PERFORMANCE ON A FIXED-RATIO SCHEDULE WITH CORRELATED AMOUNT OF REWARD[1]

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Four rats were trained to bar press on FR 9 TO 30 sec. They were reinforced with a large or small amount of water according to whether their final IRT was long or short respectively. Four control rats always received the small amount of reinforcement. The control animals produced the high rates of responding typical of fixed-ratio performance. The experimental animals, with one exception, developed superstitious behavior and maintained slow responding throughout the ratio. However, some features of the results pointed to a persistent influence of the factors which favor short IRTs.

Response rate on a fixed-interval schedule can be controlled within wide limits by making amount of reward depend on the length of the final IRT (Hendry, 1962). The purpose of the present experiment was to test the generality of the previous result by determining how performance on a fixed-ratio schedule would be affected by giving long final IRTs a larger amount of reward.

METHOD

Apparatus

Two Grason-Stadler Skinner boxes; conventional control and recording equipment, were housed in an adjacent room. A small drinking well was attached to the wall of the chamber just below and to one side of the bar. The pump to supply the reinforcement was inside the sound proof box. The pump operated with a distinctive noise and slight vibration, and delivered a fixed amount per operation. When a large amount of reward was to be given, the pump operated repeatedly the requisite number of times at intervals of 0.75 sec. The chamber was illuminated by a dim red light, and by a white signal lamp above the bar.

Subjects and Procedure

Eight male albino rats (Ss) about 6 months old were run successively in pairs for 90-min

sessions daily. One experimental (X) and one control (C) subject made up each pair. Food was always available in the home cages, and water was available for about 30 min shortly after each session.

The Ss were initially given magazine training and CRF, followed by FR 5. After the delivery of each reinforcement, the white signal lamp above the lamp went off for 30 sec. During this time responses were neither reinforced nor counted towards the next ratio requirement. The schedule is abbreviated as FR 5 TO 30″. After two sessions of FR 5 TO 30″ the schedule was FR 9 TO 30″ for a further 70 sessions.

The water reinforcement was either a large amount or a small amount. The actual volumes varied during the experiment. The Cs always received the small amount on the final bar-press. The Xs received the small amount if their final IRT was shorter than a criterion, and the large amount if it was longer. Because higher rates produce smaller amounts of reinforcement, this procedure has been called negatively correlated amount of reward. The actual relation between the final IRT and the reward is called the "terms" (Logan, 1960). The terms were chosen on the basis of performance in the previous session so that about half of the rewards would be large. For the first 23 sessions, and during the preliminary training on FR 5 TO 30″, the amounts of reward were 0.05 ml and 0.25 ml. During sessions 24-50 the amounts were 0.02 ml and 0.10 ml, and thereafter 0.02 ml and 0.16 ml.

After session 59, a piece of brass angle was attached to the wall below the bar, for the Xs

only, to change the response topography of one of them.

RESULTS

Figure 1 summarizes changes in performance during the experiment. The preliminary training sessions are not included, but it is evident that during these sessions, rate of bar pressing had already reached a high level in two cases. Cumulative records, not reproduced here, showed regular performance after the first few sessions, without breaks or excessive pausing after reinforcement.
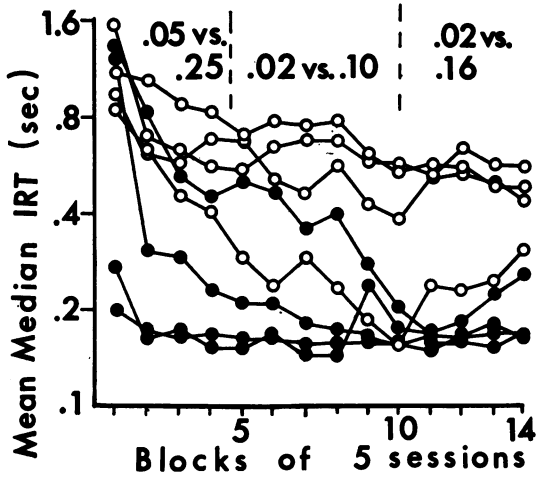

Fig. 1. Median IRTs (means of five sessions) plotted for each S. The schedule is FR 9 TO 30″. The open circles represent Xs and the filled circles represent Cs. The numbers at the top of the figure represent the terms; they show the amount of water in ml received by the Xs for short and long IRTs respectively. The deviant subject is X2. The scale of the ordinate is logarithmic.

Negatively correlated amount of reward produced longer IRTs. In one case (X2) the effect was uncertain and appeared only when the terms were most extreme at the end of the experiment. Observation showed that none of the Cs and all of the Xs, except X2, had developed obvious superstitious behavior in the presence of the white stimulus light. The superstitious behavior always occurred in the vicinity of the bar and was generally incompatible with rapid bar pressing. For example, X1 reared up to lick and chew at the lens of the stimulus lamp, and "incidentally" leaned on the bar below from time to time until reinforcement was delivered. All the Cs and

X2 learned to operate the bar by striking it alternately from above and below, using both forepaws.

The addition of the brass angle in session 60 was an attempt to change X2's response topography, to see if its performance would become more similar to that of the other Xs. The angle made it impossible for X2 to operate the bar in customary fashion. During session 60 a small temporary increase in median IRT was noted. In the following session, X2 was pressing the bar as fast as ever, having adopted the method of striking the bar sharply with alternate forepaws. Further changes in the terms during a session had no appreciable effect on performance.
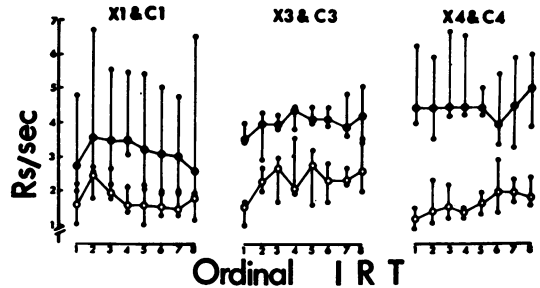

Fig. 2. Medians (large circles) and ranges (small circles) of mean speeds of bar-pressing in five sessions of FR 9 TO 30″ as a function of ordinal position of the response in the chain. Reinforcement occurs at the end of the 8th IRT. The open circles represent Xs and the closed circles represent Cs.

To determine speed of responding through the ratio, IRTs were classified according to their ordinal position or "distance" from reinforcement. Reliable records were obtained from three pairs of Ss. The results shown in Fig. 2 were obtained as follows. Every nth run in a session was selected, n being chosen to give 20 runs per session. The 160 IRTs in the selected runs were converted to rate scores. These scores yielded eight mean rates, one corresponding to each ordinal IRT in the ratio. Mean rates were obtained for five different sessions in the latter half of the experiment.

The distributions shown in Fig. 3 were very stable over about the last 20 sessions.

DISCUSSION

The results show that Ss were sensitive to negatively-correlated amount of reward on the
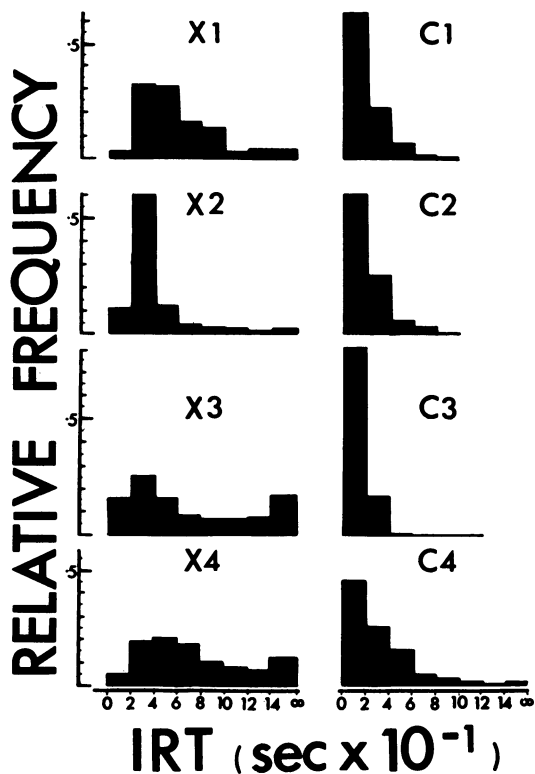
Fig. 3. Distributions of IRTs made by each *S* in a single session near the end of the experiment.

schedule used. However, the effect was uncertain in X2 and rather limited in the other Xs. They did not learn to respond more and more slowly within a session to obtain a greater proportion of large rewards. Figure 1 shows a gradual decrease of median IRTs, rather than an increase. In addition, there was no detectable effect (except possibly in the case of X2) of increasing the discrepancy between the large and small amounts of reward. The limited effect of the differential reinforcement procedure contrasts with the large

effect of a similar procedure used in conjunction with a fixed-interval schedule (Hendry, 1962). This is more surprising in view of the extremely small amount of reward (0.02 ml) given for short IRTs throughout most of the present experiment. We conclude that the contingencies which favor short IRTs in ratio schedules exert an extremely powerful influence.

Figure 2 shows no consistent trend in rate of bar pressing within the ratio in the case of either the Xs or the Cs. This result agrees with that of Millenson, Hurwitz and Nixon (1961). There is no evidence of the "goal gradient" found by Weiss (1958).

The absence of a gradient in the performance of the Xs is consistent with observation of superstitious behavior. The superstitious behavior prevented very rapid bar pressing and occurred throughout the ratio. Also, the animals did not switch back and forth between normal fast responding and slow superstitious responding. Any considerable tendency to do this would have been revealed by bimodality of the distributions on the left of Fig. 3.

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