The effects of nonreinforcement on subsequent running behavior under continuous reinforcement¹

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Contrary to Goodrich's results, the partial reinforcement acquisition effect was obtained in the goal box as well as the alley. These results suggest that Goodrich's findings were due to a confounding variable, namely, the presence or absence of discriminative stimuli. Although not statistically significant, differences between means of groups of rats that did or did not receive nonreinforced trials prior to acquisition suggest that the partial reinforcement acquisition effect may be obtained in the absence of "frustration."

Spence (1960) has adapted Amsel's (1958) "frustration hypothesis" to account for the "partial reinforcement acquisition effect" (PRAE); namely, faster running by partially reinforced than by continuously reinforced animals during acquisition. He argued that partially reinforced animals may run faster in the alley because they are running under a "frustration" drive. In contrast, continuously reinforced animals may run faster in the goal box because they will develop higher levels of "incentive motivation." Results by Goodrich (1959) and Wagner (1961) have been taken as providing strong support for Spence's view since they have shown the PRAE in the alley and its reversal in the goal box.

The present experiment was designed to remove a potentially confounding variable from the Goodrich and Wagner studies by eliminating discriminative stimuli for the presence or absence of food from the goal box. This was accomplished by placing a guillotine door in front of a drinking tube on reinforced trials only after the running response had been completed. In the Goodrich and Wagner studies the animals might detect the presence or absence of reinforcement prior to the completion of the response.

The present experiment seeks also to produce the PRAE under conditions which do not lead to "frustration." To this end, two groups of rats were given 10 and 30 nonreinforced trials, respectively, prior to the introduction of continuous reinforcement. Since nonreinforcements never follow reinforcements, frustration should not develop, and Spence's theory should predict the same level of responding as a group receiving no nonreinforced trials. On the other hand, a view advanced by Weinstock (1958) does lead to the prediction of a PRAE under these conditions.

Subjects

Eighty-four female albino rats, 100-110 days old at the start of the experiment, were purchased from Albino Farms, Red Bank, N. J.

Apparatus

A straight runway, painted flat gray and covered with Plexiglas, was used. It was 5 in. wide and 5 in. high except for the goal box, which was 12 in. high. The start box, runway, and goal box were 10, 44, and 18 in. long, respectively. A 4 x 5 in. recessed drinking area was attached at a right angle to the end of the goal box. The start box, alley, goal box, and drinking area were separated from each other by guillotine doors.

Photocell beams were placed 1 in. past the start box door, 8 in. past the goal box door, and 1/2 in. in front of the drinking area door to record start, alley, and goal times, respectively. A fourth photocell timer circuit measured first-lick latency, the time from interruption of the third beam to the first lick (a distance of 2-1/2 in.).

The number of licks was recorded on a Sodeco print-out counter which was activated by interruption of a light beam across the front of the glass drinking tube.

Procedure

The Ss were given one trial per day under 20-22 h of water deprivation and were randomly assigned to one of four groups.³ One group was given 10 (Group 10N), and another group 30 (Group 30N) nonreinforced trials followed by 60 continuously reinforced trials.

Two additional groups, one receiving continuous reinforcement (Group C) and another 50% partial reinforcement (Group P), received no prior nonreinforced trials, but instead were given equivalent handling and placement in a large natural pine box.

Drinking tube training was given to all Ss in a small natural pine box after the nonreinforced trials were administered.

Reinforcement consisted of 30 sec of drinking water. On nonreinforced trials S was confined in the goal box for 30 sec.

Ten Ss died or developed middle ear infection, six were discarded for failure to drink or run on the early trials, leaving 30, 16, 12, and 10 Ss in Groups C, P, 30N, and 10N, respectively.

Results

All time measures were converted to reciprocals (10/sec) throughout.

Reciprocal alley and goal times are presented as means of blocks of 10 trials in Fig. 1. Examination of Fig. 1 shows large differences in alley time between the four groups. An analysis of variance for all four

Fig. 1. Mean reciprocal alley and goal time as a function of trials in blocks of 10, and mean number of licks and mean reciprocal first lick time as a function of blocks of five reinforced trials. (The first five data points represent reinforced Trials 1-25 for all groups, while the last data point represents reinforced Trials 26-30 for Group P and 56-60 for Groups 10N, 30N, and C.)

groups based on the last 20 trials on the alley time measure was significant ($F=3.06$, $df=3/64$, $p<.05$); however, the comparable analysis omitting the P group did not yield significance ($F=1.64$, $df=2/49$, $p>.05$).

Examination of the goal time panel of Fig. 1 shows that the P group ran substantially faster in the goal box than the other groups and that the 30N group ran somewhat faster than the other two groups. Again analysis of variance based on the last 20 trials yielded significant differences when based on all four groups ($F=4.98$, $df=3/64$, $p<.05$) but did not yield significance when the P group was omitted ($F=2.16$, $df=2/49$, $p>.05$).

Following Hulse (1962), which this part of the present study replicates, an analysis of variance for reinforcements 21-30 of all four groups as well as a groups by reinforced trials (1-30) analysis was performed using the lick rate data. The analysis based on reinforcements 21-30 yielded no significant differences ($F=2.00$, $df=3/64$, $p>.05$). The groups by reinforcements analysis yielded significant differences between groups ($F=3.48$, $df=3/64$, $p<.05$) and no significant groups by trials interaction ($F<1$). Analyses comparable to the lick rate analyses were performed for the first-lick time measure and yielded no significant differences.

Discussion

Comparison of the P and C groups shows that the PRAE is obtained in the goal box as well as the alley. This result suggests that the reversal of the PRAE in the goal box reported by Goodrich (1959) and Wagner (1961) was due to the operation of a confounding vari-

able, the existence of discriminative stimuli for the presence and absence of reinforcement. The present result, therefore, removes a major empirical support for the theoretical treatment of the PRAE proposed by Spence (1960).

In addition, the licking rate results replicate the findings of Hulse (1962) by showing that partially reinforced Ss lick more rapidly than continuously reinforced ones during the early stages of acquisition. These results suggest that Spence (1960) may be in error in assuming that continuously reinforced Ss should show a higher level of K than partially reinforced Ss. Additional evidence on this point is provided by the first-lick latency measure which should be the most sensitive indicator of K. It is clear from Fig. 1 that the C group is not superior to the P group during the first 25 reinforced trials.

Marked differences were found between the 10N, 30N, and C groups in the alley and somewhat smaller differences in the goal box. Unfortunately, analyses of both measures for the last two blocks of acquisition trials did not indicate significant differences. It is our opinion that real differences due to the experimental variable were masked by an unusually large error variance which led, in the case of the alley measure, to insufficient sensitivity in the detection of a 40% difference in the means of the 30N and C groups. Should these differences be real, the PRAE would have been produced in the absence of frustration.

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Notes

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2. During the course of this investigation D. R. was the recipient of a NIMH Predoctoral fellowship.
3. The acquisition phase of a study still in progress is reported here. Various groups were further subdivided during an extinction phase.