RESPONSE LATENCY AS A FUNCTION OF AMOUNT OF REINFORCEMENT

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Food-deprived rats were trained to press and hold down a telegraph key in the presence of a light. Subsequent release of the key during a tone was followed by 0.15 ml of a 20-percent sucrose solution as reinforcement. The Ss were subsequently shifted to a 0-percent and to a 5-percent solution from the 20-percent base line. The median RT and the variability of RT increased markedly as a result of the shift to the lower sucrose concentrations. For all Ss, the change in median and variability was greater for the shift to the 0-percent solution than for the shift to the 5-percent solution. It is probable that median RT and variability of RT are inversely related to amount of reinforcement.

Previous papers have described a technique for measuring reaction time in lower animals (Stebbins & Lanson, 1961), the effect of alcohol on reaction time (Stebbins, Lundin, & Lyon, 1960), and the effect of variation in schedule of reinforcement upon reaction time (Stebbins & Lanson, 1962). After appropriate discrimination and differentiation training, rats will depress a telegraph key in response to a visual stimulus. They will hold the key down until an auditory stimulus occurs. The animal's latency of key release to the auditory stimulus constitutes the primary dependent variable in these experiments. This report is a preliminary attempt to describe the relation between reaction time (RT) and the amount of primary reinforcement (*i.e.*, percent sucrose concentration).

METHOD

Subjects

The subjects were four brown rats approximately 14 months old at the beginning of the experiment. They had just finished serving as subjects in an earlier experiment concerned with the relation between RT and reinforcement schedule (Stebbins & Lanson, 1962). Water was continuously available in the living cage. The Ss were food deprived; they were run for 4 hr daily and given 20 g

of Wayne Lab Blox immediately after each experimental session.

Apparatus

The apparatus is identical to that described previously (Stebbins & Lanson, 1962). In the experimental chamber a telegraph key with attached pedal served as the manipulandum. A pair of neon lights was located over the key, and a small speaker (through which a 4000-cps tone was sounded) was positioned between the lights.

The three concentrations of sucrose used were 20, 5, and 0 (or water) percent by weight.

Procedure

The conditioning, discrimination, and differentiation training for the subjects in this experiment has already been described (Stebbins & Lanson, 1962). At the beginning of this experiment, the following conditions were in effect. After a 15-sec period of no responding in the dark, the lights were turned on. Depression of the key in the presence of the lights started a variable-interval timer (with a range of from 0.05 to 3 sec and a mean of 1.5 sec). If the key was held down until the timer completed its cycle, the 4000-cps tone was introduced, and subsequent release of the key was followed by reinforcement consisting of 0.15 ml of a 20-percent sucrose solution. The same sequence of events was then repeated. If S released the key in the presence of the light, before the introduction of the tone (*i.e.*, before the timer completed

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its cycle), a 2-min time out occurred, followed by a return to the 15-sec period of no responding which preceded light onset.

The 20-percent sucrose solution was used in establishing a base line. When the subjects' behavior had stabilized (judgment of stability was based on the discrimination behavior and on the day-to-day variability in the frequency distributions of RT's), they were shifted to the 0-percent concentration for two sessions. The Ss were then returned to the 20-percent concentrations; and, again, when their be-

havior had stabilized, they were shifted to the 5-percent concentration for two sessions. They were finally returned once more to the 20-percent concentration, and after several sessions the experiment was terminated. No attempt was made to obtain steady-state behavior for the 0- or 5-percent solutions. After two sessions (8 hr) under the 0-percent solution, the behavioral output was extremely low. Consequently, frequency distributions from subsequent sessions would be based on an inadequate sample.

Fig. 1. Individual RT distributions for each subject for single sessions obtained under the 20-percent sucrose solution, the 5-percent solution, and the 0-percent solution.

RESULTS AND DISCUSSION

The RT frequency distributions in Fig. 1 illustrate the results of the experiment. Each horizontal row of graphs is for one subject. The vertical row on the left contains the distributions with the 20-percent sucrose solution on the final session before the solution was changed to 0 percent or water. The distributions in the center row are from the second session when the 5-percent solution was used. The distributions on the right were obtained from the second session when the 0-percent solution was used. The data are grouped in 50-msec class intervals, and the interval containing the median is shaded. The calculated median in milliseconds for each distribution is included under the subject's identification.

The data show that both median RT and variability of RT increase when the concentration of sucrose is decreased from 20 percent to 0 percent and from 20 percent to 5 percent. In addition, the change in the median and variability of the distributions is considerably greater when the percentage concentration is decreased from 20 to zero than when the decrease is from 20 to 5. For Subject R-4, the change in RT resulting from the shift to the 5-percent concentration is minimal. In fact, the median RT for this S under the 5-percent concentration is within the range of median RT values for the sessions under the 20-percent concentration.

Although the data are not presented here, the 20-percent-concentration base line was recoverable for all animals. After they were exposed to both the 0- and 5-percent concentrations, the animals were returned to the 20-percent concentration. The median and variability of the RT frequency distributions were well within the restricted range of values originally found under this concentration. These data on amount of reinforcement support earlier findings on the reversible nature

of RT when the schedule of reinforcement was alternated between CRF and an intermittent schedule (Stebbins & Lanson, 1962).

The results of this study and the one mentioned above suggest that the variables of amount of reinforcement and reinforcement frequency, as determined by the schedule, produce similar effects on RT. A decrease in both amount and frequency of reinforcement has brought about marked increases in the median and variability of the RT distributions for the same subjects. In addition, the 0-percent sucrose solution for the Ss under food deprivation produced changes in RT (see Fig. 1) similar to those produced by the extinction condition for the Ss under water deprivation (when water had been used as a reinforcer).

If we assume that response rate and latency are inversely related, these results on response latency and sucrose concentration are predictable from earlier findings on response rate and sucrose concentration (Stebbins, 1959; Stebbins, Mead, & Martin, 1959). Although rate is a direct function of amount of reinforcement, latency is an inverse function.

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