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# Some Remarks About Rationality

**Cover Page Footnote**

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# SOME REMARKS ABOUT RATIONALITY*

by

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1.    <u>Ambiguities of rationality</u>. The original  title of my talk, "The Limitations of Rationality," immediately raises some troublesome questions. If we knew what we intended to mean by "rationality" we might reasonably hope to become clearer about its "limitations." But both terms are unclear and "rationality" alludes to a vast range of topics.

In the context, <u>rational such-and-such</u> the second position can be occupied by 'belief,' 'action,' 'choice,' 'procedure,' 'person,' and many other words. Ignoring this plethora of related uses, I shall consider only some questions about rational <u>choice,</u> though glancing occasionally at related questions about rational <u>belief</u>. I would like to become clearer about what we mean and reasonably ought to mean when we approvingly distinguish some particular choice as "rational" rather than "less than rational" or even "irrational."

Borrowing a useful idea from Professor W.B. Gallie, we might call 'rationality' an <u>essentially</u> contested <u>notion</u>. This word and its cognates are almost always accolades of approval: except in certain advanced circles, engaged in transvaluing current values, it is a strong mark of esteem to be deemed to have chosen rationally. But there have longbeen strenuous disagreements about the proper basis for such praise: competing and opposed traditions still contest the possession of this important honorific.

2.    The <u>instrumental conception</u>. Bertrand Russell once said: "'Reason' has a perfectly clear and precise meaning [indeed!]. It signifies the choice of the right means that you wish to achieve.'It has nothing whatever to do with the choice of ends."[1] Suitably elaborated, this view reduces "Reason" or rationality to correct reasoning from accepted but unexamined premisses. Like so many of Russell's provocative <u>obiter dicta</u>, this one has the merit of being quite clear: the scope of rationality extends only to "right-- or shall we say, sufficiently satisfactory --<u>means;</u> the end in view is beyond rational criticism. Yet surely it is correct to condemn precautions against snake-bite when one has conclusive reasons for thinking that no snakes can be encountered? Not so if Russell's recommended use of rationality is accepted: carrying anti-venom is eminently reasonably if one fears, rightly or wrongly, to be bitten by a snake. (It is hard to imagine what "end" might be reasonably achieved by protection  against non-existent snakes--perhaps reduction of a neurotic's anxiety?)

This instrumental conception enjoins praise for some decidedly obnoxious undertakings: Hitler, given his monstrous "ends", would qualify as eminently rational, considering his efficiency in incinerating Jews and other "enemies of the Reich." (Would we be content to call Hitler rational but evil? Perhaps Russell would think we should do so?) Still more troublesome is the incidence of "practical inconsistency" between an agent's accepted ends, with realization of one end excluding the realization of the other. Are we to say that somebody buying air flights on planes simultaneously leaving for two places "rational" because he has chosen the "right" means to achieve each of mutually incompatible ends? If we allow ourselves to criticise ends, even on the strong ground of internal incoherence, we have jettisoned the

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engaging simplicity of the purely instrumental conception.

3.    _Rationality as a "concertina" word._ Rationality and its cognates might be called concertina words: sometimes they are contracted to refer to nothing more than valid reasoning: it is rational to do $M$, as a means to some stated end, $E$, on the instrumental view, when and only when $M$ is the most efficient way of achieving $E$ (probablities, utilities and disutilities having been calculated). This comes to identifying rationality with the correct use of logic. But "rationality" can also swell to paradox.

4.    _A more "hospitable" conception?_ Philosophers sympathetic with Aristotle's identification of rationality as what is essentially human, have sometimes offered somewhat broader and more expansive views of rationality, while not denying the relevance, so far as it goes, of "instrumental rationality." I shall briefly consider a few modern examples.[2]

In his delightful essay, "A Rational Animal,"[3] Gilbert Ryle interprets the ancient view that man is rational to mean that man is the animal able par excellence to exercise "thought." The interest of his view arises from the broad extension he assigns to "thought," finding it "in the most hospitable sense of the word" implicated in such distinctively human activities as playing games, producing and seeing jokes, striking bargains--and even feeling impatience or irritation (p. 419). I agree that such activities are distinctly human and will be ready to think otherwise only when I learn that Washoe, that paragon of chimpanzees, has uttered some epigram or convicted somebody of logical fallacy. Yet Ryle's conception is too 'hospitable' to be serviceable as a criterion for distinguishing within distinctively human performance between the rational, the less than rational, the irrational and the merely non-rational.

In similar vein, Richard Robinson, in his fine book, _An Atheist's Values_,[4] that deserves to be better known, claims that "the word 'reason' is our name for the ideal of thinking" (p. 105). So whenever we think well (probably in something less than Ryle's "most hospitable" sense of "think") we are necessarily being rational. But then what is it to think well? Robinson's notion, to which I am sympathetic, is unsatisfyingly uninformative.

Michael Oakeshott's lengthy essay, "Rational Conduct"[5] has for its epigraph Coleridge's remark that "The word _rational_ has been strangely abused of late times" and includes a severe castigation of un-named advocates of "rational agriculture," "rational diet," "rational dress," and the like.[6] His target is any kind of recommended conduct "in which an independently premeditated end is pursued and which is determined solely by that end" (p. 5). But what has Oakeshott to offer in place of what he sees as a deplorable reliance upon prior reasoning and the use of a "determinate, independent instrument" (p. 9)? Well, the following; "[T]he only significant way of using the word 'rational' in relation to conduct is when we mean to indicate ..._faithfulness to the knowledge_ of how to conduct the _activity_ we are _engaged_ in" (p. 20, italics in the original text). More succinctly, "practical human conduct may be counted 'rational' in respect of its faithfulness to a knowledge of how to behave well" (p. 26).[7]

I suppose a good tennis player knows how to play well and is "faithful to that knowledge" (tries to act on his knowledge?); and as much can be said for a good swimmer, a good drill sergeant, a good swindler, or a good anything-you-please. If "rationality" is to be synonymous with skill (for that is what Oakeshott's view seems to amount to) we hardly need that word. Rationality as "thinking well" or

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"behaving well"--here the concertina is at full stretch, producing that undifferentiated humming that used to be called "bombination".

5.     A modest suggestion. Let us start with the modest formula that action in the face of uncertainty or risk shall count as rational to the extent that it is supported by the agent's good reasons. (Needed distinctions and qualifications can be left for later.) If that unambitious and, I trust, unexceptional formula sounds circular, given the linguistic and conceptual connections between 'rational' and 'reason(s)', I would plead that the latter word has the advantage of being more specific and less mysterious than the former. It is to be hoped that however much our theories about the nature of rationality may differ, we have a sufficiently firm initial grasp, in some cases at least, of what should count as good reasons for a prospective action. I should be surprised if the articulation of the notion of a good reason for action presupposed analysis of the more controversial notion of rationality.

6.     Implicit reasons. An action is rational, I have urged, to the extent that it is supported by the agent's good reasons. In so saying, I did not wish to imply that an action properly qualifies as rational only if the doer has consciously and explicitly weighed the pros and cons of the action. Of course such prior deliberation frequently occurs, given the virtual impossibility of reaching defensible decisions in problematic situations fraught with complex and uncertain consequences. Yet it would be implausible to make prior deliberation a necessary condition for rational action.

To hold otherwise would commit us, paradoxically, to claiming that a beginner at chess, laboriously calculating consequences of his options, shows more rationality than the master playing at "lightening" speed and able post hoc to explain unhesitatingly the reasons that justified his choice of a move. Such retroactive reconstruction of sufficiently good reasons shows that the master player had good reasons for his choice, even though he had insufficient time for calculation and deliberation. Such "reconstructed" reasons need not be perfect or even the best that has been available: one remains rational even when choosing poorly, provided that the presumptively justifying reasons are relevant and sufficiently good not to be condemned out of hand.

Of course, acceptable reconstruction of implicit reasons needs to be distinguished from "rationalization." Sometimes that indefensible way of making thoughtless decisions look respectable after the act may be hard to distinguish from admissible retroactive reconstruction; yet we can sometimes adequately distinguish face-saving from genuine justification.

If I could, I should prefer to avoid admitting implicit reasons into the analysis of rationality, but I see no way to do so.

7.     A digression on "limitations." The absence of discussion about what is intended when the limitations of rationality are celebrated or deplored suggests that the notion is sufficiently clear for comment to be superfluous. I do not think so. I propose to approach the topic indirectly by introducing an analogy--which I trust may be more instructive than misleading--between a procedure of rational justification of action and the use of some mechanism. (This analogy has indeed played an important part in formulating ideals of perfect rationality.)

Consider some fairly simple machine, say a bicycle. We can usefully distinguish three related but distinct components in its operation. First, and most obviously there is the "machine itself," a complex of components ("machine parts") constructed to interact determinately in ways beyond the rider's control. Of course he

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can choose a gear, but what happens then to what has been called the "withinput"[8] is independent of the user's wishes. (Some people like to tinker with machines, turning them into something better or different--but that is another story.) Every machine, digital computers with their capacity to respond to a variety of "programs" not excluded, is essentially a deterministic system.

One obvious "limitation" is at once suggested by this glimpse of the obvious: the notion of a <u>universal</u> machine is incoherent. A sausage-machine might, I suppose, be so constructed that it also makes shoes (by a "shift of gears," as it were) but the notion of a machine that can do <u>anything</u> whatever boggles the imagination. To be a machine, or a mechanism, entails specialisation and, if one wants to say so, "limitation". But this necessary feature of all machine operation can hardly be regarded as a weakness or a defect: a machine intended to do everything would in fact do nothing.

Next, and equally obviously, no machine is self-operating, but requires an "input" of material and energy--and at some point the intervention of a fallible, unprogrammed <u>human</u> operator. (This applies to so-called "automated" factories as well as to our starting example of a bicycle.) Now the input, and especially its human component, cannot be "predetermined" as rigidly as the mechanism itself: a bicycle's manufacturer cannot and does not wish to prescribe where that bicycle will be driven or on what roads and cannot legislate about the rider's weight or skill. Of course, the character of the mechanism will imply certain constraints upon the "input" and the resulting performance (the "output"): too unskillful a rider will be unable to make the bicycle move and too obese a one will smash it. But such built-in constraints leave a relatively wide range of indetermination for input and output, to be decided by the accidents of use.

A similar point applies to the "output": the machine product will be a function, relatively indeterminate, of the predetermined "withinput" and the capriciously variable "input". Computer experts like to say, "Gargage in, garbage out": the most sophisticated computer can do no more than execute its built-in routines, using whatever inputs the intelligent or stupid program-writers have inserted. The French say it more pithily: "La plus belle dame ne peut donner plus ce qu'elle a"-- and the same applies to machines.

There is good historical precedent for stressing the analogy of desiderated rational procedures (regular ways of justifying actions or beliefs by good reasons) and mechanisms: one need only to recall the traditional conception of Aristotle's syllogistic as an <u>organon</u> (instrument), or Bacon's <u>Novum Organon</u>, or Descartes' <u>Method</u>, to recall the strong and persistent interest of the great rationalistic innovators in inventing formal and <u>routinized</u> procedures that would minimize the role of human "sagacity" and make proof--or even discovery as some have hoped--as easy as machine-minding. Such a "method" or "instrument" can quite properly be regarded as an intellectual <u>machine</u>, possessing the features I have previously emphasized. The point of inventing such a "machine" is to have a <u>predetermined</u> decision-procedure or algorithm, reproducible by human users, or embodied in some material mechanism, that can be relied upon to yield the desired outcome, with as little involvement of erratic human imagination and resourcefulness as may be feasible. Bacon, Descartes, Leibniz, and many others have shared the dream of an intellectual mechanism that could raise the powers of operators of modest talent to the level of the mechanism's inventor. (The creation of the differential and integral calculus, requiring only mediocre skill for its use, was a spectacular triumph for this formalistic program.) Today we can program any well-defined decision-procedure on a digital computer, whose use demands only the capacity to follow explicit instructions.

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But behind the computer there still stands the fallible unprogrammed human being who selects the machine input and, above all, interprets the significance of its output. And there's the rub!

8.     Cost-benefit analysis. The most widely used intellectual machine of our times is the so-called "cost-benefit analysis."[9] Many influential thinkers regard it as the supreme embodiment of rational action in the face of risk.[10]

The embodied algorithms differ, of course, from older principles of rational choice, in relying strongly upon subjective probabilities and utilities. Let us consider the following description of it:[11]

1. When we first encounter him in the decision-making situation, he [the decision maker] already has laid out before him the whole set of alternatives from which he will choose his action...

2. To each alternative is attached a set of consequences...

3. At the outset, the decision maker has a "utility function" or a "preference-ordering" that ranks all sets of consequences from the most preferred to the least preferred.

4. The decision maker selects the alternative leading to the preferred set of consequences...

It should be added that the "consequences" in question are intended to be graded according to their expected utilities, as measured by the product of the utility in view and the subjective probability of achieving it.

This piece of intellectual machinery is admirably simple: supplied with the actuarial values of all the alternatives to be considered (a breath-taking stipulation, to be sure)[12] the decision-maker need only perform the trivial task of adopting the action with the highest expected utility (or, in the case of a tie, any optimal action indifferently). This attractively simple instrument has the added charm of sufficient flexibility to admit any constellation of values, however bizarre.[13] No wonder that cost-benefit analysis (and its near relation, "systems analysis", "linear programming", and the like) has become part of the computerised technology of any corporation, ministerial agency, or public body that aspires to be modishly "rational". But the appearance of a final solution to the general problem of rational choice is a dangerous--one might say, a vicious--illusion: the price paid for the engaging simplicity of the caluclating mechanism is the endlessly controversial and informal--but still potentially rational!--deliberation that necessarily precedes the machine's application. All that determines the rationality of the final outcome has occurred in advance of the "formality of execution" by the cost-benefit calculation.

9.     Rationality in action: the case of the chessplayer. I propose now to consider some features of what may be the best available extended example of practical rationality--the familiar and instructive one of a good chessplayer's behavior--in order to strengthen the case against regarding "instrumental rationality" or its sophisticated modern elaboration of "cost-benefit analysis" as a suitable paradigm for rationality. For surely what good chessplayers do is as close to any ideal of attainable if imperfect rationality that we can reasonably entertain: compared with decisions made in the course of a chess match, the decisions made in private life,

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the market place or a law court are bound to appear as necessarily fumbling and unsatisfactory.

The relative determinateness of the chessplayer's task of playing rationally by finding the "best move" arises, clearly, from the arbitrary and perfectly precise constraints imposed by the "rules" of "play", that generate sequences of "legal" moves, normally too complex to permit exhaustive analysis. Indeed, it is easy to prove the surprising result that there must always be a "best" way to play, even if it is beyond human power to know what the optimal strategy is.[14] Thus the invariable outcome of any chess game with "best moves" on both sides must follow from the rules: a faultless encounter must always end in a win for White, a win for Black, or a draw--whichever of these is always the right answer.

But to know that this theoretical "solution" exists is of no help to an actual player, faced with a bewildering multiplicity of legal moves, beyond the powers of even a chess genius like Fischer to analyse exhaustively. If we assume no more than ten reasonable possibilities in general for each move (i.e. roughly three moves to be considered by White, each of them leading to three reasonable replies) the number of possible games lasting forty moves will be of the order of $10^{40}$ (one followed by 40 zeroes). It has been estimated that a million machines examining a billion such games each second and in constant operation since the solar system came into existence would by now have achieved only one ten-millionth part of the task of scrutiny![15] This mechanical mode of evaluation is clearly too preposterously difficult to be worth considering.

In the light of such considerations, one might reasonably conclude that Chess is too difficult a game to be played rationally. Yet vast numbers of human beings, of moderate intellectual capacity do manage to play the game with steady and deserved success. How, then, does a skillful player manage to perform this seemingly impossible task?

In answering this question, we can rely upon introspective evidence or, better still, upon the instructive "protocols" assembled and analysed in de Groot's pioneering book.[16] I have already said that a reasonably good player does not consider all the legal moves available to him and does not engage in extended sequential calculations of consequences except in especially "critical" junctures. Such essential simplification on the problematic situation requires what may be called a patterned or Gestalt-like perception of a given position: unless one is a mere beginner who "can't begin to imagine what should be done," one sees the relatively few "candidate-moves"[17] as salient possibilities against a highly structured background. The skilled player does not perceive a mere aggregate of squares occupied by pieces, but rather features describable in the distinctive (partly qualitative, partly quantitative) language of chess strategy and tactics: "a weak King," "a strong center," "batteries of pieces," "open files," and so on. Such a patterned grasp of the situation, reinforced by memories of parallel situations and their outcomes, distinguishes a few moves as alone worth consideration and rejects others as being, at least initially, unworthy of consideration.

Of course, a skillful player will proceed to calculate the likely consequences of each of the limited number of "candidate-moves," that are initially judged to be worth taking seriously. But in an actual game (by contrast with the protracted sessions in which masters aim at exhaustive analysis of "adjourned games") such analysis of anticipated consequences is necessarily truncated and incomplete. It is worth making the further point, familiar to any good player, that such analysis may well modify or radically transform one's analysis of the given position: attempts to solve the perceived problem is apt to change one's conception of the nature of the pro-

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blem. The process of rational choice is dynamic--to use a word that has perhaps been overworked in the literature.

The dynamic process of finding a rational solution to a problem of decision in playing chess does not and cannot occur in an intellectual vacuum: a chess player with a _tabula_ _rasa_, wiped clean of all preconceptions and preformed convictions, would almost certainly succumb in short order to a "Fool's Mate" or some comparably ignominious fiasco. Any moderately instructed player is strongly guided by memories of his own previous successes and failures and, still more importantly, by the sifted experience of whole generations of masters. The available tradition supplies defeasible general maxims, standardised routines for accomplishing particular sub-tasks, detailed models for the initial deployment of pieces (the "opening"), and much else. Such deliverances of a rich tradition can function as premises of the requisite "practical reasoning" and usually need not be questioned, but any of them can be questioned and p rhaps rejected in special cases. (We are far here from the unquestioned premisses of Russell's model.)

Such reliance upon traditional deliverances used in a not uncritical fashion, surely supplies the good chess player with "good reasons", however inconclusive, for his choice: it would be emininently unreasonable to ignore the available experience of past players, however fallible and defeasible the lessons to be drawn from them may be. It would be absurdly irrational to rely upon rediscovering for oneself the best and most promising ways of playing the Sicilian Defense (an opening that continues to produce a flood of relevant analysis and discussion by the masters).

The necessary reliance in such concrete exemplifications of practical reasoning on what might be called "indubita"--premisses stronger than mere presuppositions or working assumptions seems to me quite characteristic and typical of available instances of extended rational choice.[18]

10.   Practical rationality: the Cuban Missile Crisis. I turn now to an incomparably graver instance of practical rationality, the so-called "Cuban Missile Crisis" of October, 1962.[19]

The circumstances were as follows: The crisis, which brought the world to the very brink of a nuclear holocaust, arose during the second year of J. F. Kennedy's term as President. Soon after his inauguration he had, in an act that he later bitterly regretted, authorised the execution of the so-called "Bay of Pigs" expedition, that had been prepared and authorised by his predecessor: an invasion of Cuba by a force of some 14,000 Cuban refugees--armed and trained by the CIA and so in effect an American military operation. The subsequent fiasco, involving the total defeat of the expedition in no more than three days, worked incalculable harm to America's good name and to its influence in international affairs.

This disreputable and disastrous adventure set the stage for the still more serious events of October 1962. Although it had been known for some time that the Soviet Union was supplying Cuba with arms, American protests at ambassadorial and higher levels had been countered by explicit and categorical assurances that Russian military aid to Cuba was exclusively defensive in intent, supplied only to prevent a renewed attempt to invade Cuba and destroy its communist government--and hence constituted no threat to legitimate American interests. This build-up in Cuban military strength had in effect been condoned by Kennedy, although surveillance by U-2 unarmed planes continued.

In the middle of October, the position changed drastically, when the CIA gave Kennedy photographs showing that the Russians were actively installing missiles in

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Cuba. The missiles, first thought to number 30, though the estimate was soon raised to perhaps 40, were not yet fully assembled, but would be ready for operation in short order. They could not plausibly be regarded as anything but offensive weapons, since they included not only surface-to-air missiles ("SAM's"), which might perhaps be regarded as "defensive" but also, crucially, intermediate ballistic missiles with ranges of over 1000 miles. Their presence so close to the United States would reduce the "warning time" for an attack to a matter of a few moments; indeed their installation would effectively outflank the American radar system that had been constructed as a warning network against possible attack from continental Russia. To underline the seriousness of the situation thus impending, it should be noted that the new missiles were expected to increase the total Russian firing power by as much as 50%.

The situation was appallingly dangerous: each of the IBM missiles (as long ago as 1962) carried a warhead equal in destructive power to 30 or 40 Hiroshima atom bombs: the experts predicted that a "first strike" in a nuclear conflict between the two nations, inevitably followed by a retaliatory "second strike" would produce at least a hundred million casualities on each side! (It is hard to realise that we really were on the very brink of this global horror, which might have triggered by a miscalculation on either side: memory is mercifully short.) How, if at all, is it possible to behave "rationally" in the face of such an imminent catastrophe, unparalleled in history, with the very survival of the human race at grave risk?

What Kennedy actually did was to set up at once an informal group of high level advisors, identified as an ad hoc executive committee of the National Security Council (abbreviated to "EXCON"), that included Robert Kennedy, Macnamara (then Secretary of Defense), McCone (head of the CIA), Adlai Stevenson (then ambassador to the United Nations) and of course the Military chiefs. This group remained in almost continuous session for the crucial thirteen days until the crisis was eventually resolved by Khruschev's withdrawal in the face of an American "quarantine," a euphemism for a sea blockade and so, technically, an act of war against Russia.

After reviewing much of the available and copious literature, I am seized with admiration and gratitude for Kennedy's conduct in this terrible predicament, in which he alone could make the final decisions. In my judgement, he behaved throughout with admirable rationality, to which we may well owe our continued existence in this far from the best of all possible worlds. A detailed examination of what Kennedy actually did must surely show, once again, the enormous gulf between practical rationality in such situations and the available text-book models. Resisting strong and consistent pressure from the military advisors to resort to a "surgical strike" (i.e. to eliminate the missiles by aerial attack, using all the available time to find the best solutions that humane sagacity might recommend, deliberating refusing to take irreversible and potentially disastrous actions and, above all, showing an imaginative capacity to restructure the problem-situation, Kennedy managed somehow to help humanity to turn the most dangerous corner in its history.

I cannot give the Missile Crisis the detailed analysis that is still wanting--and that would require the Russian side of the story for full understanding. My purpose in recalling this grisly episode has been to illustrate the need for further attention, by philosophers and others, to the character of such complex decisions. We need to have a clearer and more acceptable conception of how persons, at their best, succeed in behaving in ways that may properly be praised as rational. I am convinced that the models of rational decision that should ultimately emerge from such study will differ substantially from those now available.

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*Revised and abbreviated transcript of a talk given at Brockport University College on March 10, 1977.

[1]Betrand Russell, Human Society in Ethics and Politics (London, 1954), preface. Similar dicta abound in the literature.

[2]Well-developed theories of what is sometimes called "substantive rationality" are hard to find. But see, for instance, J. D. Mabbott, "Reason and Desire" in R. F. Deardon and others, eds, Education and the Development of Reason (London, 19-72), pp. 320-331 for a discussion of the rationality of criticising ends.

[3]Gilbert Ryle, Collected Papers (London, 1971), vol. II, p. 419

[4]Richard Robinson, An Atheist's Values (Oxford, 1964).

[5]Michael Oakeshott, "Rational Conduct," The Cambridge Journal, vol. IV (1950).

[6]Oakeshott has an entertaining polemic against what he takes to be a prime example of the deplorable effort to empty the mind and get rid of conceptions, as exemplified in the Victorian design of bloomers, "an extraordinary garment affected by girls on bicycles" and touted as the "rational dress" for such occasions (p.4).

[7]Oakeshott continues: "'Rational' conduct is acting in such a way that the coherence of the world of activity to which the conduct belongs is preserved and possibly enhanced" (p. 20). An attractive but somewhat cryptic formula.

[8]David Easton, A Framework for Political Analysis (Englewood Cliffs, N. J., 1965), p. 114.

[9]This label is commonly used by economists for analysis of social choices; I am using it to fit all cases of rational choice.

[10]For an admirably clear and detailed exposition of this mode of analysis see R. C. Jeffrey, The Logic of Decision (New York, 1965).

[11]James G. March and Herbert Simon, Organizations (New York, 1958), pp. 137 ff. The authors do not accept the model.

[12]Restriction of the alternatives to some "reasonable" finite set raises some further difficulties about how and when to stop considering further options.

[13]To the objection that some economic analysis of recommended social action ignores considerations of, say, justice, an adherent of cost-benefit analysis will characteristically retort that individuals' "preferences" for some actions as more than others be treated as modifying their utility functions appropriately.

[14]Let a "strategy" for White (in game-theoretical style) denote a complete policy for playing the game, taking into account all possible replies by Black at every juncture. If there exists an optimal strategy for White (leading invariably to a win or a draw), he commits himself to that strategy and plays accordingly. If not, then for

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every first move by White, Black can adopt a strategy that defeats him. Thus with "best play" on both sides, there must be a single predetermined result (win for one, or a draw), the same in each case. For another indirect argument, see Morton D. Davis, Game Theory (New York, 1970), pp. 16-18.

15Based on a discussion in C. H. O'D. Alexander, A Book of Chess, (New York, 1973), p. 23.

16Adriaan D. de Groot, Thought and Choice in Chess (The Hague, 1965). The author persuaded a number of chess players, including masters, of varying degrees of skill, to "think aloud" while examining a number of selected situations chess positions. The records thus obtained were the "protocols" (supplemented by subsequent discussion with their producers).

17I take this expression from a valuable recent book by a grandmaster, which interestingly supplements de Groot: Alexander Kotov, Think Like a Grandmaster (London, 1971).

18Current efforts to simulate chess playing skill in computer programs sensibly ignore cost-benefit analysis, trying instead to incorporate the requisite knowledge of tactics and strategy to which I have alluded. Such programs try, although with only moderate success so far, to take account of the "patterned perception" and reliance upon maxims of play that I have emphasized.

19For an account by one of the principal actors, see especially Robert F. Kennedy, Thirteen Days: A Memoir of the Cuban Missile Crisis (New York, New American Library, 1969). In Graham T. Allison, Essences of Decision (Boston, 1971) a fuller account of the crisis is used to explore some controversial models of explanation of political decision-making. An essay that I have found particularly helpful is Alexander L. George, "The Cuban Missile Crisis, 1962," in A.L. George and others, The Limits of Coercive Diplomacy (Boston, 1971).

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