.

The finding that communication may reduce efficiency echoes the recent finding of Abbink et al. (2009), who show that by allowing intra-group punishment in inter-group contests leads to excessive and inefficient contest expenditures. In this study, we find that allowing intra-group communication in weakest-link contests leads to excessive effort expenditures. The crucial difference of this study is the finding that communication, commonly perceived to enhance efficiency, may cause inefficiency in a coordination game. As we discuss in the conclusion, our results suggest that improved communication within rent-seeking interest groups may have negative efficiency consequences.

2. The Model

Consider a contest between two groups A and B. Each group consists of N risk-neutral players. All players simultaneously and independently expend irreversible and costly individual efforts x_{iA} and x_{iB}. Players within the winning group each receive the valuation of a prize v. Players within the losing group receive no prize. The total effective effort of each group depends on the lowest effort chosen by a member within the group – the so-called weakest-link. Group efforts determine winning probabilities using the widely-used Tullock (1980) lottery contest success function. Therefore, the probability of group A winning the prize is defined as:

$$p_A(x_{iA}, x_{-iA}) = \frac{\min\{x_{1A},...,x_{NA}\}}{\min\{x_{1A},...,x_{NA}\} + \min\{x_{1B},...,x_{NB}\}} \tag{1}$$

That is, each group's probability of winning depends on the lowest effort within that group relative to the sum of the lowest efforts by both groups (groups win with equal probability if they

both have a lowest effort equal to 0). The expected payoff for player i in group A can be written as:

$$\pi_{iA}(x_{iA}, x_{-iA}) = p_A(x_{iA}, x_{-iA})v - x_{iA}. \tag{2}$$

Maximizing (2) with respect to x_{iA} and solving the (symmetric) best response functions simultaneously gives the theoretical predictions for this contest. Since this game is a coordination game, there exist multiple pure-strategy Nash equilibria in which the players within the same group match their efforts at the same level while best responding to the effort of the other group (Lee, 2008; Sheremeta, 2009). In particular, in any equilibrium, all players in each group best respond to the effort of the other group according to the following best-response functions: $x_A \leq \sqrt{x_B v} - x_B$ and $x_B \leq \sqrt{x_A v} - x_A$. Moreover, because of the weakest-link technology for aggregating individual efforts, in equilibrium all players in each group must match their effort levels, i.e. $x_{iA} = x_A$ for all i and $x_{jB} = x_B$ for all j. The full set of pure strategy Nash equilibria is illustrated by the shaded area in Figure 1.

Figure 1: The Pure-Strategy Nash Equilibria of the Game
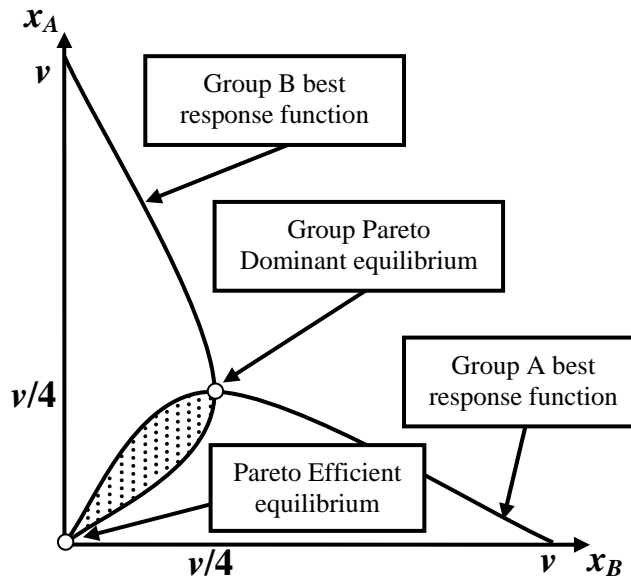
Two specific equilibria of interest are the *group Pareto dominant* equilibrium and the *Pareto efficient* equilibrium. The group Pareto dominant equilibrium may be focal because the players within a group have incentives to coordinate with each other to increase their effort levels at any other equilibrium within the shaded area. In the group Pareto dominant equilibrium all players expend efforts of $v/4$ and no group has any incentive to deviate. On the other hand, the Pareto efficient equilibrium is when all players expend 0. In this equilibrium there is no dead weight loss from competition and each group is equally likely to win the contest. Note that any symmetric or asymmetric equilibrium within the shaded area in Figure 1 is more efficient than the group Pareto dominant equilibrium and less efficient than the Pareto efficient equilibrium. Following Riechmann and Weimann (2008), we define coordination as complete if a Nash equilibrium is played (i.e., all players within each group choose the same effort) and coordination as efficient if the Pareto efficient equilibrium is reached.

If communication within each group is possible then results in the existing literature suggest that all players within each group should act cooperatively as one player (Sutter and Strassmair, 2009; Zhang, 2009). In this case it is appropriate to model all players within a group as trying to maximize their joint payoff instead of their individual payoff (2), and so the objective function of player i in group A can be written as:

$$\pi_{iA}^c(x_{iA}, x_{-iA}) = p_A(x_{iA}, x_{-iA})Nv - \sum_{i=1}^{N} x_{iA} \tag{3}$$

Maximizing (3) with respect to x_{iA} and solving the best response functions simultaneously gives us a unique Nash equilibrium where all players in each group match their efforts at the same level of $v/4$. Note that this is exactly the same as the group Pareto dominant equilibrium in the case with no communication, and is also the standard equilibrium in the two-player Tullock contest. The group Pareto dominant equilibrium is also a coalition-proof Nash

equilibrium (Bernheim et al., 1987). Therefore, if communication indeed helps members within each group to improve coordination, they may select a more competitive (higher effort) equilibrium. Theory thus predicts that the introduction of within group communication can cause inefficiency.

3. Experimental Design and Procedures

Our principal research question concerns the impact of communication in this competitive coordination game, so our experiment employs three treatments in a between-subjects design. The main research treatment implements this group contest with communication permitted among members in each group (denoted treatment C). Two baseline treatments implement the contest with no communication (denoted treatment NC) and with groups replaced by individuals (denoted treatment I). In the group treatments C and NC, there are N=3 players in each group and all players within the winning group receive the prize of v=60. In the individual treatment I, the winner gets a prize of v=60. The stage game equilibrium prediction in treatment NC is that all players within each group should coordinate on the same effort level, but this effort level can vary between 0 and 15 and can vary across groups. The equilibrium prediction in treatments C and I is that all players should choose efforts equal to the group Pareto dominant equilibrium of 15.

The experiment was conducted at the Vernon Smith Experimental Economics Laboratory. A total of 112 subjects participated in nine sessions – four sessions in each of the treatments C and NC (12 subjects per session) and one session with 16 subjects in treatment I. All subjects were Purdue University undergraduate students who participated in only one session

of this study. Some students had participated in other economics experiments that were unrelated to this research.

The computerized experimental sessions were run using z-Tree (Fischbacher, 2007). Each session proceeded in two parts. At the beginning of each part subjects were given the written instructions, shown in Appendix A, and the experimenter also read the instructions aloud. The first part of each session elicited subjects' risk attitudes using multiple price list of 15 simple lotteries, similar to Holt and Laury (2002).[2] At the end of the session, one of the 15 lottery decisions was randomly selected for payment. The second part corresponded to 30 periods of treatment NC, C or I. In the group treatments subjects were placed into group *A* or *B* at the beginning of the first period, and they stayed within the same group for the duration of the experiment. They also competed against the same opposing group for all 30 periods. We chose this fixed matching protocol to allow subjects an opportunity to coordinate with each other on the Pareto efficient equilibrium. Therefore, the 48 subjects in each group treatment generate 8 statistically independent, 30-period, 6-player supergames. Similarly, pairs of competing players were fixed for all 30 periods in treatment I, so the 16 subjects in that treatment generate 8 independent, 2-player supergames.[3]

At the beginning of each period, each subject received 60 experimental francs as an endowment (equivalent to $2.00). Effort choices were framed in the instructions using the standard labels used in voluntary contribution mechanism public good provision experiments:

---

[2] Subjects were asked to state whether they preferred safe option A or risky option B. Option A yielded $1 payoff with certainty, while option B yielded a payoff of either $3 or $0. The probability of receiving $3 or $0 varied across all 15 lotteries. The first lottery offered a 5% chance of winning $3 and a 95% chance of winning $0, while the last lottery offered a 70% chance of winning $3 and a 30% chance of winning $0.

[3] Subjects were informed that the session would last for exactly 30 periods, so because the stage equilibrium in treatments C and I is unique this equilibrium prediction also holds (uniquely) for this finitely repeated game. As noted above, we conjectured that groups or individuals might coordinate on Pareto-improving outcomes in the repeated game, since this is frequently observed in the experimental literature even in finitely-repeated games with a unique equilibrium (e.g., Selten and Stoecker, 1986). Note that no repeated game equilibria exist with effort levels greater than 15.

they could allocate to a "group account" or an "individual account." The instructions informed subjects that by allocating 1 franc to their individual account they would earn 1 franc, while by allocating 1 franc to their group account they could increase the chance of their group receiving the reward. Subjects could contribute any integer number of francs between 0 and 60. In treatment C, before subjects were asked to make the allocation decision, they had an opportunity to communicate with other members of the same group anonymously via a chat window for 60 seconds. We asked subjects to follow two basic rules: (1) to be civil to one another and not to use profanity, and (2) not to identify themselves in any manner. Messages were recorded. After the chat period was over, all subjects simultaneously made their effort (allocation) decisions.

After all subjects submitted their allocations to the group account, a random draw determined the winning group. A simple lottery was used to explain how the computer chose the winning group.[4] At the end of each period subjects were informed of group A's and B's effective efforts (i.e., the minimum effort in each group); or in the case of the individual treatment I, they learned both individuals' effort choices. Subjects were paid for 5 randomly-drawn periods at the end of the experiment. Earnings were converted into US dollars at the rate of 30 francs to $1. On average, subjects earned $18 each and the experimental sessions lasted for about 60 minutes.

4. Experimental Results

Figure 2 displays the time series of the average and minimum effort in the three treatments. In the no communication (NC) treatment, average individual effort should be between 0 and 15. The actual average effort is about 10, indicating that subjects learn to coordinate their efforts on substantial level. The increased coordination is evident in the initial

---

[4] Probabilities were explained in the instructions as a number of tokens placed in a bingo cage based on effort choices, and then one token draw determined the winning individual or group.

decline in average efforts, towards the average minimum effort. However, the persistent gap between average effort and average minimum effort indicates that the coordination is not complete. Recall that we define coordination as complete if all players within each group choose the same effort and coordination as efficient if the Pareto efficient equilibrium is reached. Importantly, note that the minimum effort does not decline to zero with repetition even in this treatment without communication. This finding stands in sharp contrast to previous findings in the minimum effort coordination game literature (Blume and Ortmann, 2007; Devetag and Ortmann, 2007), and could be due to our use of relatively small (three-person) groups or the competition between groups. To summarize:

Result 1. Even without communication, substantial but incomplete coordination exists within groups, and efforts do not decline to 0 with repetition.

Figure 2: Average and Minimum Effort
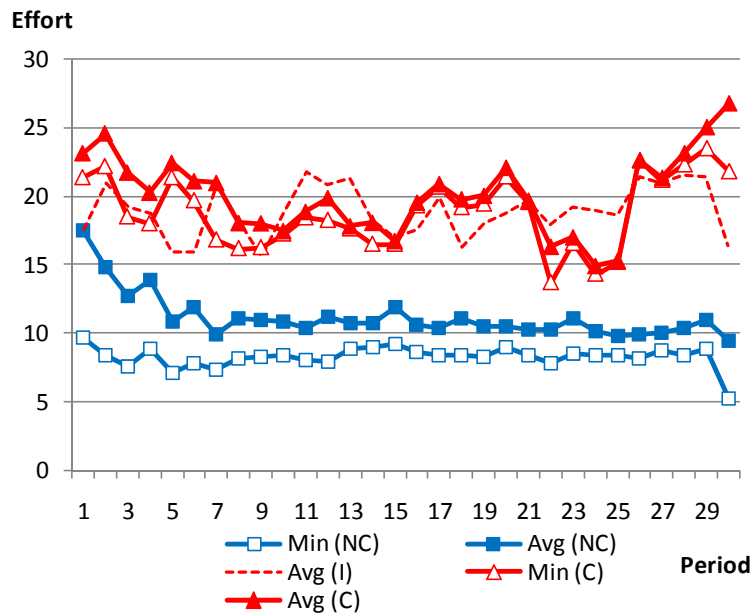
In the individual (I) and communication (C) treatments, theory predicts an effort level of 15. The actual average effort in treatment I is 18.96, which is not significantly different from the

equilibrium prediction of 15 (Wilcoxon signed-rank test, p-value = 0.58, n=8).[5] Surprisingly, however, contributions are not lower in the C treatment, and the overall average effort is 20.13. Moreover, the average effective (*minimum*) effort within groups is higher than 15 in 28 out of 30 periods, and this effective minimum effort is significantly greater than the equilibrium of 15 (Wilcoxon signed-rank test, p-value < 0.05, n=8).

Result 2. With communication, groups coordinate effort allocations, but effective effort levels significantly exceed the equilibrium prediction of 15. The average effort in the individual treatment is not significantly different from 15.

Although there is substantial coordination with and without communication, comparing the C and NC treatments indicates that with communication subjects coordinate better. In particular, the differences between the average individual effort and minimum individual effort is significantly lower with communication than without communication (Mann-Whitney test, p-value < 0.05, n=m=8).

Another way to measure the extent of coordination is to examine how much effort is wasted due to unequal effort choices within groups. We define *mean wasted effort* in a group by taking the average of the differences between individual effort and the group minimum effort within each group (Riechmann and Weimann, 2008). Complete coordination is reached when the group wasted effort equals zero. Figure 3 indicates that subjects in treatment NC learn to coordinate over time, as their wasted effort is substantially reduced in the second half of the experiment (Wilcoxon signed-rank test, p-value < 0.05, n=8). Nevertheless, the degree of coordination is better in the treatment C in almost all periods, and is significantly different from

---

treatment NC (Mann-Whitney test, p-value < 0.05; $n=m=8$). These findings lead to the following conclusion.

Result 3. Communication improves coordination.

**Figure 3: Mean Wasted Effort**
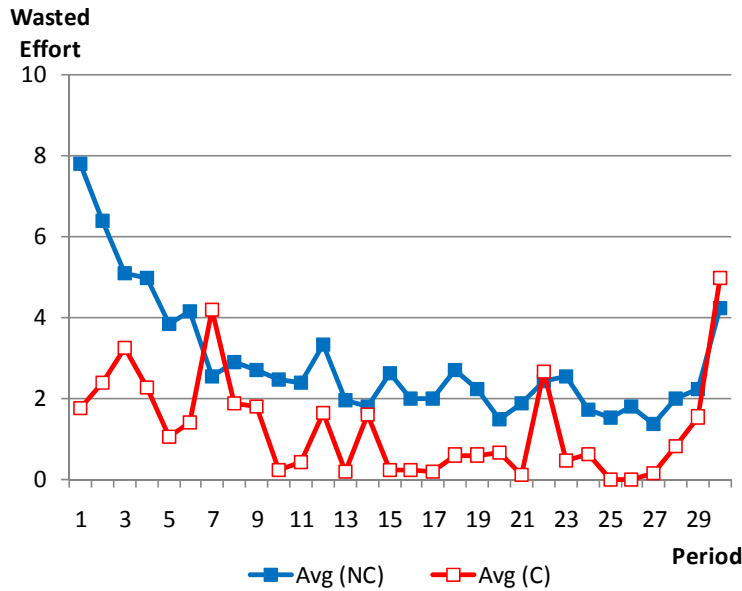
Next we compare the average and minimum effort in the C and NC treatments. Blume and Ortmann (2007) and Sutter and Strassmair (2009) document that communication leads to significantly higher coordination and efforts. Consistent with these previous studies, the average and minimum effort in the C treatment is significantly higher than the average and minimum effort in the NC treatment (Mann-Whitney test, p-value < 0.05, $n=m=8$).

Result 4. Communication increases average and minimum group efforts.

This result is illustrated in Figure 4, which displays individual or group effective average effort in the three treatments. Each average effort represents one independent observation, either a group of six interacting subjects in the C and NC treatments, or an interacting pair of subjects in the I treatment. The efforts within each treatment are ranked from the lowest to the highest.

12

Although considerable heterogeneity exists across groups, note that the distribution of average efforts in the C and NC treatments only slightly overlap.

Figure 4: Distribution of Minimum Efforts
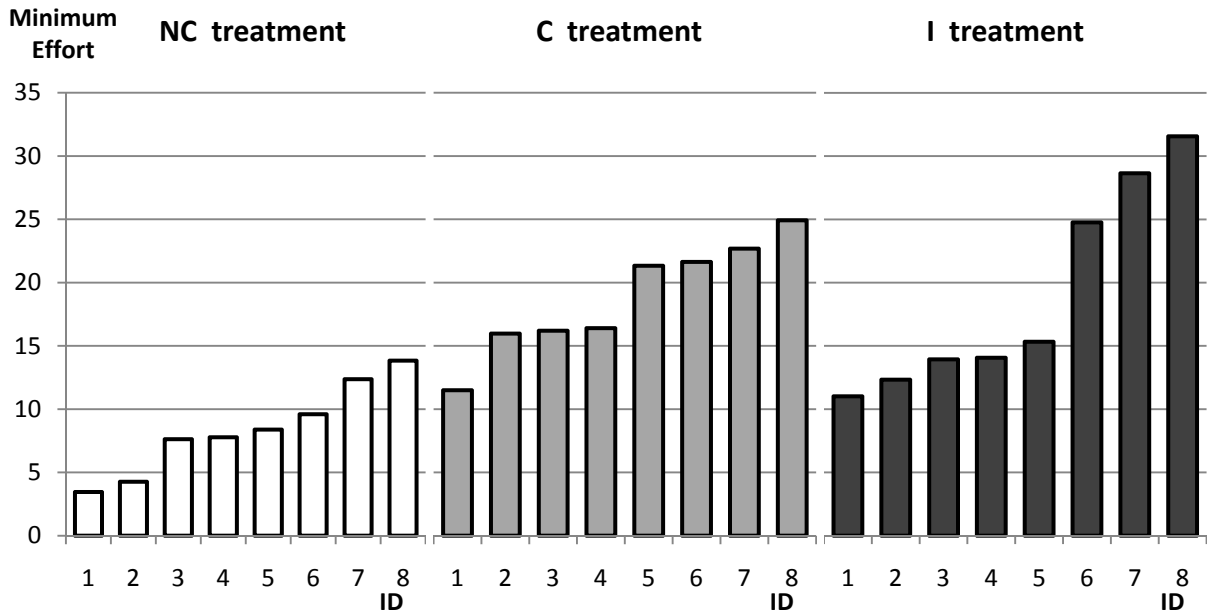
In previous studies on coordination, higher efforts corresponded to greater efficiency, while in the present environment higher efforts lead to lower efficiency. Recall that the Pareto efficient equilibrium occurs when all players expend 0 efforts. At this equilibrium there is no deadweight loss from competition, and each group is equally likely to win the prize of 60. Figure 5 displays average payoffs across all periods of the experiment. Because of the over-contribution of efforts in the C treatment the average payoff is lower than the payoff in the NC treatment in all 30 periods. This treatment difference is statistically significant (Mann-Whitney test, p-value < 0.05, $n=m=8$).

Result 5. Communication decreases payoffs and efficiency.

This result contrasts with experimental findings from public goods, team production, and coordination experiments, where communication enhances efficiency and leads to socially

optimal outcomes. [6] To summarize, communication improves coordination and increases individual efforts. However, this increase in individual efforts reduces payoffs and is inefficient. Not only are efforts under communication higher than the efficient equilibrium effort of 0, but they are also usually higher than the highest possible equilibrium effort of 15. Note that 15 is the maximum rationalizable effort level; i.e., given any effort level chosen by the opponents, 15 is the maximum effort that a rational player should expend (cf. Figure 1). As a result of this over-contribution of efforts, the average payoff in the NC treatment is twice as high as the average payoff in the C treatment.

Figure 5: Average Payoff per Player
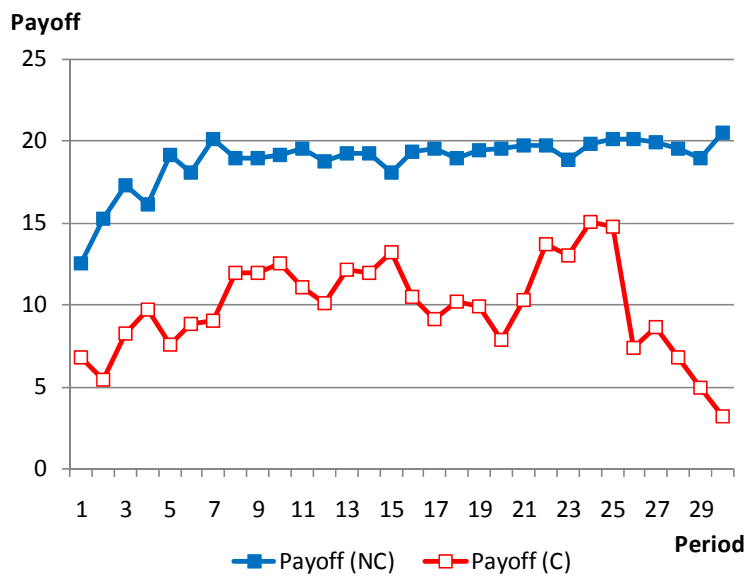
To better understand this over-contribution of efforts we conduct a multivariate regression analysis to identify a simple reduced-form relationship between some key feedback

---

variables and effort. To account for heterogeneity across subjects, we employ a random effect error structure with individual subject effects. The regressions are of the following form:

$$effort_{it} = \beta_0 + \beta_1 risk_i + \beta_2 effort_{it-1} + \beta_3 win_{it-1} + \beta_4 group\text{-}effort_{it-1} +$$
$$+ \beta_5 othergroup\text{-}effort_{it-1} + \beta_6 \left(\frac{1}{t}\right) + u_i + \varepsilon_{it} \tag{4}$$

Where $effort_{it}$ is player i's effort in a period t, $risk_i$ is a risk preference variable counting the number of risky options B chosen by player i on the preliminary lottery choice task (for details see footnote 2), $effort_{it-1}$ is player i's effort *in the previous period, win_{it-1}* is an indicator that denotes whether player i won in the previous period, *group-effort_{it-1}* and *othergroup-effort_{it-1}* denote effective (*minimum*) own group effort and other group effort in the previous period, and u_i are individual subject effects. To allow for time effects, all regressions include 1/*period*.

The key variable we wish to focus on in these regression estimates is *othergroup-effort_{t-1}*. A positive and significant coefficient estimate on the *othergroup-effort_{t-1}* variable indicates that subjects tend to choose higher efforts when they observe a higher effort chosen by their opponents in the previous period. While estimation of a structural belief-learning model is beyond the scope of the present paper, consider the simple assumption that subjects form beliefs using Cournot expectations, which is a common approximation used in theoretical and empirical learning models (e.g., Ho, 2008). In other words, suppose they tend to believe that a higher effort by the opponent in the previous period is likely to be followed by a similar, high effort in the current period. Inspection of the recorded chat messages provides some evidence for such Cournot type of expectations for every session.[7]

---

[7] For examples: "I think we stick to 25, because they seem to stick to 21" (session 081110 group 2, period 7); "wow… they went for 30? let's go for 31 then" (session 090311 group 4, period 3); "hmm…i guess they are just going 20…ya…how about we try 25?" (session 090303, group 4, period 11); "they are still at 30…suggestions? … 30…group consensus, yes?" (session 090331, group 1, period 11). The significant and positive *effort_{t-1}* coefficients in Table 1 document significant persistence in efforts and provide a systematic empirical rationale for such a belief.

We separate observations in which the efforts are above or below 15 since the reaction functions are sloped negatively and positively in these two cases (cf. Figure 1). (Recall that 15 is also the maximum rationalizable effort level.) In specification (1), the positive *othergroup-effort$_{t-1}$* coefficient is consistent with the upwardly-sloped reaction functions for the efforts less than 15. Similarly, in specification (2), the negative (although not significant) *othergroup-effort$_{t-1}$* coefficient is consistent with the downwardly-sloped reaction functions for the efforts higher than 15. This demonstrates that in the NC treatment groups strategically adjust their efforts in response to the efforts of their opponents. In the NC treatment only 6% of group efforts (81 out of 1392) are not rationalizable (bottom of Table 1).

Table 1: Feedback Determinants of Effort (Random-Effect Models)

Dependent variable, *effort$_t$*	Treatment and Data Subset							
	No Communication		Communication		Communication		Individual	
	Low	High	Low	High	Low	High	Low	High
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
risk$_t$	0.08	-0.23	0.01	0.14	0.02	0.17	0.11	0.45
[number of risky options B]	(0.06)	(0.48)	(0.19)	(0.16)	(0.19)	(0.15)	(0.25)	(0.24)
effort$_{t-1}$	0.43**	0.12	0.76**	0.46**	0.75**	0.41**	0.49**	0.60**
[effort in previous period]	(0.07)	(0.20)	(0.03)	(0.05)	(0.03)	(0.05)	(0.07)	(0.06)
win$_{t-1}$	-0.66*	0.07	-1.05	1.67*	-0.84	1.57*	-1.39	-4.26**
[1 if won in previous period]	(0.31)	(1.45)	(0.58)	(0.77)	(0.58)	(0.75)	(1.17)	(1.17)
group-effort$_{t-1}$	0.34**	0.41	(^)	(^)	(^)	(^)		
[effective group effort in *t*-1]	(0.09)	(0.36)						
othergroup-effort$_{t-1}$	0.22**	-0.14	0.22**	0.13*	0.22**	0.20**	-0.02	0.15
[effective effort of other in *t*-1]	(0.05)	(0.45)	(0.05)	(0.06)	(0.05)	(0.06)	(0.15)	(0.10)
win message volume					1.39**	6.01**		
[number of "win" chat messages]					(0.51)	(0.73)		
1/*period*	3.44	1.45	2.02	-0.49	2.25	-0.54	10.49*	-3.74
[inverse of period number]	(2.10)	(8.39)	(1.66)	(3.86)	(1.69)	(3.66)	(5.22)	(5.38)
Constant	0.93	12.79	2.84	7.41**	2.10	3.88*	6.05**	4.92
	(0.55)	(7.37)	(1.51)	(1.58)	(1.49)	(1.55)	(2.17)	(3.39)
Observations	1311	81	540	852	540	852	227	237

Standard errors in parentheses. * significant at 5%, ** significant at 1%

(^) *group-effort$_{t-1}$* is highly correlated with *effort$_{t-1}$* in the communication treatment (correlation =0.96 in specifications 3 & 5 and 0.88 in specifications 4 & 6), thus they are not included in specifications 3 through 6.

All models include a random effects error structure, with individual subject effects. Columns labeled "High" ("Low") include only those observations in which *othergroup-effort$_{t-1}$* is greater than (less than or equal to) 15. Win messages include any of the following words: "win" "winning" "won" in the chat communication.

By contrast, 61% (852 out of 1392) of group efforts in the C treatment exceed the maximum rationalizable effort of 15. Moreover, in the C treatment the *othergroup-effort$_{t-1}$* coefficient is always positive and significant (specifications 3 and 4) regardless of whether *othergroup-effort$_{t-1}$* is greater or less than 15. In other words, at least for this maintained assumption of Cournot-like belief updating, it appears that communicating groups fail to recognize the incentive to reduce efforts in response to above-equilibrium efforts chosen by their competitors.[8] This is somewhat surprising given the rich and nearly free-form communication within groups permitted by the chat windows, as well as the previous literature that suggests groups often make more rational decisions than individuals do (Cooper and Kagel, 2005; Sutter, 2005). It is also surprising given that each member of the group has "veto" power to lower effective group effort in this minimum-effort game, and more rational individuals can employ this power when the group effort is unreasonably high.[9]

Individuals do not take advantage of the opportunity to unilaterally lower their group's effective effort, however. The chat data suggest that subjects' competitive tendencies are strengthened by their communications. Define a "win message" as a chat statement that mentions the words "win" or "winning" or "won" in a given period.[10] Someone in the chat room used at least one of these words in exactly one-half of the 480 chat periods, and all 16 groups in this

---

[8] Replacing the lagged opponent effort (Cournot beliefs), *othergroup-effort$_{t-1}$*, with the average past opponent effort (Fictitious Play beliefs) reduces the explanatory power of the estimates; and while the coefficient estimate on past opponent efforts was still positive for the column (4) specification it is no longer statistically significant.

[9] Appendix B contains some selected chats for a randomly-selected group in one of the sessions. The discussions illustrate (1) how subjects use the communications to coordinate effort choices; (2) reactions to effort choices of 0 by individual group members; (3) how groups react to previous round effort levels of their opponent group; and (4) competitive escalation of higher effort levels in an attempt to win the contest, even when these effort levels far exceed the equilibrium.

[10] Some examples are shown in Appendix B. There, every single mention of word "win" corresponds to a discussion about the effort level of at least 15, such as: "okay 30.. we will win" (period 18) or "this is bad.. it has to be 40.. or we won't win.." (period 19).

treatment indicated win messages in at least 4 periods.[11] The average effort is 17.4 in the 240 periods without a win message, compared to 22.8 in the other 240 periods when at least one "win message" is sent by a group member in the chat room preceding the effort choice. In model specifications 5 and 6 of Table 1 we add a variable indicating the number of such win messages expressed in the period prior to the effort choice. The results indicate that such messages are strongly associated with higher effort choices, especially in the regression (specification 6) in which efforts are already too high. It appears that many groups focus on winning the contest, even when their efforts already exceed the maximum rationalizable level.

In summary, the analysis above provides two complementary explanations of why communication leads to higher efforts and thus lower efficiency. First, communication acts as a coordination device, allowing groups to make decisions with less wasted effort. As a result, communication induces group behavior closer to the inefficient group Pareto dominant equilibrium. Second, communication encourages group discussions about the importance of winning, and thus it makes them less sensitive to their wasteful and excessive effort expenditures in the contest.

5. Conclusion

Communication in coordination games has been shown in previous studies to induce greater coordination, improve efficiency and increase individual payoffs. This study shows that the introduction of communication causes too much competition and thus reduces efficiency and individual payoffs in an experiment in which groups compete in a weakest-link contest by expending costly efforts. Not only do subjects compete too much, but such competition is not

---

[11] Across all 16 groups, the average number of periods (out of 30) with at least one "win message" is 15 periods with a standard deviation of 6.41 periods.

predicted by theory. Although subjects in an individual-competition baseline treatment also compete aggressively, their effort levels are not significantly different from the Nash equilibrium. Communicating groups actually perform worse than individuals, since the effective effort levels of the groups statistically exceed the maximum rationalizable effort level.

Although our main finding is novel, it is not inconsistent with the broad literature discussed in the introduction highlighting the positive effects of communication in public goods and related games. We also find that communication improves coordination and reduces free-riding within groups. The key point that our experiment adds is that this improved coordination occurs even when it reduces, rather than enhances, efficiency. Therefore, communication should be thought of as a coordination-enhancing rather than efficiency-enhancing mechanism.

The experimental environment implemented the classical Tullock model of rent-seeking, which has been widely used to model incentives for competing interest groups to influence public policy. While more confident conclusions await further research, we can note preliminary implications of our results for this setting. In particular, our findings indicate that communication results in greater wasteful rent-seeking. Based on results from Sutter and Strassmair (2009) and Sheremeta (2009), we suspect that other mechanisms to aggregate individual efforts into group contests would also result in increased efforts when groups can communicate. This suggests that enhanced communication opportunities afforded by new information technologies, such as "grassroots" internet-based political organizing that is increasingly being utilized by interest groups (Fisher, 1998; Sylvia, 2002), might reduce social efficiency even while it improves group cohesion and coordination. In this rent-seeking environment, anything that leads to better coordination can reduce efficiency.

Obviously, our results were obtained in the specific environment that was used in the experiment. Future research can investigate how robust our findings are when the best-shot or summation (perfect-substitutes) technology is used within groups instead of the weakest-link effort aggregation rule (Abbink et al., 2009; Sheremeta, 2009). Two pilot sessions we have conducted suggest that the general conclusion of our experiment stands: communication also improves coordination but reduces efficiency in the best-shot and perfect-substitutes contests. We chose to focus on the weakest-link rule, since it affords subjects the ability to unilaterally reduce their group's choice, increasing the chances that some group members would reduce the excessive effort expenditures. Future research could also consider other realistic extensions to the group-contest environment. For example, between-group communication might permit groups to collude and reduce wasteful efforts, and allowing subjects to choose whether to communicate with their own group or with others might also increase efficiency. Results reported in Sutter and Strassmair (2009) for a different team contest environment suggest that between-group communication – a form of "diplomacy" in this context – could help subjects coordinate on a Pareto superior outcome. Although this is an interesting conjecture for future research, the findings of our experiment still make a clear point: communication is a good coordination-enhancing mechanism, but it cannot be always interpreted as efficiency-enhancing mechanism.

References

Abbink. K., Brandts, J., Herrmann, B., & Orzen, H. (2009). Inter-Group Conflict and Intra-Group Punishment in an Experimental Contest Game. American Economic Review, forthcoming.

Bernheim, B.D., B, Peleg, & M.D., Whinston, (1987). Coalition-Proof Nash Equilibria I. Concepts. Journal of Economic Theory, 42, 1-12.

Blume, A., & Ortmann, A. (2007). The effects of costless pre-play communication: Experimental evidence from games with Pareto-ranked equilibria. Journal of Economic Theory, 132, 274-290.

Bornstein, G., Gneezy, U., & Nagel, R. (2002). The effect of intergroup competition on group coordination: An experimental study. Games and Economic Behavior, 41, 1–25.

Brandts, J., & Cooper, D. J. (2006). Observability and overcoming coordination failure in organizations. Experimental Economics, 9, 407–423.

Buckley, N., Mestelman, S., Muller, A. R., Schott, S., & Zhang, J. (2009). Communication in Common-Pool Resource Environment with Output Sharing in Partnerships, McMaster University, Working paper.

Cachon, G.P., & Camerer, C.F. (1996). Loss-avoidance and forward induction in experimental coordination games, Quarterly Journal of Economics, 111, 165–194

Camerer, C.F., Knez, M., & Weber, R.A. (2004). Timing and Virtual Observability in Ultimatum Bargaining and Weak Link Coordination Games. Experimental Economics, 7, 25–48.

Charness, G. (2000). Self-Serving Cheap Talk: A Test Of Aumann's Conjecture. Games and Economic Behavior, 33, 177-194.

Charness, G., & Grosskopf, B. (2004). What makes cheap talk effective? Experimental evidence. Economics Letters, 83, 383-389.

Chaudhuri, A., Schotter, A., & Sopher, B. (2005). Talking ourselves to efficiency: Coordination in intergenerational minimum effort games with private, almost common and common knowledge of advice. Mimeo.

Clark, D.J., & Konrad, K.A. (2007). Asymmetric Conflict: Weakest Link against Best Shot. Journal of Conflict Resolution, 51, 457-469.

Clark, K., & Sefton, M. (2001). Repetition and signalling: Experimental evidence from games with efficient equilibria. Economics Letters, 70, 357–362.

Cooper, D.J., & Kagel, J.H., (2005). Are Two Heads Better than One? Team versus Individual Play in Signaling Games. American Economic Review, 95, 477–509.

Cooper, R., De Jong, D., Forsythe, R., & Ross, T. (1990). Selection criteria in coordination games: Some experimental results. American Economic Review, 80, 218–233.

Cooper, R., De Jong, D., Forsythe, R., & Ross, T. (1992). Communication in coordination games. Quarterly Journal of Economics, 107, 739–771.

Croson, R., Fatas, E., Neugebauer, T. (2009). Competition as a Team Incentive: Comparing Within- and Between-Team Competition. Working Paper.

Davis, D.D., & Holt, C.A. (1998). Conspiracies and secret price discounts in laboratory markets. Economic Journal, 108, 736-756.

Devetag, G., & Ortmann, A. (2007). When and why? A critical survey on coordination failure in the laboratory. Experimental Economics, 10, 331-344.

Duffy, J., & Feltovich, N. (2002). Do actions speak louder than words? Observation vs. cheap talk as coordination devices. Games and Economic Behavior, 39, 1–27.

Duffy, J., & Feltovich, N. (2006). Words, deeds and lies: Strategic behavior in games with multiple signals. Review of Economic Studies, 73, 669–688.

Fischbacher, U. (2007). z-Tree: Zurich Toolbox for Ready-made Economic experiments. Experimental Economics, 10, 171-178.

Fisher, D.R. (1998). Rumoring theory and the Internet: A framework for analyzing the grassroots. Social Science Computer Review, 16, 2, 158-168.

Friedman, J. W. (1967). An experimental study of cooperative duopoly. Econometrica, 35, 379-397

Hirshleifer, J. (1983). From Weakest Link to Best-Shot: The Voluntary Provision of Public Goods. Public Choice, 41, 371–386.

Ho, T.H. (2008). Individual Learning in Games. In S.N. Durlauf and L.E. Blume (Eds.), The New Palgrave Dictionary of Economics, Second Edition. Palgrave Macmillan.

Holt, C.A., & Laury, S.K. (2002). Risk Aversion and Incentive Effects. American Economic Review, 92, 1644-1655.

Lee, D. (2008). Weakest-link contest with group-specific public good prizes, Virginia Tech, Working Paper.

Millner, E.L., & Pratt, M.D. (1989). An experimental investigation of efficient rent-seeking. Public Choice, 62, 139–151.

Myung, N. (2008). Improving Coordination and Cooperation Through Competition. Working Paper, California Institute of Technology

Nalbantian, H., & Schotter, A. (1997). Productivity Under Group Incentives: An Experimental Study. American Economic Review, 87, 314-341.

Riechmann, T., & Weimann J. (2008). Competition as a Coordination Device: Experimental Evidence from a Minimum Effort Coordination Game. European Journal of Political Economy, 24, 437-454.

Selten, R., & Stoecker, R. (1986). End behavior in sequences of finite Prisoner's Dilemma supergames A learning theory approach. Journal of Economic Behavior & Organization, 7, 47-70.

Sheremeta, R.M. (2009). Perfect-Substitutes, Best-Shot, and Weakest-Link Contests between Groups. Purdue University, Working Paper.

Shubik, M. & Weber, R.J. (1981). Systems defense games: Colonel Blotto, command and control. Naval Research Logistics Quarterly, 28, 281-287.

Sutter, M. (2005), Are Four Heads Better than Two? An Experimental Beauty-Contest Game with Teams of Different Sizes, Economics Letters, 88, 41-46.

Sutter, M., & Strassmair, C. (2009). Communication, cooperation and collusion in team tournaments - An experimental study. Games and Economic Behavior, 66, 506-525.

Sylvia, T. (2002). The Internet and the Grassroots. Organization and Environment, 15, 336-339.

Tullock, G. (1980). Efficient Rent Seeking. In J.M. Buchanan, R.D. Tollison, G. Tullock, (Eds.), Toward a theory of the rent-seeking society. College Station, TX: Texas A&M University Press, pp. 97-112.

Van Dijk, F., Sonnemans, J., & Van Winden, F. (2001). Incentive Systems in a Real Effort Experiment, European Economic Review, 45, 187-214.

Van Huyck, J. B., Battalio, R. C., & Beil, R. O. (1990). Tacit coordination games, strategic uncertainty, and coordination failure. American Economic Review, 80, 234–248.

Van Huyck, J. B., Battalio, R. C., & Beil, R. O. (1991). Strategic uncertainty, equilibrium selection, and coordination failure in average opinion games. Quarterly Journal of Economics, 106, 885–911.

Van Huyck, J. B., Battalio, R. C., & Beil, R. O. (1993). Asset markets as an equilibrium selection mechanism: Coordination failure, game form auctions, and tacit communication. Games and Economic Behavior, 5, 485–504.

Weber, R. (2006). Managing growth to achieve efficient coordination in large groups. American Economic Review, 96(1), 114–126.

Zhang, J. (2008), Communication in Asymmetric Group Competition over Public Goods, McMaster University, Working Paper.

Appendix A – Experiment Instructions

GENERAL INSTRUCTIONS

     This is an experiment in the economics of strategic decision making. Various research agencies have provided funds for this research. The instructions are simple. If you follow them closely and make appropriate decisions, you can earn an appreciable amount of money.

     The experiment will proceed in two parts. Each part contains decision problems that require you to make a series of economic choices which determine your total earnings. The currency used in Part 1 of the experiment is U.S. Dollars. The currency used in Part 2 of the experiment is francs. Francs will be converted to U.S. Dollars at a rate of __30__ francs to __1__ dollar. At the end of today's experiment, you will be paid in private and in cash. **12** participants are in today's experiment.

     It is very important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

     At this time we proceed to Part 1 of the experiment.

INSTRUCTIONS FOR PART 1
YOUR DECISION

     In this part of the experiment you will be asked to make a series of choices in decision problems. How much you receive will depend partly on **chance** and partly on the **choices** you make. The decision problems are not designed to test you. What we want to know is what choices you would make in them. The only right answer is what you really would choose.

     For each line in the table in the next page, please state whether you prefer option A or option B. Notice that there are a total of **15 lines** in the table but just **one line** will be randomly selected for payment. You ignore which line will be paid when you make your choices. Hence you should pay attention to the choice you make in every line. After you have completed all your choices a token will be randomly drawn out of a bingo cage containing tokens numbered from **1 to 15**. The token number determines which line is going to be paid.

     Your earnings for the selected line depend on which option you chose: If you chose option A in that line, you will receive **$1**. If you chose option B in that line, you will receive either **$3** or **$0**. To determine your earnings in the case you chose option B there will be second random draw. A token will be randomly drawn out of the bingo cage now containing twenty tokens numbered from **1 to 20**. The token number is then compared with the numbers in the line selected (see the table). If the token number shows up in the left column you earn $3. If the token number shows up in the right column you earn $0.

     Any questions?

Decision No.	Option A	Option B		Please choose A or B
1	**$1**	**$3** never	**$0** if 1,2,3,4,5,6,7,8,9,10,11,12,13, 14,15, 16,17,18,19,20	
2	**$1**	**$3** if 1 comes out of the bingo cage	**$0** if 2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
3	**$1**	**$3** if 1 or 2 comes out	**$0** if 3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
4	**$1**	**$3** if 1,2, or 3	**$0** if 4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
5	**$1**	**$3** if 1,2,3,4	**$0** if 5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
6	**$1**	**$3** if 1,2,3,4,5	**$0** if 6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
7	**$1**	**$3** if 1,2,3,4,5,6	**$0** if 7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
8	**$1**	**$3** if 1,2,3,4,5,6,7	**$0** if 8,9,10,11,12,13,14,15, 16,17,18,19,20	
9	**$1**	**$3** if 1,2,3,4,5,6,7,8	**$0** if 9,10,11,12,13,14,15, 16,17,18,19,20	
10	**$1**	**$3** if 1,2,3,4,5,6,7,8,9	**$0** if 10,11,12,13,14,15,16,17,18,19,20	
11	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10	**$0** if 11,12,13,14,15,16,17,18,19,20	
12	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11	**$0** if 12,13,14,15,16,17,18,19,20	
13	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11,12	**$0** if 13,14,15,16,17,18,19,20	
14	**$1**	**$3** if 1,2,3,4,5,6,7,8,9,10,11,12,13	**$0** if 14,15,16,17,18,19,20	
15	**$1**	**$3** if 1,2,3,4,5,6,7,8,9,10 11,12,13,14	**$0** if 15,16,17,18,19,20	

INSTRUCTIONS FOR PART 2
YOUR DECISION

The second part of the experiment consists of **30** decision-making periods. At the beginning of the first period, you will be randomly and anonymously placed into a group of **3 people**: group A or group B. You will remain in the same group for all 30 periods of the experiment. At the beginning of the first period, your group will be paired with another group. This pairing remains the same for all 30 periods of the experiment. Either group A or group B will receive a reward. The reward is **60 francs** to each group member.

Each period you will be given an endowment of **60** francs and asked to decide how much to allocate to the **group account** or the **individual account**. You may allocate any integer number of francs between **0** and **60**. An example of your decision screen is shown below.

YOUR EARNINGS

After all participants have made their decisions, your earnings for the period are calculated. These earnings will be converted to cash and paid at the end of the experiment if the current period is one of the five periods that is randomly chosen for payment.

1) Your period earnings are the **sum of the earnings** from your **individual account** and the earnings from your **group account**.

2) For each franc in your individual account, you will earn **1** franc in return. So, if you keep all 60 francs that you are endowed with to your individual account you will earn 60 francs. But you can also earn some francs from your group account.

3) By contributing to the group account you may increase the **chance** of receiving the reward for your group. In determining which group receives the reward, the computer will consider only **the lowest contribution in group A's account** and **the lowest contribution in group B's account**. If the lowest contribution in group A's account exceeds the lowest contribution in group B's account, group A has higher chance of receiving the reward and vice versa. If your group receives the reward then in addition to the earnings from your individual account you receive the reward of **60 francs** from your group account. A group can never guarantee itself the reward. However, by increasing your contribution, you can increase your group's chance of receiving the reward.

4) The computer will assign the reward either to your group or to the other group, **via a random draw**. So, in each period, only one of the two groups can obtain the reward.

Example 1. Random Draw and Earnings

This is a hypothetical example used to illustrate how the computer is making a random draw. Let's say the members of groups A and B allocate their francs in the following way.

Table 1 – Allocation of francs by all members in group A and B

Group A	If Group A receives reward	Allocation to **individual account**	Allocation to **group account**	Group B	If Group B receives reward	Allocation to **individual account**	Allocation to **group account**
Member 1	60	40	20	Member 1	60	59	1
Member 2	60	45	15	Member 2	60	50	10
Member 3	60	50	**10**	Member 3	60	55	5

In group A, member 1 contributes 20 francs, member 2 contributes 15 francs, and member 3 contributes 10 francs to group A's account. In group B, member 1 contributes 1 franc, member 2 contributes 10 francs, and member 3 contributes 5 francs to group B' account.

Then the computer chooses **the lowest contribution in group A's account** and **the lowest contribution in group B's account**. The two highest contributions in group A and the two highest contributions in group B will **not** be considered by the computer. In this example, member 3 has the lowest contribution of **10 francs** in group A and member 1 has the lowest contribution of **1 franc** in group B. For each franc of member 3 in group A the computer puts **1 red token** into a bingo cage and for each franc of member 1 in group B the computer puts **1 blue token**. Thus, the computer places **10 red tokens** and **1 blue token** into the bingo cage (**11 tokens total**). Then the computer randomly draws one token out of the bingo cage. If the drawn token is red group A receives the reward, if the token is blue group B receives the reward. You can see that since group A has more tokens it has a higher chance of receiving the reward (**10 out of 11 times** group A will receive the reward). Group B has a lower chance of receiving the reward (**1 out of 11 times** group B will receive the reward).

Let's say the computer made a random draw and **group A receives the reward**. Thus, all the members of group A receive the reward of 60 francs from the **group account** plus they also receive earnings from the **individual account**. All members of group B receive earnings **only from the individual account**, since group B does not receive the reward. The calculation of the total earnings is shown in Table 2 below.

Table 2 – Calculation of earning for all members in group A and B

Group A	Earnings from **group account**	Earnings from **individual account**	Total earnings	Group B	Earnings from **group account**	Earnings from **individual account**	Total earnings
Member 1	**60**	**40**	60+40 = 100	Member 1	**0**	**59**	59
Member 2	**60**	**45**	60+45 = 105	Member 2	**0**	**50**	50
Member 3	**60**	**50**	60+50 = 110	Member 3	**0**	**55**	55

At the end of each period, the total number of francs in the two groups' accounts, group which receives the reward, earnings from individual and group accounts, and total earnings for the period are reported on the outcome screen as shown below. Please record your results for the period on your **record sheet** under the appropriate heading.

Participant ID: 3

You have been placed into **Group A** .

Francs you have allocated to the group account   3

The lowest contribution in **Group A** account: 2
The lowest contribution in **Group B** account: 2
Group which received the reward: B

Earnings from individual account: 57
Earnings from group account: 0
Total earnings for this period: 57

OK

Outcome Screen

IMPORTANT NOTES

You will not be told which of the participants in this room are assigned to which group. At the beginning of the first period, you will be randomly and anonymously placed into a group of 3 people: group A or group B. You will remain in the same group for all 30 periods of the experiment. At the beginning of the first period, your group will be paired with another group. This pairing remains the same for all 30 periods of the experiment. Either group A or group B will receive a reward. The reward is **60 francs** to each group member. A group can never guarantee itself the reward. However, by increasing your contribution, you can increase your group's chance of receiving the reward.

At the end of the experiment we will randomly choose **5 of the 30** periods for actual payment in **Part 2** using a bingo cage. You will sum the total earnings for these 5 periods and convert them to a U.S. dollar payment. **Are there any questions?**

Appendix B – Example Chats for Group 1 in Selected Periods of Session 081110

PERIOD 1
 hey guys
 yo
 whats the lowest ur gna put?
 I think we should bet real low on the first time like10
     francs
 10
 the other group will probably bet high and well lose
     money
 so 10 good?
 lets go for 15
 i was thinking more like 5 cos we just get a dollar
     more per period if we win
 okay 14

PERIOD 2
 that sucked
 how about 20 this time and yes it did suck
 i still think we should bet low
 20?
 yes no?
 we still win more per individual cos the guy who bet
     20 would just earn 80
 agreed?
 and we earn 60 thats just 20/30 = 30 cents more

PERIOD 5
 ok who put 0?
 not me i put 10
 u just lost me 20 francs
 we should put 15 at least now
 i didnt!
 i know ... someone is putting 0
 okay 15
 yes? eveyone agree
 ok evry1 put 21 then.. thats 1 more than theirs and a
     sure victory
 yeah

PERIOD 6
 theres no use ... someone keeps putting 0
 someone in here is bidding lower than their saying
     and is dumb...
 ok whoever put 15.. u won 45.. had u put 21 u would
     have won 39 + 60= 99..
 i'm putting 0 for the rest of them now, because of the
     idiot in our group
 evryq put 21 please
 once more then i'm done
 21 ... everyone!
 theyre winning at 20 each time its jst 1 franc more

PERIOD 7
 that was good
 keep putting 21 dont worry
 just bad drawing
 keep putting 21
 okay fine 21 all the time?
 yeah
 its random clock generation the next is ours
 21 again
 this is stupid if we dont get drawn
 one last time
 we will ... its luck of the draw

PERIOD 8
 there u go
 finally my goodness!
 okay 21 every time
 21 is our lucky number ... keep goin' with it ...
 ok its human psych.. they wil put 22 now../ evry1 put
     25
 or 21 if u wna try one more time.. ur call
 evry1s bets quick
 im staying with 21... if it gets too high it's not worth
     it
 i think 21 is good
 ok

PERIOD 9
 i wont say i told u so
 who did that
 WHO"S PUTTING 0!!!!!!!!!!!!!!!
 i KNOW!!!!!!!
 member 3 did you put 0????
 no i stuck with 21.. but i told u theyd go higher
 so lets just put 27 now
 21

PERIOD 10
 group b is going to be rich this is dumb
 just keep putting 21 ... we have about half the bingo
     balls .... its a 50 % chance
 IF WE ALWAYS PUT IN 21 !!!!
 exactly
 i am!
 and someone dosent keep putting in 0
 what the heck
 21 gain
 21 for the rest of the game
 ok
 fine

29

PERIOD 12
i'm pissed
theyre on to 21... thts y we had 25 we need a diff
        number.;. go with 27
or 0 ur call
27 one time
ok
k?
yeah
cool

PERIOD 15
how bout 0 for one more and then we go in at 30...
        agree?
keep going for 0.. theyre just earning a dollar more
        per peridd.. wiat for them to go low
yeah cool
sounds good
gr8
60 francs is a dollar so if we bid 0 were garenteed
        that price... not bad

PERIOD 16
one more time ... then hit them with 30
30 now? or 0 for one more??
okay thier at 20 so lets go for 30!
excellent!!!
quik. i need ur bids
30 now or the next one?
next
they might even put in 15
I think NOW
so 0 for this one?
i bid 30
yes?
ok 30
ok
mem2 - 30?
30 yes

PERIOD 17
wonderful!
what do u want to hit them with this time?
lets keep on doin' 30
i think back to 0 it'll throw them off
go for 40 now.. we'll still earn 80
theyre going to up their bid!
i think 30 will do it
exactly
no it has to be more
30!
35 final
35 fine
ok
cool
im hungry

PERIOD 18
stick to 30
we should have code names
i'll be sputnik
30's fine
ive noticed that we only win when they have more
        than 5 francs difference..
so 30 or 0?
what do you wnat to do
30!
0?
okay 30
we will win
ok 30 one more time
maybe
30
lol

PERIOD 19
they are also putting in 30
hwo the heck is the other group so lucky!
this is bad.. it has to be 40.. or we wont win..
this program is favoring
yes
how bout 40
we stil win 80
40?
sounds good
coool
40!
agreed?
yeah

PERIOD 20
lets keep it at 40
40 again?
they're not gonna go much higher than that
this is dumb though... if we lose we only get 20
        francs
45 now.. we win 5 francs less.. but 15 more than 60
okay 45
45.. one time...
might as well take a risk ... we have no money
        anyway
true
thts the spirit...!
45
go for it
45

PERIOD 21
you have to be kidding me!
they are just gonna match whatever we put
ur telling me..
lets just stay at 40

30

this program is favoring... we were higher
again
no.. its no use.. lets go 0
agreed
0
let them come dowbn.. then hit them
like before
0?
yes

PERIOD 22
0 again?
we should go 0 one more time
gr8.. they just won 15 more.. 0 again
or 40? they'll know what were doing
okay 0
0 and then next time we do it .. we'll only do one 0
theyre lucky not smart haha.. we're smarter
we should meet after to see who each other are
doesnt show

PERIOD 23
35?>
gr8.. now go 45
what if both groups put 0?
no
lets go 40 .... in between
they know.. we'll go high now
then either of us would just get the money
yeah.. 40
final
40 agreed
40 ... yeah