RATIONAL CHOICE AND THE STRUCTURE
OF THE ENVIRONMENT [1]

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A growing interest in decision making in psychology is evidenced by the recent publication of Edwards' review article in the *Psychological Bulletin* (1) and the Santa Monica Conference volume, *Decision Processes* (7). In this work, much attention has been focused on the characterization of *rational* choice, and because the latter topic has been a central concern in economics, the theory of decision making has become a natural meeting ground for psychological and economic theory.

A comparative examination of the models of adaptive behavior employed in psychology (e.g., learning theories), and of the models of rational behavior employed in economics, shows that in almost all respects the latter postulate a much greater complexity in the choice mechanisms, and a much larger capacity in the organism for obtaining information and performing computations, than do the former. Moreover, in the limited range of situations where the predictions of the two theories have been compared (see [7, Ch. 9, 10, 18]), the learning theories appear to account for the observed behavior rather better than do the theories of rational behavior.

Both from these scanty data and from an examination of the postulates of the economic models it appears probable that, however adaptive the behavior of organisms in learning and choice situations, this adaptiveness falls far short of the ideal of "maximizing" postulated in economic theory. Evidently, organisms adapt well enough to "satisfice"; they do not, in general, "optimize."

If this is the case, a great deal can be learned about rational decision making by taking into account, at the outset, the limitations upon the capacities and complexity of the organism, and by taking account of the fact that the environments to which it must adapt possess properties that permit further simplication of its choice mechanisms. It may be useful, therefore, to ask: How simple a set of choice mechanisms can we postulate and still obtain the gross features of observed adaptive choice behavior?

In a previous paper (6) I have put forth some suggestions as to the kinds of "approximate" rationality that might be employed by an organism possessing limited information and limited computational facilities. The suggestions were "hypothetical" in that, lacking definitive knowledge of the human decisional processes, we can only conjecture on the basis of our everyday experiences, our introspection, and a very limited body of psychological literature what these processes are. The suggestions were intended, however, as empirical statements, however tentative, about some of the actual mechanisms involved in human and other organismic choice.[2]

Now if an organism is confronted

[2] Since writing the paper referred to I have found confirmation for a number of its hypotheses in the interesting and significant study, by A. de Groot, of the thought processes of chess players (3). I intend to discuss the implications of these empirical findings for my model in another place.

with the problem of behaving approximately rationally, or adaptively, in a particular environment, the kinds of simplifications that are suitable may depend not only on the characteristics—sensory, neural, and other—of the organism, but equally upon the structure of the environment. Hence, we might hope to discover, by a careful examination of some of the fundamental structural characteristics of the environment, some further clues as to the nature of the approximating mechanisms used in decision making. This is the line of attack that will be adopted in the present paper.

The environment we shall discuss initially is perhaps a more appropriate one for a rat than for a human. For the term *environment* is ambiguous. We are not interested in describing some physically objective world in its totality, but only those aspects of the totality that have relevance as the "life space" of the organism considered. Hence, what we call the "environment" will depend upon the "needs," "drives," or "goals" of the organism, and upon its perceptual apparatus.

THE ENVIRONMENT OF THE ORGANISM

We consider first a simplified (perhaps "simple-minded") organism that has a single need—food—and is capable of three kinds of activity: resting, exploration, and food getting. The precise nature of these activities will be explained later. The organism's life space may be described as a surface over which it can locomote. Most of the surface is perfectly bare, but at isolated, widely scattered points there are little heaps of food, each adequate for a meal.

The organism's vision permits it to see, at any moment, a circular portion of the surface about the point in which it is standing. It is able to move at some fixed maximum rate over the surface. It metabolizes at a given aver-

age rate and is able to store a certain amount of food energy, so that it needs to eat a meal at certain average intervals. It has the capacity, once it sees a food heap, to proceed toward it at the maximum rate of locomotion. The problem of rational choice is to choose its path in such a way that it will not starve.

Now I submit that a rational way for the organism to behave is the following: (a) it explores the surface at random, watching for a food heap; (b) when it sees one, it proceeds to it and eats (food getting); (c) if the total consumption of energy during the average time required, per meal, for exploration and food getting is less than the energy of the food consumed in the meal, it can spend the remainder of its time in resting.[8]

There is nothing particularly remarkable about this description of rational choice, except that it differs so sharply from the more sophisticated models of human rationality that have been proposed by economists and others. Let us see what it is about the organism and its environment that makes its choice so simple.

1. It has only a single goal: food. It does not need to weigh the respective advantages of different goals. It requires no "utility function" or set of "indifference curves" to permit it to choose between alternatives.

2. It has no problem of maximization. It needs only to maintain a certain average rate of food intake, and additional food is of no use to it. In

[8] A reader who is familiar with W. Grey Walter's mechanical turtle, *Machina speculatrix* (8), will see as we proceed that the description of our organism could well be used as a set of design specifications to assure the survival of his turtle in an environment sparsely provided with battery chargers. Since I was not familiar with the structure of the turtle when I developed this model, there are some differences in their behavior—but the resemblance is striking.

the psychologist's language, it has a definite, fixed aspiration level, and its successes or failures do not change its aspirations.

3. The nature of its perceptions and its environment limit sharply its planning horizon. Since the food heaps are distributed randomly, there is no need for pattern in its searching activities. Once it sees a food heap, it can follow a definite "best" path until it reaches it.

4. The nature of its needs and environment create a very natural separation between "means" and "ends." Except for the food heaps, one point on the surface is as agreeable to it as another. Locomotion has significance only as it is a means to reaching food.[4]

We shall see that the first point is not essential. As long as aspirations are fixed, the planning horizon is limited, and there is a sharp distinction between means and ends, the existence of multiple goals does not create any real difficulties in choice. The real complications ensue only when we relax the last three conditions; but to see clearly what is involved, we must formulate the model a little more precisely.

PERCEPTUAL POWERS, STORAGE CAPACITY, AND SURVIVAL

It is convenient to describe the organism's life space not as a continuous surface, but as a branching system of paths, like a maze, each branch point representing a choice point. We call the selection of a branch and locomotion to the next branch point a "move." At a small fraction of the branch points are heaps of food.

Let p, $0 < p < 1$, be the percentage of branch points, randomly distributed, at

[4] It is characteristic of economic models of rationality that the distinction between "means" and "ends" plays no essential role in them. This distinction *cannot* be identified with the distinction between behavior alternatives and utilities, for reasons that are set forth at some length in the author's *Administrative Behavior*, Ch. 4 and 5 (5).

which food is found. Let d be the average number of paths diverging from each branch point. Let v be the number of moves ahead the organism can see. That is, if there is food at any of the branch points within v moves of the organism's present position, it can select the proper paths and reach it. Finally let H be the maximum number of moves the organism can make between meals without starving.

At any given moment, the organism can see d branch points at a distance of one move from his present position, d^2 points two moves away, and in general, d^k points k moves away. In all, it can

$$\text{see } d + d^2 + \cdots + d^v = \frac{d}{d-1}(d^v - 1)$$

points. When it chooses a branch and makes a move, d^v new points become visible on its horizon. Hence, in the course of m moves, md^v new points appear. Since it can make a maximum of H moves, and since v of these will be required to reach food that it has discovered on its horizon, the probability, $Q = 1 - P$, that it will *not* survive will be equal to the probability that no food points will be visible in $(H - v)$ moves. (If p is small, we can disregard the possibility that food will be visible inside its planning horizon on the first move.) Let ρ be the probability that none of the d^v new points visible at the end of a particular move is a food point.

$$\rho = (1 - p)^{d^v}. \qquad [2.1]$$

Then:

$$1 - P = Q = \rho^{(H-v)} = (1 - p)^{(H-v)d^v}. \qquad [2.2]$$

We see that the survival chances, from meal to meal, of this simple organism depend on four parameters, two that describe the organism and two the environment: p, the richness of the environment in food; d, the richness of the environment in paths; H, the storage capacity of the organism; and v, the range of vision of the organism.

To give some impression of the magnitudes involved, let us assume that p is 1/10,000, $(H - v)$ is 100, d is 10 and v is 3. Then the probability of seeing a new food point after a move is $1 - \rho$ $= 1 - (1 - p)^{1000} \sim 880/10,000$, and the probability of survival is $P = 1 - \rho^{100}$ $\sim 9999/10,000$. Hence there is in this case only one chance in 10,000 that the organism will fail to reach a food point before the end of the survival interval. Suppose now that the survival time $(H - v)$ is increased one-third, that is, from 100 to 133. Then a similar computation shows that the chance of starvation is reduced to less than one chance in 100,000. A one-third increase in v will, of course, have an even greater effect, reducing the chance of starvation from one in 10^{-4} to one in 10^{-40}.

Using the same values, $p = .0001$, and $(H - v) = 100$, we can compute the probability of survival if the organism behaves completely randomly. In this case $P' = [1 - (1 - p)^{100}] = .009$. From these computations, we see that the organism's modest capacity to perform purposive acts over a short planning horizon permits it to survive easily in an environment where random behavior would lead to rapid extinction. A simple computation shows that its perceptual powers multiply by a factor of 880 the average speed with which it discovers food.

If p, d, and v are given, and in addition we specify that the survival probability must be greater than some number close to unity ($P \geq 1 - \epsilon$), we can compute from [2.2] the corresponding minimum value of H:

$$\log (1 - P) = (H - v) \log \rho \quad [2.3]$$

$$H \geq v + \frac{\log \epsilon}{\log \rho}. \quad [2.4]$$

For example, if $\rho = .95$ and $\epsilon = 10^{-10}$, then $\log \rho = -.022$, $\log \epsilon = -10$ and $(H - v) \geq 455$. The parameter, H, can be interpreted as the "storage capacity" of the organism. That is, if the organism metabolizes at the rate of α units per move, then a storage of αH food units, where H is given by Equation 4, would be required to provide survival at the specified risk level, ϵ.

Further insight into the meaning of H can be gained by considering the average number of moves, M, required to discover food. From Equation 1, the probability of making $(k - 1)$ moves without discovering food, and then discovering it on the kth is:

$$P_k = (1 - \rho)\rho^{(k-1)}. \quad [2.5]$$

Hence, the average number of moves, M, required to discover food is:

$$M = \sum_{k=1}^{\infty} k(1 - \rho)\rho^{k-1}$$

$$= \frac{(1 - \rho)}{(1 - \rho)^2} = \frac{1}{(1 - \rho)}. \quad [2.6]$$

Since $(1 - \rho)$ is the probability of discovering food in any one move, M is the reciprocal of this probability. Combining [2.3] and [2.6], we obtain:

$$\frac{M}{H - v} = \frac{\log \rho}{(1 - \rho)} \frac{1}{\log (1 - P)}. \quad [2.7]$$

Since ρ is close to one, $\log_e \rho \simeq (1 - \rho)$, and [2.7] reduces approximately to:

$$\frac{M}{H - v} \simeq \frac{1}{\log_e (1 - P)}. \quad [2.8]$$

For example, if we require $(1 - P)$ $= \epsilon \leq 10^{-4}$ (one chance in 10,000 of starvation), then $M/(H - v) \leq .11$. For this survival level we require food storage approximately equal to $\alpha(v + 9M)$— food enough to sustain the organism for nine times the period required, on the average, to discover food, plus the period required to reach the food.[5]

[5] I have not discovered any very satisfactory data on the food storage capacities of animals, but the order of magnitude suggested above for the ratio of average search time to storage capacity is certainly correct. It may be noted that, in some cases at least, where the "food" substance is ubiquitous, and hence the search time negligible, the storage capacity is also small.

CHOICE MECHANISMS FOR
MULTIPLE GOALS

We consider now a more complex organism capable of searching for and responding to two or more kinds of goal objects. In doing this we could introduce any desired degree of complexity into the choice process; but the interesting problem is how to introduce multiple goals with a minimum complication of the process—that is, to construct an organism capable of handling its decision problems with relatively primitive choice mechanisms.

At the very least, the presence of two goals will introduce a consistency requirement—the time consumed in attaining one goal will limit the time available for pursuit of the other. But in an environment like the one we have been considering, there need be no further relationship between the two goals. In our original formulation, the only essential stipulation was that H, the storage capacity, be adequate to maintain the risk of starvation below a stipulated level $(1 - P)$. Now we introduce the additional stipulation that the organism should only devote a fraction, λ, of its time to food-seeking activities, leaving the remaining fraction, $1 - \lambda$, to other activities. This new stipulation leads to a requirement of additional storage capacity.

In order to control the risk of starving, the organism must begin its exploration for food whenever it has reached a level of H periods of food storage. If it has a total storage of $(\mu + H)$ periods of food, and if the food heaps are at least $\alpha(\mu + H)$ in size, then it need begin the search for food only μ periods after its last feeding. But the food research will require, on the average, M periods.

Thus, in terrestrial animals there is little oxygen storage and life can be maintained in the absence of air for only a few minutes. I am not arguing as to which way the causal arrow runs, but only that the organisms, in this respect, are adapted to their environments and do not provide storage that is superfluous.

Hence, if a hunger threshold is established that leads the organism to begin to explore μ periods after feeding, we will have:

$$\lambda = \frac{M}{M + \mu}. \qquad [3.1]$$

Hence, by making μ sufficiently large, we can make λ as small as we please. Parenthetically, it may be noted that we have here a close analogue to the very common two-bin system of controlling industrial inventories. The primary storage, H, is a buffer stock to meet demands pending the receipt of new orders (with risk, $1 - P$, of running out); the secondary storage, μ, defines the "order point"; and $\mu + M$ is the average order quantity. The storage μ is fixed to balance storage "costs" against the cost (in this case, time pressure) of too frequent reordering.

If food and the second goal object (water, let us say) are randomly and independently distributed, then there are no important complications resulting from interference between the two activities. Designate by the subscript 1 the variables and parameters referring to food getting (e.g., μ_1 is the food threshold in periods), and by the subscript 2 the quantities referring to water seeking. The organism will have adequate time for both activities if $\lambda_1 + \lambda_2 < 1$.

Now when the organism reaches either its hunger or thirst threshold, it will begin exploration. We assume that if *either* of the goal objects becomes visible, it will proceed to that object and satisfy its hunger or thirst (this will not increase the number of moves required, on the average, to reach the other object); but if *both* objects become visible at the same time, and if S_1 and S_2 are the respective quantities remaining in storage at this time, then it will proceed to food or water as M_1/S_1 is greater or less than M_2/S_2. This choice will maximize its survival probability. What is required, then, is a mechanism that produces a drive proportional to M_i/S_i.

A priority mechanism of the kind just described is by no means the only or simplest one that can be postulated. An even simpler rule is for the organism to persist in searching for points that will satisfy the particular need that first reached its threshold and initiated exploratory behavior. This is not usually an efficient procedure, from the standpoint of conserving goal-reaching time, but it may be entirely adequate for an organism generously endowed with storage capacity.

We see that an organism can satisfy a number of distinct needs without requiring a very elaborate mechanism for choosing among them. In particular, we do not have to postulate a utility function or a "marginal rate of substitution."

We can go even further, and assert that a primitive choice mechanism is adequate to take advantage of important economies, if they exist, which are derivable from the interdependence of the activities involved in satisfying the different needs. For suppose the organism has n needs, and that points at which he can satisfy each are distributed randomly and independently through the environment, each with the same probability, p. Then the probability that no points satisfying *any* of the needs will be visible on a particular move is p^n, and the mean number of moves for discovery of the *first* need-satisfying point is:

$$m_n = \frac{1}{(1 - p^n)}. \quad [3.2]$$

Suppose that the organism begins to explore, moves to the first need-satisfying point it discovers, resumes its exploration, moves to the next point it discovers that satisfies a need other than the one already satisfied, and so on. Then the mean time required to search for all n goals will be:

$$M_n = m_n + m_{n-1} + \cdots$$
$$= \sum_{i=1}^{n} \frac{1}{(1 - p^i)} \ll \frac{n}{(1 - p)}. \quad [3.3]$$

In particular, if p is close to one, that is, if need-satisfying points are rare, we will have:

$$M_n - M_{n-1} = \frac{1}{(1 - p^n)}$$
$$= \frac{1}{(1 - p)} \cdot \frac{1}{\sum_{i=0}^{n} p^i} \simeq \frac{M_1}{n}, \quad [3.4]$$

and

$$M_n \simeq M_1 \sum_{i=1}^{n} \frac{1}{i}. \quad [3.5]$$

Now substituting particular values for n in [3.5] we get: $M_2 = 3/2 \ M_1$; $M_3 = 11/6 \ M_1$; $M_4 = 25/12 \ M_1$, etc. We see that if the organism has two separate needs, its exploration time will be only 50 per cent greater than—and not twice as great as—if it has only one need; for four needs the exploration time will be only slightly more than twice as great as for a single need, and so on. A little consideration of the program just described will show that the joint exploratory process does not reduce the primary storage capacity required by the organism but does reduce the secondary storage capacity required. As a matter of fact, there would be no necessity at all for secondary storage.

This conclusion holds only if the need-satisfying points are *independently* distributed. If there is a negative correlation in the joint distribution of points satisfying different needs, then it may be economical for the organism to pursue its needs separately, and hence to have a simple signaling mechanism, involving secondary storage, to trigger its several exploration drives. This point will be developed further in the next section.

A word may be said here about "avoidance needs." Suppose that certain points in the organism's behavior space are designated as "dangerous." Then it will need to avoid those paths that lead to these particular points. If r per cent of all points, randomly distributed, are dangerous, then the number of available paths, among those visible

at a given move, will be reduced to $(1 - r)d^v$. Hence, $\rho' = (1 - p)^{(1-r)d^v}$ will be smaller than ρ (Equation 2.1), and M (Equation 2.6) will be correspondingly larger. Hence, the presence of danger points simply increases the average exploration time and, consequently, the required storage capacity of the organism.

FURTHER SPECIFICATION OF THE ENVIRONMENT: CLUES

In our discussion up to the present point, the range of the organism's anticipations of the future has been limited by the number of behavior alternatives available to it at each move (d), and the length of the "vision" (v). It is a simple matter to introduce into the model the consequences of several types of learning. An increase in the repertoire of behavior alternatives or in the length of vision can simply be represented by changes in d and v, respectively.

A more interesting possibility arises if the food points are not distributed completely at random, and if there are clues that indicate whether a particular intermediate point is rich or poor in paths leading to food points. First, let us suppose that on the path leading up to each food point the k preceding choice points are marked with a food clue. Once the association between the clue and the subsequent appearance of the food point is learned by the organism, its exploration can terminate with the discovery of the clue, and it can follow a determinate path from that point on. This amounts to substituting $v' = (v + k)$ for v.

A different kind of clue might operate in the following fashion. Each choice point has a distinguishable characteristic that is associated with the probability of encountering a food point if a path is selected at random leading out of this choice point. The organism can then select at each move the choice point

with the highest probability. If only certain choice points are provided with such clues, then a combination of random and systematic exploration can be employed. Thus the organism may be led into "regions" where the probability of goal attainment is high relative to other regions, but it may have to explore randomly for food within a given region.

A concrete example of such behavior in humans is the "position play" characteristic of the first phase of a chess game. The player chooses moves on the basis of certain characteristics of resulting positions (e.g., the extent to which his pieces are developed). Certain positions are adjudged richer in attacking and defensive possibilities than others, but the original choice may involve no definite plan for the subsequent action after the "good" position has been reached.

Next, we turn to the problem of choice that arises when those regions of the behavior space that are rich in points satisfying one need (p_1 is high in these regions) are poor in points satisfying another need (p_2 is low in these same regions). In the earlier case of goal conflict (two or more points simultaneously visible mediating different needs), we postulated a priority mechanism that amounted to a mechanism for computing relative need intensity and for responding to the more intense need. In the environment with clues, the learning process would need to include a conditioning mechanism that would attach the priority mechanism to the response to competing clues, as well as to the response to competing visible needs.

Finally, we have thus far specified the environment in such a way that there is only one path leading to each point. Formally, this condition can always be satisfied by representing as two or more points any point that can be reached by multiple paths. For some

purposes, it might be preferable to specify an environment in which paths converge as well as diverge. This can be done without disturbing the really essential conditions of the foregoing analysis. For behavior of the sort we have been describing, we require of the environment only:

1. that if a path is selected *completely* at random the probability of survival is negligible;

2. that there exist clues in the environment (either the actual visibility of need-satisfying points or anticipatory clues) which permit the organism, sufficiently frequently for survival, to select specific paths that lead with certainty, or with very high probability, to a need-satisfying point.

CONCLUDING COMMENTS ON MULTIPLE GOALS

The central problem of this paper has been to construct a simple mechanism of choice that would suffice for the behavior of an organism confronted with multiple goals. Since the organism, like those of the real world, has neither the senses nor the wits to discover an "optimal" path—even assuming the concept of optimal to be clearly defined—we are concerned only with finding a choice mechanism that will lead it to pursue a "satisficing" path, a path that will permit satisfaction at some specified level of all of its needs.

Certain of the assumptions we have introduced to make this possible represent characteristics of the organism. (*a*) It is able to plan short purposive behavior sequences (of length not exceeding v), but not long sequences. (*b*) Its needs are not insatiable, and hence it does not need to balance marginal increments of satisfaction. If all its needs are satisfied, it simply becomes inactive. (*c*) It possesses sufficient storage capacity so that the exact moment of satisfaction of any particular need is not critical.

We have introduced other assumptions that represent characteristics of the environment, the most important being that need satisfaction can take place only at "rare" points which (with some qualifications we have indicated) are distributed randomly.

The most important conclusion we have reached is that blocks of the organism's time can be allocated to activities related to individual needs (separate means-end chains) without creating any problem of over-all allocation or coordination or the need for any general "utility function." The only scarce resource in the situation is time, and its scarcity, measured by the proportion of the total time that the organism will need to be engaged in *some* activity, can be reduced by the provision of generous storage capacity.

This does not mean that a more efficient procedure cannot be constructed, from the standpoint of the total time required to meet the organism's needs. We have already explored some simple possibilities for increasing efficiency by recognizing complementarities among activities (particularly the exploration activity). But the point is that these complications are not essential to the survival of an organism. Moreover, if the environment is so constructed (as it often is in fact) that regions rich in possibilities for one kind of need satisfaction are poor in possibilities for other satisfactions, such efficiencies may not be available.

It may be objected that even relatively simple organisms appear to conform to efficiency criteria in their behavior, and hence that their choice mechanisms are much more elaborate than those we have described. A rat, for example, learns to take shorter rather than longer paths to food. But this observation does not affect the cen-

tral argument. We can introduce a mechanism that leads the organism to choose time-conserving paths, where multiple paths are available for satisfying a given need, without any assumption of a mechanism that allocates time among *different* needs. The former mechanism simply increases the "slack" in the whole system, and makes it even more feasible to ignore the complementarities among activities in programming the over-all behavior of the organism.

This is not the place to discuss at length the application of the model to human behavior, but a few general statements may be in order. First, the analysis has been a static one, in the sense that we have taken the organism's needs and its sensing and planning capacities as given. Except for a few comments, we have not considered how the organism develops needs or learns to meet them. One would conjecture, from general observation and from experimentation with aspiration levels, that in humans the balance between the time required to meet needs and the total time available is maintained by the raising and lowering of aspiration levels. I have commented on this point at greater length in my previous paper.[6]

Second, there is nothing about the model that implies that the needs are physiological and innate rather than sociological and acquired. Provided that the needs of the organism can be specified at any given time in terms of the aspiration levels for the various kinds of consummatory behavior, the model can be applied.

The principal positive implication of the model is that we should be skeptical in postulating for humans, or other organisms, elaborate mechanisms for choosing among diverse needs. Common denominators among needs may simply not exist, or may exist only in very rudimentary form; and the nature of the organism's needs in relation to the environment may make their nonexistence entirely tolerable.

There is some positive evidence bearing on this point in the work that has been done on conflict and frustration. A common method of producing conflict in the laboratory is to place the organism in a situation where: (a) it is stimulated to address itself simultaneously to alternative goal-oriented behaviors, or (b) it is stimulated to a goal-oriented behavior, but restricted from carrying out the behaviors it usually evinces in similar natural situations. This suggests that conflict may arise (at least in a large class of situations) from presenting the animal with situations with which it is not "programmed" to deal. Conflict of choice may often be equivalent to an absence of a choice mechanism in the given situation. And while it may be easy to create such situations in the laboratory, the absence of a mechanism to deal with them may simply reflect the fact that the organism seldom encounters equivalent situations in its natural environment.[7]

CONCLUSION

In this paper I have attempted to identify some of the structural characteristics that are typical of the "psychological" environments of organisms. We have seen that an organism in an environment with these characteristics requires only very simple perceptual and choice mechanisms to satisfy its several needs and to assure a high probability of its survival over extended periods of

[6] See (6, pp. 111, 117–18). For an experiment demonstrating the adjustment of the rat's aspiration levels to considerations of realizability, see Festinger (2).

[7] See, for example, Neal E. Miller, "Experimental Studies of Conflict" in (4, Ch. 14).

time. In particular, no "utility function" needs to be postulated for the organism, nor does it require any elaborate procedure for calculating marginal rates of substitution among different wants.

The analysis set forth here casts serious doubt on the usefulness of current economic and statistical theories of rational behavior as bases for explaining the characteristics of human and other organismic rationality. It suggests an alternative approach to the description of rational behavior that is more closely related to psychological theories of perception and cognition, and that is in closer agreement with the facts of behavior as observed in laboratory and field.

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