Acquisition of lever pressing in rats under DRL contingencies.¹

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Seven food-deprived hooded rats were exposed to various DRL schedules after magazine training. If lever pressing was not acquired in the first sessions, the Ss were further deprived and exposed to the same DRL schedule. If lever pressing did not occur, the DRL requirement was decreased until it did occur. Lever pressing was not acquired by any S exposed to DRL 60-sec but was acquired by four out of five Ss exposed to DRL 30-sec and by three out of three Ss exposed to DRL 15-sec. It is concluded that acquisition of lever pressing can occur under reinforcement delays of as long as 30 sec, even when secondary reinforcement is minimized.

The present experiment deals with the effect of delay of reinforcement on free-operant acquisition. Although the effects of delay of reinforcement on response acquisition has a long history in animal psychology (Mowrer, 1960), because of certain artifacts a comprehensive summary statement is difficult to make.

In one experiment on delay of reinforcement, Perin (1943) divided a small box into two compartments, one of which had a lever. A trial consisted of a hungry rat being released from the start compartment, running into the compartment containing the lever, pressing the lever, the lever being withdrawn, and a pellet of food being delivered x sec later. Using decrease over trials in time between release from the starting compartment and lever press as evidence for acquisition, Perin concluded that x could be as long as 10 sec and still result in acquisition.

Skinner (1938) used rats as Ss in the free-operant situation. The only response necessary for lever pressing occurred x sec before reinforcement. Responses at other times had no consequence. Skinner says, "I have been able to condition the response with intervals as long as 8 sec . . . [p. 73]."

In Perin's experiment, the S was placed in the same position at the start of each trial. This may have facilitated acquisition. More important, since lever withdrawal preceded each reinforcement, "lever absent" may have taken on secondary reinforcing properties and provided the lever press with immediate secondary reinforcement. In Skinner's experiment,

responses close to reinforcement were possible. If such responses occurred, they would have been (adventitiously) reinforced with delays shorter than the programmed delay interval.

The present experiment was intended to minimize secondary reinforcement (Perin's procedure), adventitious reinforcement (Skinner's procedure), and facilitation of acquisition due to the requirement of an explicit response chain (Perin's procedure). To this end, a differential reinforcement for low rates (DRL) procedure was in effect during acquisition. No exteroceptive stimulus preceded reinforcement, no delay of reinforcement shorter than the programmed delay was possible, and responding could occur at any time from any starting position.

SUBJECTS

The Ss were seven male Long-Evans hooded rats, labeled 02 to 08 inclusive, 85-90 days of age at the beginning of deprivation. The Ss were obtained from Canadian Breeding Laboratories, La Prairie, Quebec. The Ss were without operant experience but had been used in a shock-threshold-determination study 3 weeks previous to the present experiment, receiving about 25 shocks, most of which were subthreshold. Each S was gentled and deprived to 80% of its free-feeding weight during the 7 days immediately preceding magazine training.

APPARATUS

A Gerbrands single-lever student operant chamber (Model C) served as the experimental space. It was housed inside a double-walled sound-attenuating chamber. The standard Gerbrands lever was replaced by a Lehigh Valley lever (Model 1352) which extended 1½ in. into the space. The top of the lever was 1¾ in. from the floor. A 14-g weight, placed on top of the lever with its center of gravity ½ in. from the end of the lever, was sufficient to trip the lever microswitch. The only feedback from a lever press was the faint click of this switch. Reinforcers were 45-mg standard-formula Noyes pellets. A .3-sec buzz from a buzzing relay, mounted beneath the lever outside the end wall, accompanied each pellet delivery. Control and recording functions were done by electromechanical equipment housed in a room adjacent to the experimental station. Several fans, including one on the sound-attenuating chamber, provided masking noise.

PROCEDURE

After gentling and deprivation, each S received at least two magazine-training sessions. Immediately before the first, the S was allowed 10 min to explore the experimental space, and pellets were not delivered. For 1 h thereafter, pellets were delivered from a variable-interval (VI) 30-sec tape. During the next magazine-training session, which lasted 2 h, pellets were delivered from a VI 120-sec tape. If a S was seizing and ingesting the pellets upon delivery during this session, he was given no more magazine training. If he was not, he was given magazine-training sessions under slightly higher deprivation until he was. S 08 received four extra sessions, 03 and 06, two extra sessions, and the rest magazine-trained in two sessions. Each S was then placed on a DRL schedule of 60, 30, or 15 sec. In a DRL schedule, a S must respond and then not respond for x sec before the reinforcer is delivered. Responses during the waiting period merely extend the waiting period by x sec.

Each S received one session per day, which lasted 2 h or until 200 reinforcers were delivered, whichever came first. If response rate per minute was less than .5 per session for five consecutive sessions (shift criterion), a S was deprived to 70% of free-feeding weight during 2 days and returned to the same DRL schedule. The S was then given 10 more sessions and, if the shift criterion was met in the last five of these sessions, the S was shifted to the next lowest DRL value. If the shift criterion was met again, the S was shifted to the next lowest value. Only 08 was shifted through two DRL values. Details of the procedure can be found by reading Fig. 1. Each S was run until its response rate per minute equalled or exceeded .5 for 15 consecutive sessions, except 07, who was run 11 extra sessions to determine if response stability would occur.

RESULTS

Although stability of rate is notable by its absence, Fig. 1 indicates that all Ss eventually acquired lever pressing. Both of the Ss (04 and 07) that began on 15-sec DRL acquired immediately. This result has been replicated with four Wistar rats under similar conditions with 15- or 20-sec DRL. All of the three Ss starting on 30 sec (02, 03, and 06) also acquired, although 06 required additional deprivation. Neither of the Ss that started on 60 sec acquired until both deprivation and DRL requirement were changed. S 05 acquired on 30 sec and S 08 on 15 sec. Although systematic observation was not attempted, no evidence of a superstitious chain between response and reinforcer delivery was observed for any S.

Fig. 1. Lever pressing as a function of session number, deprivation level, and DRL requirement for individual Ss. If no deprivation level is indicated on the graph, deprivation level was 80%. Note the difference in the ordinate scale for O7.

DISCUSSION

The main point made by the present data is simply that acquisition of lever pressing can occur with DRL contingencies up to 30 sec when no explicit behavior chain is required and secondary reinforcement is minimized. That deprivation level is a factor is indicated by O6, who pressed very little at 80% body weight but acquired immediately when deprived to 70%.

Not surprisingly, the length of the DRL requirement proved to be an important variable. While neither of the Ss at 60 sec acquired, the "success rate" at 30 and 15 sec was high. The data do not indicate that 30 sec is the upper limit. The localization of this limit will be the topic

of a future experiment.

Other implications of the present results are not immediately apparent, although one possibility comes to mind. Herrnstein (1969) has hypothesized that all successful avoidance procedures have one thing in common: They allow the S to reduce the frequency of negative events. It may be that all successful positive-reinforcement procedures allow the S to increase the frequency of positive events. A DRL contingency may be a special case of the successful procedure. Immediate reinforcement of a response may be especially *helpful* in speeding up acquisition, but an increase in positive reinforcement may be the *necessary* condition. Experiments designed to

ascertain the usefulness of this latter assumption are presently in progress.

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NOTE

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