

Induction effects during a schedule of response-independent reinforcement*

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The role of response function in maintaining behavior during the delivery of response-independent reinforcers was examined. Rats were trained on two-component multiple schedules. One component was associated with response-dependent reinforcers for all rats and the second component was associated with a schedule of response-dependent or response-independent reinforcer delivery or extinction. The rats exposed to each of the multiple schedules initially developed responding in both components, but sustained responding occurred only in the components where reinforcer delivery occurred. These results suggest that response induction does not alone account for the sustained responding in response-independent reinforcer components of multiple schedules.

Several paradigms have been used to investigate the effects on responding of positive reinforcers delivered independently of responding. In the first of these, response rate reduction occurs if relatively extensive training is first given with schedules in which response-dependent reinforcers are then delivered independently of responding (Herrnstein, 1966; Rescorla & Skucy, 1969; Zeiler, 1968). Another paradigm involves introducing response-independent reinforcers following a minimal conditioning history with response-dependent reinforcers. Skinner (1948) reported the development and maintenance of stereotyped "superstitious" behaviors in pigeons by providing access to grain after fixed periods of time. Neuringer (1970) sustained keypeck responding of pigeons during schedules of response-independent reinforcer delivery following the delivery of only three response-dependent reinforcers. In a third paradigm, multiple schedules have been used in which delivery of response-dependent and response-independent reinforcers are associated with different exteroceptive stimuli. Rates of responding during response-independent reinforcer delivery in the latter paradigm are typically relatively high and consistent over many sessions (Appel & Hiss, 1962; Lattal & Maxey, 1971). A question which remains unanswered in the multiple schedule paradigm is the extent to which the behavior observed in the component associated with response-independent reinforcers is due to the presence of such reinforcers and to what extent it is due to simple positive induction of responding from the component associated with response-dependent

reinforcers (cf. Reynolds, 1968). The present experiment attempted to answer this question.

METHOD

Subjects

Nine experimentally naive male albino rats, 120 days old at the beginning of the experiment, were maintained at 80% ($\pm 3\%$) of their ad lib weights.

Apparatus

A Lehigh Valley Electronics (LVE) Model 1417 rat chamber, with a single LVE Model 1519 rat lever located to the left of the food tray, was enclosed in a sound-attenuating chamber. A minimal force of approximately 0.15 N was required to operate the lever. A Davis Model 104 pellet dispenser delivered 45-mg standard Noyes food pellets as reinforcers. Bright (30 V ac output) and dim (10 V ac) levels of chamber illumination were programmed through the houselight with a Lehigh Valley Electronics Model 1419 ac transformer panel. A Foringer multiple stimulus panel (Model 1166-4-M) provided an auditory click stimulus. White noise was continuously present. Electromechanical programming and recording equipment were located in an adjacent room.

Procedure

Each rat was placed in the operant chamber in the presence of the brightly illuminated houselight and was shaped to barpress. After the response was shaped, two successive sessions followed in which a total of 150 pellets were delivered according to a continuous reinforcement schedule in the presence of the bright houselight. A two-component multiple schedule was introduced at the beginning of the third session. The bright houselight used in shaping the barpress response was associated with a VI 1-min schedule in which, on the average of once a minute, a reinforcer was programmed for delivery upon emission of the barpress response (bright component). The dim houselight and auditory click stimulus were associated with the other component (dim component). The schedule with this component was VI 1-min for three animals, VT 1-min for three animals, and extinction (EXT) for three animals. The VT schedule was identical to the VI schedule except that the reinforcers were delivered

*Supported in part by NICHD Grant HD00043. Appreciation is expressed to W. G. Lee for his assistance. Reprints may be obtained from J. T. Treadway, Department of Psychology, George Peabody College for Teachers, Nashville, Tennessee 37203, or from K. A. Lattal, Department of Psychology, West Virginia University, Morgantown, West Virginia 26506.

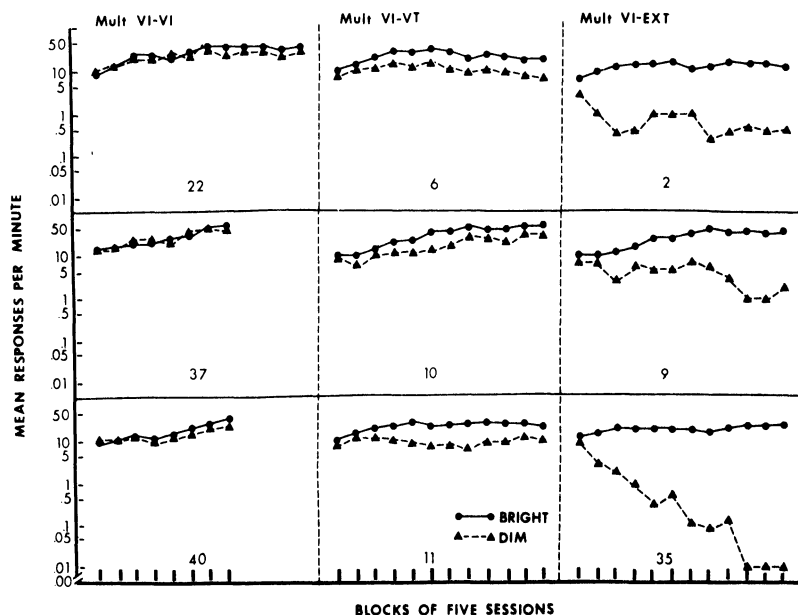


Fig. 1. Mean response rates in five-session blocks for each animal. The ordinate is plotted along a logarithmic scale. The variable-interval schedule was in effect in the bright component for all Ss and the other schedule indicated in the legend was in effect in the dim component for the different Ss.

independently of responding. In the EXT condition, reinforcer delivery was omitted.

Each 30-min session began with the VI 1-min component associated with the bright houselight. Alternating components, 5 min in duration, were presented three times per session. Each component was separated by a 10-sec blackout period during which all programmed stimuli were inoperative. Reinforcers primed at the end of either component but not collected were automatically cancelled before entry into the succeeding blackout. Sessions were conducted 5 days a week. The experiment was terminated after 60 sessions with the exception of two of the MULT VI 1-min VI 1-min animals, which were terminated after 40 sessions.

RESULTS

Figure 1 shows mean response rates per minute in blocks of five sessions for each S. The ordinate is logarithmic to more clearly differentiate low-response rates. Higher response rates are therefore compressed. Responding during the VI component was similar to that previously reported (Lattal & Maxey, 1971) and was uniform for each animal. Responding in the dim houselight component developed in all Ss. The rates and patterns of responding in this component were appropriate to the schedule in effect. Approximately equal numbers of responses were emitted in both components of MULT VI 1-min VI 1-min. Responding developed in the VT 1-min component with all animals exposed to MULT VI 1-min VT 1-min. The pattern of responding in VT was similar to that observed in VI but consistently occurred at a lower rate. Such VT responding was maintained at approximately the same overall rate during all 60 sessions of the experiment. Response rates in the EXT component of MULT VI 1-min EXT were similar to those observed in the analogous components with the other animals during the first few sessions. After this, however, there were

systematic decreases in response rates in EXT across the 60 experimental sessions.

DISCUSSION

The present paradigm was adequate for developing and maintaining for many sessions responding in the presence of response-independent reinforcers. Each of the three rats trained on MULT VI 1-min EXT responded in the EXT component during the first few sessions at rates similar to those in VI. This suggests that the responding that develops initially is due in part to an induction of responding effect commonly found in multiple schedules (Reynolds, 1968). The failure of the EXT component to sustain consistent responding across sessions suggests that simple induction of responding from the VI component cannot alone account for sustained behavior in the presence of components scheduling response-independent reinforcers. Sustained responding required the presence of reinforcer delivery, either response-dependent or response-independent. The different schedules in the dim component of the present experiment might be conceptualized as on a continuum with EXT being most dissimilar to the VI schedule since reinforcers are omitted and the VT schedule being more similar to the VI schedule, but still unlike the VI schedule because of the omitted response-reinforcer dependency. Thus, to the extent that the schedules in the different components are similar, response rate and pattern similarities might be expected.

Two types of transition data often observed in multiple schedules were not obtained in the present experiment. Unlike previous experiments using the multiple schedule paradigm (Appel & Hiss, 1962; Lattal & Maxey, 1971), systematic response rate decreases were not observed across successive sessions in the response-independent reinforcer component. In such experiments, responding is first established with response-dependent reinforcers for several sessions prior to removing the dependency. As a result of the training with response-dependent reinforcers, the rate of responding at the time the response-reinforcer dependency is eliminated is typically higher than the rates of responding observed during the first few sessions of the present study. After the response-reinforcer dependency has been absent for a few sessions, data similar to those obtained in the present VT 1-min component is observed (e.g., Lattal & Maxey, 1971). Behavioral

contrast is typically observed as an increase in responding in the unchanged component during the transition from MULT VI VI to MULT VI EXT (Reynolds, 1961). Response rates in the VI component of the rats trained on MULT VI EXT was not higher than the VI rates observed in the other groups of rats. Behavioral contrast would not, however, be expected under these conditions, since the removal of reinforcer delivery in the dim component was accomplished at the beginning of the experiment and not after exposure to a positive reinforcement schedule in that component.

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(Received for publication January 7, 1974.)

Bulletin of the Psychonomic Society
1974, Vol. 3 (4), 300-302

Inferences and predictions: Normative vs representative responding

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Ss in an inference task were given sequences of data in a symmetric, binary bookbag-and-poker-chip task. They responded not only with subjective probability estimates, but also which hypothesis they considered favored. Given the same sequences in a prediction task, the same Ss made predictions of the next-to-be-observed datum. For the latter task, differential outcomes are expected under the normative Bayesian model and the representativeness heuristic. The representativeness heuristic, which leads to the expectation that Ss' predictions would often run counter to the evidence, was supported.

The hypothesis that man "relies on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors [Kahneman & Tversky, 1973]" is in clear contradistinction to the hypothesis that man can be described as a "conservative" Bayesian (Peterson & Beach, 1967). The latter hypothesis has come under frequent attack as failing to account for experimental data (e.g., Bauer, 1973; Shanteau, 1970; Slovic & Lichtenstein, 1971; Steinmann & Doherty, 1972), and the "representativeness heuristic" (Kahneman & Tversky, 1972, 1973; Tversky & Kahneman, 1971), may under certain circumstances provide explicit, a priori

predictions which are in opposition to normative Bayesian predictions.

Representativeness is the postulated tendency for Ss in a judgment task to evaluate "the probability of an uncertain event, or a sample, by the degree to which it is: (1) similar in essential properties to its parent population; and (2) reflects the salient features of the process by which it is generated [Kahneman & Tversky, 1972, p. 431]." Both the Bayesian and representativeness approaches predict the same outcome for the usual bookbag-and-poker-chip study, which we will term an inference procedure. In a typical inference procedure, two potential data sources, or hypotheses, would be specified in terms of prior probability, data would be presented favoring one hypothesis, and S would be required to state the posterior probability of

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