Stimulus aftereffects of bar pressing[1]

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Abstract

Rat Ss were trained in the free response bar-press apparatus under a single alternation pattern of partial reinforcement. After all Ss learned to respond at a low rate following reward and a high rate following nonreward, half were transferred to a double alternation pattern. The change did not affect the learned habits, and the results were interpreted as supporting the aftereffects hypothesis.

Introduction

When rat Ss are presented a single alternation pattern of reward and nonreward (SA), they learn after a time to respond in a manner appropriate to the reward conditions on a specified trial (pattern learning). In the straight runway, for example, running speed is faster on rewarded than nonrewarded trials (Bloom & Capaldi, 1961); and in the T-maze, alternation occurs in choices between the two arms of the maze when reward is alternated between them (Petrinovich & Bolles, 1957). In addition, recent evidence indicates that rats learn to discriminate sequential patterns involving one or more nonrewarded trials in the discrete trial bar-press appratus (Wall & Goodrich, 1964).

The theoretical implication in such results is that rat Ss learn the SA problem through conditioning of stimulus aftereffects which arise as a function of the previous trial outcome. Thus, although responding on a trial in question may appear to be a function of conditions on that trial, the determinant of behavior in the SA pattern is what occurred on the previous trial.

Such a relationship has been demonstrated quite conclusively by training rats in the straight runway on the SA pattern and then transferring them to a double alternation (DA) pattern (Bloom & Capaldi, 1961). It was assumed that if the Ss learned the SA problem on the basis of stimulus aftereffects, then a change in pattern should not substantially disrupt behavior with regard to responding on the basis of the previous trial-outcome. A rewarded trial should result in slow running on the following trial, regardless of the reward condition on that trial. Similarly, a nonrewarded trial should be followed by fast running, and such results were obtained.

In the present experiment a similar strategy was employed to study the behavior of rat Ss when presented an SA pattern in the free-responding bar-press apparatus. In order to make the procedure comparable to the runway experiments, the single alternation pattern refers to a condition in which discriminative, light-on periods were alternately rewarded and nonrewarded.

Method

Subjects: The Ss were 12 female albino rats of the Sprague-Dawley strain weighing 195 to 245 gm. They were obtained from the Camm Research Institute, Wayne, New Jersey.

Apparatus: The apparatus was a standard single-lever operant conditioning cage (Scientific Prototype Manufacturing Corporation, Model A-100) containing one 6 w, 120 v stimulus light mounted behind a white translucent lens. The pedal lever required 20 gm pressure for operation. The cage was mounted in a sound resistant enclosure.

Procedure: On days 1 through 14, each S was fed 12 gm of Purina Lab Chow in the home cage. On day 15, each S was placed in the apparatus for 30 min. with the stimulus light on, and every bar press was rewarded with a single 45 mg Noyes pellet. On day 16, the apparatus was programmed so that the stimulus light came on every 10 sec. and remained on for 10 sec. Bar presses were rewarded with a pellet only if made during the period when the light was on. Each S remained in the apparatus for 30 min.

On days 17 through 36 the SA pattern was introduced, the procedure being the same as on day 16 except that bar presses were rewarded only during every other light period. Thus, out of each 40 sec. period, S could obtain reward during a 10 sec. period. Following training on day 36, the Ss were divided into two matched groups on the basis of the difference between number of presses during rewarded and nonrewarded light periods.

On days 37 through 46, group SA continued on the single alternation pattern of rewarded and nonrewarded light periods, while group DA was transferred to a double alternation pattern of two successive rewarded light periods followed by two successive nonrewarded light periods throughout the 30 min. session.

From day 15 on, the amount of reward received during the 30 min. training session was subtracted from the daily 12 gm ration. Each S was fed approximately 15 min. following the end of the session.

The light-off periods were always nonrewarded and may be considered as the intertrial interval.

Because of the limiations of the apparatus, it is conceivable that the SA pattern could be learned by means other than the conditioning of stimulus aftereffects. Therefore one group of Ss was transferred to a DA pattern following SA training in order to determine the basis of SA pattern learning.

Results

The results are shown in Fig. 1. Only presses during the light periods are represented, and for convenience the light periods will be referred to as trials. Each point on the curve for the acquisition phase is the mean percentage of presses on trials following nonrewarded trials (TFN) in blocks of four daily sessions. In the SA pattern, these are rewarded presses. A direct difference t analysis on the data of the last acquisition training day revealed that the difference between number of presses on TFN and trials following reward (TFR) was highly significant ($t = 28.70$; w/11 df; $p < .001$).

During the transfer phase of the experiment, responding on TFN in blocks of two days remained at a level similar to that at the end of the acquisition phase,

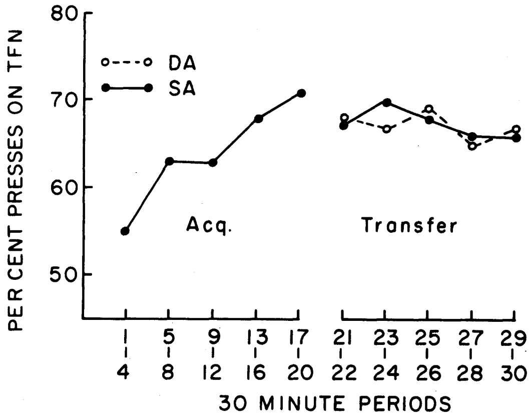

Fig. 1. Percent presses on TFN (trials following nonreinforcement) on blocks of four 30 min. sessions during acquisition and two 30 min. sessions during transfer.

and there was no difference between groups SA and DA on these trials.

Discussion

It is apparent that the reaction of rat Ss to an SA pattern of partial reinforcement in the free-response situation is not substantially different from that in the straight runway. The Ss learn to respond in a manner appropriate to the pattern of reward, and a change in pattern does not disrupt the habits of low-rate responding following reward and high-rate responding following nonreward. As Bloom & Capaldi (1961) pointed out, the DA pattern is uniquely suited to the continuation of such pattern responding because the habits acquired during SA training are reinforced 50% of the time in the DA pattern.

However, there appears to be a difference between runway and bar-press responding in the initial reaction to the pattern. Early in runway training, the Ss run slower following nonreinforcement than following reinforcement, and this phase continues for 30 to 40 trials (Bloom & Capaldi, 1961; Capaldi & Stanley, 1963). As Fig. 1 shows, there appears to be no such phase in the results of the present experiment. A close examination of the data showed that the percentage of responses on TFN fell below 50% only on day 1, when the percentage was 47%.

With regard to the transfer phase of the experiment, it is possible to distinguish between two current views of pattern learning. Wall & Goodrich (1964) have suggested that such learning may be accounted for in terms of temporal conditioning. In the present study, according to this hypothesis, the Ss learned the SA pattern because bar-pressing was rewarded for periods of 10 sec. following a constant 30 sec. inter-reward interval. Therefore, responding during the transfer phase should continue to be based upon these same temporal stimuli, at least until new learning took place. In the DA pattern, since the first R trial (a TFN except for trial 1) is rewarded, there should be low-rate pressing on the second R trial (a TFR), high-rate pressing on the first N trial (a TFR) because it occurs 30 sec. after the first R trial, low-rate pressing on the second N trial (a TFN) and so on. Thus the transfer results should show no difference in responses on TFN and TFR.

In contrast, the aftereffects hypothesis holds that the relevant stimuli are those associated with the reward conditions of the previous trial. The Ss respond at a high rate following nonreward and a low rate following reward on the SA pattern, and the transfer data should reveal continued responding on this basis. As Fig. 1 shows, this is precisely what occurred in the experiment.

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Notes

1. This investigation was supported in part by Public Health Service Research Grant M-1562 from the National Institute of Mental Health and National Institute of Mental Health post-doctoral fellowships to the authors.

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