The Effects of Intragroup Communication on Intergroup Cooperation in the Repeated Intergroup Prisoner's Dilemma (IPD) Game

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The intergroup prisoner's dilemma (IPD) game was played repeatedly in an attempt to distinguish the dynamic process associated with reciprocation at the intergroup level from that resulting from adaptation at the individual level. Results show that when players were not allowed to communicate with one another, they gradually learned that it does not pay to participate, but when within-group communication was allowed, the overall effect was to increase individual participation. However, this effect varied greatly in later stages of the game. In some cases, intragroup communication eliminated individual participation and rewarded the members of both teams with the mutually cooperative outcome, but in other cases, it intensified the intergroup conflict to its maximal level of full participation. The implications of these findings for conflict resolution are discussed.

Two-person mixed-motive games have been used to model a variety of conflicts between groups ranging from confrontations between the superpowers to labor-management disputes (Allison 1971; Axelrod 1984; Brams 1975). Such use presupposes that all group members have identical preferences over the set of possible outcomes, and therefore each group can be treated as a unitary player.

This study employs a different model of intergroup conflict. Rather than conceiving of the competing groups as unitary players, it models each group as a collection of individuals whose interests are partially conflicting. The conflict of interests within the group is a fundamental one; it stems from the fact that the payoffs associated with the outcome of the intergroup conflict (e.g., territory, salary raise) are public goods that cannot be denied to individual group members, regardless of whether they contribute to their group's effort (Rapoport and Bornstein 1987; Bornstein 1992). Because con-

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tribution is costly, a rational group member has an incentive to free ride on the contributions of others, even though all group members are better off if they all contribute than if they all do not.[1]

Taking into account the interest of the individual player, in addition to that of his or her group, makes it possible—indeed, necessary—to distinguish between two modes of conflict resolution: one that is based on reciprocal cooperation through the use of tit-for-tat strategies at the intergroup level and another that builds on the accretion of free riding due to adaptation at the individual level.

The goal of the present experiment is to study these two qualitatively different routes to "peace" in a controlled laboratory setting to gain a better understanding of the conditions that give rise to one process or the other. Because the two-person prisoner's dilemma (PD) game is obviously too restrictive for this purpose, we employed the intergroup prisoner's dilemma (IPD) game (Bornstein 1992) as both a theoretical model and an experimental tool. The IPD participation game entails a competition between two teams, A and B, and is so structured that a PD game is created both between and within the groups. A graphic representation of the game, as operationalized in the present study, appears in Figure 1. A general definition can be found in Bornstein (1992).

Figure 1 displays the payoff to player *i* (a member of team A) as a function of player *i*'s decision to contribute (C) or not contribute (D) and the difference between the number of in-group contributors (m_A) and out-group contributors (m_B).[2] The game is defined by three properties apparent in the figure:

1. The individual's payoff for defecting or withholding contribution is higher than his or her payoff for contribution, regardless of what all other (in-group and out-group) players do. Withholding contribution, in other words, is the dominant individual strategy.
2. The payoff for *i* when all in-group members contribute is higher than *i*'s payoff when none contributes, regardless of the number of out-group contributors. Thus, the dominant group strategy is for all group members to contribute.
3. Player *i*'s payoff when all players in both groups contribute is lower than his or her payoff when none contributes. This means that the collectively (i.e., Pareto) optimal outcome, the one that maximizes the collective payoff to all players in both groups, is for all of them to withhold contribution.

The first and second properties define the intragroup payoff structure in the IPD game (for any number of out-group contributors) as an *n*-person PD game or a social dilemma (Dawes 1980; Dawes and Thaler 1988). The second and third properties define the intergroup payoff structure as a two-person PD game between the two teams.[3]

1. Dawes (1980, 170) provides a similar account of this incentive structure: "Soldiers who fight in a large battle can reasonably conclude that no matter what their comrades do they personally are better off taking no chances; yet if no one takes chances, the result will be a rout and slaughter worse for all the soldiers than is taking chances."

2. Because the individual decision is binary, the game can be referred to as a participation game in which each player decides between participating and not participating. We shall use the terms *contribution* and *participation* interchangeably.

3. Note that in the degenerate cases, when the behavior of the out-group is fixed or when each group consists of a true unitary actor, the IPD team game has the form of the traditional *n*-person or two-person prisoner's dilemma (PD), respectively.

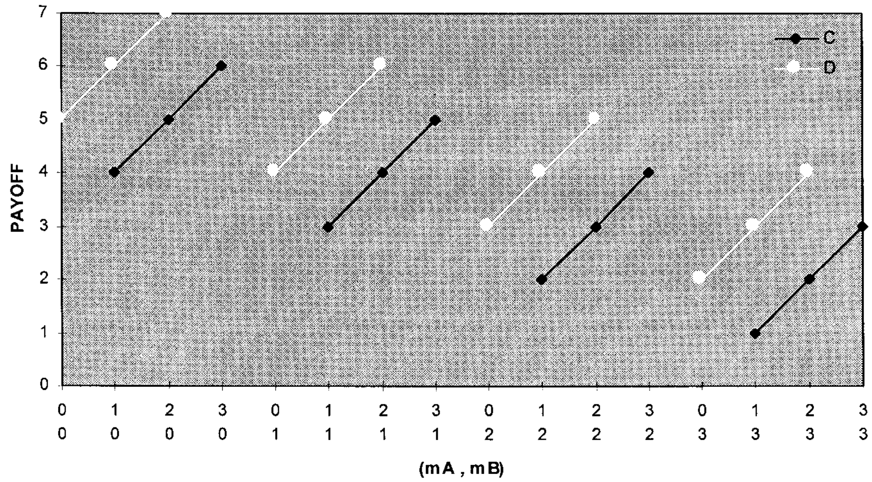

Figure 1: Payoff for a Member of Group A in the Intergroup Prisoner's Dilemma Game as a Function of Her or His Decision to Contribute (C) or Not Contribute (D), the Number of In-Group Contributors (m_A), and the Number of Out-Group Contributors (m_B)

Repeated interaction in the IPD game. A repeated game is different from a one-shot game in two important ways: first, in an ongoing interaction, choices can be dependent on the earlier choices of other players, whereas in a one-shot game, this is not possible. As a result, choices that are regarded as irrational in a one-shot game may be rational when the game is repeated. Second, an iterated environment provides players with an opportunity to learn the strategic structure of the situation and adapt their responses accordingly—an opportunity that they do not have in a one-shot game.

Several experiments have already examined the dynamics of contribution in IPD games played repeatedly (Bornstein, Erev, and Goren 1994; Bornstein, Winter, and Goren 1996; Goren and Bornstein 1999). They all show that individual contribution decreases steadily as the game progresses, slowly approaching the collectively optimal level of zero contribution. Recall, however, that within the IPD framework, withholding contribution is both the noncooperative (i.e., narrowly rational) individual strategy vis-à-vis one's own group and the cooperative group strategy vis-à-vis the other group. Therefore, low contribution levels can reflect either a failure to mobilize individual contribution within the groups or successful cooperation based on reciprocity between them.

We maintained that the gradual decrease in contribution levels observed in these experiments is most readily accounted for by individual rationality (i.e., selfishness). All one needs to assume is that players adapt their choices as they become more experienced with the task, so that choices that have led to good outcomes in the past are more likely to be repeated in the future. Because withholding contribution is the unconditionally best (i.e., dominant) individual strategy in the IPD game, the simple principle of reinforcement learning, known as the "law of effect" (Thorndike 1898), would inevitably move players in the direction of no contribution. This interpretation receives substantial support from computer simulations that, using a quantification of the law of effect by Roth and Erev (1995), closely reproduce the experimental results (Goren and Bornstein 1999).

In the experiments cited above, communication among players was prohibited, making coordinating a group strategy difficult. However, in intergroup conflicts outside the laboratory group members can typically communicate with one another throughout their repeated interaction with the other group. Communication between the groups, on the other hand, is often restricted. Will discussion within the groups change the course of the interaction between them? In particular, will intragroup communication facilitate (or perhaps hinder) reciprocal cooperation at the intergroup level?

Research on (single-group) social dilemmas demonstrated that at least in the laboratory, informal group discussion ("cheap talk") practically solves the internal free rider problem (Dawes 1980; Dawes, McTavish, and Shaklee 1977; Kerr and Kaufman-Gilliland 1994; Orbell, van de Kragt, and Dawes 1988). Apparently, discussion creates a sense of group identity, leading individuals to substitute group regard for egoism as the principle guiding their choices (Orbell, van de Kragt, and Dawes 1988). In addition, discussion provides the participants with an opportunity to publicly promise one another to cooperate. People tend to keep their promises if they believe that others will do the same (Kerr and Kaufman-Gilliland 1994), and as a result, "the effect [of informal communication, or cheap talk] could be almost as though a binding and enforceable agreement were in place" (Colman 1995, 220).[4]

The enhancing effect of communication on intragroup cooperation was demonstrated in single-shot team games as well. Several studies have shown that group discussion greatly increased cooperation among group members in a variety of team games, including the IPD game (Bornstein 1992; Bornstein, Mingelgrin, and Rutte 1996; Bornstein and Rapoport 1988; Bornstein et al. 1989). It is thus safe to assume that following discussion, group members will act in accordance with their group interest.

However, in the iterated IPD game, the group's interest can be served in two qualitatively different ways. The group can either compete by having all of its members contribute regardless of what the out-group does, or it can cooperate by having none of its members contribute provided that the out-group does the same. Both unconditional competition and conditional cooperation are rational from the group's perspective, and each has its advantages.[5] Competition is the safer (i.e., maximin) team strategy because it guarantees each group member the reward for a tie, regardless of what the out-group does. Cooperation, on the other hand, if reciprocated by the out-group, is

4. This effect of communication is generalizable to repeated social dilemmas as well (Isaac and Walker 1988; Ostrom, Walker, and Gardner 1992; Wilson and Sell 1997).

5. Both strategies are rational in the sense that both are Nash equilibria in the iterated game between teams A and B.

collectively (i.e., Pareto) optimal because it enables the members of both groups to get the same reward while keeping their endowments.

The present experiment compares behavior in the iterated IPD game played with and without (within-group) communication. Studying these two conditions in the same experiment enables us to distinguish between the dynamic process associated with reciprocation at the intergroup level and that which results from adaptation at the individual level. If reciprocation between the groups is successful, both processes should eventually lead to the same outcome—namely, the collectively optimal outcome of zero participation. However, the dynamics characterizing the two processes are predicted to be different.

Learning is an individual response uncoordinated on the behavior of others. Although all individuals are expected to learn the same thing, they cannot be expected to learn at the same rate. Based on previous results, we predict that although the average participation rate in the no-communication condition will decrease more or less monotonically, some level of participation will remain for the duration of the game.

In contrast, reciprocation at the intergroup level should be well coordinated both within each group and between the groups. If both teams simultaneously choose the cooperative strategy of designating no contributors, and all group members abide by the group decision, reciprocation should succeed. In this case, participation is expected to terminate abruptly and remain at zero level for the duration of the interaction. If reciprocation fails, however, groups are expected to resort to the maximin strategy of full participation. In this case, participation is predicted to increase and remain high for the duration of the game. To summarize, we hypothesize that in the no-communication condition, the contribution level will decrease steadily, whereas in the communication condition, the contribution will either decrease completely or increase to nearly the maximal level.

Experiments on repeated interaction in the two-person PD game (Radlow 1965; Rapoport and Chammah 1965; Guttman 1986) showed that players first react to the structure of the one-shot game, treating the behavior of the other player(s) as invariant. It takes players longer to realize that the behavior of the others may be contingent on their own behavior. The result is a general decrease in cooperation at the beginning of the game and then a rise or recovery as players start reciprocating. In addition, the frequency of unilateral responses decreases steadily as paired players (male in particular) become more and more alike. Some pairs locked in on the CC cooperative outcome, whereas others locked in on the DD trap; as a result, variance among pairs became increasingly large.

Generalizing this result to the context of the IPD game, we hypothesize that groups will first use the opportunity for communication to facilitate the myopic group interest by having all members contribute. Only then will they attempt to reciprocate with the out-group. The predicted divergence between cooperative sessions (where intergroup reciprocation succeeds) and competitive sessions (where it fails) is not expected to appear until later in the game.

METHOD

Participants. A total of 120 undergraduate students at the Hebrew University of Jerusalem participated in the experiment. The participants were recruited by campus advertisements promising a monetary reward for participating in a decision-making experiment.

Procedure. The participants arrived at the laboratory in cohorts of 6 and were instructed both verbally and in writing about the rules and payoffs of the IPD game. The instructions were phrased in terms of the individual's payoffs as a function of her or his own decision (to contribute or not) and the decisions made by the other players. The payoffs were summarized in a table that was available to the participants throughout the experiment. Participants were not instructed to maximize their earnings, and no reference to cooperation or defection was made. Participants were given a quiz to test their understanding, and the instructions were repeated until the experimenter was convinced that all the participants understood the payoff rules. Participants were also told that they would receive their payment in sealed envelopes and leave the laboratory one at a time with no opportunity to meet the other participants.

The cohort of 6 participants was divided into two 3-person teams by a public lottery. Each team was seated in a separate room, with each group member facing a personal computer. The PCs were arranged so that the players could not see each other's monitors. Each cohort played 60 rounds of the IPD game (with the payoff parameters described above) under one of two conditions: no-communication condition, in which no discussion among group members was allowed, and within-group communication condition, in which discussion among team members was permitted. There were 10 six-person cohorts in each condition.

Group discussions were conducted according to the following protocol: 6 minutes of discussion before the decision phase of the first round, 2 minutes of discussion before the decision phase of rounds 2 to 10, and 1 minute before decision in rounds 11 to 60.[6] The discussions were audiorecorded, with the experimenters announcing the round number and the time permitted for discussion.

Following each round, participants received feedback concerning (a) the number of in-group contributors in that round, (b) the number of out-group contributors, (c) the number of points they had earned on that round, and (d) their cumulative earnings. The number of rounds to be played was not made known.[7]

After the last round, the points were added up by the computer and cashed in at the rate of IS 1 for 8 points (1 Israeli Shekel was equal to $.29 at the time the experiment took place, and the average subject earned IS 32.2, about $9.20). The participants filled out a questionnaire in which they were asked to assess the motivations of the other

6. This scheme was designed to provide group members with more discussion time at the early stages of the game while keeping the duration of the experiment less than 2 hours.

7. The participants received information about the decision made by each individual (in-group and out-group) member on each round. However, they did not know the identity of the other players. All decisions and feedback information were handled by a computer program based on the RatImage toolbox (Abbink and Sadrieh 1995).

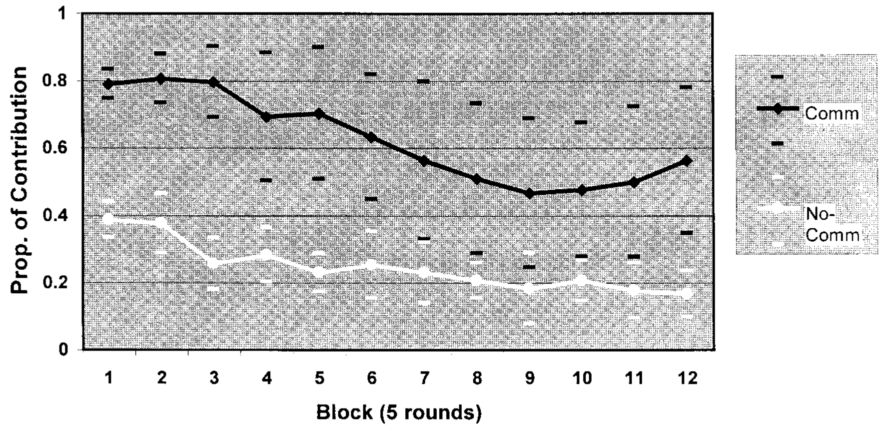

Figure 2: Average Proportion of Contribution as a Function of Block and Condition (communication vs. no communication)

NOTE: Bars in corresponding colors display the standard deviation ranges around the average proportions.

(in-group and out-group) players. Finally, the participants were debriefed on the rationale and purpose of the study and were paid and dismissed individually.

RESULTS

Contribution rates. The 60 rounds of the game were divided into 12 blocks of 5 rounds each, and the mean proportion of contribution in each block was calculated for each experimental session separately (i.e., the cohort of 6 persons participating in the same session served as the unit for analysis). These means were then subjected to a 2 (experimental condition) by 12 (block) repeated-measures ANOVA.

The proportions of contribution per block averaged across the 10 sessions in each condition appear in Figure 2. As can be seen in this figure, the overall contribution level was more than twice as high in the communication condition ($M = 0.63$) than in the no-communication condition ($M = 0.25$). This difference is, of course, statistically significant; $F_{(1, 18)} = 15.26$, $p < .001$. Contribution rates also varied significantly as a function of block; $F_{(11, 198)} = 4.95$, $p < .001$. In both conditions, contribution decreased as the game progressed. The interaction between condition and block was not statistically significant ($F_{(11, 198)} < 1$), indicating that mean contribution levels in the two conditions decreased at about the same rate.

At the aggregated level, then, the results seem clear and unambiguous: within-group communication enhances individuals' willingness to contribute their endowments toward their group's effort. This willingness dwindles with time regardless of whether group members are allowed to communicate.

However, a closer look at the data suggests the possibility of a more complex (and more interesting) picture. As can be seen in Figure 2, from about the fourth block onward, the variability of contribution rates across the 10 sessions in the communication condition is extremely large—much larger than that in the no-communication condition.[8] This large variance indicates that sessions in the communication condition were rather different from one another. In fact, it is quite likely that the mean contribution pattern in Figure 2 is not an accurate description of any of the individual sessions in that condition.

Figure 3 displays the proportion of contribution in each of the 10 sessions in the communication condition separately (contribution proportions are presented separately for each of the two teams). As suspected, none of the individual sessions exhibits the nearly linear decrease in contribution over time as it appears in Figure 2. Initially, the overall effect of within-group communication (as compared with the no-communication condition) was to increase individual contribution in accordance with the narrow group interest. Subsequently, however, communication served either to increase contribution even further or to diminish it completely.

The different dynamic patterns in Figure 3 were classified into three types: cooperative (sessions 2, 5, 9, and 10), in which the two teams eventually reached the collectively efficient outcome of no contribution; competitive (sessions 3, 7, and 8), in which the two teams approached the most competitive (and least efficient) outcome of full contribution; and intermediate (sessions 1, 4, and 6), in which intermediate contribution levels characterized the entire game.[9]

According to our hypothesis, this variability in contribution behavior reflects the fact that in some cases, the two groups were successful in implementing contingent tit-for-tat strategies and, as a result, managed to achieve a cooperative, no-participation solution to the intergroup conflict, whereas in other cases, reciprocation between the groups failed, and consequently the conflict escalated to the most competitive outcome of full participation. This hypothesis receives additional support from the correlational analysis reported in the following section.

Dependencies among players. We examined the extent to which the decisions of the individual player were contingent on the decisions made by the other (in-group and out-group) players. First, the contribution decision of each individual player in round t was correlated with the number of contributions made by the other in-group members

8. The F ratios for comparing the variances of the two conditions ($df = 9,9$) in blocks 1 to 12 are 0.67, 0.69, 1.88, 5.50, 11.81, 3.46, 6.65, 18.29, 4.40, 10.89, 7.31, and 9.86, respectively. The critical F value (for $\alpha = 0.05$) is 3.18, meaning that from block 4 onward, the variance in the communication condition is significantly larger than that in the no-communication condition.

9. We used the payoffs in the second half of the game as an objective criterion for classifying the sessions into types. The maximal number of points that a cohort of 6 participants could have earned in the last 30 rounds was 900, whereas the minimum was 540. For each cohort, we computed a measure of efficiency by converting the number of points actually earned into percentage within the 540 to 900 range: [(points earned – 540)/360]100. In sessions classified as competitive, the participants earned only 11.1%, 0%, and 4.4% (sessions 3, 7, and 8, respectively) of the maximum; in sessions classified as cooperative, the participants earned 100% (sessions 2, 10, and 11) and 85% (session 5) of the maximum; in sessions classified as intermediate, the participants earned 31.7%, 26.1%, and 28.3% of the maximum (sessions 1, 4, and 6, respectively).

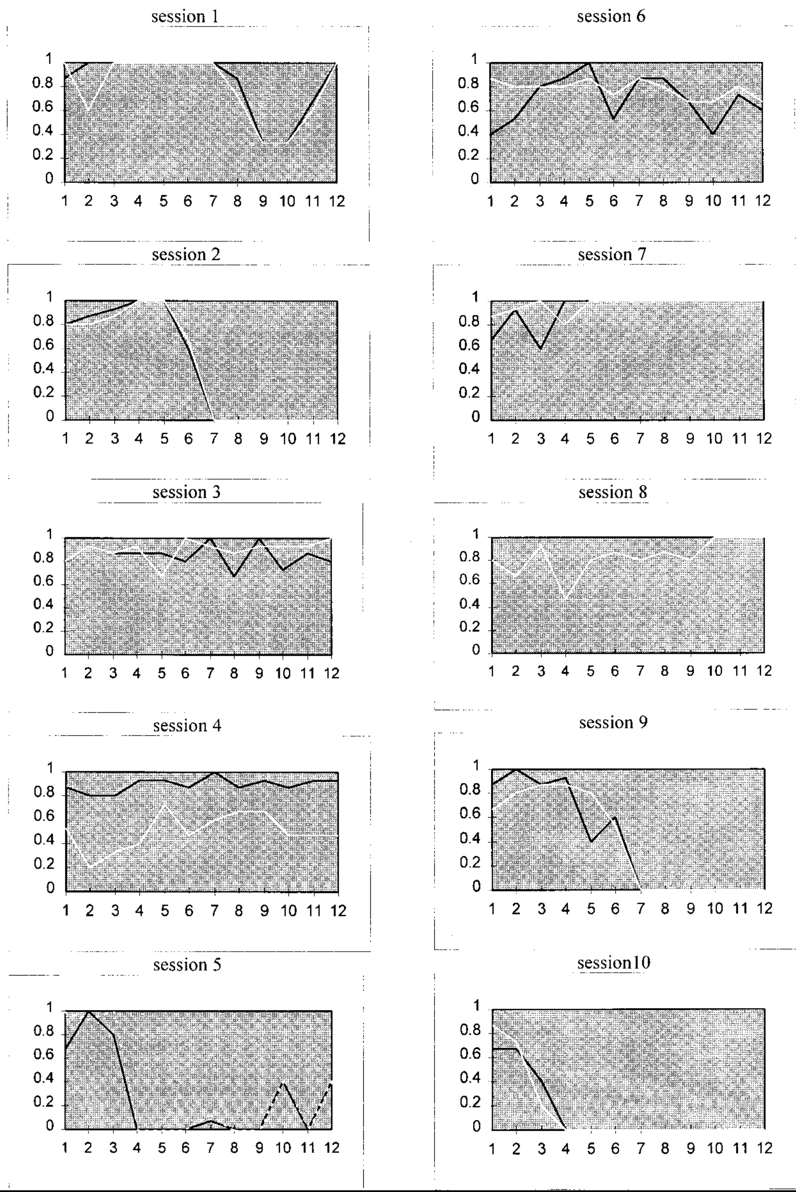

Figure 3: Proportions of Contribution by Team and Block in the 10 Sessions of the Communication Condition

NOTE: Horizontal axis = block number; vertical axis = proportion of contribution.

in the previous ($t - 1$) round. If the players' contribution decisions were contingent on past behavior of other in-group members, this correlation should be positive. The proportion of contributions in round t (2 to 60) as a function of the number of in-group

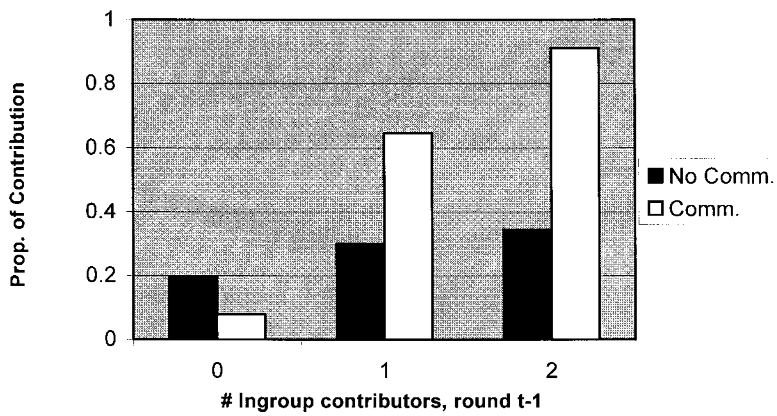

Figure 4: Proportion of Contribution (by Individual Players) in Round *t* as a Function of the Number of Other In-Group Contributors in Round *t* – 1 in the Two Experimental Conditions

contributors (0, 1, or 2) in round $t-1$ (1 to 59) appears in Figure 4 (the data are aggregated across the 10 sessions in each experimental condition).

Clearly, in both conditions, the individual's decision to contribute depended to some degree on the number of in-group contributors in the previous round. As could be expected, this dependency was much larger in the communication condition than in the no-communication condition. In the communication condition, about 8% of the players contributed when none of their teammates contributed in the previous round, 65% contributed when one other teammate contributed in the previous round, and 91% contributed when both teammates had done so. In the no-communication condition, contribution rose more moderately, from 20% to 34%, as the number of other in-group contributors in the previous round increased from 0 to 2.[10]

Next, and more important, we correlated the number of contributors in each team in round t with the number of contributors in the other team in the previous round. If the players used strategies of between-team reciprocation, this correlation should be positive. Figure 5 shows the number of in-group contributors (0 to 3) in round t (2 to 60) as a function of the number of out-group contributors (0 to 3) in round $t-1$ (1 to 59). Again, the data are aggregated over all 10 sessions in each condition. Clearly, in both conditions, the number of in-group contributors increased with the number of out-group contributors in the previous round. However, this effect was much more pronounced in the communication condition than in the no-communication condition. In the former condition, the contribution rate was 9%, following no out-group contribution in the

10. For each participant, we computed the correlation between his or her decision to contribute in round t and the number of other in-group contributors in round $t-1$: the average Kendall's tau-b ordinal measure of association in the no-communication condition is .132 as compared with a correlation of .507 in the communication condition. The difference between the two correlations is statistically significant; $t_{(93.6)} = 8.82$, $p < .01$.

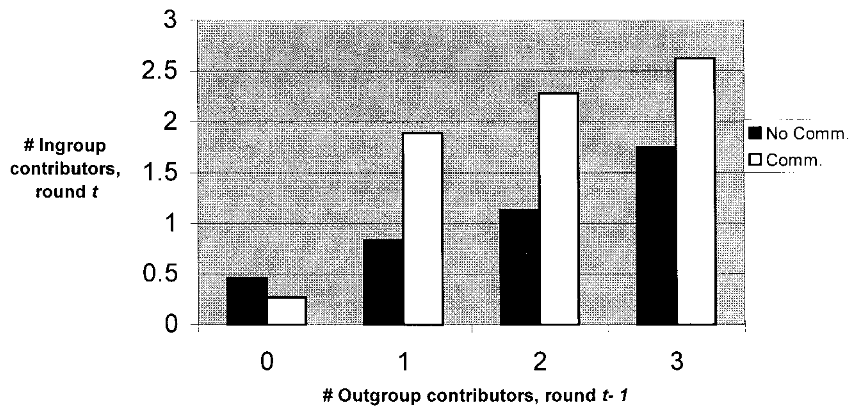

Figure 5: Number of In-Group Contributors in Round *t* as a Function of the Number of Out-Group Contributors in Round *t* – 1 in the Two Experimental Conditions

previous round, and 63%, 76%, and 87% when there were 1, 2, or 3 out-group contributors, respectively. When in-group members were not allowed to communicate, contribution rates rose from 15% to 58% as the number of out-group contributors increased from 0 to 3.[11]

Next we computed the lagged correlations for the cooperative, competitive, and intermediate-type sessions separately. Assuming that between-group cooperation was indeed based on reciprocation, one would expect the correlation between the number of in-group contributors and the number of out-group contributors to be higher in cooperative than in competitive (or intermediate) sessions. Figure 6 displays the average number of in-group contributors in round t as a function of the number of out-group contributors in round $t - 1$ for each of the three types.

The figure shows that in the cooperative sessions, the number of in-group contributors in round t increased as a function of the number of out-group contributors in round $t - 1$. The most dramatic increase occurred when the number of out-group contributors increased from 0 to 1. If there were no out-group contributors in the previous round, there was a meager 4% contribution rate in the in-group. However, following even a single contribution by the out-group, the in-group's contribution rate increased to 86%. Clearly, groups in sessions classified as cooperative used an "all-or-none" tit-for-tat strategy vis-à-vis the other group; a peaceful, no-contribution move was reciprocated in kind, but any positive level of out-group contribution was retaliated against with nearly full force.

11. For each team, we computed the correlation between the number of contributors in round t and the number of out-group contributors in round $t - 1$. The average Kendall's tau-b ordinal measure of association was .245 in the no-communication condition and .533 in the communication condition. The difference between these two average correlations is significant; $t_{(25.9)} = 3.73$, $p < .01$.

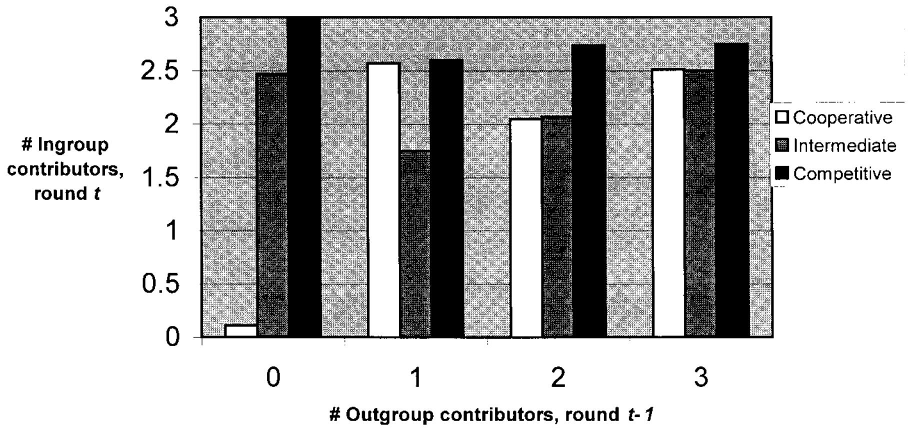

Figure 6: Number of In-Group Contributors in Round *t* as a Function of the Number of Out-Group Contributors in Round *t* – 1 in the Three Session Types within the Communication Condition

This was not the case in the competitive and intermediate sessions, in which the number of in-group contributors was very high (82% and 87% in the intermediate and competitive sessions, respectively), even when no one in the out-group had contributed in the previous round. This finding suggests that at least one of the two teams failed to reciprocate, choosing instead the maximin strategy of full contribution.[12]

Content analysis of within team discussions. To gain some more insight into the group processes that underlie the different dynamic patterns, we analyzed the content of group discussions. Special attention was given to content categories that, based on our theoretical reasoning, could potentially distinguish between cooperative and competitive intergroup interactions. The coding scheme included the following content categories:[13]

(a) expressions of within-team mistrust (i.e., fear that in-group members would renege on the agreed-on course of action),

(b) explicit comprehension that lowering contribution levels is optimal for both teams,

(c) explicit willingness to signal cooperative intentions to the out-group by lowering in-group contribution,

12. We computed for each team the correlation between the number of contributors in round t and the number of out-group contributors in round $t - 1$. The average Kendall's tau-b ordinal measure of association for the cooperative-type sessions was .771, and for the intermediate and competitive types, it was .456, and .174, respectively. The differences between these average correlations are significant; $F_{(2, 15)} = 17.43$, $p < .01$.

13. As a first step, we listened to group discussions in one cooperative (number 2) and one competitive (number 7) session and devised a list of content categories. Two raters independently coded the two sessions and discussed the exact meaning of each category. Minor changes to definitions were made until agreement as to the exact meaning of each category was reached.

(d) explicit belief that the out-group discerns the mutual efficient outcome,
(e) interpretation of a sudden drop in out-group contribution as a signal of cooperative intentions,
(f) expressions of competitive intentions toward the out-group.

The recorded discussions were analyzed by two coders according to the above scheme. Disagreements were resolved by a third coder. Each coder recorded the number of times each content category appeared in the first 30 rounds of the game, and these frequencies were then analyzed as a function of session type (recall that this later classification was based on the last 30 rounds).[14]

We found that the participants in the cooperative sessions referred significantly more often to the mutually efficient outcome (i.e., zero contribution) than participants in the other two session types ($M = 3$ in cooperative sessions, $M = 1.67$ in each of the other two types; $\chi^2 = 5.3$, $p = .07$, in median scores analysis). An explicit discussion of the Pareto-optimal solution by both teams seems to be a necessary condition for achieving the cooperative solution. Indeed, in all the cooperative sessions, both teams explicitly discussed this solution (except possibly for session 5, in which the data for team A were lost due to faulty equipment), whereas in only a single session (7) of the competitive type did both teams do so. In all other competitive or intermediate-type sessions, either only one team discussed this solution or neither did.

We also found a relationship between the number of explicit attempts to signal the out-group and session type: there were more such attempts in cooperative sessions ($M = 8.57$) than in the other two types ($M = 4.83$, $M = 3.33$ for the intermediate and competitive types, respectively). Although this relationship is not statistically significant, explicit signaling occurred in all teams of the cooperative type but only some of the teams of the other types.

Participants in the cooperative sessions were more likely to assume that the out-group's members had reasoned out the mutually beneficial outcome ($M = 3.43$) than participants in the intermediate ($M = 1.83$) and the competitive ($M = 0.83$) sessions ($\chi^2 = 6.51$, $p < .05$, in median scores analysis). They were also more inclined to interpret a sudden drop in the number of out-group contributors as a signal of cooperative intentions ($M = 1.43$), as compared to players in intermediate and competitive sessions ($M = 0$ and $M = 1.17$, respectively; $\chi^2 = 9.49$, $p < .05$, in median scores analysis). These results are consistent with the notion that strategies of between-team reciprocation played an important role in sessions classified as cooperative and much less so in

14. Each rater independently counted the statements in each content category made by each team during the first 30 rounds of the game. (Due to equipment failure, we lost the data of one session. We thus had 19 team scores for each rater in each of the six content categories.) Interrater reliability was assessed in two different ways. First, we correlated the scores of the two raters for each category. The correlations were 0.99, 0.90, 0.89, 0.77, 0.81, and 0.91 for categories 1 through 6, respectively, indicating a generally high level of agreement between the two raters. Second, we averaged the scores of each content category for each session type and looked at how the means of the three session types (cooperative, competitive, and intermediate) were ordered by each rater. With regard to five of the content categories, the two raters ranked the three means in exactly the same order. As to the sixth category (understanding the collectively optimal outcome), both raters judged the cooperative sessions to contain the highest number of relevant statements but differed in the way they ordered the other two session types. A third rater judged the number of statements in the intermediate and competitive sessions to be equal.

other sessions.[15] Finally, indications of within-team mistrust were completely absent from group discussions in the cooperative sessions ($M = 0$). Some mistrust was voiced in the competitive ($M = 1.5$) and the intermediate sessions ($M = 8.5$).[16]

Questionnaire data: Perception of in-group and out-group motivations. The questionnaire was analyzed to find out whether the perception of in-group and out-group members reflected (or was correlated with) the course of the interaction. Participants estimated the extent to which each of the individual players (including themselves) was motivated to maximize (1) his or her own payoff (max-own), (2) his or her team payoff (max-in-group), (3) the collective payoff of all members of both teams (max-joint), and (4) the difference in outcomes between in-group and out-group (max-rel). For each participant, we computed his or her average rating of the in-group and the out-group members. We report first the overall differences in these ratings between the two conditions and then examine the ratings for each session type (within the communication condition) separately.

Differences between conditions. Table 1 reports the mean ratings for in-group and out-group members (on each of the four scales) in the two experimental conditions. As can be seen in the table, participants in the communication condition perceived both in-group and out-group members as less motivated to maximize their own payoff ($t_{(92.9)} = 2.68$, $p < .05$; $t_{(99)} = 2.09$, $p < .05$, for in-group and out-group ratings, respectively) and more motivated to maximize their team's payoff ($t_{(118)} = 10.61$, $p < .05$; $t_{(118)} = 7.59$, $p < .05$, for in-group and out-group ratings, respectively) than participants in the no-communication condition.

As compared with the no-communication condition, participants in the communication condition perceived both in-group and out-group players as more motivated to maximize the collective payoff ($t_{(106.7)} = 4.8$, $p < .05$; $t_{(109.1)} = 3.66$, $p < .05$, for in-group and out-group, respectively). However, at the same time, they rated both in-group and out-group members as more motivated to maximize the relative difference between the in-group and the out-group ($t_{(105.4)} = 2.46$, $p < .05$; $t_{(106.5)} = 3.15$, $p < .05$, for in-group and out-group ratings, respectively).

At first glance, this pattern of results seems rather perplexing. In the IPD game, the two motivations clearly contradict one another. Contributing one's endowment lowers the collective payoff and increases the payoff difference in favor of one's in-group, whereas withholding contribution increases the collective payoff but lowers the relative difference. Table 2, which displays the mean ratings of in-group and out-group members (on each of the four scales) separately for the cooperative, competitive, and intermediate-type sessions, may help explain this phenomenon.

15. In session 1 (classified as intermediate), the two teams decreased their contribution in an attempt to signal cooperation, but they did not eliminate it completely. Although these teams managed to sustain a long period of relatively low contribution (a single contributor in each team), this partial cooperation did not last throughout the game, and contribution levels eventually rose again.

16. The high mean of the intermediate type has to do with the fact that one team in session 4 was extremely occupied with the issue of trust (42 expressions).

TABLE 1
Mean Ratings of Motivations of In-Group and Out-Group Members by Communication Condition

	No Communication		*Communication*	
Motivation	*In-Group*	*Out-Group*	*In-Group*	*Out-Group*
Maximize self-payoff	7.72	7.58	6.5	6.66
Maximize team payoff	4.18	4.49	8.18	7.61
Maximize collective payoff	2.75	2.66	5.24	4.47
Maximize in-out payoff difference	4.51	4.61	5.84	6.18

TABLE 2
Mean Ratings of Motivations for In-Group and Out-Group Members by Session Type in the Communication Condition

	Cooperative		*Intermediate*		*Competitive*	
Motivation	*In*	*Out*	*In*	*Out*	*In*	*Out*
Maximize self-payoff	6.28	6.74	7.17	6.59	6.13	6.61
Maximize team payoff	8.08	7.81	8.31	6.72	8.17	8.22
Maximize collective payoff	6.25	6.22	5.44	3.78	3.7	2.83
Maximize in-out payoff difference	5.01	5.29	5.7	6.06	7.07	7.5

As can be seen in Table 2, participants of the cooperative sessions rated both in-group and out-group members as more motivated to maximize collective payoff than did participants in the intermediate and competitive sessions.[17] Participants in the competitive sessions, on the other hand, rated both in-group and out-group members as more motivated to maximize the relative advantage of the in-group over the out-group than participants in the intermediate and cooperative sessions. Thus, what seems like a contradiction at the aggregated level is explained by the fact that participants in the cooperative sessions rated both in-group and out-group players as more cooperative, whereas those in the competitive sessions rated them as more competitive (as compared with the no-communication control condition).

Perceived in-group/out-group differences. Next, we examined whether the participants viewed in-group members differently from out-group members. To do this, we calculated the difference between the ratings of in-group and out-group members on the max-own, max-in-group, max-joint, and max-rel scales.

17. The differences among session types on this scale were significant; $F_{(2, 57)} = 3.43$, $p < .05$, for in-group members and $F_{(2, 57)} = 8.85$, $p < .01$, for out-group members.

On the max-own and max-rel scales, the in-group/out-group differences were small and did not vary much as a function of experimental condition.[18] On the max-in-group scale, the differences between ratings of in-group and out-group members were 0.57 and –0.32 for the communication and no-communication conditions, respectively. This difference, which is statistically significant ($t_{(118)} = 2.53$, $p < .05$), indicates that participants in the communication condition perceived in-group members as more motivated to maximize their own team's gain (more "patriotic") than out-group members, whereas participants in the no-communication condition perceived in-group members as somewhat less motivated to do so than out-group members.

On the max-joint scale, the differences between the ratings of in-group and out-group members were 0.77 in the communication condition and 0.11 in the no-communication condition. Thus, although in both conditions, participants perceived in-group members as more motivated than out-group members to maximize the joint outcomes (of both teams), the in-group/out-group difference is more pronounced when communication is allowed ($t_{(77)} = 1.83$, $p = .07$).

DISCUSSION

This study examined repeated interaction in intergroup conflict as modeled by the IPD team game. The game was studied under two conditions, one in which the members of each group were able to communicate with one another more or less freely throughout their interaction with the other group and another in which communication among players was prohibited. We found that when group members could not communicate with one another, they gradually learned that it does not pay for them, as individuals, to participate. This finding corroborates the results of other experiments on repeated interaction in the IPD game.

When within-group communication was allowed, its overall effect was to increase, in fact double, individual contribution or participation as compared with the no-communication control condition. However, participation levels in later stages of the interaction varied greatly. In some of the cases, within-team communication resulted in between-group cooperation, and individual participation was eliminated altogether, but in other cases, intragroup communication intensified the intergroup competition to its maximal level of full participation. The critical factor that seems to be responsible for these divergent dynamics is whether both teams used contingent strategies in an explicit attempt to bring about the cooperative and mutually beneficial solution to the conflict.

Several findings support this claim. The correlation between the number of in-group and out-group contributors was much higher in the cooperative than in the com-

18. On the max-own scale, the differences were –0.16 in the communication condition and 0.16 in the no-communication condition. On the max-rel scale, the differences were –0.34 and –0.06 in the communication and no-communication conditions, respectively. The differences between the two conditions on these two scales are not statistically significant.

petitive sessions. Players in cooperative sessions were more likely than those in competitive sessions to consider the mutually beneficial outcome of no contribution and to assume that the out-group would do the same. They were also more likely to try to signal their cooperative intentions to the out-group and interpret relevant out-group behavior as a cooperative signal.

Signaling seems to have played a particularly important role in this process. Cooperative sessions were characterized by explicit and unequivocal signals in which the signaling team reduced its number of contributors from 3 to 0 from one round to the next (and often persisted with the no-contribution strategy for at least one more round). Weaker signals (i.e., reducing the number of contributions by 1 or 2) were much less effective. For example, in session 1, one of the teams reduced contribution from 3 to 1 to signal its cooperative intention. This behavior was reciprocated by the other team, and for some time both teams designated a single contributor. However, this partial cooperation did not last for long, and eventually one team raised its contribution level, the other team immediately followed, and the game ended in a full-scale "war." In all other sessions in which a team reduced the number of contributors by one to signal its cooperative intention, the behavior was not reciprocated, and as a result, cooperation did not evolve.

Clearly, an effective signal was one in which the team eliminated contribution altogether and did so immediately following a round of full contribution. This may have two related reasons. First, a strong signal is more likely to be recognized as such (Axelrod 1984). Second, in intergroup competition as modeled by the IPD game, a weak signal can be easily misperceived as defection by an individual group member rather than as a deliberate and coordinated group move. If a team suspects that cooperation within the out-group is breaking down, its best response is to exploit this internal weakness to win the competition. Only if it believes that the out-group is capable of mobilizing the individual participation necessary for retaliation does the group have a strategic incentive to cooperate. In-group cohesion, in other words, is a necessary condition for effective intergroup cooperation. The fact that within-team mistrust was never voiced in sessions of the cooperative type supports the notion that only cohesive groups can hope to achieve "a long and lasting peace."

The positive effects of intragroup communication on intergroup cooperation found in nearly half of the experimental sessions are particularly interesting in light of research on the "discontinuity effect" by Insko and his associates (see Insko and Schopler 1998 for a review of this literature). This line of research has demonstrated that intergroup behavior tends to be highly competitive, much more so than interindividual relations under the same structural conditions. Insko and Schopler (1987) and Schopler and Insko (1992) offer two explanations for the observed competitiveness of groups. The "schema-based distrust" hypothesis explains intergroup competitiveness in terms of fear. It postulates that group members decide to compete because they expect the out-group to behave competitively and wish to defend themselves against the possibility of being exploited. The "social support for shared self-interest" hypothesis explains group competitiveness in terms of greed. It argues that groups are competitive even when they expect the out-group to cooperate because group members provide each other with support for acting in an exploitative, in- group-oriented way. Both explanations assume communication among group members (Insko and Schopler 1987) and in the IPD game; either one is sufficient to motivate a competitive group strategy (Coombs 1973; Dawes 1980).

Nevertheless, our results show that when the "shadow of the future" is long enough, groups are quite capable of mutual cooperation. A willingness to resolve the conflict in a mutually beneficial way and an effort to communicate this cooperative intention to the out-group characterized many of the team discussions. When these attempts were reciprocated by the other group, a cooperative solution was invariably reached.

This is not to say that intergroup competition was not present. On the contrary, competitive attitudes toward the out-group were expressed by practically all teams.

However, this was unrelated to the actual pattern of interaction that eventually evolved.[19] Competitive motivation and strategic reasoning seem to be orthogonal. Even highly competitive teams often realized that it is in their own interest to cooperate with the out-group.

Final words. By modeling intergroup conflict as an IPD game, we were able to explicitly define the relations between the collective interest of the group and the interests of the individual group member. The literature on intergroup conflict was never entirely clear on this issue. Although some researchers assumed that if it is rational for the group to compete, it must also be rational for individual group members to do so (Taylor and Moghaddam 1987); others argued that what is best for the group is not necessarily best for the individual group member (Campbell 1965; Dawes 1980).

Consequently, we were able to theoretically distinguish between two modes of conflict resolution, one that evokes individual selfishness and another that entails reciprocation at the group level. Our experimental results clearly demonstrated that although both processes are feasible, they involve very different dynamics. When individual rationality prevails (in the no-communication condition), the decrease in contribution over time is gradual and slow. When group rationality predominates (in the within-team communication), the decrease in contribution (when it occurs) is instantaneous, total, and stable over time.

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19. The average number of competitive expressions was 7.50, 6.57, and 5.67 in the competitive, cooperative, and intermediate types, respectively. These differences are not statistically significant.

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