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Effects of Group Size and Communication Availability on Coalition Bargaining in a Veto Game

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This study examined the effects of manipulating the size of groups of male student negotiators and their ability to communicate with one another in a game in which one player held veto power (i.e., had to be included in any winning coalition). The predictions of three models, the core, the value, and the weighted probability model, were tested. The game, in which the veto player could form a winning coalition with any other single player, was repeated for a series of 10 winning coalitions (trials). Each variable had a significant main effect on the veto players' payoffs: Payoffs increased when group size increased, when communication opportunities were not available, and as the trials progressed. The effects for group size indicated significant differences between three-person groups and four-, five, and six-person groups, and between all of these groups and seven-person groups. The increasing payoffs over trials were significant in the no-communication conditions, but no significant increases occurred in the conditions in which communication was available. Combined with previous results, the findings appear to be quite consistent. The increasing payoffs for the veto player when communication opportunities were not available yielded the only support for the predictions of the core; the overall payoffs consistently supported the predictions of the value and the weighted probability model. All of the models, however, might benefit from modifications that incorporate the dynamic nature of coalition bargaining.

Recently, research on coalition behavior has begun to focus on the dynamics of veto games (e.g., Michener, Fleishman, & Vaske, 1976; Murnighan & Roth, 1977, 1978). Although Gamson's (1961) original definition of a coalition situation excluded conditions in which one player was a required member of any powerful coalition (i.e., a veto player), the dictates of the real world make the study of veto games considerably more relevant. Indeed, one does not have to look past the security council of the United Nations or the Organization of Petroleum Exporting Countries (OPEC) to realize the importance of veto games.

This study was designed to determine the effects of varying group sizes and communication opportunities on the outcomes and processes of a simple veto game. The game in this study required that the veto player find at least one coalition partner to share the 100 point payoff that was available on each of a series of trials. The nonveto players had two options: to attempt to form a coalition with the veto players or to attempt to form a blocking coalition including all of the nonveto players. The veto player, on the other hand, could deal with any of several players in trying to find a coalition partner, and as group size increased, additional partnerships became available. Murnighan and Roth (1978) investigated the effects of group size in such a game

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with size varying from 7 to 12 players. Their findings showed only a negligible effect due to group size. In an earlier study, however, Murnighan and Roth (1977) studied the analogous three-person game and reported payoffs to the veto players that were considerably lower than those received by veto players in the study of larger groups. With 3 players, the veto players' payoffs averaged approximately 65 of the 100 points; with 7 to 12 players, the payoffs averaged 89 points. Procedural variations between the studies make firm conclusions concerning the effects of group size impossible. Thus the present study varied group size from three to seven, overlapping the sizes in both previous studies and focusing on the area in which the most significant changes could be expected.

In his discussion of the applications of the weighted probability model, Komorita (1974) suggested that powerful players should have little difficulty in retaining their advantage if they could control the information and communication among the weaker players. In the games studied here, one player (the veto player) was powerful, and the others were relatively weak. Thus communication opportunities and information availability became important factors in the veto player's efforts to retain control. Previous research (Murnighan & Roth 1977, 1978) found that the sharing of information concerning which payoffs were being obtained had relatively little impact on the agreements that were reached. Thus Komorita's suggestion that keeping everyone uninformed may inhibit a union of the weaker players was not supported. Effects for communication, however, were consistent: When the players could communicate with one another, the veto players' payoffs did not increase; they did increase when the players could not communicate. As Komorita (1974) suggested, controlling communication channels allowed the powerful player to exert influence more easily. However, Murnighan and Roth (1978) also found that with groups that included eight or more nonveto players, even the presence of communication opportunities did not hamper the veto player's move for higher payoffs as the bargaining progressed. Instead, the data suggested (without reaching significance) that with either large groups or a lack of communication opportunities, the veto player's payoffs increased. Thus, the present study also focused on the effects of communication opportunities in an attempt to delineate their effects over what might be a more sensitive range of group sizes, at least for games in which veto players need to find only a single partner.

The core (see Luce & Raiffa, 1957), the value (Roth, 1977a 1977b; Shapley, 1953), and the weighted probability model (Komorita, 1974) all make static predictions in this situation. None of them explicitly considers the possibility of finding systematic changes in the veto players' payoffs over trials. Each of these models was tested in this study. Their basic assumptions and the predictions that result from these assumptions are briefly reviewed below, along with a short review of recent empirical tests.

The core is based on the concept of domination: An outcome x is said to dominate an outcome y if the members of a particular coalition H receive more at x than they received at y, and the members of coalition H are strong enough to achieve their payoff of x without help from any players outside of H. Thus in the games studied here, the veto player may form a coalition with another player whereby the payoff is divided 90,10 (i.e., 90 for the veto player, 10 for the nonveto player). This outcome is dominated by 95,5 outcome, which the veto player can obtain by forming a different coalition with another of the nonveto players. In this new coalition, the veto player's payoff increases from 90 to 95, while the new coalition partner's payoff increases from 0 to 5. This 95,5 payoff can also be dominated by a 99,1 payoff, which in turn can also be dominated. Thus the limit, in which the veto player receives the entire payoff, is 100,0 and is the only undominated outcome and the only outcome in the core.

When studies have allowed players to bargain over a series of trials, as in this study, payoffs in certain conditions have increased to the point at which they approach the core. Murnighan and Roth (1977), in their study of three-person groups, found increases in the veto players' payoffs in the no-communication conditions, even though the payoffs were

Table 1
Frequencies of the Different Agreements and All-Included Proposals

Group size	Communication availability	All-included agreements	Two-player agreements	Other agreements[a]	All-included proposals[b]
3	No	3	47	—	28 (2.8)
	Yes	11	39	—	45 (4.5)
4	No	0	48	2	8 (0.53)
	Yes	2	47	1	28 (1.86)
5	No	0	49	1	34 (1.7)
	Yes	1	46	3	26 (1.3)
6	No	0	50	0	24 (0.96)
	Yes	0	48	2	19 (0.76)
7	No	0	49	1	73 (2.43)
	Yes	0	50	0	72 (1.4)

[a] These included agreements between the veto player and more than one, but less than all, of the nonveto players.
[b] All-included proposals are only those made by the nonveto players. The number of all-included proposals per nonveto player over 10 trials is noted in parentheses. (There were five groups in each group size–communication combination.)

still considerably distant from the core. With larger groups, however, results in the no-communication conditions frequently approached the core (Murnighan & Roth, 1978). Murnighan and Szwajkowski (1979) also found increasing payoffs that approached the core in five-person games, particularly in the one game that duplicated the structure of the games studied here. Thus a behavioral interpretation of the core would predict that when there is little opportunity for collusion among the nonveto players, the veto players' payoffs should move toward the core.

The value (Roth, 1977a, 1977b; Shapley, 1953) and the weighted probability models (Komorita, 1974) make identical predictions for these games, predicting larger payoffs for the veto players as group size increases. The models, however, use different points of view to arrive at their predictions. As originally formulated by Shapley, the value of a game was presented as the unique outcome satisfying a certain set of (prescriptive) axioms. It has subsequently been shown (Roth 1977a, 1977b) that the payoff which the value assigns to each player can be interpreted as the expected utility of a risk-neutral player for playing the game. In games with constant payoffs for the winning coalition, the prediction for each player is computed by dividing the number of times a player's resources are "pivotal" (in the sense that a losing coalition is converted to a winning coalition by the addition of this player) by the total number of permutations of the players. For instance, in the three-person veto game studied here, the veto player is pivotal in all permutations that place him or her second or third in the ordering of players. The nonveto players are pivotal only when they are ordered second and the veto player is first. Thus, the veto player is pivotal in four of the six permutations of the three players; each of the nonveto players is pivotal once. The resulting payoff prediction is $66\frac{2}{3}$, $16\frac{2}{3}$, $16\frac{2}{3}$.

This prediction does not apply to a specific coalition or trial; instead it is a prediction of the average outcomes of the players over the entire game. For the games in this study, where a veto player needs only a single partner to form a winning coalition, the value predicts average payoffs of $100 - 100/n$ for the veto player and $100/n(n-1)$ for each nonveto player, where n is the number of players in the game. Thus the predicted payoffs for the veto players increase from $66\frac{2}{3}$ in the three-person groups to 86 of the 100 points in the seven-person groups.

Komorita's (1974) weighted probability model (WPM assumes that because of the difficulty of communicating offers and counteroffers and because of the number of potential defectors from large coalitions, coalitions with few members will form more frequently than coalitions with many members. In the current case, the model suggests that with more and more nonveto players it becomes increasingly difficult to obtain the unanimous support necessary to "block" the veto player. Details of the assumptions used to generate the model's predictions can be found in Komorita (1974); the WPM's predictions are identical to those of the value.

Previous research has shown mixed to positive support for the value–WPM predictions. (As in this study, they tend to be quite similar; this is not always true, however.) Murnighan and Roth (1977, 1978) noted overall payoffs that supported both models. However, increases in the veto players' payoffs over trials and interactions between the communication conditions and trials were not predicted by either model. In nonveto games, Murnighan (1978a) also found mixed support: The absolute predictions of the models were not strongly supported, but in the four five-person games studied, the models predicted the relative outcomes of the players very well. Michener et al. (1976) reported results that were close to those predicted by the models. Kahan and Rapoport (1976), also using nonveto games, found little support for the predictions of the value. And in a very recent study, Michener, Ginsberg, and Yuen (1979) found general support for the value in 16 four-person games; the core also received some support. Thus the present study, in testing these models over different communication conditions and a potentially critical range of group sizes, may shed additional light on the predictive ability of the models.

Method

Subjects

Subjects were 250 male undergraduate students at a large midwestern university. Participants volunteered for this experiment and received credit in a course on management and organizational behavior for their participation.

Design

The design manipulated three factors: group size, communication availability, and trials. Groups varied from three to seven members, with 10 groups of each size. Communication availability was manipulated by allowing half of the groups in each group size to exchange written messages, with no constraints on the content of the messages. Members in the remaining groups only exchanged proposed agreements (see procedure, below). Each group played the veto games for at least 10 trials. A trial was defined as an exchange of proposals that resulted in the formation of a winning coalition. Players were not told when bargaining would end. The three variables, then, constituted a completely crossed design, with two between-subjects factors (group size and communication) and one repeated factor (trials).

Procedure

The game was presented as a market consisting of three to seven players, depending on the group size for that session. For each trial in the game, the subjects were told that Player A (the veto player) owned a right shoe and that each of the other players owned a left shoe. Single shoes had no value but a pair of shoes (consisting of one right shoe and one left shoe) or combinations of one right shoe and several left shoes could be sold for 100 points. Thus no player acting alone could earn any income from the market, but any coalition of players that could assemble a pair of shoes could earn 100 points. Player A thus controlled a monopoly on right shoes. The game can be modeled in characteristic function form where $N = (A, B, C, D, E, F, G)$, $v(A) = v(X) = v(XX) = \ldots = O$, and $v(AX) = v(AXX) = \ldots = 100$, where X indicates one of the players in positions B through G, XX indicates two players in the positions B through G, and so on, and v indicates the value or payoff that the coalition identified inside the parentheses could obtain.

The participants were given written instructions that were also read aloud by the experimenter. The instructions presented the game and the following (summarized) information: "Your task is to bargain among yourselves to determine who will sell their shoes and how the sellers will divide their payoff. We will repeat this procedure several times, with each player assuming the same position each time."

Each player filled out offer slips that consisted of the choice of a bargaining partner and a proposed payoff division totalling 100 points. For example, if person X wished to form the AXY coalition, he addressed offers to both Persons A and Y and specified a division of the rewards (e.g., 50, 25, 25 for Persons A, X, and Y, respectively). For two-person coalitions, a player was required to send a single offer slip. For n-person coalitions, a player was required to send $n-1$ offer slips. In the latter case, players were instructed that the $n-1$ offers must be identical with regard to the proposed division of rewards. For example, they could not send an offer

Table 2
Mean Payoffs to the Veto Players in Each Condition

Group size	Communication availability	Trial 1	2	3	4	5	6	7	8	9	10
3	No	67.0	72.5	62.0	64.7	65.2	69.0	67.5	68.4	71.2	70.4
	Yes	54.1	60.7	61.3	59.9	63.9	59.0	50.7	55.4	54.5	57.9
4	No	78.6	76.7	74.6	74.6	79.3	83.0	85.8	85.8	85.8	80.8
	Yes	72.7	80.3	86.7	89.0	73.8	69.0	68.0	76.0	77.0	79.1
5	No	68.2	72.0	79.5	83.1	87.0	86.1	94.8	84.7	85.9	90.9
	Yes	68.2	79.0	71.0	70.8	76.0	78.9	67.0	65.0	73.9	68.3
6	No	66.0	83.0	91.2	85.5	88.0	89.8	91.0	90.1	91.2	92.5
	Yes	75.0	76.4	68.4	74.0	59.5	79.0	56.0	77.0	76.4	73.4
7	No	73.0	90.0	97.5	98.9	99.3	99.8	99.6	95.8	99.7	99.6
	Yes	83.0	75.0	83.0	71.2	78.0	70.8	74.0	78.9	85.1	88.5

to one person to form one coalition and a second, different offer to the other persons to form another coalition. This procedure allowed all coalitions to form in a single step. Although larger coalitions may have been more difficult to form, the only difficulty inherent in the procedure was the need to fill out several offer slips. After the players had completed their offer slips, the experimenter collected, examined, and distributed them to the proper persons. On receiving one or more offer slips, each player could accept at most one of the offers. An agreement was defined to be reached when an offer was accepted. However, when more than one offer was accepted, each player was bound to the offer he had made (i.e., if an offer was accepted, the player was held to his own offer even if he had accepted an offer for another agreement). The experimenter carefully explained to the players that if a left-shoe player received an offer from A and accepted it, he would be included in the winning coalition. In addition, A could ensure that an agreement would be reached by accepting a two-person offer from any one of the left-shoe players. If his own offer was rejected, his choice of the left-shoe players' offers would determine the agreement. In cases in which two players accepted each other's offers but the payoff divisions were different, the average of the two payoff divisions was awarded. For offers that included more than one player, all players receiving the offer were required to accept it if that coalition were to form. This procedure (originally used by Komorita and Meek, Note 1) was repeated for 10 completed trials. The players, however, were not told how many trials would be run. Following the offer-acceptance exchanges, the points won by each of the coalition members were announced. This often resulted in vocal exclamations by some of the players. The experimenter's instruction to formulate one's next offer usually quieted any commotion. In addition, none of the players seemed to communicate anything other than surprise in these situations.

In the communication conditions, the players could send any written messages they wished to any of the other players. In the no-communication conditions, no mention was made of the possibility for sending messages, and any attempts by the players to send messages were intercepted. After explaining these instructions, the experimenter presented several examples to insure that each of the participants understood the rules and mechanics of the game. Only after all the players expressed understanding of the entire set of instructions did the procedure continue. This instruction phase typically consumed 30 minutes.

The players were separated from one another by opaque partitions so that they could not determine the identity of any of the players in any of the positions, and no verbal communication was permitted. Players were randomly assigned to positions.

After completing the last trial, participants completed a short questionnaire. Following this, a detailed discussion of the purposes of the experiment was presented, and all questions of the participants were answered.

Results

Almost all of the agreements reached in the groups involved two players—the veto player and one nonveto player (see Table 1). Only 17 of the 500 agreements included all of the players, and over half of these were reached in the smallest size groups (3) when communication was available. Also depicted in Table 1 are the number of proposals sent by the nonveto players suggesting agreements that included all of the players.

Prior to inferential analysis of the data, distributional tests were performed to determine if the distribution of the veto player's payoffs exhibited homogeneity of variance or skewness. Previous research with similar data (e.g., Murnighan & Roth, 1978) had encountered difficulties in these areas. The current data also encountered distributional irregularities: The data were not homogeneous with respect to the different cell variances, and some of the cells exhibited marked skewness. Most of the unusual cells were in the seven-person, no-communication conditions, where many of the outcomes approached the core prediction of 100 points for the veto player. In several cells, all of the outcomes were above 99 of the 100 points, resulting in very small variances. In others, where four of the five outcomes gave the veto player more than 99 of the 100 points, the single discrepant outcome resulted in exaggerated skewness coefficients.

These points occurred in only two groups, on a total of four trials. In each case, the veto player demanded a very low payoff (e.g., 1 of the 100 points). Since these outcomes did not appear to conform with the instructions to subjects to maximize their outcomes, they were dropped from the sample. They were replaced by the outcomes obtained on the 11th and 12th trials for each of these groups.[1] This change removed some of the skewness problems. A log transformation [log(101 − x)] was then used to circumvent the distributional problems caused by heterogeneous variances. Data included in the tables, however, are means of the nontransformed responses.

The Veto Players' Payoffs

The veto players' payoffs were transformed and analyzed in a 5 (Group Size) × 2 (Communication Availability) × 10 (Trials) analysis of variance. Group size, ranging from three to seven, and communication availability were between-subjects factors; trials was a repeated factor. All three main effects were significant: For Group Size, $F(4, 40) = 10.69$, $p < .001$; for Communication Availability, $F(1, 40) = 19.21$, $p < .001$; and for Trials, $F(9, 360) = 6.67$, $p < .001$. Two of the two-factor interactions were also significant: For Group Size × Communication Availability, $F(4, 40) = 3.51$, $p < .02$; and for Communication Availability × Trials, $F(9, 360) = 5.89$, $p < .001$. Each of the cell means is shown in Table 2.

Table 3
Means of the Veto Players' Payoffs in the Group Size × Communication Availability Interaction

Group size	Communication availability: No	Communication availability: Yes	M	Value–WPM predictions
3	$67.8_{b,e}$	57.7_{c}	62.8	66.7
4	$80.5_{b,e}$	$77.2_{b,e}$	78.8	75.0
5	83.2_{b}	$71.8_{b,c}$	77.5	80.0
6	85.8_{b}	$71.5_{b,c}$	78.7	83.3
7	95.4_{a}	$78.8_{b,c}$	87.1	85.7
M	82.5	71.4		

Note. Means with common subscripts are not significantly different from one another at the .05 level using the Neuman-Keuls test. WPM = weighted probability model.

The main effects were all as predicted. The availability of communication resulted in considerably lower payoffs for the veto player, as expected (see Table 3). Payoffs increased over trials primarily from the first to the second trial (see Table 4). Planned comparisons between the means for each succeeding group size (see Table 3) indicated that veto players in the three-person groups received significantly lower payoffs than veto players in the four-person groups, and veto players in the seven-person groups received significantly higher payoffs than those in the six-person groups. No significant differences resulted among the four-, five-, and six-person groups.

The differences among the means (see Table 3) in the Group Size × Communication interaction (which was not predicted a priori)

[1] Each group participated for 90 minutes. Because of variable bargaining rates, some groups, including the two noted, completed more than 10 trials. To accommodate the analyses, only the first 10 trials were included (with this exception).

Table 4
Means and Simple Effects for the Veto Players' Payoffs for the Communication Availability × Trials Interaction

Communication availability	Trial 1	2	3	4	5	6	7	8	9	10	*M*	*F*	*p* <
No	70.6	79.0	79.0	81.4	83.8	85.5	87.7	85.0	86.8	86.8	82.5	10.90	.001
Yes	70.6	74.3	74.1	73.0	70.2	71.3	63.1	70.5	73.4	73.4	71.4	1.65	*ns*
M	70.6	76.7	76.6	77.2	77.0	78.4	75.4	77.8	80.1	80.1			

Note. Degrees of freedom for each simple F test were 9, 180.

were analyzed using the Newman-Keuls procedure. Results showed more marked increases in the veto players' payoffs as group size increased in the no-communication conditions, with a less gradual increase in the communication conditions. The only group size that resulted in significant differences for communication availability was the seven-person group, where a lack of communication opportunities significantly augmented the veto players' payoffs. In each of the other group sizes, veto players obtained higher, but not significantly higher, payoffs when communication was not allowed.

The Communication × Trials interaction was further analyzed using simple main effects. Results of this analysis indicated highly significant differences for trials in the no-communication conditions and no significant effects for trials in the communication conditions (see Table 4). It is noteworthy in discussing the Communication Availability × Trials interaction that each of the communication conditions started with the same mean payoff (70.6) on the first trial. Thus, subsequent differences were not a function of different starting points.

Goodness-of-Fit Test

In order to assess the accuracy of the models' predictions for the players' payoffs in the different coalitions, the following discrepancy index (Michener et al., 1976) was used in an additional analysis:

$$d = [\sum_{i=1}^{n} (O_i - P_i)^2]^{\frac{1}{2}},$$

where d = the discrepancy index, O_i refers to the observed payoff of individual i in coalition n, P_i refers to the predicted payoff for individual i in coalition n, and the summation is over the n players in each coalition that forms. A separate discrepancy score can be calculated for each coalition for the core prediction and for the value–WPM prediction. These two indices were used as dependent variables in a 5 (Group Size) × 2 (Communication Availability) × 10 (Trials) × 2 (Theories) analysis of variance, with Trials and Theories the repeated measures.[2]

All of the main effects were significant, as were the Size × Theories interaction, $F(4, 40) = 4.07$, $p < .01$; the Communication × Theories interaction, $F(1, 40) = 10.18$, $p < .01$; the Trials × Theories interaction, $F(9, 360) = 5.26$, $p < .001$; and Communication × Trials × Theories interaction, $F(9, 360) = 4.75$, $p < .001$. The main effects indicated that the value–WPM predictions were more accurate than those of the core, and that both sets of predictions improved as group size increased, as the trials progressed, or when communication was not available (see Table 5). The Communication × Trials × Theories interaction was probed by testing the simple effects at each of the levels of communication availability. In the communication conditions, the only significant simple effect was for theories, $F(1, 20) = 26.79$, $p < .01$, indicat-

[2] Comparable analyses were also conducted on indices that were similar to the discrepancy scores reported but had been divided by group size prior to analysis. There were no noticeable differences in the two analyses.

Table 5
Mean Discrepancy Scores for the Communication × Trials × Theories Interaction

Communication availability	Theory	Trial 1	2	3	4	5	6	7	8	9	10	*M*
No	Core	41.6	29.7	29.4	25.6	22.6	20.2	17.4	21.1	18.8	18.3	24.5
	Value–WPM	31.2	23.0	24.9	23.4	22.3	22.1	21.2	21.9	21.9	21.8	23.4
Yes	Core	41.1	35.9	35.9	37.7	35.8	39.5	45.1	40.4	37.1	36.2	38.5
	Value–WPM	30.3	27.3	29.1	31.3	28.4	30.9	33.5	30.7	29.4	29.0	30.0

Note. Lower scores indicate more accurate predictions. WPM = weighted probability model.

ing that the value–WPM predictions were more accurate in these conditions than the predictions of the core. No significant effects were noted for trials in the communication conditions.

In the no-communication conditions, the simple main effect for theories was not significant (indicating no overall advantage for either model), but the Trials × Theories simple interaction was significant, $F(9, 180) = 8.87$, $p < .01$. This effect was probed further by testing the simple effects for each theoretical prediction, again within the no-communication conditions. This analysis found no significant differences over trials for the value–WPM predictions, but did find a significant trials effect for the core predictions, $F(9, 180) = 4.41$, $p < .01$.

Thus as can be observed from the means in Table 5, the predictions for the core showed significant improvement over trials in the no-communication conditions. Indeed, there were no overall differences between the models in the no-communication conditions. This effect highlights the only condition in which the core's predictions were accurate: as trials progressed when communication was not available. The value–WPM predictions, on the other hand, were considerably more consistent and significantly more accurate than the core over all trials when communication opportunities were available.

The goodness-of-fit analysis was conducted to quantitatively compare the two models. Given the assumptions of the core and the value, however, the test was not completely appropriate. For this game, the core makes an extreme prediction (with the veto player obtaining the entire payoff) that realistically can only be expected to be approached. Thus, later trials are a more appropriate measure of the core's predictability (given its assumptions). The results do tend to be more supportive of the core in the later trials, at least for the conditions in which communication was not available. The core did not adequately predict the outcomes in conditions in which the players could communicate with one another.

The value, on the other hand, is most usefully interpreted as making predictions about the average outcome rather than predictions for a single trial (unlike the weighted probability model). Thus by forming an index based on the payoff distribution for each individual trial, the value was being submitted to a very conservative test. This is important if a quantitative comparison of the models is to be made. The value's consistently successful

Table 6
Frequencies of Core and Close-to-Core Outcomes in the Size and Communication Conditions

Group size	Communication availability: No 99+	No 100	Yes 99+	Yes 100	Total
3	0	0	0	0	0
4	6	0	3	0	12
5	5	0	0	0	5
6	4	0	1	2	7
7	27	7	2	0	36
Total	42	7	6	5	60

Table 7
Summary of Message Frequencies

Group size	Message frequencies: To veto player	From veto player	Nonveto collusive
3	41	38	71
4	56	42	151
5	94	81	216
6	101	68	203
7	152	115	396

predictions, then, are even more noteworthy.

A final test of the accuracy of the core can be pursued by considering the number of agreements that actually fell in the core (where the veto player received all of the 100 point payoff) and the number of agreements that fell reasonably close to the core. In previous research (Murnighan & Roth, 1978), "reasonably close" was arbitrarily defined as payoffs to the veto player of 99 points or more. Table 6 displays the frequencies of these outcomes. Most of the core and close-to-core outcomes occurred in the seven-person groups when communication was not available. Altogether, however, only 60 of the 500 agreements gave the veto player 99 points or more.

Effects of Message Content

Additional analyses were conducted on the relationship between the content of the messages sent and the bargaining outcomes.[3] In particular, messages were coded into one of three categories: from the veto player, to the veto player, and nonveto collusive. Messages to the veto player typically requested information (e.g., "How much do you want?") or proposed future agreements (e.g., "I'll give you 90 points on the next three trials."). Messages from the veto player tended to probe for future agreements (e.g., "Would you be willing to give me 85 on the next trial?") or to cement current partnerships (e.g., "I'm happy with our last agreements. Why don't we continue them?"). Nonveto collusive messages were exchanged by nonveto players who suggested cooperation among themselves to limit the veto player's payoffs (e.g., "Everyone propose a 20-point-each agreement. It's for our own good!"). Only 20 of the 1,845 messages did not fit into these three categories; these tended to communicate the frustration felt following unsuccessful attempts to either bargain individually with the veto player or to form a unified movement to oppose him.

Messages were counted for each trial; the frequency counts were then correlated with the other dependent variables, particularly the veto players' payoffs. A smaller frequency of messages was sent in the early trials. Correlations between messages to and from the veto player with his payoffs showed no significant effects. There was, however, a significant, but small, correlation between the frequency of nonveto collusive messages and the veto players' payoffs: $r(250) = -.11$, $p < .05$. There was considerable variation among group sizes for this correlation. Only in the five- and seven-person groups was there a significant correlation ($r = -.47$ and $-.39$, $p < .01$, respectively), indicating that with more collusive messages there were lower veto-player payoffs. In both cases, there were more collusive messages in these groups than might be expected from the frequencies observed in the other groups (see Table 7). In addition, there were more messages overall in these conditions (including those sent to and from the veto player). It may be that the volume of messages limited the veto players' abilities to bargain effectively.

Discussion

In comparing the data to the predictions of the core, the value, and the weighted probability model, it is clear that the core was not reached. But as stated earlier, this could not be realistically expected. However, the increases in the veto players' payoffs over trials, particularly in the no-communication conditions, and the extremely high payoffs

[3] Note that the term *bargaining* as used here refers to negotiations that determine both the membership of the winning coalition and the distribution of payoffs within that coalition. This kind of bargaining is therefore different from the "pure bargaining" studied by Roth and Malouf (1979), which involves no coalition formation.

received by the veto players in the seven-person, no-communication conditions attest to the applicability of the core in at least some of the conditions studied here. The present data suggest that with small groups or communication opportunities, the competitive play necessary to lead to the core may not be present. Only under fairly restrictive conditions are the core's predictions supported (at least for this game).

The value and the weighted probability model, on the other hand, were consistently accurate predictors of the outcomes of the veto players in the different sized groups (see Table 5), as they were in Michener et al. (1976). Although the expected differences between the four-, five-, and six-person groups did not materialize, the increasing trend of the veto players' payoffs as group size increased was predicted fairly accurately by both models. Their lack of consideration, however, of the effects of communication opportunities and trials indicates that the models might be altered to incorporate such effects. The current data, and other data recently reported (Murnighan & Szwajkowski, 1979), suggest that a melding of some of the current coalition models (cf. Murnighan, 1978b) to more accurately depict the processes of coalition negotiation might be appropriate.

The data replicated previous results very strongly. Each of the main effects had a considerable impact on the veto players' payoffs. In addition, two interactions were significant, indicating more than an additive effect for the independent variables. The effects for these variables, then, are quite striking.

Group size had a marked effect. As size increased, so too did the veto players' payoffs. The data do not show a consistent increase, but instead indicate a distinction between three-person groups and those larger and between seven-person groups and those smaller. From the veto player's perspective, this translates into a differentiation between dealing with two potential partners versus three or more, or dealing with six potential partners versus five or less. This might relate semantically to a difference between "a couple," "a few," and "several." Previous research (Murnighan & Roth, 1978) indicates that there are only minimal effects of group size when groups vary from 7 to 12 members, so the depiction of "several" may hold true for larger groups as well. There is a ceiling effect in these studies, however, that may limit the possibility for larger groups to display any noticeable effects.

The availability of communication also affected the veto players' payoffs. As with previous research (Murnighan & Roth, 1977, 1978), making communication opportunities available reduced the veto players' payoffs. Probing the bargaining process suggests some possible reasons why this particular effect occurs. Analyzing the veto players' demands indicates that just like their payoffs, demands increased over trials when communication was not available and remained constant over trials when communication was available. The main effect for communication for the veto players' demands was also significant. The presence of communication opportunities thus appears to lead to cautious demands by the veto players. These demands are in turn highly correlated with payoffs. Thus it may be that the nonveto players' efforts to block the veto players' payoffs do not need to be completely successful to have an impact.

Comparing the results of this study with the two previous studies (Murnighan & Roth, 1977, 1978) indicates many similarities. Although the large-group study used somewhat different procedures, particularly in relation to the exchange of messages, the data show no marked irregularities when the three studies are compared (see Figure 1). Indeed, the veto players' payoffs for three-person groups show little variation between this study and the payoffs reported by Murnighan and Roth (1977). The seven-person data show little variation from the seven- and eight-person data reported by Murnighan and Roth (1978). Figure 1 also documents the trends suggested by the (nonsignificant) three-way interactions noted in both studies. As group size increases with no communication, the veto players' payoffs increase markedly until they approach approximately 90% of the total payoff. As group size increases with communication, the veto players' payoffs increase less severely, but continue to increase past the point at which the no-communica-

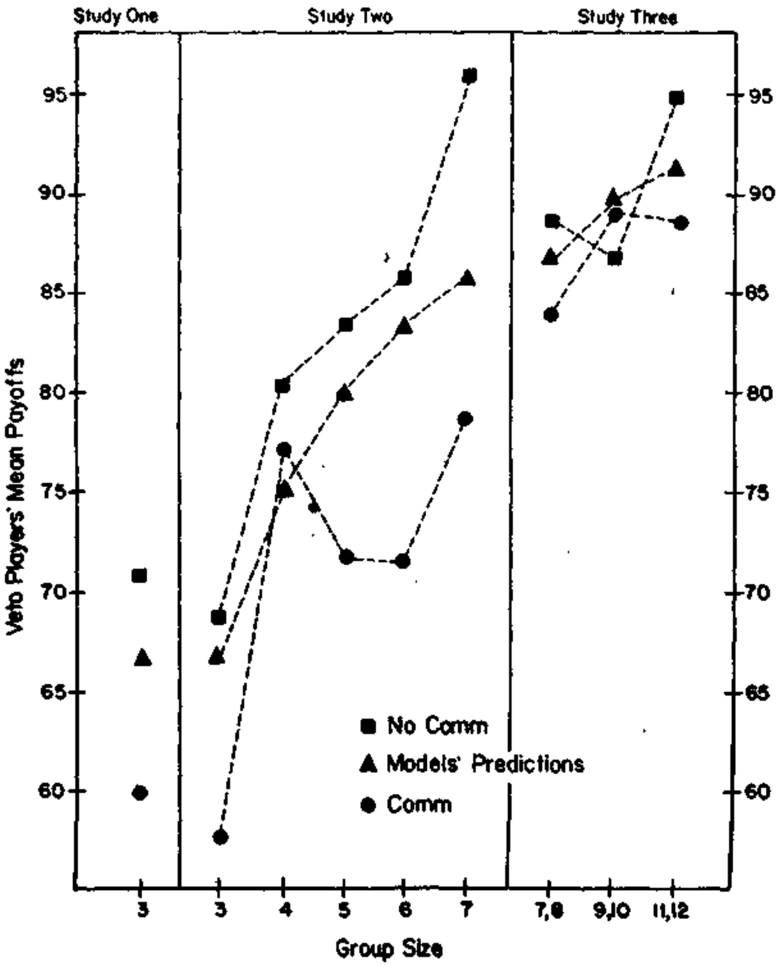

Figure 1. Veto players' mean payoffs in the size and communication conditions for three studies (including Murnighan & Roth, 1977, 1978) compared with the predictions of the value and the weighted probability model.

tion groups level off. Thus with no communication, there are marked increases for a short range of group sizes; with communication, increases are more gradual (but also more continuous) until both communication and no-communication groups reach an asymptotic level that approaches the entire payoff. Both the value and the weighted probability model make predictions that split the difference between these two curves (see Figure 1). In only two cases do the data points not surround the predictions. Thus not only are the data consistent among the three studies, but they are also consistent with these two models.

Conclusion

This article reports on the third in a series of studies on the effects of communication availability and group size in a veto game in which the veto player needs but a single partner to obtain a payoff. The data clearly document the impact that these two variables have on coalition bargaining. The data also document the strength of a party that holds veto power. With restricted communication and large groups, veto players wield considerable power. The studies discussed here indicate that communication opportunities among those dependent on the veto player can reduce the size of the veto player's payoffs; reducing the number of those players has a similar dampening effect. Future research that investigates the effects of more personal (e.g., face-to-face) interactions and the possibility for retribution, or at least continued interaction (cf. Roth & Murnighan, 1978), might be pursued to further delineate the factors that might reduce a veto player's power.

Reference Note

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