

theory. However, in the Stigler-Becker model, addicts feel no internal conflict about their addiction – they face no self-control problems. Their addicts would never utilize the services of Alcoholics Anonymous or Smokers Anonymous, would never buy their cigarettes by the pack instead of the carton in an attempt to cut down; in fact, they would never try to quit! In short, their model fails to describe observed behavior.

In conclusion, maximization theory is a useful tool for modeling human and animal behavior. Its constructs can also be used to model self-control problems, but only if more than one set of preferences is permitted.

NOTE

1. Rachlin & Green (1972) have shown that animals can learn to use a precommitment strategy if one is given to them. In their experiment pigeons were initially given a choice between (a) a large delayed reward or (b) a small immediate reward. The pigeons chose (b) in 95 percent of the trials. They were then offered an option (c) which would allow them to precommit to (a). This option was more likely to be used the further in advance of the rewards it was offered. This implies that the pigeons had a self-control problem and recognized it as such. As Rachlin and Green point out, one difference between human and pigeon behavior is that humans can invent their own precommitment strategies, while pigeons (presumably) cannot. In terms of the planner-doer model, the set of options available to a pigeon's planner is much more limited than for a human's planner.

Bliss points and utility functions

William Timberlake

Department of Psychology, Indiana University, Bloomington, Ind. 47401

The maximization theory proposed by Rachlin et al. has the following elements: (1) a multidimensional behavioral space in which each axis refers to a response (it is not necessary to limit the units of the axes to time); (2) a "bliss point" within the behavioral space that represents the subject's most preferred distribution of responding under the experimental conditions; (3) constraints on behavior within the space in the form of scheduled relations between responses, and fixed limits on times and responding; (4) a value (utility) function that assigns values to points in the space – the maximum value is at the "bliss point," and the values of other points decrease with distance from it; (5) an organism that behaves so as to reach the highest value point in the space, given the constraints imposed upon it.

The focus of this commentary is on the statement by Rachlin et al. that the maximization approach is meaningless and cannot be applied unless the utility function in (4) above is fixed and its parameters are constant. I will argue that (a) Rachlin et al. do not test this apparently vital assumption in their paper; (b) more than a little data, including some of their own, do not support this assumption; (c) a weaker form of the utility function assumption, when combined with an independent assessment of the "bliss point," generates most, if not all, of the qualitative predictions made by the authors.

In fairness to Rachlin et al., one must note that they do refer the reader to tests of utility functions in other papers; but their report of these test results is ambiguous. Given the avowed importance of fixed functions and constant parameters for their case, it seems important to report these tests in the present paper. Instead, their paper deals with qualitative effects derivable from weaker assumptions.

The assumption of a constant utility function is contradicted by data reviewed by Timberlake (1980). Several experiments have shown that animals under the same schedule ratio (the ratio of instrumental requirement, I, to contingent payoff, C), but with different absolute values of I and C, differ in their steady-state performance. The outcome cannot

be predicted if the utility function is fixed over constraints. Rachlin et al. themselves report unpublished data of Krasnoff (Figure 14) on drinking and eating in food-deprived rats that do not appear predictable from a constant utility function. Along similar lines, there is the authors' example of eating pie and whitewashing a fence. It seems quite possible that the value of this point (one pie, one fence) will vary with whether access to the pie or fence is provided first, unless the schedule intermixes the two responses by requiring that bites of pie must be alternated with swipes at the fence.

A weaker form of assumption (4) above is that there exist functions or sets of functions that produce concave, nonintersecting value contours around the bliss point. If the location of the bliss point is known, the qualitative effects reported by Rachlin et al., as well as considerable data mentioned in Timberlake (1980) and Staddon (1979), can be predicted. Even the effects of substitution might be handled by probable changes in the distance of the bliss point from a fixed constraint as a function of substitutability of the two responses, rather than by a sharp alteration in the form or constants of a utility function.

The key to employing this weaker utility assumption is the ready establishment of the bliss point. Fortunately there exists a well-tried method for establishing the preferred levels of responding of an animal using a paired or multiresponse baseline prior to the imposition of a constraint (Premack 1965; Timberlake & Allison 1974). The bliss point is measured prior to imposition of the contingency when all behaviors and their eliciting stimuli are freely and simultaneously available. Such a baseline typically results in reliable measures that can be recovered after the animal has been exposed to constraint conditions (Timberlake 1980).

Rachlin et al. appear to object to the above bliss point technique when they suggest in Footnote 4 that there may be molecular changes in the control of responding that makes the free baseline unrepresentative of the bliss point. For example, when food is presented intermittently, the animal may drink more than when food is freely available, either because competition with eating has been reduced (a likely explanation for Krasnoff's results) or because intermittent presentation elicits drinking (Rachlin et al.'s suggested explanation). In the case of decreased competition the authors' objection is moot. The baseline accurately reflects the most preferred combination of responding. In the case of increased elicitation, the result can be handled by assuming either that the bliss point or the utility function changes as a function of constraint.

However one solves the problem of changing elicitation with changing constraints, the free baseline remains a more accurate measure of the bliss point than Rachlin et al.'s proposal to index the bliss point by measuring instrumental responding while providing access to the contingent response at intervals determined by the subject's access under the contingency. This procedure is useful in determining if there is an associative effect of the schedule on instrumental responding independent of its effect in reducing the contingent response and providing periodic access (Timberlake 1979). It hardly reflects the subject's most preferred point in the behavioral space. If Rachlin et al. suppose this is an appropriate bliss point, they should show that it works with a utility function to predict the results of their experiments. When I tried this with some of my data, it didn't work.

The above arguments are not intended to invalidate the quantitative approach of Rachlin et al., but to call attention to the power of a weaker assumption about utility functions when used in conjunction with independent measurement of the bliss point. Even if one assumed a fixed utility function, independent assessment of the bliss point is still worthwhile, for it provides another test of the accuracy of the derived utility function. The maximum of the utility function

describing performance under schedules should coincide with the bliss point.

More attention to the bliss point might also clarify some misstatements by Rachlin et al., such as when they say "According to both maximization and reinforcement theories, behavior will change so as to increase reinforcement." From the above analysis, one must consider the relation of the bliss point and the constraint in predicting changes in responding. One can predict (and obtain) either increases, decreases, or no change in the instrumental response (and thus reinforcements) depending on the relation of the bliss point and the constraint (Timberlake 1980). The bliss-point approach also clarifies the potential advantages of the maximization approach over various forms of reinforcement theory, including the ability to predict the circumstances of reinforcement in a priori fashion, rather than depending on after-the-fact identification of the causal agent (a reinforcer) on the basis of its presumed results.

A last point on the tautology of maximization theories - all theories have tautologous aspects; a good theory also has some vulnerability to data. A potentially unfortunate trend in modern behavior theory has been to postulate imaginary dimensions or agents that cannot be independently measured and to describe their putative relation to behavior with increasingly complex mathematical functions. A possible antidote to this trend is to view maximization theories as equilibrium theories that emphasize a rationalistic approach in specifying the equilibrium, as opposed to identifying underlying physical or psychological forces or reactions. Viewed as equilibrium theories, maximization theories may become more vulnerable, not only in their ability to fit data, qualitatively and quantitatively, but, more importantly, in their proposed relation to forces and reactions presumed to underlie the equilibrium.

Reinforcement or maximization?

William Vaughan, Jr.

Department of Psychology and Social Relations, Harvard University, Cambridge, Mass. 02138

Rachlin et al. make a basic logical mistake, which implies that they have inadvertently made a methodological mistake. The logical mistake consists in assuming that consistency with indifference contours is equivalent to consistency with maximization theory alone. (They state, for example, that "Tests of maximization theory as a general theory will be tests of the constancy of such contours.") The maximization framework, however, is more general than the set of processes that lead to maximization of some variable. I have employed a maximization framework (Vaughan 1976) to account for behavior on single-key VI (variable-interval) and VR (variable-ratio) schedules, among others. The process, however, was assumed to be one of distributing time from locally-poorer to locally-richer situations, which we have termed melioration (Herrnstein & Vaughan 1980). I assumed that the value of situations was a joint function of rate of responding and rate of reinforcement. Thus, tests of the constancy of indifference contours may well fail to discriminate between maximization as a process and other processes that lead to qualitatively similar predictions, given certain schedules.

The methodological mistake, as suggested above, is that Rachlin et al. have failed to discriminate maximization theory from certain alternatives. Their straw man is reinforcement theory, narrowly construed. It is possible to deduce melioration from assumptions in terms of reinforcement (Vaughan in press); Rachlin et al. have thus simply demonstrated consis-

tency between a static maximization framework and a set of data. Platt (1964) suggests that science advances most rapidly when alternative hypotheses are elaborated and experiments are done to discriminate between them as clearly as possible.

Let me give one pertinent example of a case that I believe corresponds to Platt's strong inference. Rachlin (1973) suggested that on concurrent VI/VI schedules, birds match, because by doing so they are maximizing rate of food intake. We (Herrnstein & Vaughan 1980) report an experiment in which two VI schedules had zero slopes over most of their range, so that overall rate of reinforcement was largely independent of the distribution of behavior. Two distinct outcomes may be imagined. Since most distributions of behavior gave rise to the same overall rate of reinforcement, maximization, as construed by Rachlin, should predict a random distribution of behavior. Melioration, on the other hand, predicts matching, since it assumes that animals are basically sensitive to local rates, not overall rates. The birds did in fact match, an outcome Rachlin et al. do not directly address.

Since Rachlin et al. have an opportunity to respond to my commentary, I would like to hear whether they have a prediction regarding the outcome of a particular experiment currently underway. Birds are run on a Findley concurrent VI 3'/VI 3', the response key alternately red and green following pecks to the white CO key. We all agree that approximately half the time will be spent in the presence of red and green. In a second condition, superimposed on the original contingency, a VI 1' tape advances only while red is on. Any reinforcement it sets up, however, can only be picked up in green, following satisfaction of the changeover delay.

Under these contingencies, distributing more than half the time to red will increase the overall rate of reinforcement, while distributing more to green will decrease that rate. On the other hand, because the extra reinforcements are collected in green, the local rate in green is greater than the local rate in red, given equal distributions of time. Melioration thus predicts that more time should be spent in green than in red. Does maximization make a prediction?

Authors' Response

Howard Rachlin

Department of Psychology, State University of New York at Stony Brook, Stony Brook, N.Y. 11794

Ray Battalio

Department of Economics, Texas A&M University, College Station, Tex. 77843

John Kagel

Department of Economics, Texas A&M University, College Station, Tex. 77843

Leonard Green

Department of Psychology, Washington University, St. Louis, Mo. 63130

Maximization theory vindicated

We would like to express our appreciation for the generally friendly and constructive tone of the commentaries. We will try to be equally friendly and constructive in our Response. We will start with a few