DISCRETE-TRIALS DRL

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METHOD

One of the apparent points of similarity between the conditions I have studied (Logan, 1960) and the schedules of reinforcement described by Skinner (1938) and Ferster and Skinner (1957) is what these investigators have called the differential reinforcement of low rate (DRL) and what I have called discontinuous negatively correlated reinforcement. A rat on a schedule of differential reinforcement of low rate in a free-responding, bar-pressing apparatus must permit at least a specified amount of time to elapse between presses in order to be rewarded. A rat on a discontinuously correlated reinforcement condition in an alley must permit at least a specified amount of time to elapse between the time the start door is opened and the time that it reaches the goal in order to be rewarded. Both of these situations presumably involve a temporal discrimination, and rats have been found to be reasonably adaptive to both situations.

However, the quantitative details of the performance on a DRL schedule appear to differ somewhat from those found in the alley. Sidman (1956) reported a substantial number of long inter-response times in the bar-pressing situation, and an even larger number of very short inter-response times. In contrast, response times in the alley rarely exceed the time required by the condition by very much and never attain the fast speeds observed under uncorrelated conditions. In short, rats seem to "zero in" to the condition somewhat better in the alley than in the Skinner box.

These differences in behavior could result from differences in the boundary conditions of the studies; e.g., the required IRT on a DRL schedule is customarily substantially longer than the typical cutoff used in the alley, and hence might be expected to produce larger absolute errors. In addition, there is the procedural difference between free responding and discrete trials. Thus, Sidman argued that the short IRT's in bar pressing represent additional presses stemming from the preceding response rather than extreme errors of timing. If so, then fast speeds would not be expected in the alley simply because the rat can not be run through another trial quickly enough to be taken as a second chance.

In any event, the evidence that the situations are comparable in the sense that the same laws apply to both is largely presumptive. The present study was an attempt to obtain some data on this problem by running rats in a bar-pressing situation under conditions designed to be analogous to those used in the alley. Principally, this involved using a stimulus change to generate discrete trials and requiring the rat to delay pressing the bar after the onset of the trial stimulus.

¹Research supported in part by the National Science Foundation.

Subjects

Four Sprague-Dawley albino rats were used as subjects. They were approximately 300 days old at the beginning of this experiment, since they had previously been run in an alley experiment. In that experiment, they were run four trials a day and were rewarded with 12 pellets only if they took over 6 seconds in the alley. Two had been maintained on 16 grams per day of Purina Laboratory Chow, and the other two had been given only 9 grams per day; these same maintenance conditions were continued during the present study.

Apparatus

Foringer operant-conditioning equipment was used. The reinforcement interval was timed by a Hunter silent timer so that no audible clicks could cue when the reward was set up.

Procedure

The rats were first given an hour in the box with the houselights on and the right bar on a continuous-reinforcement schedule. (The left bar was always available but never functional.) All rats acquired the bar-pressing response during this session without special shaping.

Thereafter, the rats ran 48 trials a day for 80 days on a discrete-trials DRL. The intertrial interval was irregularly 15 or 25 seconds, during which time the box was dark and any bar press reset the intertrial-interval clock. The onset of the lights signalled a trial. If the rat delayed responding for 5 seconds or more, a bar press was rewarded with a single 45-milligram Noyes pellet. The first bar press, whether rewarded or not, turned off the lights and started the subsequent intertrial interval.

RESULTS

Although I do not have control data on response times under an uncorrelated condition (see, however, Dinsmoor, 1950, and Carlton, 1959), it is clear that the rats adjusted to the condition in the sense that both response times and reward frequency increased during training. The solid curves in Fig. 1 show the frequency distributions of asymptotic response times for each rat. Terminal adjustment appears to be reasonably good, since modal times are somewhat longer than the cutoff.²

²Were the stimulus change absent, the condition would be a variable DRL since sometimes a 20-second and sometimes a 30-second IRT would be required for reinforcement. The study of such conditions is currently in progress as a further control on the effectiveness of the stimulus change as a trial stimulus. In this regard, it might be noted that there were no discernible differences between the latencies following the 15-second and 25-second intertrial intervals.

Fig. 1. Latencies (in seconds) at the end of training for rats on a discrete-trials DRL schedule of 5 seconds and on a discontinuous negatively correlated condition of 6 seconds in an alley. (The alley distributions have been moved to the left by 1 second in order to make the cutoffs coincident.)

Of particular relevance to the present purpose, it should be observed that the distributions are unimodal and do not display a high frequency of very short response times. In this regard, the distributions are like those observed in the alley, represented by the dashed curves. However, there were appreciably more long response times in the bar-pressing situation.

The virtual absence of very short response times on discrete-trials DRL is not necessarily inconsistent with their presence on free-responding DRL. Indeed, if the data from the present study were plotted without regard to the trial stimulus so as to include presses in the dark, a substantial number of additional responses would be included, most of them with short inter-response times. Discrimination of the trial stimulus was ultimately very good, and the predominant pattern of behavior was a single press in the light and no presses in the dark. However, there were, on the average, about 25% extra presses in addition to those necessary for optimal adjustment. These extra presses tended to occur in occasional clusters, as the sample cumulative records in Fig. 2 show; that is, the rats occasionally ran for several responses amidst generally optimal adjustment.

DISCUSSION

The results of the present study may be looked at in two ways. On the one hand, similarities between the

Fig. 2. Cumulative records of the performance on a discrete-trials DRL at two stages near the end of training.

data from the bar-pressing and alley situations are clear. The rats showed reasonable adjustment in both situations, and, particularly for the two low-drive animals, the distributions of response times were closely comparable. Most important, short response latencies were not frequent when an external stimulus was used to isolate trials. This finding is consistent with Sidman's contention that short IRT's on a free-responding DRL do not represent extreme errors. Hence, there is some justification for the belief that a DRL schedule in a bar-pressing situation is analogous to a condition of negatively correlated reinforcement in an alley.

On the other hand, several differences between the results should also be noted. Whereas higher drive had led to somewhat faster over-all speeds and a sharpening of the time discrimination in the alley, the results in the Skinner box confirm and extend those of Conrad, Sidman, and Herrnstein (1958) that deprivation conditions have little effect on DRL performance. In general, there were appreciably more unnecessarily long response times in the bar-pressing situation, and individual differences in degree of adjustment to the two problems were not consistent.

Of course, a number of differences between the situations might produce these differences in behavior; but one that seems particularly relevant is the degree of control over the subject's orientation at the time of the onset of the relevant stimulus. Rats tend to adjust to such conditions considered here by learning some pacing behavior which consumes the required time. Because the rat is always facing the start door of the alley when it is opened, each trial begins with the rat in the same position from which to respond. In the Skinner box, in contrast, the rat may be in any number of positions at the time the trial stimulus goes on, and a way

of responding that is adequate from one location may not be adequate from another. Presumably, the more stable the condition the subject actually encounters, the more stable the resulting behavior.

SUMMARY

Four rats that had been trained to take time running an alley were required to delay pressing a bar after the onset of a light signal in order to obtain food reward. This discrete-trials procedure eliminated the short latencies found in free-responding DRL and yielded unimodal response-time distributions similar to those observed following negatively correlated reinforcement in the alley. However, unnecessarily long latencies occurred more frequently in the bar-pressing situation, and there were differences in the effects of drive and in the individual rats. It was suggested that control over the subject's orientation at the time the requisite interval is started may be an important variable in the fineness of the subject's adjustment to the condition.

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Received December 30, 1960.