Do Democracies Breed Chickens?

Gary Bornstein*

Arthur Schram[#]

Joep Sonnemans[#]

Abstract

Our interest is in assessing the effect of different group decision-rules (or ‘regimes’) on conflict resolution. Toward this goal, we model intergroup conflict as a two-stage Chicken game between two groups (teams) of players and distinguish two decision-making procedures for determining a team's choice: democracy (majority rule) and dictatorship (one individual makes the team's decision). In an experiment with three individuals per team, we found that (i) decision-making procedures had no effect on choices at the team level; (ii) decision-making procedures did not affect first-stage choices by individuals; (iii) in the second stage, individuals in democracies were more likely to concede than dictators; (iv) dictators facing a democratic team were least likely to concede, whereas individuals in a democratic team facing a dictator were most likely to concede.

*Department of Psychology and Center for the Study of Rationality and Interactive Decision Theory, the Hebrew University, 91905 Jerusalem, Israel.

[#]CREED, Department of Economics, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, the Netherlands.

This project is part of the European Union-TMR Research Network ENDEAR (FMRX-CT98-0238)

1. Introduction

When modeling conflicts between groups (e.g., labor and management), one must take into account that each of the sides actually consists of a set of individuals, each making his or her own private decision. The way in which these individual decisions are aggregated to determine the group decision may affect the outcome of the game. Our interest is in assessing the effect of the different decision-rules (or 'regimes') on the resolution of intergroup conflicts in a controlled environment.

Two-person games are often used to study Intergroup conflicts but they cannot account for the institutions governing decision-making within the group. It is generally acknowledged that economic and political institutions can affect behavior. For example, labor negotiators might behave differently in negotiations with management when they can make important decisions by themselves than when all major decisions are put to a vote by the union's members. In political science, it has often been argued that democratic nations are less likely to engage in a military conflict than non-democratic nations (see Thompson and Tucker, 1997, for a discussion and references). We will use laboratory experiments to study the relationship between decision-making procedures within groups that are in conflict. Outside of the laboratory, institutions may be formed endogenously, and this can make it very hard to study their effect on behavior (e.g. democracies and dictatorships may differ in many more ways than their decision rule). Therefore, controlled laboratory experiments can be very helpful. Economic experiments have a long tradition of studying the effect of institutions such as different market institutions, or auction mechanisms (Cox and Grether, 1996; Evans, 1997), but the number of studies about the influence of intragroup institutions on conflict resolution at the intergroup level is rather limited (e.g., Putnam, 1988).

As a model of intergroup conflict, we use the game of Chicken. The two-person game of Chicken is associated with the following story: Two drivers race towards each other down the center of the road. If one swerves and the other does not, then the first is called a 'chicken' while the second is a 'hero'. If neither swerves, both suffer a collision. If both swerve, damage to the reputation of each is limited. Each driver thus prefers to compete (by continuing down the center of the road) if the other concedes (swerves), but to concede if the other competes (Oye, 1986).

While the story is about individual drivers, many of the game's applications involve competition between groups. The two-person Chicken has been used to model a variety of intergroup conflicts, ranging from confrontations between the superpowers to disputes between management and workers (Allison, 1971; Brams, 1975; Snidal, 1986). As in the original story, these situations involve mutual threats and the failure of both sides to yield leads to an outcome, such as war or bankruptcy, that is disastrous to both sides. There are various reasons why the use of the two-*person* Chicken, as well as other two-person games, to model intergroup conflicts is unsatisfactory. One is that the benefits associated with the outcome of these conflicts (e.g., territory, higher wages) are public goods for the members of each group involved in the competition. Since contribution (e.g., fighting, standing on a picket line) is costly, free-riding within the groups is a potential problem – a problem which two-person games necessarily ignore (see Bornstein *et al.* 1997).

In the current investigation we put aside this internal problem of public goods provision and focused instead on the role of political institutions. We studied a game of Chicken in the laboratory, with the sides being teams rather than individuals. To avoid the free-riding problem, we compelled the members of each team to make a binding (and costless) decision as to the collective team's choice. What we varied was the social-choice rule by which the choices of the individual team members determined the team's choice. Specifically, we considered two types of groups: 'democracies', where the group's decision is determined by the majority of its members, and 'dictatorships', where the group's decision is determined by a single group member (the dictator). In both cases, individuals made their decisions independently, but the payoffs were determined exclusively by the teams' choices.

Our experiment employs a two-stage variant of the original matrix game of Chicken. One example we had in mind when devising the two-stage Chicken was labor-management negotiations (although there are many other applications of the game). Typically, in such negotiations there is an initial stage were each side states its starting position. If, at this early stage, either side is willing to make the necessary concessions, the result is a quick settlement. However, if neither side is willing to make concessions, there is a delay which is costly to both (e.g., a strike). Then the negotiations are resumed and each side has an opportunity to revise its position. If again neither side is willing to give up, the game ends in a "collision" (e.g., bankruptcy of the firm). Similar phases can be distinguished in cases of military conflict. In an initial phase there is either concession or mutual threat. This threat can escalate into war if both sides stick to their initial positions.

The two-stage Chicken game as operationalized in our experiment is described in Table 1. As in the examples above, if either (or both) side(s) concedes in stage one (*i.e.*, chooses A), the game is terminated. But if neither side concedes, the game is played again with a fixed delay cost (equal to 1) subtracted from the original payoffs. Following the second stage, the game is terminated regardless of the players' decisions. In this setup, there is a gain to be made by not conceding – that is, 'playing tough'. In fact, the payoff to a player if (only) the other player concedes at stage 2 is higher than the payoff if both concede at stage 1.

The organization of this paper is as follows. Section 2 below describes the experimental procedures and design. Section 3 presents some theoretical considerations for the game. We shall show that the argument that democratic nations are less likely to let a conflict escalate to a war is not supported by game theoretic analysis. Game-theoretically, *individual* behavior may be different under different regimes, but this should not affect the likelihood of collision at the *group* level. Results of the experiment are presented and analyzed in section 4. Section 5 offers conclusions.

Table 1: The two-stage game of Chicken

Stage 1

		Side 2	
		A	**B**
Side 1	**A**	3 3	6 2
	B	2 6	go to stage 2

Stage 2

		Side 2	
		A	**B**
Side 1	**A**	2 2	5 1
	B	1 5	0 0

2. Experimental procedure and design

The experiment was run at the computerized laboratory of the Center for Research in Experimental Economics and political Decision making (CREED) of the University of Amsterdam.[1] A total of 190 subjects participated in 11 sessions. Of the participants, 61% were economics majors,[2] and 66% were male. The average age was 21.9 years. When stating the motivation for their participation in the post-experimental questionnaire, 95% stated that they were interested in earning money. A translation of the (computerized) instructions is presented in appendix A. The instructions included a quiz to test the subjects' understanding of the rules and payoffs.

Two sessions (with 14 subjects each) were used to run a control treatment where the game in Table 1 was played as a two-person game. The numbers in the table are Dutch guilder (at the time of the sessions *ƒ* 1 was approximately $ 0.60). Each individual player chose either A or B at stage 1. If both chose B, the second stage was played with the same strategy space. Subjects were then rematched and played the game again. This went on for 7 periods.[3] It was common knowledge that subjects would not be matched with the same player twice. Moreover, they knew that they would not be matched with a player X who had previously been paired with Y if they themselves had already been matched with Y. Hence, only 'third order' influence of other subjects' behavior in future rounds of the two-stage game was possible. In total, these control sessions yielded

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[1] The computer software was developed using RatImage, a tool developed at the University of Bonn. The software is available upon request.

[2] In the Netherlands a major in economics includes business school areas such as accounting or finance.

[3] We chose a small number of periods in order to restrict the interaction of the subjects across periods.

7(pairs)x7(rounds)x2(sessions)=98 plays of the two-stage (individual) game of Chicken (with 98x2=196 individual plays).

In the remaining 9 sessions (with 18 participants each), the players were in groups of 3. This constitutes a six-person game. The payoffs were determined by the two-stage game of Chicken played between the two teams. The ‘team’ choice between A and B was determined by the individual choices. The payoffs in table 1 were paid to each subject. Thus, if both teams decided to choose A at stage 1, each of the six players received 3 guilder. If both teams chose B at stage 1, the second stage was played with the same teams and strategy space. After payoffs were determined, all subjects were allocated to new teams and a new round was played. The (common knowledge) criterion used for rematching in these sessions was that no two subjects would be in the same team more than once.[4] In total, these sessions yield 3(pairs)x7(rounds)x9(sessions)=189 plays of the two-stage (team) game of Chicken (with 189x6=1134 individual plays).

The treatment effects in the team-game sessions involved the way in which individual choices were aggregated into a team choice. We distinguish two social choice rules: ‘democracy’ (dem) and ‘dictatorship’ (dic). In dem teams, team choices at both stage 1 and stage 2 were determined by a (simple) majority rule. In dic teams, every team member made a decision for stage 1. Then one of these players was randomly selected and her or his choice determined the choice of the team. If stage 2 was reached, this same subject made the decision for the team. The other two team members did not make decisions at stage 2. This procedure was common knowledge. Finally, subjects received information about the choices of other individual players. Thus, the decisions of the three players in a dem team were made known to both teams in the game, while for dic teams only information about the decision of the dictator was made public.

In three of our team game sessions, each group used the dem-rule in every round. In three other sessions, each group used the dic-rule in every round. In the three remaining sessions, a team using the dem-rule was paired with a team using the dic-rule in every round. In these sessions, each subject was typically in a team using the dem-rule in some of the rounds and in a team using the dic-rule in the remaining rounds.

To summarize, our experimental design involved three treatments: a competition between two democracies (dem-dem), a competition between two dictatorships (dic-dic), and a mixed condition where a democracy competed against a dictatorship (dem-dic). In addition, we included a control condition where the game was played by individuals (ind-ind). Following stage 1, players were informed about the decisions made by all the relevant decision makers. Namely, in case of a democracy players received feedback about the decisions made by all three group members, while in case of a dictatorship they were told about the decision made by the dictator.

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[4] The ‘opposing’ team might include a player that the subject had met before. However, this gives little opportunity for strategically trying to influence future behavior of other subjects.

Subjects seemed to understand the instructions and rules without difficulties. They usually finished reading the instructions within 15 minutes. The 7 rounds were generally finished within 15 minutes as well. In total, most sessions took considerably less than an hour. The average earnings were ƒ 15,67 plus a show-up fee of ƒ 10,00.

3. Theoretical considerations

Game-theoretical analysis

This section summarizes the results of the game-theoretic analysis of the two-stage game of Chicken (the detailed analysis appears in Appendix B). The subgame perfect Nash equilibrium strategies are the same for the game between two individuals and between two dic teams. In both cases, there are pure strategy equilibria where one player (or each player in one team) chooses A in stage 1 and the other player (team) chooses B.[5] In these equilibria stage 2 is never reached; the A-player is the "Chicken" and earns 2 guilders while the B-player earns 6 guilders. The only other equilibrium is a symmetric mixed strategy equilibrium where each player chooses A with probability 0.2 in stage 1 and, if stage 2 is reached, each player chooses A with probability 0.25. The expected payoff in the mixed strategy equilibrium is ƒ 2.25 for each player.

In the dem teams, the same equilibria in pure strategies exist. There is also a mixed strategy equilibrium where both *teams* play A with probability 0.2 in stage 1 and probability of 0.25 in stage 2, although *individuals* playing A with these probabilities do not create an equilibrium. If each individual member of a dem team independently chooses A with probability 0.2, the group will choose A with probability $(0.2)^3+3*0.8*(0.2)^2 =0.104$. In fact, the only symmetric equilibrium strategies for individuals in a dem team involve choosing A with probability 0.287 at stage 1 and 0.323 at stage 2. This yields the group probabilities 0.2 and 0.25. Hence, even though there is no difference at the team level, at the individual level the mixed strategy equilibrium involves a higher probability of choosing A at both stages of the game.

Signaling

The two-stage game of Chicken confronts the players with a difficult coordination problem, as is usually the case in games without an obvious focal point. In such settings, where the potential gains for coordinated behavior are substantial, signaling could prove useful (Palfrey and Rosenthal, 1991). In particular, in a game of Chicken (when signaling between players is possible) each player can gain an advantage by committing herself to the non-cooperative strategy, and communicating this intention

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[5] More formally, the ‘pure strategy’ equilibrium may involve a mixed strategy at stage 2, which is not reached (see appendix B).

to the other player. A player who succeeds in making her intention to compete seem convincing is bound to win if the other player is rational.

Unilateral commitment can thus be viewed as a coordination device which enables players to select an equilibrium. By introducing asymmetry between the players to match the asymmetry inherent in the pure-strategy equilibria, it can help them avoid the inferior outcome associated with uncoordinated action. Indeed, a simulation by Ward (1990) demonstrates that joint gains are more likely to be realized in a three-person game of Chicken if the game is preceded by a pregame phase in which the players can signal their commitment to a certain course of action.[6]

The coordination problem might, however, differ across treatments, depending on the opportunities for signaling in the two-stage game. Obviously, since choices at the first stage are made simultaneously, signaling can play a role only if the game reaches the second stage. Moreover, a signal is useful as a coordination device only if it contains asymmetrical information. It is easy to see that this could never be the case in a game between two dictatorships (or between two individuals), since if the game has reached stage 2, both (decisive) players must have chosen B in stage 1. Signaling, in other words, can take place only if at least one of the competing groups is a democracy. Consider first the dem-dem treatment. If all members of both groups chose the competitive (B) strategy at stage 1, the signal is symmetric and therefore uninformative. But if only two members of group I chose B at stage 1, while all three members of group II did so (in this case too the game would reach stage 2), the signal could be useful for solving the coordination problem. In other words, by increasing the fear that the members of group II may not yield and consequently the appeal of concession for the members of group I, such a signal increases the likelihood of the BA equilibrium which favors group II. In a competition between a democracy and a dictatorship, only the democracy can send an informative signal. Again, if the decision to compete at stage 1 was supported by only two group members rather than by all three, the dictator might be less likely to yield in stage 2.

Comparison with Political Science Predictions

There seems to be a consensus among political scientists that democratic states rarely, if ever, fight other democratic states (Thompson and Tucker, 1997). This fundamental premise of “democratic peace” has led international relations researchers to conclude that widespread democratization will lead to a more peaceful world. In our experiment, the premise that democratic dyads are less war prone than other types of dyads implies fewer collisions (i.e., B,B outcome at stage 2) between two democratic teams than between two dictatorships.

In contrast, game theory predicts no differences in behavior at the *team* level as a function of regime. At the *individual* level, game theory predicts that, if the mixed strategy equilibrium is played, individuals in the dem teams are more likely to choose A than others. Players may have a hard time coordinating a pure strategy equilibrium, and so the outcome of the first stage game may function as a device for the selection of a equilibrium of the (second stage) subgame (although that this is not an equilibrium for the whole game). The purpose of the experiment was to compare behavior in a controlled environment to the predictions based on insights from political science and game-theoretic predictions.

4. **Results**

In line with the predictions above, we performed two types of analyses. First, we considered the data at the team level. At this level the game-theoretic prediction is identical for all treatments, but the political-science 'truism' would lead us to expect fewer (B,B) outcomes in the dem-dem treatment. Table 2 reports the percentage of teams that chose A at stages 1 and 2 for each kind of decision rule.[7] The lowest rates of concession at stage 1 are found for individuals and dem teams and the highest for dic teams. Differences across treatments are not statistically significant, however. This is in line with the game-theoretic predictions at the team level. Across treatments, a higher fraction of teams chose A at stage 1 than at stage 2 (26.0% versus 16.2%). Using a z-test for proportions, this difference is statistically significant (p<0.01). Compare this to the mixed strategy in equilibrium, which predicts 20% in stage 1 and 25% in stage 2.[8]

Table 2: Percentage of A choices by teams across treatments*

	%A in stage 1	**%A in stage 2**
Ind	24.0	15.5
dem	25.4	17.9
dic	28.6	15.3
Total	26.0	16.2

*Ind = individual (control) treatment; dem: team decision by majority rule; dic: team decision by appointed dictator. The percentage for stage 2 is conditional on reaching that stage.

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[6] Similar effects of non-binding communication on cooperation were found in the experimental studies of the minimal contribution set paradigm -- an n-person game of Chicken (van de Kragt, Orbell, & Dawes, 1983).

[7] In Table 2 (and Table 5, below), we aggregate across all dem (dic) teams, irrespective of the type of team they are facing. When split according to the team they are facing, the differences are small and insignificant.

[8] To be sure, there is a kind of selection bias for stage 2: only those teams that are inclined to be 'tough' (play B at stage 1) move on to stage 2. This is not relevant if one takes the game-theoretic prediction as the null hypothesis, however. Only the mixed-strategy equilibrium takes the game into stage 2. This equilibrium involves independently randomized decisions at stages 1 and 2.

Another issue at the team level is the number of times that the game ends in ‘war’, *i.e.*, a (B,B) outcome of stage 2. Table 3 reports the percentage of “wars” per treatment. We now distinguish the various combinations of teams. The differences across treatments are small and statistically insignificant.

Table 3: Percentage of “Wars”

Ind	38.8
dem facing dem	38.1
dem facing dic	39.7
dic facing dic	34.9
Total	38.0

Finally, we used team level data to look at the issue of signaling. Specifically, we examined whether an asymmetrical signal at stage 1 affected the decisions of the teams at stage 2, as discussed in the previous section. Table 4 gives the percentage of teams switching from B to A for the case where two democracies faced each other, broken down for various situations at stage 1.

Table 4: Switches to A in stage 2 in dem-dem treatment*

	stage 1		**% switch to A in stage 2**
number of cases	**own team**	**other team**	
16	2-1	3-0	31.3
34	2-1	2-1	17.6
8	3-0	3-0	12.5
16	3-0	2-1	12.5

*The numbers ‘x-y’ in the columns ‘own-team’ and ‘other team’ indicate that there were x (y) votes for B (A).

Even though the number of cases is relatively small and the differences are statistically insignificant, the effects are in the predicted direction: if a team has fewer votes in favor of B at stage 1 than the other team, it is more likely to switch to B at stage 2. In the treatment where democracies face dictators (not reported in the table) no evidence of a signaling effect was found.

The second type of analyses was performed at the individual level. Unlike the prediction at the team level, the theoretical predictions at the individual level are not the same for all treatments. One of the equilibria (in symmetric mixed strategies) predicts a higher rate of A-choices in both stage 1 and stage 2 among members of a democracy as compared with dictators and individuals (who are predicted to behave similarly in that respect).

When looking at the data per period, there is no trend in choices. Therefore, to correct for individual idiosyncrasies we can aggregate the 7 decisions per subject.[9] Table 5 presents the percentage of A choices at stages 1 and 2 made by the individual participants in each of the treatments. Differences at stage 1 are small, with the possible exception that fewer A-choices are made in the individual treatment (ind). These differences are statistically insignificant, however. At stage 2, the differences appear to be larger. In fact, a Mann-Whitney test shows that subjects in a dem team choose A at stage 2 significantly more often than subjects in the individual treatment (p<.0.05). Furthermore, dictators were significantly less likely to choose A than members of a democracy (p<0.01). Thus, as predicted by the mixed-strategy equilibrium, individuals were more likely to concede (i.e., choose A) at stage 2 if they were in a dem team.

Table 5: Percentage of individual A choices*

	%A in stage 1	**%A in stage 2**
ind	24.0	18.0
dem	32.4	32.7
dic	32.5	16.0
Total	31.5	24.9

*The difference between the numbers in Tables 2 and 5 is due to the level of aggregation. In Table 2 a single observation is the choice of a team. In Table 5 the percentage of A choices per individual is the unit of observation.

Nevertheless, the same is not observed at stage 1. Moreover, a type of selection bias may once again be taking place (see note 6). In a dic team, only those subjects who chose B at stage 1 make a decision at stage 2. In a dem team, on the other hand, subjects who chose A at stage 1 are still required to decide at stage 2 if the other two members of the team chose B. If one considers only those subjects in the dem teams who chose B at stage 1, it turns out that they switched to A 25.0% of the time. This is still significantly higher than the 16% of switches in dic teams (Mann-Whitney, p<0.01).

Across social choice rules, the outcomes of the two-stage game of Chicken were relatively inefficient. Whereas subjects could have earned *ƒ* 3,00 per period if they had all chosen A at stage 1 of every period, they earned on average only *ƒ* 2.24 per period (with little variation across treatments). This is very close to the predicted earnings in the mixed-strategy equilibrium (*ƒ* 2.25). One of the reasons for the fairly low earnings is the fact that a ‘war’ with payoffs equal to 0 was the outcome in 38% of the games. Again, this is remarkably close to the result one would expect if all subjects played

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[9] An exception is made for the subjects in the dem-dic treatments. In these cases we aggregate across decisions when the subject was in a dem team and when (s)he was in a dic team, yielding two observations per subject.

the mixed-strategy equilibrium (in which case (B,B) would be the outcome with probability 0.8x0.8x0.75x0.75=0.36).

To check whether or not subjects used the mixed strategies of the (symmetric) subgame perfect equilibrium, we conducted binomial tests. These tests assume as a null hypothesis that individual decisions are made randomly, with a probability p of choosing A. For all treatments, we tested the values p=0.2 (stage 1) and p=0.25 (stage 2). Remember that this is not an equilibrium strategy for subjects in the dem teams, however. For these teams, we also tested the equilibrium values p=0.287 (stage 1) and p=0.323 (stage 2). The two tailed p-values in various treatments for these tests are presented in Table 6.

Table 6: Test results for mixed strategies at the individual level (p-values)

		Ind	**dem (facing dem)**	**dem (facing dic)**	**dic (facing dem)**	**dic (facing dic)**
stage 1	**p=0.2**	0.19	0.00**	0.00**	0.12	0.00*
	p=0.287	--	0.09	0.31	--	--
stage 2	**p=0.25**	0.03*	0.04**	0.05**	0.15	0.16
	p=0.323	--	0.69	0.79	--	--

*Rejects game-theoretic prediction (5% level). **Rejects team-level equilibrium (5% level)

This table shows that the mixed-strategy game-theoretic prediction is rejected in 2 out of 10 tests: individuals in a dic team facing another dic team choose A more often than predicted at stage 1 and subjects in the individual treatment (ind) choose B more often than predicted at stage 2. Moreover, for the dem teams the probabilities predicted by the equilibria at the team level are rejected in all four cases where they are not an equilibrium at the individual level. We shall return to the issue of mixed strategies in the concluding discussion.

5. Conclusions

It is a well-established finding in (experimental) economics that institutions matter (Cox and Grether, 1996; Evans, 1997). In this paper-we studied the effect of specific political institutions (social choice rules) in a game of Chicken between two groups. Contrary to the political-science prediction, but in line with the game theoretic prediction, we find no relationship between social-choice rules within groups and the occurrence of ‘wars’ between them. It appears that there is an influence at the individual level, but the effect at the group level is relatively small. Our subjects adjusted their behavior in a way that left the team outcome basically constant across treatments. At least in this study, decision-making procedures seem to be more important for *intra*group decisions than for *inter*group decisions..

Predictions based on mixed-strategy equilibria were generally confirmed. First, at the aggregate level, behavior is in accordance with the mixed-strategy equilibrium: The average earnings and the number of (B,B) outcomes are remarkably close to what this equilibrium predicts. The most notable exception is that, at the team level, the probability of choosing A is significantly higher at stage 1 than at stage 2. Second, the mixed-strategy equilibrium provides differential predictions concerning individual behavior in the different treatments. Specifically, it predicts a higher rate of A choices among individual members of a democratic team. The results presented in table 6 generally support this prediction.

Readers may wonder whether conclusions from a Chicken game between 3-person groups in a laboratory can be relevant for the study of international conflicts. Countries are large groups of individuals, with complex institutions (e.g. indirect democracy), ideologies, coalitions and a common history and in thus are quite different from our anonymous 3-person groups. Nevertheless, we believe that experiments can teach us something. A political system is more or less endogenously determined by other characteristics of society. Political science based upon historical statistics is not able to tell us whether or not democracies engage in war less often because of the way political decisions are made, or because of other, asociated characteristics of a democratic society. Our experiments suggest that decision rules *alone* are not the explanation of the absence of military conflict between democracies.

Our study is meant to serve as a starting point for a variety of future studies. Research on this topic might go in many directions. It could focus on repeated games, either by playing two-stage Chicken games repeatedly, or by playing Chicken games with more than two stages. Another line of future research would appoint a dictator before the decision for a round is made. This would avoid the 'strategy method' we use here. Alternatively, an indirect democracy, where group members choose a 'dictator' who receives a mandate to act as (s)he likes, may also be of interest. For example, voting for a 'crazy' dictator may act as a commitment device to convince the other group that they had better chicken out.[10]

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[10] We thank Uri Gneezy for this suggestion.

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Appendix A

This appendix provides an English translation of the computerized Dutch instructions. The computer screens are separated by horizontal lines. Subjects could page back and forth.. The instructions given here were used for the dem-dic sessions.

Introduction

Welcome to this experiment on decision making. You will make money in this experiment. How much you make depends on your own decisions and the decisions of other participants. The money will be paid to you personally and privately after today's session. Your decisions are anonymous. They will not be associated with your name. On your table is an envelope. Please do not open it until you are instructed to do so.

Please read the following instructions carefully.

At the bottom of each screen you will see buttons. By typing the letter 'v' you will move on to the next page. By typing the letter 't' you will move back to the previous page. This way, you can page back if anything is unclear. You will not be able to use the computer mouse in today's experiment.

Groups

The experiment consists of 7 'periods'. In each period the 18 participants are randomly divided into 6 groups of 3. You do not know who will be in your group and the others do not know who will be in theirs.

The groups are formed in such a way that no one will be in the same group with any other participant more than once. In other words, in every period there will be new people in your group. Thus, you will not be in a group with the same people in later periods either.

After the groups have been formed in a particular period, each group is randomly paired with another group. Therefore, in each period there are 3 'pairs' of groups.

Group decision

The participants in a group must reach a common group decision. How this is done will be explained below. Your earnings in a period depend on the decision of your group and the decision of the group with which your group is paired in that period.

Choices and Earnings

A period starts with ‘STAGE 1’. The group decision at this stage is a choice between 2 alternatives: A and B. This gives 4 possible outcomes:

If BOTH GROUPS choose A at stage 1, the period ends (which means there will not be a stage 2). Each participant in the two groups receives 3 GUILDER.

If YOUR GROUP chooses A and the OTHER GROUP chooses B at stage 1, the period ends (which means there will not be a stage 2). In YOUR GROUP each participant receives 2 GUILDER. In the OTHER GROUP each participant receives 6 GUILDER.

If YOUR GROUP chooses B and the OTHER GROUP chooses A at stage 1, the period ends (which means there will not be a stage 2). In YOUR GROUP each participant receives 6 GUILDER. In the OTHER GROUP each participant receives 2 GUILDER.

If BOTH GROUPS choose B at stage 1, the period moves to stage 2.

Stage 2

The group decision at stage 2 is again a choice between the options A and B.

If BOTH GROUPS choose A at stage 2, each participant in each group receives 2 GUILDER for this period.

If YOUR GROUP chooses A and the OTHER GROUP chooses B at stage 2, each participant in YOUR GROUP receives 1 GUILDER. In the OTHER GROUP each participant receives 5 GUILDER.

If YOUR GROUP chooses B and the OTHER GROUP chooses A at stage 2, each participant in YOUR GROUP receives 5 GUILDER. In the OTHER GROUP each participant receives 1 GUILDER.

If BOTH GROUPS choose B at stage 2, each participant in each group receives 0 GUILDER.

Summary

The period ends after stage 2, irrespective of the group decisions. There is no third stage. New groups are formed and the next period is started.

The payoffs for stages 1 and 2 are summarized in a table. You will find it in the envelope on your desk. You may now open this envelope. In each cell of the table the payoff to members of your group is given on the bottom left and the payoff to members of the other group on the top right. Note that the payoffs at stage 2 are always 1 less than the corresponding payoffs at stage 1.

In the envelope, subjects found the payoff tables given in Table 1. Instead of 'player 1' the term 'Decision own group' and instead of 'player 2' the term 'Decision other group' was used. The own payoffs were shaded, and this was stated below the tables.

Questions

Before we explain how group decisions are made, you will have to answer a few questions, to check whether you have understood the instructions thus far. For the multiple choice question, give the number of the correct answer. For the open questions, give the answer asked for. If you answer a question incorrectly, you will be asked to give a new answer. You are also given the option of reading the corresponding part of the instructions again. If you cannot find the correct answer, you may raise your hand. Someone will come over to help you.

The first question was a multiple choice question:

Which of the following statements is CORRECT?

1. In the other group there are participants that were in your group in an earlier period.
2. In your group there may be participants that were also in your group in an earlier period.

3. In the other group there may be participants that were in your group in an earlier period.

Correct answer: 3. If the question was answered correctly, the participant was given the option of going back to the corresponding part of the instructions or moving on to question 2. If it was answered incorrectly, the options were to go back in the instructions or try again.

Questions 2-7 tested understanding of the payoff table. They were all of the form "If your group chooses A(B) and the other group chooses A (B) at stage 1 (2), how much will you (someone in your group/someone in the other group) earn?"

Group types

The way in which the group decision is determined depends on the GROUP TYPE of the group you are in, in each period. There are two group types: GROUP TYPE I and GROUP TYPE II.

Of the two groups that are paired in each period one is always group type I and the other group type II. Whether your group is type I or type II in any specific period is determined randomly. It is therefore likely that you will participate in a group type I in some periods and in a group type II in other periods.

NB. By pressing 'T', you will return to the text before the questions. To get back here, you would have to answer the questions again.

Group type I

Group type I makes the group decision by majority vote. Each participant must make a choice between A and B privately and without consulting the others. If the majority (which means 2 or 3 members of the group) chooses A, the group decision is A. If the majority chooses B, the group decision is B. At a possible stage 2 the decision is made by majority vote as well.

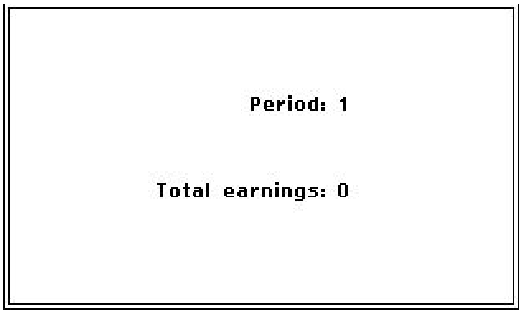
Group type II

In group type II one participant is appointed to make the group decision. Which group member decides for the group is determined after every member has independently made a decision at stage 1. One of the decisions of the three participants will be randomly chosen to be the group decision.

Every participant in the group will then get a message on the screen stating whether their own decision or that of some other group member has determined the group decision.

If stage 2 is reached, only the participant who determined the group decision at stage 1 will make a new choice. This will determine the group decision at stage 2.

Information



Period: 1

Total earnings: 0

What information is made public depends on the group type. How the information will appear on your screen is described below.

For group type I the exact outcome of the individual decisions and the group decision are announced.

For group type II only the group decision in a period is announced.

Question

Before we continue, you must answer another question.

Which of the following statements is CORRECT?

1. You are in the same group type in every period today.
2. In group type I you do not know how many people voted for A.
3. If you are in group type II you sometimes do not need to make a decision at stage 1.
4. If you are in group type II you sometimes do not need to make a decision at stage 2.

Correct answer: 4. If the question was answered correctly, the participant was given the option of going back to the corresponding part of the instructions or moving on. If it was answered incorrectly, the options were to go back to the previous instructions or try again.

Your screen

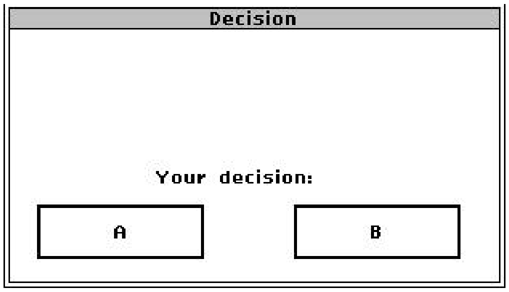
We shall now show parts of the computer screen as they will appear later.

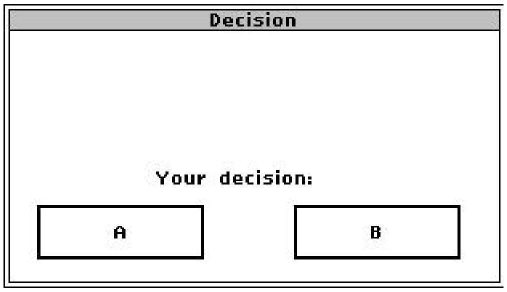
Period: 1

Total earnings: 0

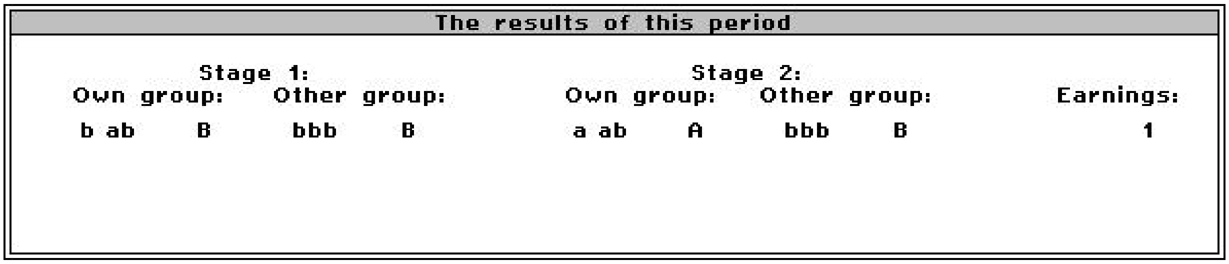
At the top left you see a window with information about the period and your earnings.

Decisions window





At the top right a window will appear where you can make your decision, or a window announcing that you do not need to make a decision. The window you see now is just an illustrattion. You cannot give us a decision now. After you have made a decision you will be asked to confirm it.



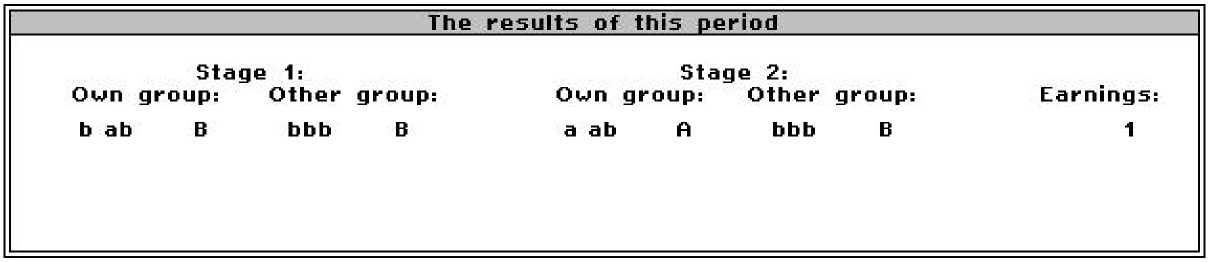
```
                         The results of this period

          Stage 1:                          Stage 2:
 Own group:    Other group:        Own group:    Other group:        Earnings:

  b ab     B      bbb     B          a ab     A      bbb     B              1
```

Results window

At the bottom of your screen you will see a window with information about the results in some period. What you will see depends on the group type. For group type I, first the decision of each participant in your group is presented. The other participants are presented in black, your decision is in red. The group decision (decided by majority vote) is presented in capitals.



```
                         The results of this period

          Stage 1:                          Stage 2:
 Own group:    Other group:        Own group:    Other group:        Earnings:

  b ab     B      bbb     B          a ab     A      bbb     B              1
```

Results window

For group type II only your own decision (red) and the decision of your group (capitals) are presented. If you are not the one making the group decision at stage 2, only the group decision is presented.

Group type II

For group type II the participant making the group decision is announced. This is done after everyone has made a decision at stage 1 and before the outcome is made public. You will receive a message at the bottom of your screen.

End

This brings you to the end of the instructions. You can still page back, if you like. When you are finished, you have to let us know by pressing ‘k’ (finished). When everyone is finished, we shall start the experiment.

Appendix B

This appendix provides a game-theoretic analysis of the two-stage Chicken game. We start with an analysis of the two-person game. We denote the payoffs at stages 1 and 2 as follows

Stage 1

player 2

		A	**B**
player 1	**A**	a+c a+c	r+c b+c
	B	b+c r+c	go to stage 2

Stage 2

player 2

		A	**B**
player 1	**A**	a a	r b
	B	b r	0 0

with $r > a \geq b > 0$, $c>0$. We further assume that $r > b+c$: it is better to be ‘tough’ at stage 2 than ‘chicken’ at stage 1. In our experiments, we chose a=2, b=1, r=5, c=1. This implies that a move to stage 2 always involves an efficiency loss. The equilibria for the subgame at stage 2 can be derived straightforwardly. There are two pure strategy equilibria, (A,B) and (B,A). The only mixed strategy equilibrium is symmetric and involves each player chosing A with probability $p^* \equiv \dfrac{b}{b+(r-a)}$ (note that $0 < p^* < 1$). This yields an expected stage 2 payoff of $y^* \equiv \dfrac{rb}{b+(r-a)}$. For our experiments, we have $y^*=1.25$.

Denote the probability that player 1 (2) chooses option A in stage 1 by p^1 (q^1) and the probability that player 1 (2) chooses A in stage 2 (if it is reached) by p^2 (q^2). A strategy for the two-stage game is given by a pair $\underline{p} = (p^1,p^2)$ ($\underline{q} = (q^1,q^2)$). A subgame perfect Nash equilibrium is a pair $(\underline{p},\underline{q})$ that constitutes a Nash equilibrium for the game, such that (p^2,q^2) is an equilibrium at stage 2 of the game.

In order to determine the subgame perfect Nash equilibria of the two-stage game, we add the stage 2 equilibrium payoffs to the payoff matrix of the first-stage game. For the equilibria (A,B), (B,A), (p^*,p^*) this gives, respectively:

player 2

		A	**B**
player 1	**A**	a+c a+c	r+c b+c
	B	b+c r+c	r b

player 2

		A	**B**
player 1	**A**	a+c a+c	r+c b+c
	B	b+c r+c	b r

player 2

		A	**B**
player 1	**A**	a+c a+c	r+c b+c
	B	b+c r+c	y* y*

In the first table, there is a pure strategy Nash equilibrium (A,B) at stage 1. This yields the subgame perfect equilibrium (p,q) = ((1,1) , (0,0)) for the two-stage game. Notice that for this stage 1 game, B is a dominant strategy for player 2, so there is no equilibrium involving a mixed strategy at stage 1. Similarly, the only subgame perfect Nash equilibrium following from the second table is (p,q) = ((0,0) , (1,1)). Here, player 1 plays B and player 2 plays A.

Now, consider the third table. In this case, the equilibria depend on the parameters chosen. If $y^* \geq b+c$, it is a (weakly) dominant strategy to choose B in stage 1, and the subgame perfect Nash equilibrium is (p,q) = ((0,p*) , (0,p*)). If $y^* < b+c$ (as in our experiments), then there are three equilibria. The first two are trivial: they involve pure strategy equilibria that do not take the game into stage 2: (p,q) = ((1,p*) , (0,p*)) and (p,q) = ((0,p*) , (1,p*)). The third involves a mixed strategy in stage 1, where A is chosen with probability $p^{1*} \equiv \dfrac{b+c-y^*}{(r-a)+(b+c-y^*)}$. Note that $0 < p^{1*} < 1$. For the parameters in our experiment, this yields $p^{1*} = 0.2$. This gives the equilibrium (p,q) = ((p^{1*},p*) , (p^{1*},p*)).

Summarizing, we have (in terms of (p, q)) the following subgame perfect equilibria for our parameters:

Type	p	q	(expected) payoffs
Pure strategy	(1,1)	(0,0)	(2,6)
Pure strategy	(0,0)	(1,1)	(6,2)
Mixed strategy	(1,0.25)	(0,0.25)	(2,6)
Mixed strategy	(0,0.25)	(1,0.25)	(6,2)
Mixed strategy	(0.2,0.25)	(0.2,0.25)	(2.25,2.25)

The above holds for the 2-person game. Now consider the team game where independent individual choices determine the team choice. This constitutes a 6-person game. Whereas the equilibrium for the team as a whole is independent of the social choice rule, the equilibria of the 6-person game do depend on it.

Start with the dic teams. In this case, players are only interested in the situations where they are the dictator, because expected payoff is only affected by an individual's decision if (s)he is decisive. In such a case, the team strategy is identical to the individual strategy. For example, if a decisive individual chooses A with probability p, the team choice is A with probability p as well. In other words, given that the other team is following an equilibrium strategy, choosing the corresponding equilibrium strategy weakly dominates any other strategy an individual in a dic team could follow.

Finally, consider an individual in a dem team. In case (s)he wants the team to follow pure strategy A (B), (s)he should vote for A (B). There is no way that (s)he can increase the probability of the team choosing an option by voting for the other option. Difficulties arise when the individual wants the group to follow a mixed strategy. Note that individuals do not vote for a team *strategy* but for a team *choice*. An individual can, however, individually mix between voting for A or B. Consider the case where each individual in a team wants the team to choose A with probability p, $0<p<1$. If they each choose A with probability p, the team will choose A with probability $p^3 + 3*p^2*(1-p)$, which is larger (smaller) than p for $p > (<) 0.5$. In the symmetric case, an individual mixed strategy that gives the team a probability p of choosing A is the x that solves $x^3 + 3*x^2*(1-x) = p$.

Now assume that individuals in team I make choices that imply that their team is choosing the strategy (0.2, 0.25). It follows that any individual strategies in team II that yield different group probabilities than (0.2, 0.25) are out of equilibrium. If each individual plays the mixed strategy (0.2,0.25) this yields group probabilities (0.104, 0.156). Hence, this is not an equilibrium. A mixed strategy equilibrium involves strategies yielding (0.2, 0.25) as the group probabilities. The only symmetric mixed strategy equilibrium with this characteristic is (0.287, 0.323).[11] Therefore, the symmetric mixed strategy subgame perfect Nash equilibrium implies a higher *individual* probability of choosing A (in both stage 1 and stage 2) in case of a dem team than in case of a dic team. The *team* equilibrium probabilities of choosing A are the same across social choice rules, however.

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[11] There are also asymmetric equilibria. An obvious one is for one player in a team to play the pure strategy A, another the pure strategy B and the third the mixed strategy (0.2, 0.25).