ences panel that reviewed the Condon Report. On the other hand, scientists who *have* looked closely at the data may come to be termed "UFOlogists" and held in disrepute. It seems that, in this business, you are damned if you do and damned if you don't!

As one can see from this volume, the UFO problem was not solved by the Condon Report, nor is it settled by this debate. The crux of the difficulty is perhaps that UFO reports have spawned not merely a problem but a heresy. It may be that concerned parties are not recognizing phenomena which are comprehensible in terms of present-day science (a view to which Menzel subscribes); or it may be that we are faced with a phenomenon which present-day science is unable to comprehend (a view to which McDonald would have subscribed). Modern heretics may not be consigned to the dungeon or the stake, but they could nevertheless call —with some justification—for less heat and more light.

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Dilemmas and Sure Things

Paradoxes of Rationality. Theory of Metagames and Political Behavior. NIGEL HOWARD. M.I.T. Press, Cambridge, Mass., 1971. xxiv, 248 pp., illus. $12.95. Peace Research Studies Series, 1.

"Free enterprise" is sometimes defended on the grounds that if everyone pursues his individual self-interest the result will benefit the collectivity. This simple economic notion has something of a counterpart in political thought, namely the idea of pluralism, where the "individuals" are special-interest groups rather than enterprises. Unfortunately the free interplay of political or economic actors need not lead to optimal results. A classic example of a nonoptimal outcome arises with nuclear armaments, where the actors are nations and where nonregulation leads to arms races and proliferation. We return to this example later. Another appears in Garrett Hardin's "The Tragedy of the Commons" (*1*), in which the self-interest that leads each individual to increase his herd finally renders the commons virtually useless to all for grazing (*2*).

The book under review confronts this dilemma of "individual rationality" at odds with "group rationality" on the level of highly abstract constructions called metagames. To move part way along the path to abstraction, consider the following gross simplification of an arms race: The actors are two nations, and it is assumed that each has two alternatives: to arm and not to arm. Individual national interest calls for arming, since if the other nation fails to arm the first can gain a diplomilitary advantage which outweighs the cost of arms, and if the other nation does arm then the arming of the first prevents unacceptable inferiority. Individual interest thus prescribes arming whatever you believe the other side will do. But if both nations arm the result is worse for both than if both decline to arm (*3*). This incompatibility between collective and individual rationality constitutes the second, and most celebrated, of Howard's three "breakdowns of rationality."

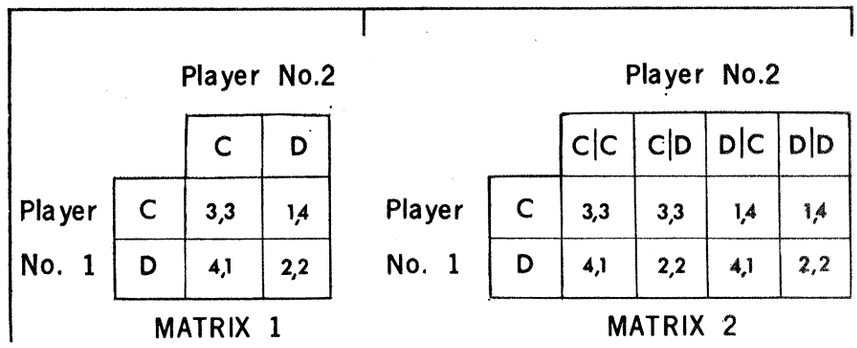
To resolve this paradox and to unify certain aspects of game theory, Howard introduces the concept of a metagame. Before defining metagames it is necessary to put in a word about games. To tie the discussion together, we shall use as a sample game one which has precisely the outcome-preference structure of the simplified arms race above.

A game in "normal form" has some number of players each of whom must choose one strategy from a set of available strategies. Choices are made simultaneously and privately. The particular alternatives chosen by the various players, taken together, constitute an "outcome." Players may have preferences among the outcomes. Thus in Matrix 1 (next page), player No. 1 chooses a row and player No. 2 a column. The cell so determined contains the respective "payoffs" to the two players. A payoff of "4" designates a player's most-preferred outcome, "3" is next best, and so on. This particular game is called Prisoner's Dilemma and (as promised) has the structure of the arms race model, above. The cell with payoffs 2,2 is an "equilibrium" because if either player unilaterally switches his choice from there the outcome is worse for him. This equilibrium is "deficient" or "group-irrational" because both players could simultaneously do better at the "group-rational" cell (3,3) which, however, is not an equilibrium; hence the dilemma and paradox.

"A *metagame* is the game that would exist if one of the players chose his strategy after the others, in knowledge of their choices" (p. 23). Thus for player No. 2 with Matrix 1, there would be four possible contingent strategies: unconditional C (choose C no matter what player No. 1 does), match player No. 1, do the opposite of player No. 1, and unconditional D. In Matrix 2 these strategies are denoted by C|C, C|D, D|C, and D|D, respectively, the letter before the vertical stroke indicating the response to No. 1's choice of C, the letter after it the response to No. 1's choice of D. This particular metagame is called the "2-metagame" (the "2" is for player No. 2) of Matrix 1; here Matrix 1 is called the "basic" game.

If now Matrix 2 is taken as basic and the 1-metagame is formed from it, we obtain a matrix with 16 ($=2^4$) rows, corresponding to all the ways of assigning C or D in response to the four alternatives for player No. 2 in Matrix 2. It is in this 16×4 second-order metagame, called the 1-2-metagame of Matrix 1, that the "second paradox" is resolved, for here there are no fewer than three equilibrium cells, two of which have the payoffs 3,3 and thus correspond to the cooperative or group-rational outcome in the basic game. Howard proves that no equilibria can be introduced or lost by ascending to still higher meta-levels.

Will it solve any political, or even philosophical, problems to know that the 1-2-metagame of Prisoner's Dilemma has an outcome which is both individually rational and group-rational? After all, players of a game—or real-



Matrix 1 represents the game known as Prisoner's Dilemma, in which the use of "individual rationality" leads to an outcome that is worse for both players than another outcome they could have attained (see text). The name comes from a classic example in which two suspects are taken into custody and separated. They are told by the district attorney that he does not have adequate evidence to convict them in a trial; that if neither confesses he will have them booked on a trumped-up minor charge with a one-year sentence; that if both confess they will both be prosecuted but he will recommend leniency (a five-year sentence); and that if one confesses and the other does not, the confessor will be released for turning state's evidence and the other will have the book thrown at him (ten-year sentence). (Note that strategy D is to confess.) Matrix 2 represents the "2-metagame" taken from Matrix 1.

life participants in a situation modeled by a game—must ultimately make decisions on the level of the basic game, not some abstract construction formulated by a nonplayer (nonparticipant) called a game theorist. This position has been argued by Harris (*4*).

In answer to this question, Howard presents three interpretations of what it means to consider progressively higher meta-levels. He says that the sequence game, 2-metagame, 1-2-metagame, and so on "may be traversed: (i) in the mental processes of a single player, as he reasons 'if I do this, he will do that; but if he is going to react in that way, I should do this . . . '; (ii) in the process of bargaining and negotiation between players; (iii) in the process of making physical moves in a crisis situation (e.g., a post-war 'Berlin crisis') with the object of conveying one's intentions to the other players" (p. 101). Real players, he argues, actually negotiate in terms of essentially metagame concepts. An example of second-level thinking is " 'If it were the case (I do not say it is) that my client could pay such and such damages, would you be willing to settle out of court?' " (p. 99).

Rapoport (*5*) calls this work a genuine "escape from paradox." To resolve a paradox, says Rapoport, one must find the logical error that leads to the apparent contradiction which constitutes that paradox. In this case one might simply "recognize that 'rationality' has two different, irreconcilable meanings in this context. Howard's metagame model goes farther. There the collectively rational strategy becomes also *individually* rational."

This interest in the mathematical transcending of a paradox is not Howard's central theme. In a reply (*6*) to both Harris and Rapoport, he stresses two points: that stability of outcomes is the crux of the theory, and that the theory is predictive or empirical, not normative. Though predictive, the theory "does not predict what players will do, but only what they will do under conditions of *stability*, i.e., when each somehow succeeds in predicting the other's choice."

The book treats many other provocative and significant points, which can only be touched fleetingly here: metagame analysis for individuals in a coalition in a game with more than two players; the relationship of "free will" to the concept of choosing a metastrategy; and perhaps most important the third, previously unnoted, "breakdown of rationality."

This third breakdown hinges on the notion of a "sure-thing strategy," one which is best no matter what you think the other player will do. Use of such a strategy might seem unimpeachably "rational." Now if one of two players has a strategy, then the second has an "induced" strategy, best for him under the assumption that the first plays his sure-thing. One might think that the resulting outcome would benefit the sure-thing player. This is true in the second meta-level of Prisoner's Dilemma but false at that level in other equally simple situations. In fact, says Howard, to be "rational" in the sense of choosing a sure-thing strategy "is to be a 'sucker' that capitulates entirely to the other side" (p. 181). I suggest that no one act on this advice without fully digesting Howard's arguments.

Mathematical and nonmathematical readers alike may want to know that rigorous proofs of theorems are given roughly "equal time" with examples and interpretative comments. Though parts of Howard's work have appeared earlier, in *General Systems* and in *Papers* of the Peace Research Society (International), much here is new and it is most helpful to have such a unified presentation of the subject.

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Understanding Sentences

Psychology of Reasoning. Structure and Content. P. C. WASON and P. N. JOHNSON-LAIRD. Harvard University Press, Cambridge, Mass., 1972. viii, 264 pp., illus. $10.

There are two distinct but related aspects to the meaning of the term "rationality." One has to do with overt behavior, the other with mental processes. Behavior is judged to be rational when it seems temperate or measured, as opposed to instinctive or impulsive. The first sense of rationality, while the more common, is actually derived from the second. It is based on the not always accurate assumption that complex mental processes lead to behavior that is temperate in nature.

The notion of rationality as it applies to mental processes is sometimes used quite broadly to cover all thinking and decision making, and some-