Nondifferential reinforcement and discrimination learning

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Albino rats were maintained for 7 days in home cages lined with black-and-white striped inserts or in regular metal home cages. Ss then learned either a position discrimination or a brightness discrimination. It was found that Ss maintained in the black-and-white home cages learned the position discrimination more quickly than did Ss kept in the regular cages. Ss maintained in regular cages learned the brightness discrimination more quickly, although not significantly so. Results were discussed in terms of attentional theories of discrimination learning.

Sutherland (1964) and Mackintosh (1965) have proposed a two-stage model of discrimination learning in which they suggest that, in the course of discrimination learning, S learns both to attend to the relevant stimulus dimension and to respond differently to specific cues along that dimension. For example, in a black-white discrimination, S must learn to attend to the brightness cues (rather than, say, to position cues) and to respond differently to black and white. In fact, they suggest that nondifferential reinforcement of responses to cues along a dimension should cause an S to ignore that dimension and thus hinder performance in a subsequent discrimination task with that dimension relevant. Results of an experiment by Siegel (1945) are consistent with this contention. However, Bitterman, Calvin, & Elam (1953) found that nondifferential reinforcement in the presence of orientation cues facilitated later discrimination learning with orientation relevant. The authors suggested that a certain amount of perceptual differentiation had occurred in the course of sheer experience with the stimuli, despite the lack of differential reinforcement. In both of these experiments, the response involved in the nondifferential pretraining was the same response required of Ss in the subsequent discrimination training. For example, Bitterman, Calvin, and Elam forced Ss to jump equally often to vertically and horizontally oriented striped cards, with all responses reinforced. In the discrimination task, Ss were required to jump either to

vertical or to horizontal for reinforcement. The present study involved a different procedure in that the response to be required in the subsequent discrimination task was not involved in the pretraining phase.

SUBJECTS AND APPARATUS

The Ss were 40 male albino rats, 90-120 days old at the beginning of the experiment. Pieces of $\frac{1}{4}$ -in. plywood, painted with alternating vertical 2-in. black-and-white stripes, were used to line certain of the home cages used in the experiment. The discrimination apparatus consisted of two T-mazes, each with a startbox, stem, and arms 1 ft long, with the height and width 6 in. throughout. The ceilings of the mazes were of wire mesh. Guillotine doors were operated manually to separate the startbox and the arms from the stem. The startbox and stem were painted flat grey. The left arm of one maze was painted white and the right black, the other maze being the reverse.

PROCEDURE

Twenty Ss were assigned randomly to home cages lined with the inserts. The remaining 20 Ss were assigned to regular, unlined home cages. Of the 20 Ss in each group, 10 were housed in pairs in small home cages, and the other 10 were housed in groups of 5 in larger cages. Ss were fed and watered on an ad lib schedule for 4 days. On the 5th day, Ss were put on a 23½-h food-deprivation schedule. At the end of the 7th day, the cage inserts were removed, and on the 8th day, discrimination training was begun. Ten Ss from each pretraining condition (regular and black-and-white home cages) learned a brightness discrimination, and the other 10 learned a position discrimination.

Thus, there were four treatment groups, according to the type of pretraining and type of discrimination task (regular, brightness; regular, position; B-W, brightness; B-W, position). Five Ss in each of the position groups were reinforced for turning left and five for turning right. Similarly, in the brightness groups, five Ss were reinforced for running to black and five for running to white. Each S was run 14 trials per day, with the trials being spaced about 1 min apart. For each S, the black and the white goalboxes were on the left seven times and on the right seven times in each 14-trial block. Thus, in the case of the brightness discrimination, position was an irrelevant cue, and in the position task, brightness was an irrelevant

cue. The two mazes were used simply to facilitate running of Ss. A noncorrection procedure was employed, S being detained in the incorrect goalbox for 10 sec following an incorrect response. A correct response was rewarded with three Noyes pellets. Each S was run for a total of 56 trials.

RESULTS

All Ss had reached a 9-of-10 performance criterion by 56 trials. Factorial analyses based on two measures, trials to criterion and errors to criterion, were computed. The trials-to-criterion analysis indicated no main effect of pretraining [$F(1,36) = 2.74, p > .10$] or of type of discrimination task [$F(1,36) < 1$]. However, there was a significant interaction [$F(1,36) = 12.16, p < .005$]. Individual comparisons using msw as the error term revealed that the B-W Ss learned the position task more quickly ($t = 3.64, df = 36, p < .005$). The regular Ss learned the brightness discrimination more quickly, but the difference was not significant ($t = 1.30, df = 36, p > .10$). The group means were: regular, position = 47.60; regular, brightness = 37.60; B-W, position = 34.40; B-W, brightness = 42.30. The analysis of errors to criterion yielded similar results. There was no effect due to pretraining [$F(1,36) = 1.66, p > .20$] or of type of discrimination [$F(1,36) < 1$], but the interaction was significant [$F(1,36) = 5.31, p < .05$]. Again, the performance of the B-W group was superior on the position discrimination ($t = 2.54, df = 36, p < .02$), but there was no difference in performance on the brightness task ($t < 1$). The treatment means were: regular, position = 16.60; regular, brightness = 12.80; B-W, position = 12.00; B-W, brightness = 14.10.

DISCUSSION

The position data appear consistent with the contention of Sutherland (1964) and Mackintosh (1965) that nondifferentially reinforced responding (in this experiment, eating, drinking, etc.) in the presence of cues causes an S to ignore those cues. Thus, in the position discrimination, the B-W Ss were apparently able to ignore the irrelevant brightness cues and learn the position task more quickly than the regular Ss. Although little can be said regarding the nonsignificant comparisons in the case of brightness discrimination, it is interesting that the results are at least in the direction predicted by Sutherland and by Mackintosh. Further studies involving longer periods of pretraining are planned.

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Within-session behavioral contrast?¹

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No within-session contrast was found with a mult FR EXT schedule that produced positive behavioral contrast between sessions. The absence of within-session contrast agrees with an earlier study by Reynolds (1968) and poses a difficulty for response-rate interpretations of behavioral contrast.

Positive behavioral contrast refers to increased responding in one component of a multiple schedule when responding decreases in the other component. Since Reynolds's (1961) initial analysis, behavioral contrast has been studied as a between-sessions phenomenon. Recently, Reynolds (1968) sought evidence of within-session contrast during the early phases of mult VI EXT and mult VR EXT training. He reasoned, "If the prevailing rate of responding during extinction determines the magnitude of behavioral contrast, there should be a substantial negative correlation: the lower the rate of responding in extinction in the presence of S—, the higher the rate of responding in the presence of S+ [p. 321]." The technique employed was to inspect the scatterplots of response rate for each 3-min S+ period plotted against the response rate for the immediately preceding 3-min S— period. No negative correlations were evident for either of two pigeons in either of the multiple schedules investigated, although both birds showed positive contrast. The

present paper examines comparable data for rats trained with a mult FR EXT schedule that produces excellent behavioral contrast.

METHOD

A Scientific Prototype Model A-102 box was modified for discrimination training. Three male hooded rats, 78-91 days old, were trained. They had been on 23-h food deprivation for a week. Each rat was given 1 day of CRF and 1 day of FR3 training (approximately 200 45-mg Noyes pellets each day) in the presence of S+, a white jewel light located above the lever. On the 1st day of discrimination training, the light was on when the animal was placed in the box and continued in this state until 20 reinforcements were obtained on the prevailing FR3 schedule. The light was then turned off for a 2-min S— period. The first S+ period following the introduction of S— was extended beyond 2 min if necessary to insure reinforced responding

in S+. Each session began and ended with an S+ period. There were 11 S+ and 10 S— periods daily, each 2 min in length except as noted above. Response-rate calculations do not include the first S+ period of the day. There were 4 days of training with mult FR3 EXT.

RESULTS AND DISCUSSION

Table 1 shows that responding increased in S+ and decreased in S—. The rapid development of discrimination is typical with mult FR3 EXT. It is worth noting that the response rate in S— was higher than the response rate in S+ on the 1st day, in spite of the fact that the prior CRF and FR3 training was carried out in the presence of S+. This initial rate bias favoring S— is characteristic of the first discrimination session with rats and has been reported in other studies (e.g., Smith & Hoy, 1954).

Having established that all three rats exhibited positive behavioral contrast, the relationship of S+ responding to S— responding in the immediately preceding period was analyzed. Scatterplots were made of the pairs of response-rate scores for S— and S+ periods. Pearson rs, corresponding to the scatterplots, are shown in the table. Only two of the correlations were negative. The only one to approach statistical significance was for Rat BD on Day 2. On the 3 other days for this animal, responding in S+ was positively correlated with responding in S—. However, a negative correlation does not necessarily imply a sequential divergence of the S+ and S— period scores within a session, the form that a within-session contrast should take, and there was no sequential divergence associated with either of the negative correlations observed in this study.

The absence of within-session behavioral contrast is in complete agreement with Reynolds (1968). It may be concluded that behavioral contrast can and does occur between sessions without within-session contrast. As Reynolds has said, such data "... make it difficult to account for the development and magnitude of contrast ... by appealing directly to the prevailing rate of responding in the presence of S— [p. 322]."

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NOTE

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Table 1
Responses Per Minute and Within-Session Correlations

Rat	Day	S+	S—	r
BC	1	16.5	23.5	+ .39
	2	20.2	12.8	+ .04
	3	22.3	10.7	+ .24
	4	23.0	7.3	+ .68
BD	1	10.8	14.6	+ .77
	2	14.1	9.5	— .52
	3	17.8	6.4	+ .48
	4	25.6	4.2	+ .30
CB	1	15.3	20.6	+ .01
	2	18.5	10.5	+ .16
	3	25.1	10.0	— .29
	4	28.0	8.3	+ .16