THE EFFECT OF OPPONENT COOPERATION IN THE PRISONER'S DILEMMA GAME AS A FUNCTION OF PLAYER MOTIVATION AND TRUST

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ABSTRACT

The purpose of the present research was to examine the hypothesis that the effect of the average amount of opponent cooperation on player cooperation is a function of both the player's motivation and trust. 71 Ss played 24 trials of the prisoner's dilemma game under either cooperative or competitive motivation conditions. S's level of trust was obtained from previous trials on the prisoner's dilemma game which required the S to predict his opponent's responses. One-half of the Ss played a cooperative opponent, the other half a noncooperative opponent.

The results indicated that neither player motivation nor trust were related to the amount of player cooperation in this experiment. A secondary analysis suggested that research in this area should take into consideration a more detailed description of the interaction in the prisoner's dilemma game.

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CHAPTER I

INTRODUCTION

Various games have been employed to study social interaction. These games require a player and two or more opponents to select one of a limited number of responses in a highly structured game situation. The prisoner's dilemma game has been of particular interest as a setting for the study of cooperative behavior. Since the payoffs in this game are contingent on both player and opponent responses, the assumption has been that the game represents an interaction situation in which the cooperation of the player is contingent on the cooperation of the opponent. In addition, decision theories, based on the hypothesis that the player's cooperation is a function of the expected utility of the payoffs, predict a similar contingency. However, opponent cooperation has been found to have no effect on player cooperation. If the prisoner's dilemma game is to be used to study interaction and decision theory is to be the basis for predictions in the prisoner's dilemma game, then the relationship between player and opponent cooperation must be demonstrated. While opponent cooperation does not effect the average amount of player cooperation, it may have consistent effects relative to other variables in the situation. The present experiment was designed to examine the effect of opponent cooperation as a function of two such variables, the player's motivation and trust.

Theoretical Background

The systematic study of social interaction has been greatly facilitated by the mathematical treatment of games by Von Neumann and Morgenstern (1964). Their analysis requires that the social interaction be described as a game in which two or more players receive payoffs, i.e. points, money, or anything of value which can be ordered according to preference on an interval scale. The distribution of these payoffs must be effected by the play of each participant in the game. For each participant, the object of the game is to accumulate as large a total payoff as possible. Since the payoff is partially controlled by every participant in the game, each player must take into account his opponent's behavior when selecting his own strategy. Game theory consists of the analysis and classification of games to aid in the selection of a best strategy. The basic postulate is that all participants are perfectly rational. A rational participant, given that all other participants are rational, can easily arrive at the best strategy for a simple game. A familiar example of a game which has an obvious best strategy is tic-tac-toe. The best strategy for each player in this game is to mark at least one square in each row, column, and diagonal. However, a best strategy can be arrived at in game theory only when the player can be absolutely certain that the opponent is rational and that the game contains enough information to assign the opponent one and only one best strategy. In practice, it is not always possible to be so certain.

When decision theories are applied to the analysis of games, they introduce the concept of probability, thus eliminating the need for certainty about the opponent's behavior. Decision theories are based on the general hypothesis that a response A is preferred to a response B because the subject expects the response A to lead to a greater payoff in the long run. This expected value corresponds to the mathematical concept of expected value in that it is a function of both the value (numerical value on the interval scale of preference) of the payoff and the probability that this payoff will occur on any one trial. The probability that a particular payoff will occur is the probability of each of the possible opponent responses. The introduction of the concept of probability is particularly useful in making predictions for the prisoner's dilemma game.

Prisoner's Dilemma

The prisoner's dilemma game usually involves two persons, a player and an opponent, each with two choices. The choices are only of two kinds - cooperative (C) and noncooperative (D), although the game can be expanded to include a larger number of choices and opponents. The noncooperative choice gives the player a greater payoff than the alternative kind of choice, regardless of what his opponent does. However, the cooperative choice for each player gives a greater payoff if both players make this cooperative choice (C,C) than if both players make a noncooperative choice (D,D). Should the player make a cooperative choice when his opponent makes a noncooperative choice (C,D), the player receives the lowest possible payoff and his opponent receives the highest possible payoff and vice-versa. Thus the dilemma, to cooperate and risk a noncooperative opponent choice, or not to cooperate and settle for a smaller payoff if the opponent makes the same choice. The mathematical properties of the game are given in Figure 1.

The experimenter is also in a dilemma when he attempts to make predictions about cooperation in the prisoner's dilemma game. From a simple game theory analysis we find that when the player is required to base his play on the assumption that his opponent is rational, he starts out on the following circular reasoning path:

"The best outcome for both of us is (C,C). However,

		Opponent	
		Cooperative	Defecting
Player	Cooperative	$x_1 x_1$	$x_2 x_3$
	Defecting	$x_3 x_2$	$x_4 x_4$

Where $2x_1$ is greater than $x_2 + x_3$ and x_3 is greater than x_4 ^{1}is greater than x_2.

Fig. 1. The mathematical properties of the prisoner's dilemma game.

> if player 2 assumes that I shall choose C, he may well also play D to win the largest payoff. To protect myself, I will also play D. But this makes for a loss for both of us. Two rational players certainly deserve the outcome (C,C). I am rational and by the fundamental postulate of game theory, I must assume that player 2 is also rational. If I have come to the conclusion that C is the rational choice, he too must have come to the same conclusion. Now, knowing that he will play C, what shall I play? Shall I not play D to get the greatest payoff? But if I have come to this conclusion, he has also probably done so. Again we end up with (D,D). To insure that he does not come to the conclusion that he should play D, I better avoid it also. For if I avoid it and am rational, he too will avoid it if he is rational. On the other hand, if rationality prescribes D then it must also prescribe D to him. At any rate because of the symmetry of the game, rationality must prescribe the same choice to both. But if both choose the same, then (C,C) is clearly better. Therefore I should choose C."
>
> (Rapoport, 1966, p. 141.)

Evidently there is not enough information in the structure of the prisoner's dilemma game to assign the opponent one and only one best strategy. However, a few trials of the game should be sufficient to give the player some idea of the likelihood that a particular opponent will cooperate. While the player can seldom be certain on any one trial that his opponent will cooperate, he can assign some probability to the opponent's cooperation. This probability will effect the expected value of each payoff. Decision theory can thus predict that the player choice having the largest expected value will predominate.

Expected Value

Varying the numerical value of the payoffs in the prisoner's dilemma matrix has produced differences in player cooperation. Rapoport and Chammah (1965), in considering the player payoff relative to the opponent payoff, labeled each of the payoffs as follows: (C,C) - reward payoff - R, (D,D) - punishment payoff - P, (C,D) - sucker payoff - S, (D,C) - temptation payoff - T. He found support for the hypothesis that player cooperation increases as the ratio $\frac{R - P}{T - S}$ increases. Varying only the numerical values of the payoffs varies the expected value of the payoffs. Thus the ratio of the expected values corresponding to the payoff ratio $\frac{R - P}{T - S}$ should be similarly related to player cooperation. Other experiments have also found that changing the relative value of the payoffs produces significant differences in player cooperation (Lavé, 1965; Bixenstine & Blundell, 1966; Dolbear & Lave, 1966; Ellis & Sermat, 1966). However, it should be noted that changes in the absolute value of the payoffs have no effect on player cooperation (Dolbear & Lavé, 1966).

Another way of varying the expected value of a payoff is to vary the probability that it will occur. The equation for expected value is $EV = \sum_i p_i V_i$, where p_i is the probability that the event i will occur and V_i is the value of the event i. Since T or R occur whenever the opponent cooperates, the expected value of T is the probability that the opponent will cooperate (p_c), times the value of the payoff T (V_T). Similarly the expected value of R is given by the equation $EV_R = p_c V_R$. There are only two opponent choices so the probability that the opponent will not cooperate is $1-p_c$. Thus $EV_S = (1-p_c)V_S$ and $EV_P = (1-p_c)V_P$. The ratio of the expected values is therefore $\frac{p_c V_R - (1-p_c)V_P}{p_c V_T - (1-p_c)V_S}$. The mathematical properties of the game require that T is greater than R and P is greater than S. When the probability that the opponent will cooperate is increased, T and R are increased proportionately and P and S are decreased proportionately. The result is an increase in the ratio. Therefore, increasing the probability that the opponent will cooperate should increase player cooperation.

However, no differences in player cooperation have been found between opponents whose cooperation varies from 0% to 100% (Minas, Scodel, Marlowe, & Rawson, 1960; Solomon, 1960; Komorita, 1965; Oskamp & Perlman, 1965; Wrightsman, Davis, Lucker, Bruiniks, Evans, Wilde, Paulson, & Clark, 1967). Komorita did find a slightly greater player cooperation with a cooperative opponent when the player was female. The other exception is a study by Lave (1965). His graphs indicated that occassional cooperation was superior to no cooperation for the first four trials in 100 trials and that the 100% cooperative opponent received an initially high level of cooperation. However, no significance levels were given in Lave's study. Thus the evidence from experiments varying the average amount of opponent cooperation fails to support the hypothesis that increasing opponent cooperation increases player cooperation.

It has been shown that the decision theory hypothesis that player cooperation is a function of the expected value of the payoffs in the matrix leads to the prediction that increasing cooperation will increase player cooperation. Thus the more cooperation the player has reason to expect, the more cooperation he should give. The subject's prediction that the opponent will make a cooperative choice in the prisoner's dilemma game is generally considered a measure of trust. In common usage the term trust is rich in meaning. In the present context the term trust will mean nothing more than predicting that the opponent will make cooperative responses. Personality measures which reflect such trust, i.e., which indicate that the subject predicts a great deal of opponent cooperation, have been used. In addition to the prediction of opponent cooperation these measures generally indicate that the subject places a high value on cooperation. Such a subject may persist in cooperation even in a situation in which he expects little or no opponent cooperation. Thus the experiments correlating player cooperation and personality variables (Deutsch 1960;

Lutzker, 1960; Bixenstine, Potash & Wilson, 1963; Bixenstine & Wilson, 1963; Marlowe, 1963; McClintock, Harrison, Strand & Gallo, 1963; McClintock, Gallo & Harrison, 1965; Uejio & Wrightsman, 1967; Wrightsman, 1966) are not necessarily sufficient evidence for a correlation between player cooperation and trust. More direct evidence for this correlation comes from experiments in which the subject is simply asked to predict his opponent's response before making his own response. Deutsch (1960) and Loomis (1959) have found that the subject cooperates more when he predicts opponent cooperation than when he predicts player defection. However, Bixenstine, Levitt, and Wilson (1966) reported a negative correlation between trust and cooperation. The present study is designed to examine the relationship between trust and player cooperation. At this point it is sufficient to note that there is an inconsistency in the results relating trust and player cooperation. This inconsistency throws additional doubt on the decision theory hypothesis and suggests that something in addition to the expected value of the payoffs is effecting player cooperation.

Opponent Strategy and Player Motivation

Experiments manipulating the average opponent cooperation do not take into consideration what opponent strategy is being communicated to the subject. Two experiments have found that opponent strategy does effect player cooperation when the strategy is varied during the game. Bixenstine and Wilson (1963) found that a sequence of 5% - 50% - 95% - 50% - 5%, first increased and then decreased opponent cooperation. Harford and Solomon (1967) found that a sequence of 3 noncooperative trials - 3 cooperative trials - 24 matching trials, was superior to 3 cooperative trials - 27 matching trials, when the player cooperation was compared. Harford attributes this difference to the communication of "reformed sinner" and "lapsed saint" strategies. These experiments illustrate that something can be communicated to the player about opponent strategy in addition to the probability that the opponent will cooperate.

If the opponent's strategy communicates something additional to the player, it is apparent that average opponent cooperation does not have the same communicative value as the simple strategies previously mentioned. Bixenstine, Potash and Wilson (1963) compared player cooperation on matching trials following 83% or 17% opponent cooperation. Although his design was the same as Harford's and the strategy differences between the opponents were more striking, Bixenstine found no differences between the player cooperation with the different opponents. It is apparent from this study that the average opponent cooperation did not communicate the unambiguous strategy represented by Harford's opponent strategies. The problem is how to account for Bixenstine's failure to find differences in player cooperation with such different opponent strategies.

One possibility is that the average opponent cooperation does not contain sufficiently precise information to communicate one and only one opponent strategy. For example, a highly cooperative opponent may simply value cooperation. On the other hand, he may just not understand the game, particularly when he continues to cooperate against a noncooperative opponent. Since the average opponent cooperation is constant, which opponent strategy is communicated to the player will depend on the player and in particular, it will depend on the player's motivation. For instance, one would expect a highly cooperative opponent would communicate a high value for cooperation when the players are motivated to cooperate. On the other hand, the same opponent would communicate a lack of understanding of the game when the players are motivated to compete. Studies manipulating average opponent cooperation have been particularly careful not to introduce either a competitive or a cooperative motivation. However, when the motivation is not manipulated or controlled, the ambiguity of the opponent strategy communicated to the subject by a highly cooperative opponent should increase the variability of the results. If the effect of opponent cooperation is dependent on the players motivation, then this variability decreases the probability of demonstrating significant effects from opponent cooperation.

This study was designed in part to test the hypothesis that the effect of opponent cooperation is a function of player motivation.

As previously mentioned, this study is also designed to study the effects of the player's initial level of trust on player cooperation in the prisoner's dilemma game. The decision theory analysis leads to the hypothesis that increasing opponent cooperation will increase player cooperation. From this it follows that there will be a positive correlation between the subject's prediction that the opponent will cooperate and his own cooperation. In addition, the actual probability which the player assigns his opponent's cooperation may depend on his initial level of trust. For example, a person initially low in trust may not assign as high a probability to opponent cooperation as persons initially high in trust, although both encounter the same amount of opponent cooperation. Thus a highly cooperative opponent would be assigned a higher probability of cooperating by a person high in trust and a noncooperative opponent would be assigned a lower probability of cooperating by a person low in trust, i.e., the effect on player cooperation of initial level of trust would parallel the effect of opponent cooperation.

There is one problem which arises from the use of a behavioral measure of trust. Since the subject's prediction of opponent cooperation is simply a note to the experimenter, in no way a part of the interaction or scoring in the game, it may be used to justify the players own responses, without penalty to the player. A measure of trust which is indirect and imbedded in the game, i.e. which adds to the player's score if he makes a correct prediction and detracts from it if he is wrong, would be preferable. Thus when trust is a measure of only the predicted probability that the opponent will cooperate, the effect of initial level of trust should parallel the effect of opponent cooperation.

Statement of the Problem

Decision theory predicts that player cooperation will be a function of the expected value of the payoffs in the prisoner's dilemma game. Experiments varying the numerical value of the payoffs have supported the hypothesis that player cooperation increases as the ratio $\frac{R - P}{T - S}$ increases. Since increasing opponent cooperation increases the $\frac{R - P}{T - S}$ ratio of expected value, increasing opponent cooperation should also increase player cooperation. Both experiments varying the amount of opponent cooperation and experiments correlating trust with player cooperation have failed to support this prediction.

However, a variation in average opponent cooperation is also a variation in the information communicated to the player.

Opponent cooperation will communicate that the opponent places a high value on cooperation when the player is motivated to cooperate, but lack of understanding when the player is motivated to compete. The present hypothesis is that the effect of opponent cooperation is a function of the player motivation. In addition, the amount of opponent cooperation communicated to the player will depend on the player's initial level of trust. Since persons high in trust should assign higher probabilities than persons low in trust, the effects of trust should parallel those of opponent cooperation. These hypotheses lead to the prediction that there will be a three way interaction between opponent cooperation, player motivation, and initial level of player trust. More specifically, while no main effects are predicted, it is expected that the independent variables will interact so that a highly cooperative opponent will elicit more cooperation under motivation to cooperate, particularly from a subject initially high in trust, while a noncooperative opponent will elicit more cooperation under a motivation to compete, particularly from a subject initially low in trust.

CHAPTER II

METHOD

Subjects. The Ss were 71 students enrolled in the introductory psychology course at the University of Manitoba, participating in this experiment for course credit.

Design. Eight groups of Ss were used in a 2 x 2 x 2 factorial design. The main treatment variable was the amount of opponent cooperation, with one half of the Ss playing a cooperative opponent who was cooperative on 75% of the trials and the other half playing a noncooperative opponent who was cooperative on 25% of the trials. The second treatment variable was the motivation to increase or decrease the opponent's score, i.e. to cooperate or compete. One half of the Ss were instructed that their final score consisted of their own payoffs plus one half of their opponent's payoffs, i.e. they were motivated to cooperate. The other Ss were instructed that their final score consisted of their own payoffs minus one half of their opponent's payoffs, i.e. they were motivated to compete. The third variable was the initial level of trust, with high and low trust groups in each of the four treatment conditions.

Procedure. S's were tested at the conclusion of a series of ability tests not related to the present study. Each S was informed that another student was scheduled to participate with him in this part of the experiment because two persons were required. Shortly after S was seated, a paid confederate arrived to begin his series of tests. The players were seated at a table divided by a wooden partition with a window of frosted glass which allowed the players to see that they actually had an opponent but obscured his features. The players were instructed that they were to play a series of games developed from mathematical reasoning problems used in an advanced intelligence test. This rationale was employed to insure involvement in the game.

The first game was a paper and pencil measure of strategy preference which was an individual game. S simply chose which of two bets he would rather place on the toss of a fair die. Some pairs of bets allowed a rational choice, others forced a nonrational choice. While the game was later scored for rational, conservative and extravagant choices, this data was not collected for purposes of the present study.

The second game began with six trials on the prisoner's dilemma matrix to familiarize the S with the game. At this time S was instructed that the object of the game was to get as high a score as possible. The matrix shown in Figure 2 was displayed at right angles to the players. The players

		Player II A	Player II B
Player I	A	6,6	1,9
	B	9,1	4,4

Fig. 2. The prisoner's dilemma matrix.

Player II A	Player II B		
+6,+6	-6,+9	A	Player I
-6,+1	+6,+4	B	

1.

		Player II A	Player II B
Player I	A	+6,+6	+1,-6
	B	+9,-6	+4,+6

2.

Fig. 3. The trust matrices for the prisoner's dilemma game. Matrix 1 is the trust measure for the subject, Player I. Matrix 2 is the same measure for the opponent, Player II.

made their choices simultaneously. At the end of 15 seconds, E asked the players to announce their choice for that trial to their opponent. During these six trials the opponent cooperated 50% of the time. Three trials were then played on each of the matrices shown in Figure 3. These matrices were designed to require the S to predict the opponent's play, and thus are designated trust matrices. In the first matrix, S receives 6 points for a correct prediction, i.e. playing the same as his opponent, and -6 points for an incorrect prediction. In the second matrix, the payoffs are reversed and the opponent receives 6 points for a correct prediction, -6 points for an incorrect prediction. The second matrix was necessary to assure the S that his opponent was also a subject and that the game was completely symmetrical. Choices were simultaneous but E did not ask the players to announce their choices on the trust matrices. Ss were designated high trust if they predicted 2 or 3 cooperative plays, low trust if they predicted 1 or 0 cooperative plays.

The third game consisted of 24 trials on the prisoner's dilemma matrix. Before beginning this game, one half of the Ss were instructed that their final score would consist of their own score plus one half of their opponent's score. The other half were instructed that their final score would consist of their own score minus one half of the opponent's score. The predominant opponent strategy for the assigned treatment condition was given on all trials except the 2nd, 5th, 10th, 14th, 19th, and 23rd.

CHAPTER III

RESULTS

The dependent variable was the number of cooperative choices the player made in 24 trials of the prisoner's dilemma game. The mean number of such choices for each level of trust within each motivation condition for the cooperative and non-cooperative opponents are presented in Table 1. The average amount of player cooperation in each condition was quite low, there being an overall mean of only 4.7 cooperative responses over 24 trials. A 2 x 2 x 2 analysis of variance was performed on the data and the summary of this analysis is presented in Table 2. The predicted triple interaction was not significant at the .05 level. Similarly all main effects and interactions were nonsignificant. Only the main effect of opponent cooperation approached significance ($p = .06$). Thus the hypothesis that the effect of opponent cooperation is a function of player motivation and initial level of trust was not supported.

An examination of the means, however, indicates that they were in the direction predicted for the motivation manipulations. The mean number of cooperative choices for the motivation conditions are graphically presented in Figure 4. The 75% cooperative opponent received slightly

TABLE 1

Mean Number of Cooperative Choices for High and Low Trust Subjects Under Each of the Four Treatment Conditions

Motivation	Opponent Cooperation 75%	25%
Cooperative Motivation		
High Trust	7.40	3.00
Low Trust	4.20	3.78
Competitive Motivation		
High Trust	6.00	4.78
Low Trust	4.56	3.89

TABLE 2

Analysis of Variance for the Number of Cooperative Responses

Source	df	MS	F
Opponent cooperation (O-C)	1	49.9551	3.92
Motivation (Mot)	1	.7897	.06
Trust (Tru)	1	25.0440	1.97
O-C x Mot	1	9.4813	.74
O-C x Tru	1	22.7502	1.79
Mot x Tru	1	.0087	.00
O-C x Mot x Tru	1	12.9374	1.01
Within cells	63	12.7337	

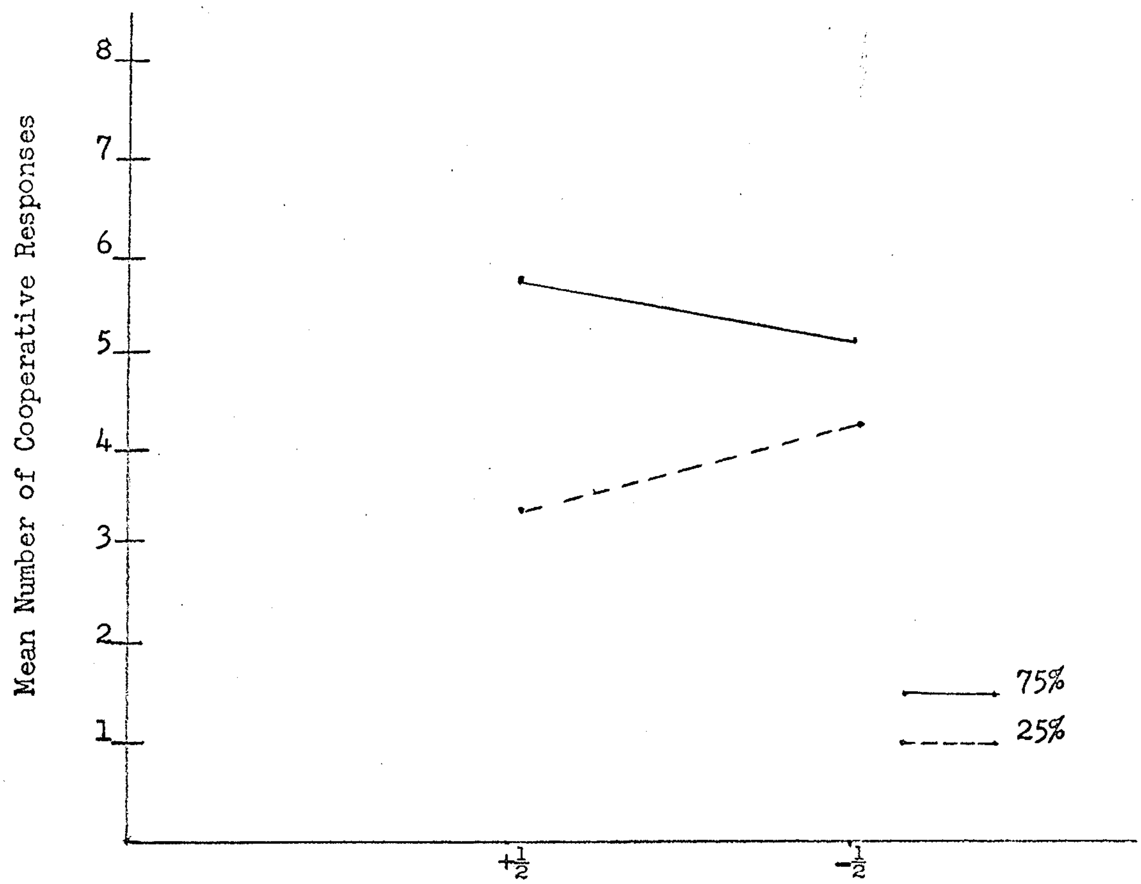

Fig. 4. Mean number of cooperative responses for players motivated to cooperate ($+\frac{1}{2}$) or to compete ($-\frac{1}{2}$) when they face a cooperative opponent (75% cooperation) or a noncooperative opponent (25% cooperation).

more cooperation when the player was motivated to cooperate and the 25% cooperative opponent received slightly more cooperation when the player was motivated to compete. A graph of the mean number of cooperative choices for each of the trust conditions is given in Figure 5. The relationship between the trust groups was not as predicted except that the high trust group cooperated more with the 75% cooperative opponent in the cooperative motivation condition than did the low trust group.

Since the analysis failed to reach the .05 level of significance, no further tests were performed on the average number of cooperative responses. For descriptive purposes, a secondary analysis was performed on certain indices suggested by Rapoport and Chammah (1965). They have suggested that indices of when the players cooperate may be useful in describing groups which do not differ in average cooperation. These indices are:

E_1 - the probability that player I responds cooperatively following player II's cooperative response on the preceding play.

N_1 - the probability that player I responds cooperatively following his own cooperative response on the preceding play.

L_1 - the probability that player I responds cooperatively following his own defecting response on the preceding play.

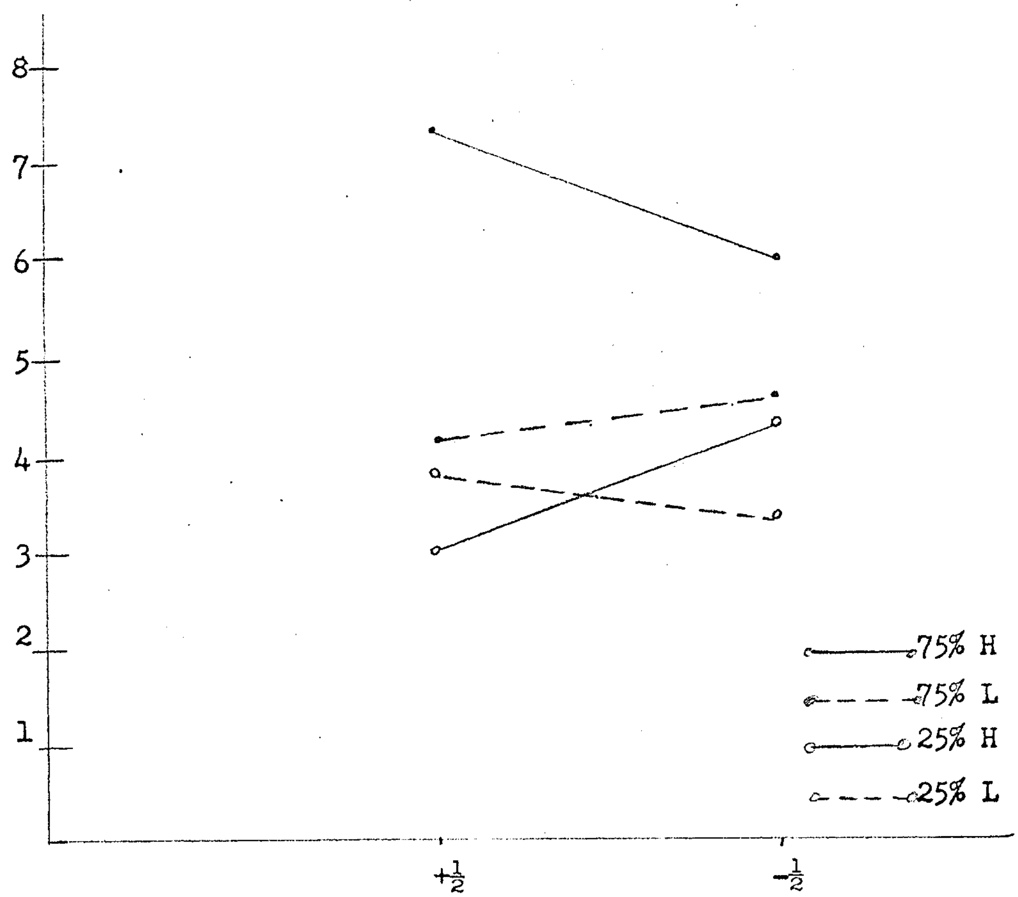

Fig. 5. Mean number of cooperative responses for players high in trust (H) and players low in trust (L), motivated to cooperate (+½) or to compete (-½) when they face a cooperative opponent (75% cooperation) or a noncooperative opponent (25% cooperation).

W_1 - the probability that player I responds cooperatively following player II's defecting response on the preceding play.

X - the probability that a player will choose cooperatively following a play in which he chose cooperatively and received R (i.e. following a play in which both players chose cooperatively).

Y - the probability that a player will choose cooperatively following a play in which he chose cooperatively and received the sucker's payoff (i.e. following a play in which he was the lone cooperator).

Z - the probability that a player will choose cooperatively following a play in which he defected and received T (i.e. following a play in which he is the lone defecter).

W - the probability that a player will choose cooperatively following a play on which he defected and received P (i.e. following a play in which both defected).

The indices computed for the player considered as player I and the opponent considered as player II are given in the Appendix. An analysis of variance was performed on each of the indices. The summary of the analysis of variance for the only index in which significant differences were found, the Z index, is given in Table 3. The Z index was significantly greater for the cooperative opponent, i.e. the player cooperated more often after a payoff in which he was the lone defecter when the opponent was cooperative.

When the opponent is considered player I and the player is considered player II, the indices are different. Some indices for the opponent are necessarily constant for each level of opponent cooperation. For example, the 75% cooperative opponent has an L_1 index of 1 because he always cooperates after one defecting response, while the 25% cooperative opponent has an N_1 index of 0 because he always defects after one cooperative response. However, other indices are not constant. For example, E_1 depends on when the player cooperates because the sequence of opponent responses is constant. A 2 x 2 x 2 analysis of variance was conducted for the indices which admit some variability for both levels of opponent cooperation, i.e. the E_1 and W_1 indices. A 2 x 2 analysis was conducted for the indices which admit variability for one or the other level of opponent cooperation, i.e. the X,Y,Z and W indices. The summary of the analysis of variance for the only index which indicated a significant interaction, the W_1 index, is given in Table 4. The triple interaction for this index was significant at the .05 level. This indicates that the opponents were not constant across motivational and trust conditions. The mean opponent

TABLE 3

Analysis of Variance for the Z Index

Source	df	MS	F
Opponent cooperation (O-C)	1	1921.3552	4.81*
Motivation (Mot)	1	47.4752	.12
Trust (Tru)	1	690.3003	1.73
O-C x Mot	1	30.1691	.08
O-C x Tru	1	5.4529	.01
Mot x Tru	1	5.9632	.01
O-C x Mot x Tru	1	501.7979	1.26
Within cells	63	399.5352	

$^{*}p < .05$

TABLE 4

Analysis of Variance for the W_1 Index

Source	df	MS	F
Opponent cooperation (O-C)	1	10724.3477	153.38*
Motivation (Mot)	1	189.6413	2.71
Trust (Tru)	1	2.5262	.04
O-C x Mot	1	241.9034	3.46
O-C x Tru	1	557.9034	7.98*
Mot x Tru	1	162.6089	2.33
O-C x Mot x Tru	1	311.0608	4.45*
Within cells	63	69.9201	

$^*p < .05$

W_1 index for each of the experimental groups is graphically presented in Figure 6. The experimental design required comparisons between the different motivational and trust groups, on the assumption that the players in these groups had constant opponents differing only in average amount of cooperation. However, the systematic differences in the W_1 index indicate that the opponents were not constant.

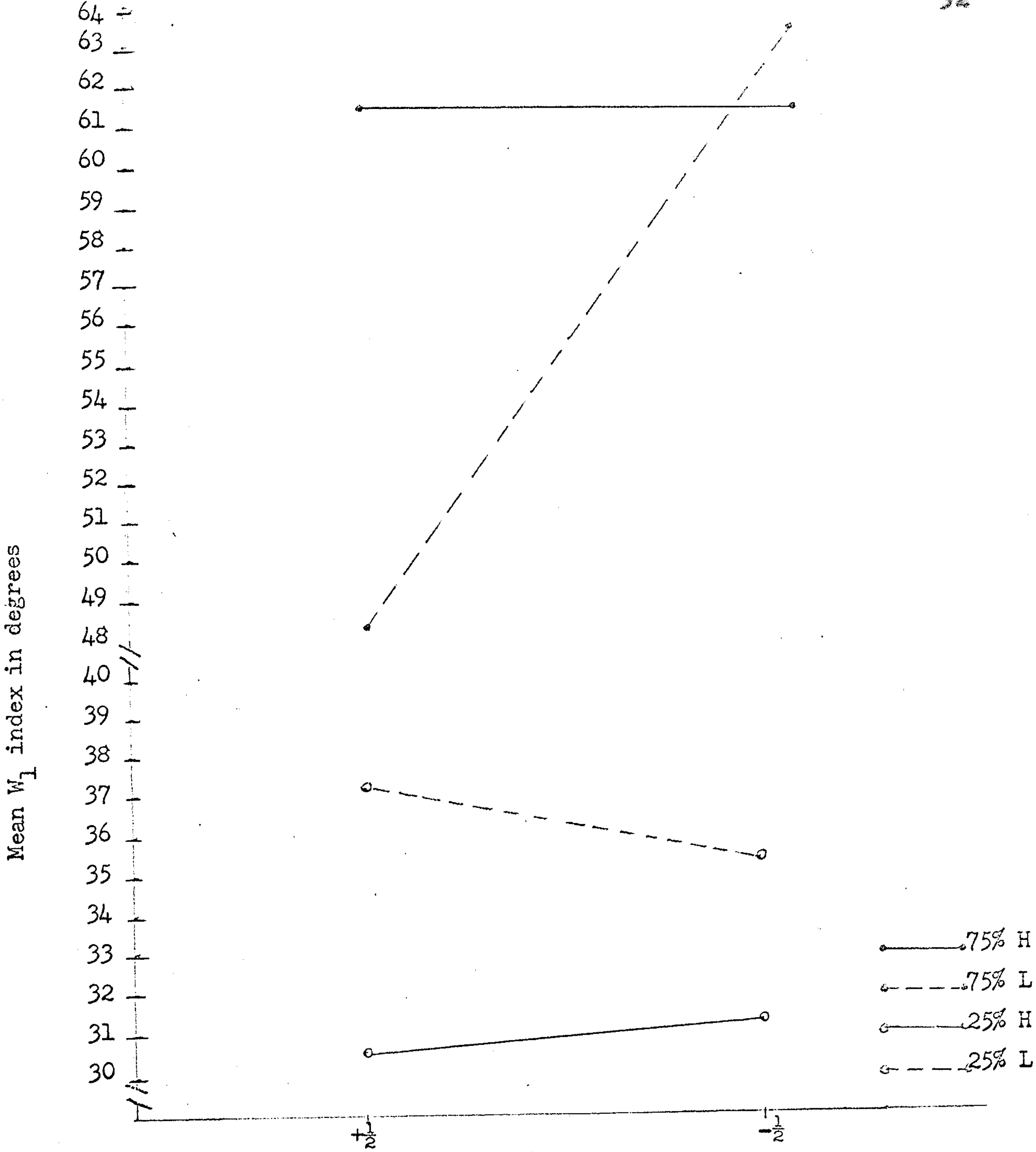

Fig. 6. Mean W_1 index for players high in trust (H) and players low in trust (L), motivated to cooperate ($+\frac{1}{2}$) or to compete($-\frac{1}{2}$) when they face a cooperative opponent (75% cooperation) or a noncooperative opponent (25% cooperation).

CHAPTER IV

DISCUSSION

The hypothesis that the effect of opponent cooperation is a function of player motivation and initial level of trust was not supported by the results. While the means of the motivation conditions were in the direction predicted they were not of sufficient magnitude to reach significance. Differences between trust groups were not in the direction predicted, except when the subject was motivated to cooperate and was playing a highly cooperative opponent. As in previous experiments, the differences in player cooperation elicited by different amounts of opponent cooperation failed to reach significance.

The secondary analysis suggested by Rapoport and Chammah (1965) provided a closer look at the data. Their indices are basically a refinement on the measure of average cooperation. The indices can be applied to either player or opponent cooperation. When this refinement is made for player cooperation, the differences in player cooperation attributable to differences in opponent cooperation can be localized. For instance, in this study only when a (D,C) payoff occured did the amount of opponent cooperation become a factor in player cooperation. If the player is facing a highly cooperative opponent he is more likely to cooperate after a (D,C) payoff than if he is facing a noncooperative opponent. Rapoport would consider this a difference in the player's propensity to repent, since he has just taken advantage of his opponent's cooperation on the previous trial. However, such a specific difference can not be predicted from the gross manipulation of average opponent cooperation. Nor would this difference be predicted from the decision theory treatment of the game discussed previously.

More specific predictions about player cooperation can be made from a somewhat different development of decision theory recently proposed by Rapoport (1967). In his analysis the probability that the opponent will cooperate is reduced to the more specific probability that the opponent will cooperate after a given payoff. Each of the payoffs has a contingent probability of opponent cooperation. The four contingent probabilities are represented by the X,Y,Z and W indices. If the indices assigned to opponent cooperation are known, then a best strategy can be arrived at for a series of trials in the prisoner's dilemma game. Rapoport considers the fact that the experimenter does not know what contingency probabilities the player assigns, a serious limitation to his analysis. He has not considered the possibility of using the contingency probabilities as an independent variable. Yet, there is no reason for not manipulating the contingency probabilities. They may well describe the dynamics of strategy in the prisoner's dilemma game better than average cooperation. For example, an opponent who cooperates equally often regardless of the player's strategy may not appear too rational to the player. On the other hand an opponent who is very likely to cooperate after a (C,C) or (D,C) payoff but seldom cooperates after the opponent defects might be a more convincing cooperative opponent. Some consideration should be given to the systematic manipulation of certain of these contingency probabilities.

Whether or not the indices are manipulated, the analysis of the opponent indices in the present study suggests that they are a factor to be considered when the experimental design calls for a constant opponent strategy. Since there was no systematic variation in player cooperation associated with trust or motivation, the triple interaction in the opponent W_1 index would appear to be a chance happening. Nevertheless, it was evident from this analysis that the opponents were not constant across trust and motivation conditions. If the W_1 index is considered a measure of the proportion of the player's defecting responses rewarded by subsequent opponent cooperation, the higher W_1 index should elicit less cooperation. An examination of Figure 6 indicates that a set of predictions made on the basis of the W_1 indices for opponent cooperation would directly contradict the predictions concerning trust. These indices would also deflate the differences between the levels of opponent cooperation. It is difficult to say to what extent this systematic difference in opponent cooperation effected the results. It is equally difficult to envisage a method for arriving at an opponent strategy in which both the average amount of opponent cooperation and the opponent indices are constant. Should future research indicate that the opponent indices are an effective variable, these indices will present a considerable methodological problem for experimenters concerned with the effects of average amounts of opponent cooperation.

There are more obvious methodological difficulties which are not peculiar to the prisoner's dilemma game. The manipulation of player motivation may not have produced sufficiently extreme differences in motivation. Presenting the game as a reasoning problem may have introduced a general competitive set. Such a set would decrease the effectiveness of telling the player that he would receive one-half his opponent's score and thus the motivation to cooperate may not have been produced. The low mean cooperation would tend to support such an interpretation. A post-experimental questionnaire would have been useful. Research in this area has largely neglected post-experimental questionnaires both to check on experimental manipulations and for descriptive purposes.

More generally, measures of trust are often unsatisfactory. In this case, the measure was not at all related to player cooperation. Dividing persons into high and low trust groups on the basis of three predictions was not a very sensitive measure of trust and may be too gross to reflect any relationship between trust and player cooperation. Increasing the number of familiarization and trust trials might increase the sensitivity of the measure enough to indicate differences between high and low trust players. On the other hand, previous correlations between trust and cooperative behavior may simply be an artifact resulting from the subject's use of the measure to justify his behavior. Some method for validating trust measures is definitely needed if research with this variable is to continue.

Future research in this area will have to take into consideration a more detailed description of the interaction in the prisoner's dilemma game than average cooperation. This could be accomplished by using Rapoport's indices both as dependent variables and as independent or controlled variables. If experimental evidence warrants it, Rapoport's decision theory analysis may replace the simpler decision theory analysis presented in the introduction as the basis for predictions in the prisoner's dilemma game. Greater use of post-experimental questionnaires would shed some light on what is communicated to the subject by his opponent's strategy. Measuring player variables relevant to the game situation will probably remain the greatest obstacle to use of the prisoner's dilemma game in the study of two-person interactions.

SUMMARY

A decision theory analysis of the prisoner's dilemma game combined with research varying the payoffs in the prisoner's dilemma game lead to the prediction that player cooperation will be a function of opponent cooperation. Experiments varying opponent cooperation have not found this to be so. However, these experiments have not considered the possibility that a variation in average opponent cooperation is also a variation in the information communicated to the player. The ambiguity of this communication suggests that what is communicated will depend on the player's motivation. In addition, the actual amount of opponent cooperation which is communicated to the player will depend on the player's initial level of trust. The present experiment was designed to examine the hypothesis that the effect of opponent cooperation is a function of player motivation and trust.

The 71 Ss played 24 trials of the prisoner's dilemma game. One-half of the Ss played a highly cooperative opponent who cooperated on 75% of the trials. The other half played a highly noncooperative opponent who cooperated on 25% of the trials. One-half of each of these groups were instructed that their final score would consist of their own score plus one-

half their opponent's score, i.e. they were motivated to cooperate. The other half were instructed that their final score would consist of their own score minus one-half of their opponent's score, i.e. they were motivated to compete. Ss were assigned to high or low trust groups on the basis of an initial trust measure imbedded in a 12-trial familiarization game which preceded the experimental manipulations.

The results indicated that neither player motivation nor trust were related to the amount of player cooperation in this experiment. A secondary analysis suggested that more detailed attention should be given to both player and opponent strategies. In particular, the use of Rapoport's indices describing when the player will cooperate was suggested as the dependent variable in future studies. The problems which these indices present for the manipulation of opponent cooperation was also considered. Suggestions for improved methodology in future research were made.

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APPENDIX

TABLE A

Player Indices, in Degrees,[1] for High and Low Trust Subjects under all Four Treatment Conditions

	Indices							
	E_1	N_1	L_1	W_1	X	Y	Z	W
75 +½ H	35.09	27.70	33.70	30.16	29.41	12.00	33.98	24.29
+½ L	19.45	14.39	20.31	19.77	11.73	12.00	21.25	16.21
-½ H	25.24	13.91	30.24	21.98	14.33	6.43	27.72	21.90
-½ L	21.45	16.31	26.30	20.17	15.33	10.00	26.85	12.39
25 +½ H	18.65	10.31	16.28	14.59	22.50	8.16	18.98	16.02
+½ L	18.74	16.70	21.66	19.93	10.00	16.89	18.06	17.27
-½ H	24.42	16.66	27.80	25.01	8.16	16.25	20.80	28.54
-½ L	10.69	17.77	22.35	25.26	16.89	10.79	10.35	22.17

CODE - 75 = Cooperative opponent

+½ = Cooperative motivation

-½ = Competitive motivation

H = High trust

L = Low trust

25 = Noncooperative opponent

[1] Arc-Sine Transformation of Proportions

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