THE EFFECTS OF STRATEGY AND REWARD STRUCTURE ON THE DEVELOPMENT OF COOPERATION

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37

TABLE OF CONTENTS

Abstract i

Introduction 1

Method 6

Results 9

Discussion 13

Tables 18

Figures 22

Bibliography 30

ABSTRACT

The way in which Prisoner's Dilemma type games are presented to players has been shown to have an effect on how they play. In addition, differences in programmed strategies have been shown to affect the game-playing behavior of subjects. The present study compares the effects of different ways of presenting the game reward structure to the subjects, as well as the effects that the different strategies of an opponent have on the subject's game-playing behavior.

The following games were compared: A basic two-person Prisoner's Dilemma Game, a two-group Prisoner's Dilemma Game, a three-person Prisoner's Dilemma Game, and three two-person Decomposed Prisoner Dilemmas Games. Within each game the effects of three programmed strategies were compared: Unconditional Benevolence, Conditional Benevolence, and Unconditional Malevolence.

The behavior exhibited in the two-person, two-group, and three person Prisoner's Dilemma Games did not differ. The three two-person Decomposed Prisoner's Dilemmas games all differed from the basic two-person Prisoner's Dilemma Game in terms of the cooperative behavior exhibited by the subjects. An examination of the effects of the different strategies indicates that subjects are most likely to make cooperative choices if exposed to a "Conditionally Benevolent" other. They are least likely to cooperate if exposed to an "Unconditionally Malevolent" other. "Unconditional Benevolence" leads to exploitation on the part of the subjects in most of the games except where the structure of the game predisposes the subject to start off by making cooperative

choices. In this case, the "Unconditionally Benevolent" strategy rewards and strengthens early cooperative choices. These results are interpreted in terms of the information that the subject receives from the strategy of the other player. It is suggested that the subject receives the most information from the Conditionally Benevolent strategy, since this strategy rewards him for cooperative choices and punishes him for non-cooperation, or competitive choices.

INTRODUCTION

This experiment is part of a program of studies concerning techniques of inducing cooperation between adversaries in experimental laboratory games. Prior research has indicated that two variables which affect cooperation are the reward structure of the experimental game and the strategy employed against a player.

"Reward structure" refers to the number of alternative courses of action available to each party and the value associated with each alternative for every party. The importance of reward structure as an antecedent to cooperation is acknowledged in all applications of Game Theory to social behavior and in the recent theorizing of Thibaut and Kelley (1959) and Homans (1961).

Prior research on the question of strategy has shown that when a bargainer employs noncontingent cooperative strategy, he will be exploited by an individualistically or competitively oriented other (Deutsch, 1958, 1960, 1962; Solomon, 1960; Bixenstine and Wilson, 1963; Shure, Meeker, and Hansford, 1965).

The experimental game of concern in this study is the Prisoner's Dilemma Game (PDG) and some of its variations. In a typical study employing the PDG (see Rapoport and Orwant, 1962; Rapoport, Chammah and Orwant, 1964; Gallo and McClintock, 1965). two Ss are given a matrix such as those illustrated in Figure 1 and instructed to make a series of plays. Figure 1: Example of the Prisoner's Dilemma Game.

Insert Figure 1 about Here

On each play, player X chooses between the two rows, and player Y between the two columns. After each play, the players receive the amount of money (chips, points, etc.) shown in the cell of the matrix defined by their choices. The first number in each cell refers to the payoff for the row player; the second, to the payoff for the column player.

As can be seen in Figure 1, on a single play of the PDG, a choice of alternative C (the "cooperative" alternative) in preference to alternative D (the "noncooperative" alternative) improves the other player's payoff while reducing one's own, regardless of what the other player does. Therefore, short-term rationality dictates a choice of D. The "dilemma" posed by the game results from the fact that short-term rationality on the part of both players will land them in the DD cell, and the payoffs in the DD cell are lower than those in the CC cell.

The findings concerning the effect of reward structure on the frequency with which the cooperative alternative is chosen have been summarized by Rapoport, Chammah and Orwant (1964). The frequency of cooperative choices

(1) increases with payoff for mutual cooperation (entries in the CC cell),

(2) decreases with the payoff for choosing noncooperatively while the other player chooses cooperatively (the larger entries in the CD and DC cells), and

(3) decreases with the payoff for mutual noncooperation (the entries in the DD cell).

Pruitt (1965) has raised serious doubts about the generality of the PDG reward structure as it applies to real life situations. He suggests that one questionable feature of the PDG is the association of payoffs with joint action. This situation is sometimes found in real life, but more often value is associated with individual action. A person may choose his actions in the light of what the other person has done or may do, but he will, nevertheless, regard his own actions and those of the other player as having intrinsic value apart from the way they are combined.

To correct for this deficiency in the PDG without altering its basic features, Pruitt suggests a Decomposed Prisoner's Dilemma Game (DPDG). In the DPDG both players are given the same outcome schedule; however, their payoffs are associated with individual instead of joint outcomes. But these DPDGs retain the basic features of the PDG in the sense that the payoffs of the PDG can be reconstructed from the payoffs to the players in the DPDG by computing the value to each player of every possible pair of moves. Figure 2 illustrates the PDG and DPDG that Pruitt used.

Insert Figure 2 about here

Pruitt found that two of the DPDGs (games b and c) produced more cooperation than the PDG, and that game (a) produced less cooperation. Cooperation fell off fairly rapidly in game (a). It rose precipitously and remained uniformly high over most trials in game (b). It rose more slowly to the same level, in game (c). Pruitt postulates two processes which might account for these results. One process attributes the differences between games to differences in <u>reaction</u> to the other player's actions. The other process attributes differences in level of cooperation to differing goals that develop during the game.

Solomon (1960, 1965) studied the effects of three different behavioral strategies on the part of a stooge on the subject's behavior in a PDG. He used the following strategies:

(1) an Unconditionally Benevolent strategy which required the stooge to choose cooperatively no matter what the naive subject did;

(2) a Conditionally Benevolent strategy which required the stooge to match the subject's behavior; and

(3) an Unconditionally Malevolent strategy which required the stooge to make a competitive choice no matter what the subject did.

Solomon's results indicated that the Conditionally Benevolent strategy produced most cooperation and most favorable attitudes toward the stooge, while neither the Unconditionally Benevolent nor Unconditionally Malevolent strategy induced much cooperation.

Recently Deutsch et al (1967) used an extended form of the Allocation Game to study the effects of a number of different behavioral strategies. They found that the strategy which elicited the most cooperation on the part of the subject was one in which a stooge adopted a non-punitive strategy rather than a punitive or altruistic strategy in response to non-cooperation from the subject. Deutsch suggested that a strategy which does not reciprocate hostility and which, also, does not allow it to be rewarding is most effective in eliciting cooperative behavior.

Purpose of the Present Study

The strategy of another player is clearly an important determinant of one's own behavior. The present study was designed to find out to what extent two aspects of reward structure, structural (two-person versus two-group versus three-person) and informational (PDG versus DPDG) variables depend for their effect on the nature of the other's strategy. Does the number of players playing the game have an effect on behavior despite the strategy? As the number of decision makers increases, does cooperation increase or decrease despite the strategy? Do different decomposed matrices affect play differentially, no matter what strategy each party develops? Is there a strategy that always produces cooperation, no matter how the information about the game is presented to the players?

To investigate these questions, extreme variations of both the structural and informational aspects of reward structure were used, as well as extreme strategies.

The structural variations of the PDG used were the following:

(1) a three-person PDG (Game I) in which the utilities of the payoff matrix were equivalent to a control two-person PDG (Game II);

(2) a two-group PDG (Game VI) in which the payoff matrix was the same as the control two-person PDG (Game II), but the "player" consisted of a group of three individuals who had to come to a decision about which alternative would be chosen on every trial, and who were faced with a similarly constituted group.

Figure 3 illustrates the payoff matrix for each of these games.

Insert Figure 3 about here

The informational variations of the PDG used were three decomposed matrices which could be reconstructed to form the control two-person PDG (Game II) from which they were generated. Figure 4 illustrates the payoff matrices for each of these games as they were presented to the subjects.

Insert Figure 4 about here

The programmed strategies used were the following:

(1) Unconditional Benevolence (UB) - in which the program only included cooperative responses regardless of the subject's responses.

(2) Conditional Benevolence (CB) - in which the program began with a cooperative response for the first trial regardless of the subject's response. Thereafter the program followed the subject's response. That is, if the subject responded non-cooperatively, on the next trial the program would respond non-cooperatively.

(3) Unconditional Malevolence (UM) - in which the program only included noncooperative responses regardless of the subject's responses.

In addition, subjects actually played with each other for 30 trials in a control treatment termed Natural (N). This N treatment was included to see how the subjects behave in each of the games when they were playing with a real Other.

METHOD

Subjects and Design.

One hundred and ninety-two Ss were recruited from Teachers College, Columbia University, and Actor's Equity in New York City. They were told that they could earn up to $4.00 by participating in a decision-making experiment. The Ss ranged in age from 18 to 55. Both men and women were recruited and used randomly throughout the design. Twenty-four Ss were assigned at random to Games I, II, III, IV and V. In Game VI (two-group PDG) 72 individuals were randomly assigned to 24 groups composed of three members each. Ss played for 120 trials which included 30 trials of each strategy and 30 trials in which they were actually playing another subject. Strategies were arranged in four different orders: UB, CB, UM, N; N, UB, CB, UM; UM, N, UB, CB; and CB, UM, N, UB. Within each game subjects were assigned at random to a strategy order.

Procedure and Instructions.

Ss were run three at a time in Game I; two at a time in Games II, III, IV, and V; and six at a time in Game VI (that is, two groups of three Ss each were run two at a time). Each S was brought into an experimental room and seated at a table. A response box with a three-position switch was located on the table. Although some Ss became aware of the presence of other Ss before the experiment, they were never allowed to interact with these other Ss and were told this fact in the instructions. At no time during or after the experiment were the Ss able to see any other participant, except in Game VI, in which

Ss saw the two other members of their own group, but were not able to see the members of any other group. Ss were given mimeographed copies of the instructions to read.

The experiment consisted of 120 trials, broken up into four series of 30 trials each. Ss were told that they were going to be participating with a different person on every 30 trials and that, although they would not have to leave the experimental cubicle, they would have to wait a few minutes between every series of thirty trials while the experimenter reconnected their response box with a different player. Actually, Ss played against a programmed strategy for 90 trials and against each other for only 30 trials out of the 120 trials.

Trial numbers were announced by the experimenter into an overhead speaker in the S's cubicle. Ss recorded their choices for each trial, what they expected the other participant to choose, and what they thought the other participant expected them to choose. They were then told to push the three-position switch on the response box either to the left or right indicating their choice of red or green, and to leave their switch in that position until the experimenter told them what the other had chosen and what their score was for that trial. Their responses lit up appropriate lights on a master control panel in the experimental control room so that the experimenter was able to see and record their choices as well as give them correct feedback. Ss then recorded their score, returned the switch to neutral and waited for the next trial to be announced. In the decomposed matrix games, Ss were told what their gains and the other person's gains had been for their choice. Then they were told what the other person had chosen and their score for that trial. In Game VI the 3 members of each group had to come to a group decision as to what their choice was going to be on every trial. They were given a time limit of a minute to do this.

Ss were given a $1.00 stake to start with, and their payoffs were in pennies. The Ss' scores were announced to them on each trial, but they were not given the money they had earned until the end of all 120 trials. Ss were told that they could keep whatever they earned, and that they would not have to pay the experimenter if they lost more than the $1.00. (In fact, Ss were always paid at least $1.00 even if they lost all of the $1.00 they started with.) Although it would have been possible for a subject to make up to $9.00, most subjects averaged about $2.50.

The instructions described the situation as an experiment in decision making. An individualistic orientation (Deutsch, 1958) was instilled by telling them that their objective should be "to make as much money as you can." To avoid unwarranted assumptions about the kind of behavior that was expected, they were also told, "You can pursue this objective in any way that you choose. We don't care how you go about it. It's your money" (Pruitt, 1965). At no point during the game or in the instructions were terms used that might introduce a cooperative or competitive set such as "game," "play," "prize," "oppo-ent," or "partner." The other member of the pair was always referred to as "the other participant."

To be sure the subjects understood the payoff matrix, they were given a practice sheet asking them to indicate what would happen in each of the choice combinations. Play did not begin until the experimenter was sure the subject understood the payoff contingencies.

RESULTS

The four treatment orders of strategies were designed to avoid any one treatment order effect, or the effect of one strategy on the remaining trials of play. Ss were told that they would be playing each series of thirty trials with a new and different person, as it was thought that there would be no effect of one strategy on the other strategies. However, preliminary examination of the data indicated that there was significant order effects, and that any strategy that followed UM was severely affected by that strategy. S choices during the thirty trials when they were playing each other were not independent, and therefore could not be analyzed as if they were; and it could be argued that trials following the N strategy were also not independent.

To avoid these problems and to be able to examine the pure game and pure strategy effects, only the first 30 trials of the 120 trials of any game were examined, and only the three programmed strategies were included in any analysis. The results that follow were thus based on a strategy by game factorial design. The N for any cell was reduced to 6 because for each strategy only the individuals who were exposed to the strategy during the first 30 trials of the game could be included in the analyses.

Summary results are presented in Tables I - IV and Figures 5 and 6.

Insert Tables I - IV and Figures 5 and 6

Comparison of the Three-Person and Two-Person PDG

In a separate analysis of variance performed on just Games I and II, no significant differences were found between the results of the two games.

Comparison of Groups versus Individual PDG

A comparison of Games II and VI enables one to see whether it makes any difference if the decision -making unit is a group or an individual. The data indicate that the frequency of non-cooperative choices and the tendency to exploit (i.e., to choose noncooperatively when expecting the other to cooperate) is somewhat greater for the groups than for the individuals. These differences, however, are not significant.

The Effects of the Decomposed Matrix

There is a significant interaction effect between type of game matrix, strategy, and Trial Blocks (Tables I and II). The matrix in Game V seems to be particularly effective in eliciting cooperation if an "Unconditionally Benevolent" strategy is employed (number of cooperative choices greater in Game V than in any of the other games, significant at $p < .05$, Neuman-Keuls).

On the other hand, Games III and IV are least likely to elicit cooperation under such a strategy. Under "Conditional Malevolence" and when subjects are playing each other, the games differed little in the type of behavior they elicited. (See Figure for these results.)

The Effects of the Different Strategies

Statistical analyses indicate that there are significant effects of strategy ($p < .01$) on the number of cooperative choices made; however, the effects of the strategy interact with the "type of game" (Table I) and with "trial blocks" (Table II). Table III gives the means for the game by strategy combinations. Table IV consists of the means for game by strategy combinations broken into trial blocks. Figures 5 and 6 are the plotted means for number of cooperative choices by game and by strategy, as well as exploitation ratio and a defense ratio. The strategy of the other also has significant effects ($p < .001$) on the cooperation expectation of what the other will do. That is, that from "Unconditional Benevolence" to "Conditional Benevolence" and, finally, to "Unconditional Malevolence," the expectation of cooperation on the part of the other went down. However, cooperative expectation does not differ between games.

The results indicate that the subjects are most likely to make cooperative choices if exposed to Conditional Benevolence. Only subjects in Game V make significantly more cooperative choices in "Unconditional Benevolence" ($p < .05$, Neuman-Keuls).

The subjects exposed to the playing of other real subjects make more cooperative choices than those exposed to "Unconditional Benevolence" except in Games II and V. Across games Ss exposed to the playing of other real subjects do not differ significantly from subjects in the "Conditional Benevolence" strategy. Decreases in the frequency of cooperative choice occur consistently in all games under "Unconditional Malevolence," but the size of the decrease is not the same for all games. An analysis of variance of the difference in number of cooperative choice from first trial block to last trial block reveals a significant effect for strategy ($p < .005$) and for game $p < .01$), but the game effect is accounted for solely by the increase in number of cooperative choices for the last trial block as compared to the first trial block in Game V in the "Unconditional Benevolent" strategy; and the increase in the number of cooperative choices for the last trial block as compared to the first trial block in Games II and V in the "Conditional Benevolent" strategy.

An exploitation ratio, which consisted of the proportion of times a subject chose competitively when he expected a cooperative response from the other over the total number of cooperative expectations, was computed. An analysis of variance of this exploitation ratio reveals that strategy has a significant effect ($p < .05$) on this ratio. In Games (I, II, III, IV, and VI) subjects exploited most under "Unconditional Benevolence," and least under "Conditional Benevolence." The game effect also approaches significance ($p < .10$), but can be explained by the results of Game V in which the Ss exploited the most in "Conditional Benevolence" and the least in "Unconditional Benevolence." This finding is exactly the reverse of what is true for the other games. These results are shown in Figure 5.

A defense ratio, which consisted of the proportion of times a subject chose competitively when he expected a competitive response from the other over the total number of competitive expectations, was computed. An analysis of variance of this defense ratio reveals that there is a significant strategy effect ($p < .01$) and a game effect ($p < .05$). Across games, subjects increased their competitive choices when they had competitive expectations of the other, from "Unconditional Benevolence" to "Conditional Benevolence" to "Unconditional Malevolence." The game effect is explained by the fact that Games IV and V were always lower in defense ratio than the rest of the games. There were no significant individual differences between games within strategies, but within Game VI the "Unconditional Malevolence" strategy was significantly different from either the "Unconditional Benevolence" or "Conditional Benevolence" strategies ($p < .05$, Neuman-Keuls). These results are shown in Figure 5.

DISCUSSION

It is evident from the data that the form of presentation of a given matrix may affect game-playing behavior, but the effects will be altered by the strategy employed by the other player. The fact that Games I and II did not differ from each other is somewhat surprising since it is much more difficult for three subjects to end up in the cooperation cell than it is for two subjects to end up in the cooperative cell. It may be that subjects in Game I took this difficulty into account and decided to cooperate. A more reasonable explanation is that the strategies were powerful enough to overcome whatever the game effects might be and in this way erased the differences between these two games.

Wallach et al (1962) found that individuals are more willing to take risks in groups than they are as individuals. The results of Game I do not indicate this if risk-taking behavior is defined as making a cooperative choice. However, it might be argued that making a non-cooperative or exploitative choice could be viewed as risky. The trend in Game VI was in this direction. That is, subjects tended to be exploitative rather than cooperative. The fact that this trend was not significant may be due to the very powerful strategy effects.

"Unconditional Benevolence" as a strategy reinforces any choice which the subject chooses to start out with, so one would expect large differences in the behavior exhibited. This is attested to by the fact that the within cell variance in the number of cooperative choices in this strategy was large in all of the games except Game V. In Game II the range of cooperative choices went from 1 to 30 and yielded a range of 0 to 11. Game IV yielded a range of 3-16, Game V yielded a range of 17 to 30 (actual number of cooperative choices was: 17, 21, 29, 30, 30, 30), and Game VI yielded a range of 2 to 29. Put another way, because "Unconditional Benevolence" rewards any choice the subject makes, it does not give the subject enough information on which to base a change of behavior, nor for that matter any reason to change his behavior.

Conditional Benevolence rewards only one strategy --

cooperation. What is more, the strategy not only rewards subjects for cooperative choices, it also punishes them for any competitive choice they make. As a strategy, it is the most sensitive to changes in the subject's behavior. When one examines the within cell responses for all games in Conditional Benevolence, one sees a much smaller range of response:

Game II:	1 - 30	(actual numbers	1, 19, 25, 27, 28, 30)
Game III:	3 - 14	(" "	3, 8, 9, 13, 13, 14)
Game IV:	6 - 30	(" "	6, 7, 13, 13, 14, 18)
Game V:	11 - 18	(" "	11, 12, 13, 13, 14, 18)
Game VI:	5 - 25	(" "	5, 17, 21, 22, 24, 25)

In "Unconditional Malevolence" the strategy rewards (relatively) only one choice and that is the non-cooperative choice; therefore, there are very few differences between games in this strategy.

One puzzling result in the data is the non-conformity of Game V to the overall results for the other games. What makes the decomposed matrix of Game V so different? A closer look at the matrices (Figure 3) may yield an explanation for this.

It is true that if the subject took the time he could see that in the case of all matrices, if he chose Green he either made 10¢ or lost 20¢; and if he chose Red, he either made 20¢ or lost 10¢. In his research Pruitt (1965) did not re-construct the matrix for his subjects. To some extent it could be argued that this was done for the subjects, since a practice sheet was given to the subject and he had to work out the choice contingencies before he could start playing the game. This might wash out the effect of the decomposed matrices. Our results, however, show that this did not happen.

There is another way the subject could look at the decomposed payoff matrix. He could look at the difference between what he seemed to gain and what the other seemed to gain for each of his choices independently of what the other's choice happened to be. In Game III the difference between his gain and the other's gain for his choice of Green is 10¢; the difference when his choice is Red is 30¢. In Game IV, the difference between their gains for a choice of Green is 30¢, and for a choice of Red is 10¢. In Game V the difference for a Green choice is 10¢, but the difference for a Red choice is 50¢ (from +20 to -30).

In addition, in both Games III and IV it might appear to the subject that in choosing Green he stands to make either 0¢ or lose 10¢. Furthermore, a choice of Red in both of these games does not seem to be punishing the other subject very much. In one case he loses 20¢ while the subject makes 10¢, and in the other case he loses 10¢ while the subject makes 0¢. It is only in Game V that the subject actively stands to gain anything from his own choice of Green, 10¢; and if he chooses Red, he is giving himself 20¢, but penalizing the other player 30¢. By choosing Red he is thus widening the gap between his payoff and that of the other subject by 50¢. It is only in Game V that the deliberate choice of Red on the part of the subject might be interpreted as conveying: "Look, I'm being greedy, instead of taking 10¢ and giving you 0¢, I'm taking 20¢ and penalizing you 30¢." Subjects probably did not want to take this apparent position of extreme greed. The matrix, therefore, may have pushed them in the direction of making cooperative choices initially. In the "Unconditionally Benevolent" and "Conditionally Benevolent" strategies this initial tendency to make a cooperative choice would have been reinforced. However, if the S yielded to the temptation to choose Red, in the "Conditionally Benevolent" strategy the S might learn from the other person's response of Red that greed was socially permissible -- the other person behaved similarly. On the other hand, the other's continued cooperative behavior in the "Unconditionally Benevolent" strategy might suggest that a choice of Red was too deviant t be socially appropriate. Unfortunately, we have no data to support this post hoc interpretation of the results in Game V.

Table I

TWO-WAY ANALYSIS OF VARIANCE FOR NUMBER OF COOPERATIVE CHOICES

[GAME (II, III, IV, V, VI) BY STRATEGY (UB, CB, UM)]

Summary

Source	DF	SS	MS	F
A (strategy)	2	1057.0	528.5	8.98*
B (game)	4	806.1	201.5	3.42**
AB	8	1512.7	189.08	3.21*
Error	75	4415.4	58.87	
TOTAL:	89	7791.2	87.5	

*p <.01

**p <.02

Table II

THREE-WAY ANALYSIS OF VARIANCE FOR NUMBER OF COOPERATIVE CHOICES

[GAME (II, III, IV, V, VI) BY STRATEGY (UB, CB, UM)]

Summary

Source	DF	SS	MS	F
Between S	89	1298.52		
A (strategy)	2	176.16	88.08	8.97*
B (game)	4	134.34	33.58	3.42*
AB	8	252.13	31.52	3.21*
Error (between)	75	735.89	9.81	
Within	450	539.67		
C (trials)	5	167.7	33.54	34.93***
AC	10	52.86	5.29	5.51**
BC	20	43.86	2.14	2.28*
ABC	40	63.07	1.58	1.65*
Error	375	363.11	.96	

*$p < .01$

**$p < .005$

***$p < .001$

Table III

MEAN NUMBER OF COOPERATIVE CHOICES

	Game					
Strategy	I	II	III	IV	V	VI
UB	16.0	17.16	5.67	8.50	26.16	10.33
CB	17.8	21.66	10.0	17.12	13.50	19.00
UM	9.6	8.00	9.50	10.00	9.50	3.16
N	9.67	11.83	10.33	14.67	11.33	12.33

Table IV

MEAN NUMBER OF COOPERATIVE CHOICES BY TRIAL BLOCK

		Game				
Strategy	Trial Block	II	III	IV	V	VI
UB	1	2.83	1.5	2.67	3.67	3.00
	2	3.00	1.17	2.33	4.17	1.83
	3	2.67	.00	1.17	4.17	1.50
	4	2.83	.67	.67	4.50	1.50
	5	2.83	1.17	.67	5.00	1.50
	6	3.00	1.17	1.00	4.67	1.00
CB	1	2.33	1.83	2.67	1.33	2.17
	2	3.67	2.17	3.50	3.00	2.83
	3	3.33	2.17	3.33	1.83	3.50
	4	4.17	1.33	3.17	1.83	3.33
	5	4.17	.83	2.00	2.50	4.00
	6	4.00	1.67	2.50	3.00	3.17
UM	1	2.17	2.33	2.17	2.67	1.87
	2	2.33	1.50	1.83	1.67	.33
	3	.50	1.50	2.00	1.17	.83
	4	1.17	1.33	2.33	1.67	.00
	5	1.50	1.67	.67	.83	.17
	6	.33	1.17	1.00	1.50	.00

Figure 1

EXAMPLE OF THE PRISONER'S DILEMMA GAME

		Y: C	Y: D
X	C	+10, +10	20, +20
	D	+20, -20	-10, -10

Figure 2

DECOMPOSED PRISONER'S DILEMMA GAMES (a, b, c) AND

THEIR PARENT PRISONER'S DILEMMA GAME (d)*

a

	Your Gains	Other's Gains
C	6	6
D	12	-6

b

	Your Gains	Other's Gains
C	0	12
D	6	0

c

	Your Gains	Other's Gains
C	-6	18
D	0	6

d

	C	D
C	12, 12	0, 18
D	18, 0	6, 6

*In the decomposed games, both players utilize the same payoff schedule.

Figure 3

PRISONER DILEMMA GAME VARIATIONS

Game I: Three-Person Prisoner's Dilemma Game

Person			Payoff to		
A	B	C	A	B	C
* G	G	G	+10	+10	+10
G	G	R	- 5	- 5	+20
G	R	G	- 5	- 5	- 5
G	R	R	-20	+ 5	+ 5
R	G	G	+20	- 5	- 5
R	G	R	+ 5	-20	+ 5
R	R	G	+ 5	+ 5	-20
R	R	R	-10	-10	-10

Games II and VI: Two-Person and Two-Group Prisoner's Dilemma Game

** Person		Payoff to	
A	B	A	B
G	G	+10	+10
C	R	-20	+20
R	G	+20	-20
R	R	-10	-10

*G = green; R = red.
**Group.

Figure 4

THREE DECOMPOSED PRISONER'S DILEMMA GAME MATRICES (Games III, IV, V)

AND THEIR PARENT PRISONER'S DILEMMA GAME MATRIX (II)

Game II

		G	R
A	G*	+10, +10	-20, +20
	R	+20, -20	-10, -10

Game III

My Choice	My Gain	Other's Gain
G	0	+10
R	+10	-20

Game IV

My Choice	My Gain	Other's Gain
G	-10	+20
R	0	-10

Figure 4 (Con't)

Game V

My Choice	My Gain	Other's Gain
G	+10	0
R	+20	-30

*G = green; R = red.

Figure 5

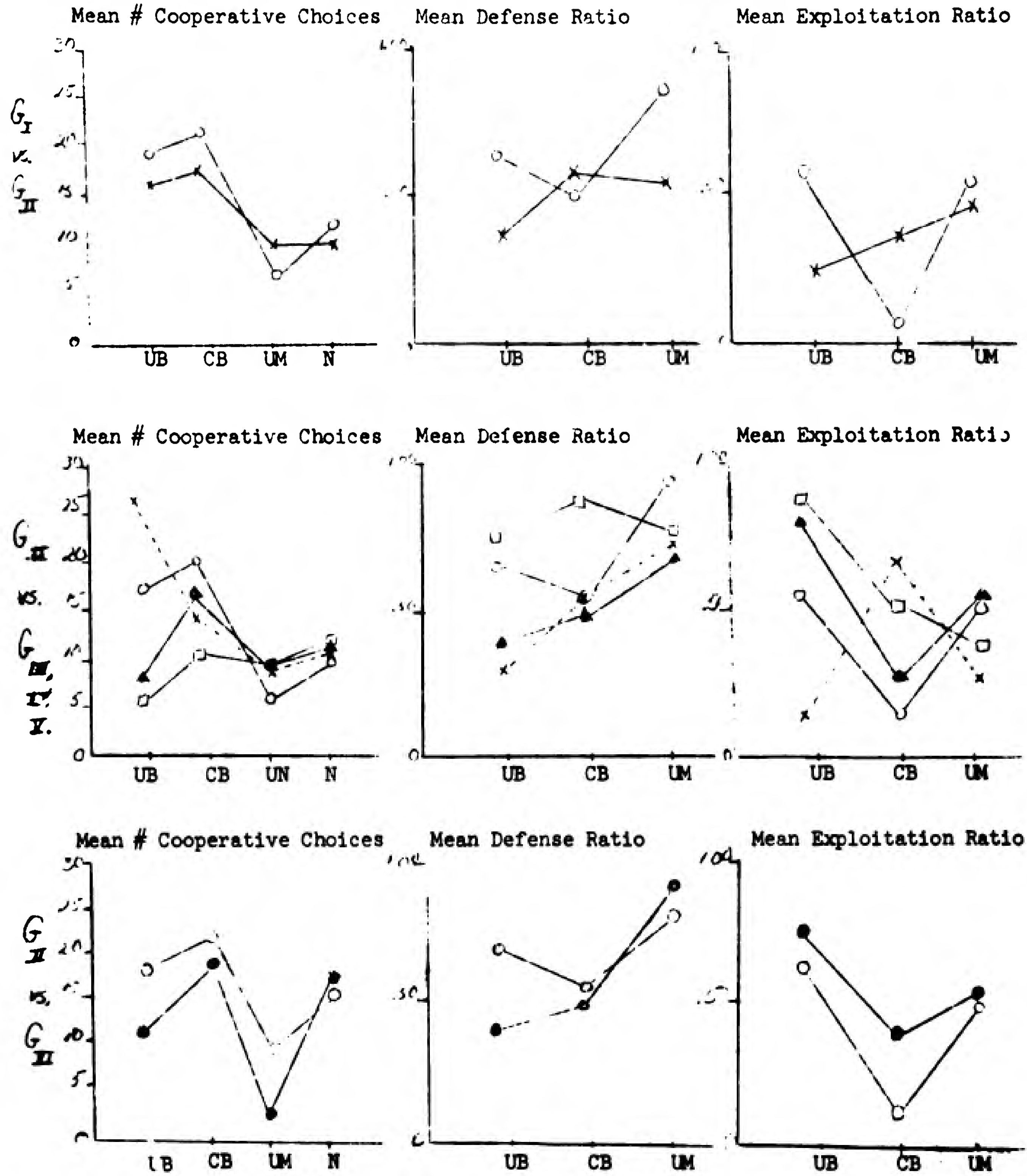

Mean # Cooperative Choices
Mean Defense Ratio
Mean Exploitation Ratio
UB
CB
UM
N
Mean # Cooperative Choices
Mean Defense Ratio
Mean Exploitation Ratio
UB
CB
UN
N
UM
Mean # Cooperative Choices
Mean Defense Ratio
Mean Exploitation Ratio
CB
UM
N

Figure 5 (con't)

KEY:

Game I: x——x = 3 Person PDG

Game II: o——• = 2 Person PDG

Game III: ·——·= 2 Person DPDG
(G: U=0, O=+10; R: U=+10, O=-20)

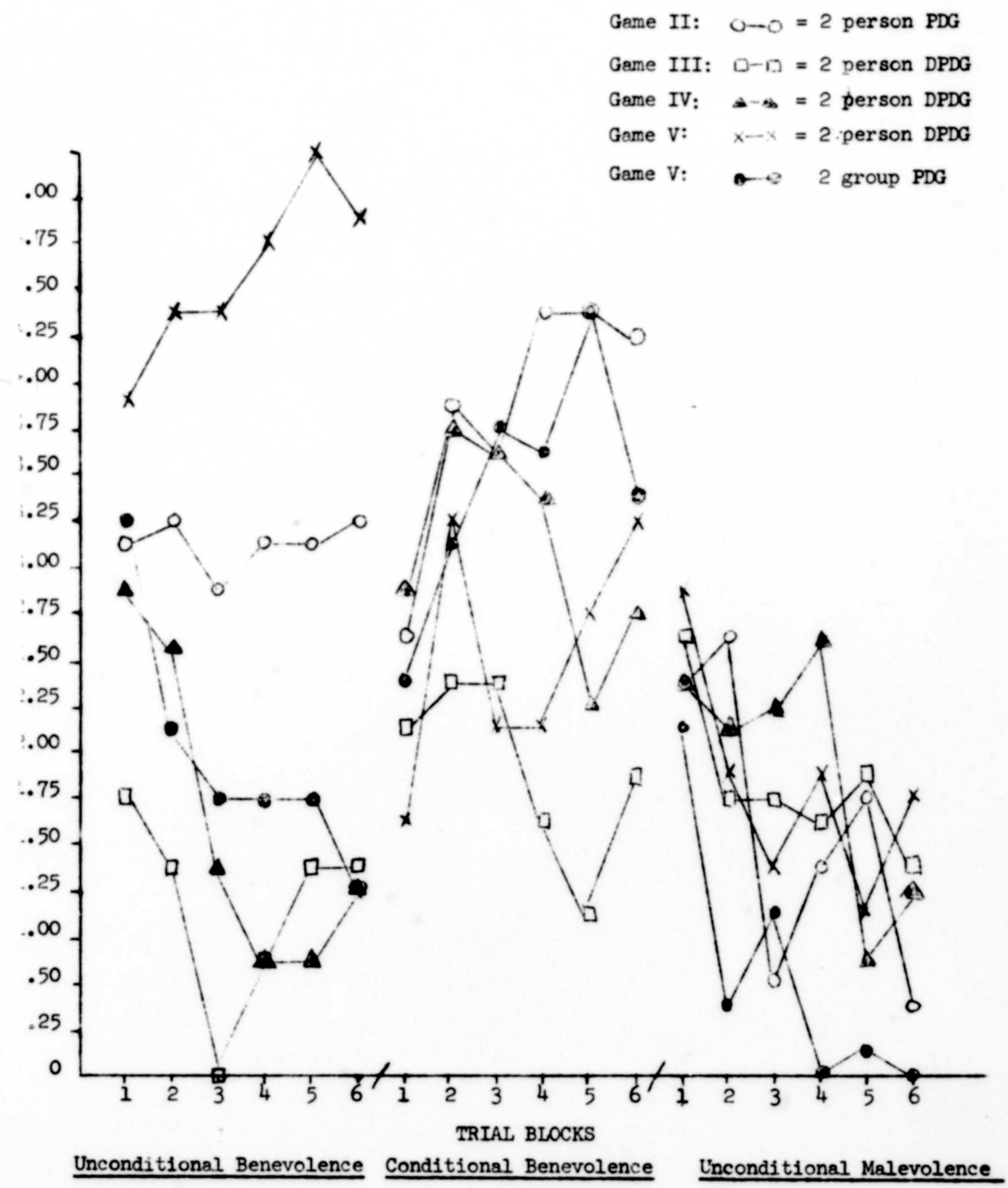
Game IV: ▲——▲ = 2 Person DPDG
(G: U=-10, O=+20; R: U=0, O=-10)

Game V: x·····x = 2 Person DPDG
(G: U=+10, O=0; R: U=+20, O=-30)

Game VI: ●——● = 2 Group PDG

Figure 6

X # OF COOPERATIVE CHOICES BY TRIAL BLOCK



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