THE EFFECT OF INCENTIVE MAGNITUDE ON COOPERATION IN THE PRISONER'S DILEMMA GAME

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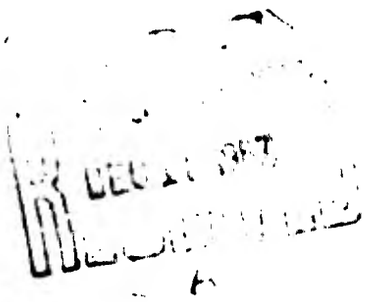

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ABSTRACT

Recent criticism of research using the Prisoner's Dilemma (PD) game suggests that previously obtained results may be seen as an artifact of the typical use of only trivial monetary incentives in the game. Critics propose that PD subjects under imaginary or trivial incentive conditions compete primarily because they become bored with cooperation.

The present experiment varied incentive magnitude for subjects playing the same basic 20-trial PD game. In five experimental conditions, subjects played for imaginary dollars, small and intermediate amounts of real money, and real dollars. Results indicated that cooperation tended to decrease over time in all conditions; that subjects who played for real money played quite competitively regardless of incentive magnitude; and that subjects who played for real dollars were significantly more, rather than less, competitive than were subjects who played for imaginary dollars. The results were interpreted as failing to support the "insufficient-incentive-to-cooperate" criticisms.

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In recent years a two person mixed-motive game known as the "Prisoner's Dilemma" (PD) has come to be widely used in the investigation of various factors contributing to the cooperative or competitive resolution of human conflict. Aspects of communication -- decision-making, motivation, person perception, and personality -- have been studied with the PD game; a considerable number of generalizations about conflict resolution have been suggested by reference to data collected in this format (see a review by Gallo and McClintock, 1965).

The basic game matrix used in the experiment reported below is illustrated in Figure 1. The gains or losses incurred by each player are dependent on choices between the two available behaviors made by both players. The essential psychological feature of the game is that unless the conditions for mutual trust exist for the players (Deutsch, 1962), they will choose the behaviors leading to minimum loss or maximum gain for themselves; and thus their behavior will tend to stabilize in the A_2B_2, or mutually competitive, cell of the matrix.

Insert Figure 1 about here

Gallo and others (Gallo, 1966; Kelley, 1965; Gallo and McClintock, 1965; McClintock and McNeal, 1966) have proposed that since previous research within the framework of the PD game has typically been done using very small or "imaginary" incentives for play, the research is subject to two related alternative interpretations, both of which are potentially quite damaging. One of the alternatives suggests that subjects become bored with making long sequences of mutually cooperative choices for rewards of only trivial value, and therefore convert the game to a more interesting one in which the object is to maximize the difference between their own payoffs and those of their opponents. The second alternative is that the subjects do not, initially, understand the consequences of their choices, and experiment with various strategies. "By the time the subject learns the implication of what he is doing, if he ever does, it is probably too late to break out of the competitive pattern that has been established, particularly if motivation to do so is minimal or entirely lacking" (Gallo and McClintock, 1965, p. 76).

Gallo (1966) has reported an experiment in which subjects played a game similar in some respects both to the PD game and to the trucking game devised by Deutsch and Krauss (1960, 1962). In Gallo's experiment, subjects who played for imaginary money behaved in typically competitive fashion, but subjects who played for a sizable amount of real money played the game far more cooperatively. Gallo interpreted his results as calling into question the interpretation by Deutsch and Krauss (1960, 1962) of their experiments on

the effects of threat availability on the outcome of interpersonal bargaining. Although subsequent research using the trucking game with moderately large monetary incentives has not supported the alternative interpretations made by Gallo (e.g. Brown, 1967; Gumpert, 1967), the PD research remains open to these questions.

In the experiment reported here, subjects played the PD game illustrated in Figure 1 under five incentive conditions. In one condition the numbers in the matrix represented imaginary dollars. In another condition the numbers represented real dollars. In the other three conditions the matrix values represented cents and were multiplied by 1, 5, and 10 respectively.

METHOD

Subjects

One hundred subjects of both sexes were recruited by means of an advertisement placed on bulletin boards at Teachers College and in a New York weekly newpaper.[1] Money was the primary incentive used in recruitment. Ten pairs of subjects were run in each of the five experimental conditions.

Procedure

When subjects arrived at the laboratory, they were escorted to different experimental cubicles containing the game appartus: the players never saw one another or met during the experiment. Instructions were delivered by tape recording and included the usual "individualistic orientation" instruction -- that is, subjects were

instructed to attempt to maximize their own earnings without regard to the earnings of the other subject. After the instructions, subjects responded to a set of practice questions which ascertained their comprehension of the game.

Subjects played a twenty-trial PD on electric control panels which, after both players had responded, displayed the choices and outcomes of both on each trial. Before each trial, subjects recorded what they expected the other player to do on that trial. After each trial, subjects recorded the actual choices and outcomes of both players on that trial.

Subjects in the Imaginary Dollars (ID) conditions were given $4.00 in real money before the instructions were delivered. In the instructions, they were told that they would keep this money regardless of the outcomes of the game. They were also given a "credit" of $10.00 in imaginary money and instructed to "play as though you felt real money was at stake." They were told to "feel that whether you win or lose the imaginary money is very important to you." Subjects in the Real Dollars (RD) condition were given a credit of $10.00 in real money and asked to attach great importance to winning or losing this money. In order to increase the credibility of the large sum of money involved, these subjects were given ten single dollar bills which they placed in their pockets at the beginning of the experiment. Subjects in the 1-2, 5-10, and 10-20 conditions were given a stake of $2.00 in real money before the game, and, as in the RD condition, were asked to attach great importance to winning or losing money in the game.

At the conclusion of the game subjects were paid, carefully debriefed, and asked not to discuss the nature of the experiment with anyone.

RESULTS

Table 1 presents the mean number of cooperative choices made by dyads in the five conditions in each of the four trial blocks. Inspection of Table 1 suggests that subjects in the ID condition were more cooperative than were subjects in the various real money conditions. Indeed, analyses of variance indicate that the game behavior of subjects in the four real money conditions was similar, and that subjects in the RD condition behaved quite differently from subjects in the ID condition.

Two-way mixed model analysis of variance of the number of cooperative devices in the four real money conditions shows no condition differences ($F < 1.00$), a highly significant overall decrement in cooperation over trial blocks ($F = 5.84$ with 3 and 108 df; $p < .001$), and a non-significant conditions-by-blocks interaction effect ($F = 1.82$ with 9 and 108 df; $p < .10$). Comparing the ID and RD conditions using the same technique yields a significant condition effect ($F = 5.57$ with 1 and 18 df; $p < .05$), a significant decrement in cooperation over time ($F = 16.32$ with 3 and 54 df; $p < .001$), and, again, no significant conditions-by-blocks interaction effect ($F = 1.34$, with 3 and 54 df; $p < 7.10$).

Our data, then, indicate that subjects in the imaginary dollars (ID) condition were choosing cooperatively about half (46)

of the time; this proportion is consistent with previous PD findings. As monetary incentives became strong, on the other hand, subjects chose cooperatively less of the time -- about 38% of the time in the 1-2 condition and about 31% of the time in the other three. The mean total outcomes of dyads in the RD condition was $-14.80, as compared with $-3.00 in the ID condition ($t = 2.39$, $p < .025$). Clearly, Gallo and McClintock's fears about the PD game are not borne out in this experiment.

DISCUSSION

In view of the unambiguous results obtained in the present research, it becomes necessary to attempt to account for the markedly different results obtained by Gallo (1966) in his trucking game experiment. A close reading of Gallo's experimental procedure does suggest some differences in the two experiments that could account for differences in their results. In Gallo's experiment, the experimenter took great pains to convince subjects in the real-money conditions that they could keep all the money they earned; in his imaginary money conditions, subjects were urged to play as though real money was at stake. It does not seem unreasonable to suggest that Gallo's instructions made his subjects sensitive to the criteria by which the experimenter might judge their performance, and that these criteria might have appeared different in the two incentive conditions. The instructions in the real-money conditions might have made profit-maximization particularly salient as the experimenter's

criterion for good performance, while the imaginary money instructions seem more ambiguous and could have allowed some of the subjects, especially those under Gallo's relative-value (competitive) instructions, to believe that they might be judged by the degree to which they earned more than their opponents.

In our experiment no special "credibility" instructions were required to assure subjects that they would keep what they earned, since they were publicly recruited for money. Our imaginary money instructions, however, might be accused of making profit-maximization particularly salient for the subjects as the experimenter's criterion for good performance. Thus, we must be willing to admit that the difference observed between the ID condition and the RD condition could be due to artifactually inflated cooperation in the ID condition. Even if this were true, however, there is no evidence to support the contention that subjects in the RD condition behaved more cooperatively than did subjects in any of the other conditions. Gallo and McClintock's alternative interpretation of earlier PD game results must be considered unsupported.

Table 1

Mean Number of Cooperative Choices Made by Both Players*

Experimental Condition	Trial Blocks			
	I (1-5)	II (6-10)	III (11-15)	IV (16-20)
Imaginary Dollars (ID)	5.7	4.2	3.8	4.7
1¢ - 2¢	5.0	4.2	3.7	2.7
5¢ - 10¢	2.6	3.9	3.3	2.4
10¢ - 20¢	3.6	3.3	2.5	3.2
Real Dollars (RD)	4.7	3.1	2.6	2.2

*The maximum number of cooperative choices in a five trial block is, of course, 10.

Figure 1

Basic PD Matrix Used in This Experiment

	B_1	B_2
A_1	+1, +1	-2, +2
A_2	+2, -2	-1, -1

FOOTNOTES

[1] This study was actually conducted at two different times over a period of two years. Subjects in the three small real money incentive conditions (1-2, 5-10, and 10-20) were recruited from the Teachers College population. Subjects in the ID and RD conditions were recruited a year later by means of a newspaper advertisement.

REFERENCES

Brown, B. The effects of need to maintain face on the outcomes of interpersonal bargaining. Ph.D. Dissertation. New York: Teachers College, Columbia University, 1967. Typewritten.

Deutsch, M. Cooperation and trust: some theoretical notes. Nebraska Symposium on Motivation, 1962 (M. F. Jones, Ed.). Lincoln: University of Nebraska Press, 1962.

Deutsch, M. and Krauss, R. M. The effect of threat on interpersonal bargaining. Journal of Abnormal Social Psychology, 1960, 61, 181-189.

Deutsch, M. and Krauss, R. M. Studies of interpersonal bargaining. Journal of Conflict Resolution, 1962, 6, 52-76.

Gallo, P. S. Effects of increased incentive upon the use of threat in bargaining. Journal of Personal Social Psychology, 1966, 4, 14-20.

Gallo, P. S. and McClintock, C. G. Cooperative and competitive behavior in mixed-motive games. Journal of Conflict Resolution, 1965, 9, 68-78.

Gumpert, P. Some antecedents and consequences of the use of punitive power by bargainers. Ph.D. Dissertation. New York: Teachers College, Columbia University, 1967. Typewritten.

Kelley, H. H. Experimental studies of threats in interpersonal negotiations. Journal of Conflict Resolution, 1965, 9, 79-105.

McClintock, C. G. and McNea;. S. P. Reward level and game playing behavior. Journal of Conflict Resolution, 1966, 10, 98-102.

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13 ABSTRACT

A basic Prisoner's Dilemma matrix was multiplied by one cent, five cents, ten cents, or one hundred cents so as to alter the payoff magnitudes without affecting any of the ratios of values within the matrix. In addition to varying the amount of money at stake, we studied the effect of "imaginary" versus "real" money by comparing the situation in which real dollars were used with one in which "imaginary dollars" were employed.

The results indicate that the subjects were more rather than less competitive when playing for "real" rather than "imaginary" dollars. No significant differences were obtained among the four real money conditions. These results question the assumption made by some investigators that it is the "weak incentives" employed in experimental games which lead to the relatively high degree of competition.

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