Stepwise disarmament and sudden destruction in a two-person game: a research tool

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A Method for Testing Propositions about Graduated Arms Reduction

The two-person, two-strategy game is fast developing a wide empirical literature. Of most apparent applicability to the problem of arms reduction are the prisoner's dilemma varieties of this game in which mutual cooperation yields rewards for both parties, mutual defection is detrimental to both, and unilateral defection is most highly rewarding to the defector but punishing to the single cooperator. So basic are the mixed motives in this game—for cooperating on one hand and competing on the other—that the game has become a basic tool for use in studying the parameters which underlie cooperation and competition and for analytical models useful in understanding the strategy of conflict.

Without denying the usefulness of these simple games, one may question their direct applicability to problems of the current arms race. There is of course the unavoidable question of how one may extrapolate results based upon a mock or game situation played between individuals in a laboratory to a situation existing between nations where the stakes are real and large. This question is discussed elsewhere, and will not be considered here (Quant, 1961; Rapoport, 1960). A second question, however, is whether the simple choice presented in these games, always between two alternatives, and the trial by trial progression of rewards and punishments contain a sufficiently realistic method for bringing into the laboratory several critical dimensions of the arms reduction problem.

Several investigators have met this second reservation by the construction of games which are specific simulations of real or imagined problems of inspection, surprise attack, and various deterrence arrangements. These simulations have generally been constructed with the assumption that only strategic considerations will enter into moves and some have assumed that the annihilation of the opponent is the positive and primary goal. One simulation which is particularly exciting because of the flexibility of its assumptions and the inclusion of numerous realistic features of political systems is the inter-nation game developed by

Guetzkow (1957). These games are rich simulators of the world scene and produce intriguing insights into the possible course of events in specific conflict situations.

In practice, these games also have a common limitation. Either they are played by computers in which the decision rules may be set at variance from live subjects, or they entail so much time and so much free variation in moves that replication becomes a difficult task.

The family of game situations presented here is related both to the simple prisoner's dilemma games and to the more complex simulations. These games are not intended as simulations of an entire problem in all its richness. Rather, they seem to permit a controlled introduction of several key dimensions of the arms reduction problem into game situations which are still simple enough to permit both replication and clear analysis of findings.

Most conflicts proceed through a series of moves and counter-moves with each party controlling his own moves and responding in accordance with the information he obtains about the other party's moves and the intention which he attributes to the other party. In most conflicts either party is capable of making a move which either increases or decreases the degree of threat cast upon his opponent. In addition, many conflicts move along with gradual increases or decreases in the level of threat until one party challenges the other to a showdown. The experimental game attempts to capture these features of two-party conflicts, and, in some forms, it attempts to deal with several additional features of the present disarmament dilemma. These include:

1. The possibility of weakening oneself to the point at which a surprise attack by the adversary would mean total and immediate loss.
2. The possibility of winning by reallocating military resources to economic ends.
3. The possibility of being detected in making reconversions back to military power.
4. The evaluation of weapons strength in terms of interrelated systems of weapons.
5. The dangers of accidental war.
6. The dangers of an escalation of threatening moves and counter-moves.

The games presented here are selected to illustrate the process in which complexity is gradually (in stepwise fashion) introduced into the experimental situation. Games B through G will each add one characteristic not found in the previous games. Games H and I describe the unique-resources game which is more than a single step beyond its predecessors. The remaining instances are offered to suggest more complex games which are designed to simulate more of the conditions inherent in the disarmament problem. Words like weapons, economic conversion, surprise attack, inspection and military showdown which are used in describing the games are intended only to make the games appear more concrete to players and to suggest a potential area of applicability.

The novel feature of expressing payoffs as long-term retribution for cooperative or competitive behavior holds a striking analogy to current international behavior. This is an area to which data on the conditions for resolution of the "prisoner's dilemma" have been widely applied. Negative retribution in the current international crisis is expressed in terms of one large and sudden mutual loss should the players not achieve an unknown criterion level of cooperative

moves. The game, however, is intended as a psychological experiment in the determinants of choice between a competitive and a cooperative response when both are available. The analogy is drawn freely but it is purely analogy and should be regarded as such. The only direct implications to nuclear-era international behavior contained in such studies is their clarification of the psychology of the above-mentioned choice.

THE EXTENDED PRISONER'S DILEMMA GAME (GAME A)

In this simple game two players are each given twenty tokens which represent resources. A token has two faces, W and E, and the side of the token facing up indicates the current allocation of the resource. W units represent military or weapon resources and E units represent economic resources. At the point of origin, all 20 tokens represent weapons. In a given move, a player may convert 1 or 2 W units to E units, or he may reconvert 1 or 2 units back to W units, or he may make no conversions. Moves may be either successive or simultaneous but they are made in secret.

At the end of twenty trials players reveal their terminal strength in W and E units. Payoffs are arranged such that:

(a) Both players are punished if both have retained full weapons strength.

(b) Both parties are rewarded if both have converted fully (to E units).

(c) Between these extremes, rewards will be assigned in accordance with the number of conversions achieved and the disparity between one's own weapon strength and that of the opponent. That is, conversions to E units will enhance one's gains while a disparity in W units will enhance the rewards of the party of greater power while punishing the weaker party in a degree proportional to the size of the disparity.

One formula for such a system of payoffs would be:

To the more heavily armed player (1)

$$20 - aW_1 + k\ (\frac{W_1}{W_2} - 1);$$

To the less heavily armed player (2)

$$20 - aW_2 - k\ (\frac{W_1}{W_2} - 1);$$

where a and k are positive constants

W_1 = Player 1's weapon strength

W_2 = Player 2's weapon strength

(Note that if $W_1 = W_2$, rewards increase to both in proportion to units converted.)

The use of this formula presents a feature often considered to be generic to disarmament in the nuclear age, viz., that the dangers of disarming may be greater in the late stages of the disarmament process than in the early stages.

The motives for making cooperative or competitive moves in this game match those of the prisoner's dilemma games. However, the new form offers opportunity for a quantitative measure of a degree of cooperativeness or competitiveness in a player's moves, indicated by the number of his economic conversions upon termination.

Obliging the player to make the decision about this number of conversions in a series of twenty sequential steps is intended to represent a feature commonly found in two-party conflicts, i.e., that payoffs frequently occur not after the individual cooperative or competitive act but after a series of such acts. The logical analysis of this procedure would be identical to that of a situation in which players made a single decision as to the proportion of conversions to be made. But the psychology differs. In instances where corrective information is totally absent, persons are still likely to change their anticipations regarding an opponent's behavior or to react to their own partial execution of a strategy.

The game offers several experimental possibilities. For example, varying the con-

stants in the equation offered for payoffs changes the relative importance of economic accumulation and military disparity.

THE RANDOM INSPECTION MODIFICATION (GAME B)

The game is an elaboration of game A. All that was said in the rules for game A applies here. In addition the experimenter will, at random intervals during the game, reveal the *W* strength of both parties. Naturally the frequency of inspection is an important variable.

The random inspection modification is an attempt to introduce, in controlled quantities, information about the other party's actions and opportunities for response to such information prior to the game's terminal point. The modification will permit a study of reactions to the discovery of various absolute and relative discrepancies in weapon strength between a player and his adversary. It should be noted that the introduction of this inspection procedure holds no single mandate for action by players. Rather, the prisoner's dilemma is reiterated in each response following an inspection. A player weaker in *W* units may take the inspection to mean either that he must rearm to avoid tempting his partner to defect further in order to accrue a wider margin, or that he can continue to disarm now that he has assured his opponent that he is not threatening him. The stronger player also may be motivated to keep defecting (trying for a greater edge) or, on the contrary, to keep disarming, feeling safe because of his edge. Disparities revealed by inspections may communicate aggressive intent, fear, caution, reassurance or invitations to reciprocate. The experimental dissection of these various communicated meanings is one possible use for the game described.

THE SUDDEN DEATH TERMINATION (GAME C)

This game is played in a manner similar to that of game B. The added feature is that immediately following any inspection, initiated at random by the experimenter, if the disparity between the *W* strengths of the two players exceeds a critical value the game will terminate immediately with all rewards accruing to the player with greater *W* strength. Critical disparity may be measured in either absolute or relative terms. In addition it is suggested that the decision as to whether a given disparity is or is not critical may be a probabilistic function, the greater the disparity the more likely that it will be deemed critical and result in sudden termination.

In real conflicts, exchange of information about relative power between adversaries is likely to include, among its possible consequences, the outbreak of violent conflict. Game C offers the situation in which the single defector from a cooperative pattern will gain immediate payoff at his opponent's expense upon the discovery of his opponent's weakness. This introduces a feature typical of some two-party conflicts in which payoffs for cooperation depend upon sustained cooperation while an aggressive desire for competitive advantage may terminate the relationship in short order.

THE PLAYER-INDUCED INSPECTION (GAME D)

This game, like game C, entails an automatic termination in favor of the player who has greater strength (by the critical amount) whenever such a disparity is revealed by inspection. However, the inspections occur not by a random procedure external to the players but at the request of either one of the players. Players must pay each time they exercise this option of calling for inspection. In real conflicts, an inspection of

the relative power of the two parties may, conceivably, be initiated either by conditions independent of the players' control or in a call for a showdown initiated by one of the players. Game D leaves the initiative for revealing of comparative strength to the players themselves.

It should be noted that the incentives for calling an inspection again entail conflicting motives. The desire for assurance in the safety of disarming may be as important as the desire for producing a military showdown. On the other hand, either fear of showing one's weakness or a desire to hide one's strength will militate against the initiative for inspection. The cost of inspection is an additional controlled variable.

THE WITHDRAWAL OPTION IN INSPECTION SHOWDOWNS (GAME E)

In this game inspections occur, as in game D, upon the request of either player, again at a cost to the initiator. In this form, however, the party not initiating the challenge may reject the inspection at a possibly greater cost. In such a case the inspection does not occur.

In real conflicts the call for an inspection which reveals relative power and which may thereby precipitate a showdown may sometimes by initiated by one party but declined by the adversary who would prefer to make some concession. The situation presents an excellent opportunity to observe tacit communications and possible misinterpretation of intentions. Just as the motives for initiation of inspection may be either aggressive or cooperative, the motives for declining may also vary. A player believing himself to be ahead slightly and intending to rearm may withdraw just as may a player who fears that inspection will reveal his weakness and result in sudden termination in favor of his opponent. On the other hand, since inspection offers an opportunity to check the opponent's strength, the same motives operate in the opposite direction.

THE ATTACK OPTION IN CASES OF WEAPONS DISPARITY (GAME F)

In this game the form of each previously described game is maintained. However, the detection of a disparity before the full series of trials has occurred does not automatically terminate the game. A showdown with a probabilistic result must still be initiated by either player. The player who has detected the disparity in his favor may elect to have the game continue. At this point it is important to introduce a feature which might well have been introduced in game C but which is crucial in this game to the maintenance of mixed motives in the decision to attack. A disparity in one's favor does not mean that one automatically wins in a showdown. Although favored by odds in proportion to the disparity, it is possible that one will lose in the showdown. In any event one loses the possibility of playing the game to a mutually advantageous resolution when one's partner seems to be demonstrating a willingness to do this. An unsuccessful attack which does not terminate the game may communicate aggressive designs forcing one's partner to rearm to the detriment of both players. Payoffs may be so arranged as to increase or decrease the desirability of risking an attack.

The separation of the attack from the inspection represents a feature which is important but sometimes neglected in models which assume that an attack will follow the revelation of certain critical disparities in power. The conditions under which the attack option is selected may be studied with this procedure.

THE PARTIAL INSPECTION GAME (GAME G)

This game incorporates all features of the

previous game but modifies the nature of an inspection so that it does not give a complete statement of the power of the players. It is possible to subdivide the resources of the original game into two separate zones with ten tokens in each. A player could then, during a single move, disarm or rearm in one of his two separated zones. At his own discretion, he could use one of the five alternative moves for converting, reconverting, or standing still in a single zone or in both zones. This differentiation into two zones is paralleled by an inspection which indicates the strengths of the players in only one zone at a time. A chance mechanism will determine, separately for each player, which zone is exposed at any given inspection.

In this game, only imperfect comparisons of power are possible. This compares to certain real conflicts in which one's own power is known and one's opponent's power is surmised from partial knowledge. The game holds obvious possibilities for experimental manipulation of inspection arrangements other than the two-zone inspection already described. It would be possible, for example, to have five separate zones, or even twenty, with inspection revealing the status of a given number of such loci selected either at random or at the discretion of the player requesting the inspection. The procedure offers possibilities for contrasting the relative effects of frequency vs. thoroughness of inspection in determining the propensity of parties to engage in open conflict.

Further Variations of the Stepwise Disarmament Game

SPECIFIC UNITS AND MODES FOR CALCULATING ADVANTAGE (GAME H)

The partial inspection game opens the doorway to games of increasingly complex strategy. Economic units and military units in this game acquire a location which is independent of their purely quantitative contribution to an individual's economic or military power. The division of units into locations makes possible the use of zones in providing not only for inspection, as in game G, but for computation of strength as well. For purposes of illustration we may take the extreme case in which each of twenty units has its unique identity, signified by a locus. This may be referred to as a unique-resources game. In addition, we may superimpose upon these resources a set of zonal groupings so that the tokens, numbered one through twenty, are grouped in sets of five. In this circumstance it would be possible to modify payoffs such that a balanced economy, one with economic units from each zone, might be more lucrative than an unbalanced economy with equivalent numbers of tokens converted to their economic side. The incentives for disproportional conversion to economic units may be arranged by introducing a complementary factor in the calculation of weapon strength, i.e., the grouping of weapons into systems. Each zonal grouping of weapons may be conceived as a regional grouping of nuclear weapons, delivery systems, trained personnel, etc., such that in the calculation of weapon strength an additional bonus is present for each intact weapon system. Naturally, the unique demarcation of each resource token would permit limited transferability such that some (and only some) deficiencies in a weapon system may be made up from weapon units in other regions, perhaps restricted to neighboring regions.

UNILATERAL INSPECTION AND INSPECTION VARIATIONS (GAME I)

The differentiation into specific locations vastly increases the number of inspection

procedures which would be of experimental interest. The idea of the partial peek is basic to all of these modifications.

The possibility of varying the ratio of inspections to conversions in the unique-resources modifications of the game may or may not produce results identical to those obtained by similar ratios in the simpler games. It would be interesting to observe and contrast the ways in which fragmentary evidence of defection is treated in games with increasingly flexible, and complicated, possibilities for strategy.

The occurrence of inspection may be initiated by several sources: (a) by fixed schedule, (b) by random mechanism, (c) by initiation of an individual player, and (d) by agreement of the players as in the case of the withdrawal option game. Similarly, the inspection may be of a single resource, of a fixed number of resources, of a zone of resources, of an entire board, or of locations to be agreed upon by the players themselves. It would be possible, in the more complex games, to remove the costs of inspections and to replace the player-initiated inspection with one which is as much a part of the player's move as is his conversion. A player might thereby inquire as to the status of any two locations of his opponent at each turn, gradually creating an image of the opponent's strength which he would use to guide his own decisions to disarm or to rearm. Since an opportunity for reconversion after an inspection is always possible, opportunities for creative gamesmanship are present. Mixed motives for and against fickle changes in resources can be preserved by allowing unchanged economic resources to earn interest after a given number of trials.

LIMITED WAR, LIMITED VICTORY, AND CONCESSIONS

A military showdown has, thus far, been considered either successful if a critical disparity is revealed or unsuccessful if it is not. In the real world, however, if certain types of destructive weapons are successfully controlled, a graded series of outcomes of a conflict may still be possible. The more complex games permit such a differentiation of outcomes following an attack. The differentiations may be stated in terms of payoffs reflecting the actual size of the disparity. In the specific-resource games with partial inspections, the disparity between the players is at best an educated guess and the attacker faces risks in addition to any artifactual risks which were included in the description of game F. It is possible to allow the attacker to retract upon the discovery that his disparity is less than the critical amount. A suitable cost for this may be the revelation to his opponent of one or more systems of weapons, i.e., his opponent gains an added degree of inspection. In addition, withdrawing an attack could result in the neutralization of certain resources —using them up—so that a turn otherwise used for making a conversion would be required for bringing the resource into circulation again.

It is also possible to grant options to the attacked player who may not want to see the attack result in a possible sudden termination of the game. Since the consequence of an attack is not known until the disparity is tabulated, it might be possible for an attacked player to offer his opponent a small but certain gain instead of a large and uncertain one. The gain could be in the neutralization of units or in the actual ceding of units to an adversary.

Lastly, it is possible that the attack may be initiated not on a total basis but by one zone of the attacker against one zone of the opponent. Here the possibilities of escalation enter and total war could result. In

principle, the conditions which produce escalation could be isolated and contrasted with conditions which terminate the conflict.

DIRECTION OF THE RACE AND SYMMETRY

In all the forms so far described, the game resembles a cooperative disarmament race; both parties hold maximal military strength at the onset and are capable of concluding the game with less military strength but not with more. There may be some basis to the argument that military capacity beyond a certain level serves no purpose in the tabulation of military power. Even if this were true, allocations for military power beyond such an optimal level may still occur as warnings of intention to an opponent or as reassurances to the side which is arming. If each player starts with a random selection of half of his resource tokens allocated as military units, the race may proceed in both directions. The proportion could vary from game to game to permit the testing of propositions about the conditions of onset which are most likely to produce violence. It is equally possible to give each player a different starting position, e.g., one with 70 percent weapons, the other with 50 percent.

Asymmetries, of course, need not be restricted to conditions of onset. It would be possible, for example, to offer different rewards to each player with one player's rewards *relatively* higher for a military victory (or for mutual economic conversion) than those of the opponent. One further asymmetry might be useful in simulating those asymmetries of power which are introduced by unequal technology or general geography in the case of real conflicts. This could be achieved by assigning asymmetrical weights to weapon systems such that one side loses more weapon strength by making some conversions than does the other.

NEGOTIATION AND PRIOR ANNOUNCEMENT OF MOVES

In the games previously described, communication has been restricted to the information implied in one's moves, i.e., converting, inspecting, challenging, or attacking. The conditions under which these moves are made were set by the original structure of the game. This need not be the case. It is possible to allow these conditions to vary (1) at the discretion of a player, as in the case where he chooses to increase the number of conversions he is allowed by offering in exchange increased inspection to his opponent, or (2) by negotiation between the players, as where several zones may be permanently demilitarized by mutual agreement. Almost all features of the game described previously may be considered fair possibilities for negotiation between the parties. Frequency and thoroughness of inspection are prime candidates. Experimental manipulations could allow one to study the effects of imposing certain limits on the range of values for negotiated agreements.

Perhaps the concept of trust is basically the notion that one's partner will perform in a reliable fashion after he has once given an indication of doing so. Similarly, distrust is probably more a function of unpredictability than of malevolence, although malevolence is often attributed to the partner whose indications of performance are unreliable. A simple method of expanding the communication between players would capture this aspect of the development, maintenance, and breaching of trust. Players could be permitted to announce their intention of making certain conversions before actually making them. Verification by unilaterally initiated inspection is always

possible in the opponent's next turn, but no new information is gathered if confirmation is obtained. Hence successive confirmations should increase belief in the opponent's announcements. The converse seems also true. It would be interesting to observe the proportion of accurate information necessary to create trust. It is also possible to initiate contingent promises of reciprocation and to test propositions about the proportion of times that an offer of reciprocation must be (a) promised and (b) fulfilled for mutual cooperation to result.

VARIATIONS ON THE CONCEPT OF VICTORY

The concept of a game, even a non-zero-sum game in which both parties may net gains, connotes a struggle in which one player is designated winner, the other loser, and there is no ambiguity in the identification of victor and vanquished. The concept of war, before the nuclear revolution, had similar connotations, although instances of a stalemate could be identified. In the game described, the concept of winnings earned through mutual economic conversion is a prominent feature. But how are such winnings received? Does a person who has won more than his opponent feel that he has won the game? Is the feeling the same if he has won identical rewards for a successful attack which has wiped out his opponent's winnings? Total victory has important psychological meaning. Even in games it offers something like a cathartic discharge of hostility against an opponent whose demise is one's sole objective. However, the costs of such satisfaction may be prohibitive.

It is possible to use the game situation to gain insight into the worth of the total victory feeling by manipulating payoffs and controlling opportunities for comparison of winnings. There is a sense in which absolute victory can be declared in the case of an economic resolution. It is possible to allow each game to continue to a final and absolute termination. For those games which are not terminated by an attack which decides the victor, the game may be terminated by the achievement of a criterion level of economic conversion; the player first converting is judged the victor and achieves a payoff identical with that for military termination. The game has its parallel in the real world where the cold war, conceived as a fight for ideological and economic leadership among neutral nations, may well be "won" by the side first rechanneling its extensive military allocation into economic and psychological frontiers. Be that as it may, the game when played for absolute victory has undergone a change which might well be formalized by a zero-sum game.

An absolute victory game may be contrasted, experimentally, with one in which the concept of victory is meaningless for an economic resolution, or for a military resolution, or for any resolution. Gains made from an economic resolution may be so arranged as to be both mutual and equal. Short of this, the rewards may be mutual but made not comparable as to size by artificial separation of the players. The number of moves allowed in the game may be extended to lengths not known to the players to discourage the incentive to competition which may result from the presence of arbitrary deadlines.

On the other hand, it is possible to accentuate the competitive aspects of economic resolutions and to make the results of a military showdown both equal and detrimental for both players. Sudden and equal loss automatically following the detection of a critical weapons disparity would permit this. It is often assumed that competitive

incentives are necessary justifications for non-competitive moves—i.e., improve education in order to beat the Russians. The manipulations suggest a way of studying the importance of such incentives in the laboratory.

N-PARTY GAMES AND COALITIONS

Much that has been said in the literature on small groups, on three-person games, and on coalition formation is applicable to an *n*-party variation of the stepwise disarmament game. The introduction of a third player makes possible a situation in which the balance of power is easily shifted. One of the intriguing possibilities opened up by the presence of the third player is the opportunity for playing the game without the presence of the impartial outside experimenter present in the two-person game. The function of the experimenter in the non-zero-sum game is to act as a banker who suffers losses when both players win and accrues savings when both lose. The three-person game allows a participant to play the bank; he can be hurt by a coalition between the other two. Having three simultaneous games, with each party a player in two and a banker in one, would offer many opportunities for collaboration, betrayal, reciprocation, and bargaining. If the games were not wholly separate but related by the method of payoffs, by the limitations on total number of inspections, or by the calculation of power advantage, an interesting array of games varying the degree of sovereignty or dependency of the players could be evolved. The same principles could be used in games with more than three players. The number of players, the nature of their alliances, the asymmetries of their resources, and the conditions for obtaining winnings offer possibilities for reproducing analogues of some complex problems of the cold war; yet the moves remain simple and easily coded and they stay within the paradigm presented by the original two-person prisoner's dilemma game.

THE NATURE OF THE PLAYER

Ambiguous and conflictful situations are conducive to expression of those deeper personality characteristics which are often concealed in situations set entirely by rules and roles. The same may be true in the behavior of larger social organizations or nations. The stepwise disarmament game is not ambiguous, but it is laden with conflict. The simple prisoner's dilemma offers a situation with clear alternatives leading to uncertain outcomes. Whether a given move proves beneficial or detrimental depends upon the opponent's move, and anticipations regarding the other person are a decisive factor in decision. The stepwise disarmament game magnifies the dilemma by repeating it in several circumstances and by making long-term dependence upon the partner's behavior a factor in obtaining delayed rewards. The essential conflict between cooperation and competition is present and is likely to bring out those individual characteristics which underlie a position of enduring trust or omnipresent suspicion. Some traits such as authoritarianism and internationalism have already been found to relate to performance in the simple prisoner's dilemma game (Deutsch, 1960; Lutzker, 1960). Others seem promising.

Personality characteristics, as currently measured, are notoriously poor prognostic indicators for group behavior. The group behavior here, however, takes place in a relatively simple game of strategy where the range of behavioral alternatives is restricted to several moves on each trial. The moves reflect integrative and disintegrative tendencies within the two-person or *n*-person

group, an important group variable, and yet are reasonably related to personality characteristics like anxiety level, tolerance for ambiguity, fear of failure, and risk preference. Since prior work with the prisoner's dilemma task does show a wide range of variability left unaccounted (after many group conditions have been systematically controlled) it does seem a worthwhile place to look for specific personality predictors of performance. The traits suggested are measurable by tests already in the literature. Interaction between such game conditions as the degree of secrecy of one's position or the severity of losses involved in a military showdown and such personal characteristics as tolerance for ambiguity and risk preference may be important predictors of the propensity for competitive, sudden-death strategies.

A Note on the Selection of Variables for Study

No single study could feasibly include all of the variables, and combinations of them, described for this game. A few principles for the selection of conditions for an experiment are offered as a beginning.

The single most important guide, relevance to the propositions being tested, is of limited value in a pilot study intended to develop a means for testing a wide range of propositions. Another consideration, however, is that the results or conclusions obtained can only be understood as well as the task on which they were obtained is understood. Trials with simpler games, comparable to those two-person two-choice games frequently studied, offer an opportunity for comparison of findings with those obtained on a known task. Each additional variation, when added to a previously studied situation, has a built-in basis for comparison with prior studies. This is of great use in the selection of parametric weights along which to vary conditions of the more complex games. Suggestions from results in simpler games may be a most economical way of making correct decisions about these parameters.

A further consideration in selecting variables is their suitability to a design offering controls which correct for the effects of unwanted artifacts of the experimental situation.

A third principle for selection is presentable only in heuristic terms. Even in a study which is not yet at the stage of hypothesis confirmation, certain questions are of major relevance to the inquiry for reasons of the curiosity of the investigator. A sample of such questions, all potentially answerable by these experimental games, is offered below:[1]

Is the party who is disarming more or less prone to call for an inspection than the party who is rearming?

Does more frequent inspection lead to a greater tendency to produce mutually beneficial results?

Are players likely to yield individual advantage in order to strive for advantage relative to the other player?

Is the desire to initiate an attack when one detects an advantage solely a function of the expected value of the attack?

Does the possibility of having one player incur sudden gain at the other's expense in-

[1] The questions are answerable by use of the game but the user should be forewarned that the answers are meaningful only for the conditions adequately sampled by the game. Literal interpretations of the terms "attack," "disarm," "inspect," etc., are not warranted and analogues suggested by the terms are indeed supplementary to interpretations of psychological behavior in conflict situations as studied directly in the experiment. This game approaches the larger social problems only from the more limited, psychological point of view.

crease or decrease the incentives to cooperate?

Does infrequent and/or incomplete inspection decrease the deterrent value of particular weapon disparities? If so, what sizes or ratios of disparity prevent showdowns with given degrees of inspection?

What are the effects of secrecy of position upon the likelihood of violent terminations in a two-party conflict?

Is frequency or thoroughness of inspection more effective in enhancing (or discouraging) cooperation?

Is the decision either to arm or to disarm affected by evidence against one's suspicion that an opponent is arming?

What must inspection reveal in the relative power of the two players to stop a mutual arms buildup which has already begun?

How would prior announcement of moves affect the propensity for violent showdowns (a) with all announcements proving honest; (b) with 20 percent of the announcements proving false?

How does the experience with resolution of prior conflicts affect the incidence of violent outcomes to two-party conflicts?

How are individual propensities to initiate (a) inspections, (b) attacks, related to such personality characteristics as risk preference, tolerance for ambiguity and isolationism-internationalism in attitudes?

One strategy for meeting these objectives is to start experiments with the simplest games in the order presented. The simplest experiment described here, game A, should be presented alone with numerous replications to check against results obtained with similar payoff matrices for the original prisoner's dilemma game. Following this a series of those games which add a single feature, games B through H, might be tried on a single population.

After completing studies of eight games, A through H, games can be designed to answer specific questions like those posed above. In each variation a sufficient number of games would be played to reveal:

(a) a stable ratio of cooperative to competitive resolutions;
(b) learning effects over blocks of trials;
(c) the effects of selected player characteristics upon the ratio of cooperative to competitive resolutions.

While it is premature to state a design to test specific hypotheses, the authors do have particular interest in the effects of absolute victory, of secrecy of position, and of prior announcement of moves upon the types of resolutions obtained. Manipulation of these variables would provide some opportunity for a laboratory test of the Osgood proposals for graduated reciprocation in tension reduction.

The possibilities for analysis in any experimental series of these games are numerous and several analyses will undoubtedly be suggested by examination. One form of analysis of apparent interest deals with the parameters underlying game outcomes. In most of its forms the game offers a choice of outcomes between resolution by a sudden military challenge by one party and resolution by a more gradual (economic conversion) process. Those variations of the game which preserve this choice of outcomes as a dependent variable could be contrasted to reveal the conditions which favor one type of resolution.

While the game may be played on an ordinary sheet of paper, game boards are being constructed which will (a) facilitate inspection, (b) provide immediate summaries of weapons strength for players, and (c) permit the experimenter to reconstruct the entire ordinal sequence of the game from the players' score cards. This opportunity for reconstruction of the responses will permit analysis of intermediary responses in the course of a game.

Summary

This article describes a method, i.e., an experimental game, which offers opportunity for control of several variables relevant to the resolution of two-party conflicts.

The game is one which is intermediate in complexity between intricate small-group simulations of international conflict and simple two-person two-choice games prominent in game-theory-inspired studies of cooperative and competitive behavior. In all forms of the game the contradictory motives imposed by the simpler prisoner's dilemma game are preserved. Mutual cooperation—or disarmament in this case—is beneficial to both parties. Mutual attempts to remain more powerful than an adversary are detrimental to both players and unilateral attempts to remain more powerful reward only the more powerful party by permitting exploitation of the disarmed party. A new feature of the game is that payoffs do not result from the outcome of a single move by the two players but rather from an extended sequence of cooperative or competitive moves.

The game is built up by a graded series of increasingly complex variations designed to include features which frequently appear in the course of real conflicts, whether between two persons or between nuclear powers engaged in a cold war. Forms of inspection permitting comparisons of behavior, and calls for showdowns via contests of power, are introduced with each new addition built upon a simpler form. In the most complex forms such features as negotiation between participants, the grouping of weapons into systems, and the waging of limited war are described to demonstrate the suitability of the game as a tool for gaining insights into the psychology of a stepwise disarmament process. Even in more complex forms the range of alternative moves remains simple enough to permit easy scoring and replication of the procedures.

This article contains a comparison of the game with other experimental games now in use. It includes a complete description of the elementary game and of an extended series of more complex forms, with suggestions regarding the possibilities which these forms offer for manipulation of important variables of the conflict process. Last of all, the article suggests some criteria for selection of problems for study with this method.

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