

A cross-situational test of utility theory

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Rachlin et al. (1981a) adopt the view that if we assume that organisms maximize utility, we can construct a general and predictive theory of behavior. In fact, the authors suggest (see their Response, Rachlin et al. 1981b) that the maximization principle will lead to a concise but integrated account of schedule-maintained behavior, whereas the traditional text (Ferster & Skinner 1957) is a weighty, procedurally organized tome. There is a caveat, though. Rachlin et al. acknowledge that maximization theory's contribution depends on whether utility functions remain constant across different settings. As they put it, "Maximization theory is meaningless without fixed (or relatively fixed) utility functions" (1981a, p. 376).

Rachlin et al.'s concern is that if utility functions do not remain fixed, then maximization theory has no predictive value. Therefore, in order to establish the scientific usefulness of maximization theory it is essential to begin with a cross-situational test. The general strategy is to derive a utility function for one experiment (assuming maximization), and then use this function to predict behavior in a new experiment. The experimental settings will be operant procedures, and according to Rachlin et al., in this sort of environment utility consists of reinforcement rate, response costs, and time not occupied with instrumental responding (leisure).

Independent (Findley 1958) and interdependent (Fantino, Squires, Delbruck & Peterson 1972; Stubbs & Pliskoff 1969) concurrent variable-interval (VI) schedules provide environments that are especially convenient for evaluating maximization theory. First, consider the contribution of leisure and response cost. These two factors depend on the absolute response rate, with both reducing utility as response rate increases. Response rate is, however, constant in independent and interdependent concurrent variable-interval schedules. For example, if a subject shifted from a 2:1 to a 3:1 division of time between the component VI schedules, total response output would not change, it would simply be redistributed. This is a most helpful finding. If response rate is constant then neither leisure nor response cost contributes to changes in utility. Therefore, if utility changes it must change with changes in the nominal (measured) reinforcement rate. (In other words, in concurrent interval schedules, the maximizing solution does not depend on the tricky business of estimating the value of leisure for hungry rats.)

For the independent timer procedure, time allocations that approximate (but do not exactly equal) the obtained reinforcement proportions maximize overall reinforcement rate (Heyman & Luce 1979). That is,

$$T_1/(T_1 + T_2)_{\max} \cong R_1/(R_1 + R_2), \quad (1)$$

where R_1 plus R_2 sum to the maximum possible reinforcement rate. For the interdependent procedure, time allocations that fall about midway between .50 and the obtained reinforcement proportions maximize overall reinforcement rate (Heyman & Luce 1979).¹ That is,

$$T_1/(T_1 + T_2)_{\max} \cong \frac{1}{4} + \frac{R_1/2}{R_1 + R_2} = \frac{(3R_1 + R_2)}{4(R_1 + R_2)}, \quad (2)$$

where R_1 plus R_2 sum to the maximum possible rate and $R_1 \cong R_2$. It is important to note that these solutions (Equations 1 and 2) are general and show little variation as a function of subject and standard procedural differences (Heyman 1982). The argument so far, then, is that independent and interdependent schedules arrange different reinforcement-rate maximizing solutions but hold leisure and response cost constant. Therefore, if

subjects maximize utility, time allocation will vary as predicted by Equations 1 and 2.

Baum (1979) compared performance in the two procedures. On the basis of over 100 sets of data, he concluded that subjects did not allocate time differently in independent and interdependent procedures. Under both contingencies, time proportions approximated reinforcement proportions. Put somewhat differently, time allocation was independent of the overall reinforcement-rate contingencies. This is an important finding, and it implies that it is not possible to construct a fixed-utility function for independent and interdependent schedules (as long as overall reinforcement rate is in the equations).

In their commentary Baum & Nevin (1981) described somewhat similar results for concurrent variable-interval, variable-ratio (conc VI-VR) schedules. They argued that the discrepancy between reinforcement-rate maximization and performance in conc VI-VR schedules was too large to be accounted for "without making ad hoc and unrealistic assumptions about the value of 'leisure'" (p. 390). Rachlin et al. responded that performance in conc VI-VR was compatible with the utility functions:

$$U \cong C^{.01} + 4L^{.01}, \quad (3)$$

where U is utility, C is reinforcement rate, and L is leisure time. However, the exponent .01 drives the utility of reinforcement to approximately 1.0 independently of the reinforcement rate. For example, according to Equation 3, a hungry rat assigns about the same amount of utility to the following two packages: 10 feedings an hour at 10 responses a minute and 100 feedings an hour at 40 responses a minute. This prediction indicates that Equation 3 is not a realistic model.

Although the maximization assumption fails, it should be remembered that the empirical content and much of the theoretical content of Rachlin et al.'s target article does not depend on any particular view of individual psychology (see the commentaries of Herrnstein 1981 and Vaughan 1981 for discussions of this point). This suggests that one of Rachlin et al.'s major points may prove true; a healthy synthesis of behavioral psychology and portions of economics will emerge. However, the available data indicate that this synthesis will substitute the matching law, which is an equity principle, for the utilitarian maximization rule.

NOTE

1. There are two different ways to arrange an interdependent schedule (Fantino et al. 1972; Stubbs & Pliskoff 1969). However, the effective contingencies are nearly identical so that Equation 2 closely approximates the reinforcement-rate maximization solution for both. The different arrangements are described in Heyman (1982).