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Effects of reinforcement level and number of N-R transitions on resistance to discrimination

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Four groups of eight rats were trained in a successive brightness differential conditioning problem. All groups received partial reinforcement in S+ and nonreinforcement on all S– trials. Two groups were rewarded on 75% of their S+ trials and two groups were rewarded on 87.5% of their S+ trials. Three of the four groups received transitions from nonrewarded to rewarded trials (N-R transitions) in S+. Speed of running in S– was inversely related to percentage of reward in S+ and was greater in groups given N-R transitions than in the group given no N-R transitions. The results were in agreement with an extension of sequential theory, incorporating the reinforcement level principle, to differential conditioning.

McHose and Peters (1973) reported that speed of running in the negative (S–) alley in differential instrumental conditioning was inversely related to percentage of reward in the positive (S+) alley. Haggbloom (1980b, 1980c) and McHose and Blackwell (1975), however, reported differences in S– behavior among groups given the same percentage of reward but different sequences of rewarded (R) and nonrewarded (N) trials in S+. Extinction of responding in S– was retarded in groups given partial reinforcement (PRF) schedules in S+ that contained transitions from N to R trials (N-R transitions), compared with groups given no N-R transitions in S+ (Haggbloom, 1980b, 1980c; McHose & Blackwell, 1975, Experiment 1). The retarded extinction of responding in S–, or resistance to discrimination (Haggbloom, 1980b), in groups given N-R transitions during differential conditioning, parallels the effect of N-R transitions on resistance to extinction following conventional PRF (e.g., Capaldi, 1966).

Both the incentive-based description of performance in differential conditioning recommended by McHose (1970) and Capaldi's (1974) reinforcement level theory predict that speed of running in S– will decrease as the difference between average reward obtained in S+ and S– increases. According to both views, average reward increases as percentage of reward increases. Hence, the finding by McHose and Peters (1973) that performance in S– was inversely related to S+ reward percentage is in agreement with both the incentive averaging model and reinforcement level theory. However, unless the sequence of R and N trials is specifically equated between groups given different percentages of reward, the number of N-R transitions contained in a reinforcement schedule will tend to decrease as reinforcement percentage increases. Since McHose and Peters (1973) did not equate sequential variables between groups, their results might be due to differences between groups in the number of N-R transitions experienced rather than to differences in average reward in S+ and S–. Haggbloom (1980c) argued that "predictions regarding S– behavior must take into account both sequential variables and reinforcement level" (p. 426).

The purpose of the present experiment was to investigate the joint effects of reinforcement level (by varying percentage of reward) and number of N-R transitions in S+ on resistance to discrimination in differential instrumental conditioning. Groups 0-H and 5-H both received a high (87.5%) percentage of reinforcement and 0 and 5 N-R transitions, respectively, in S+. Groups 5-L and 10-L both received a low (75%) percentage of reinforcement and 5 and 10 N-R transitions, respectively, in S+. If resistance to discrimination is strictly a function of the average reward difference between S+ and S–, Groups 0-H and 5-H should respond alike in S– and run slower than Groups 5-L and 10-L, which should also respond alike in S–. On the other hand, if resistance to discrimination is strictly a function of the number of N-R transitions experienced in S+, Group 0-H should run slowest in S–, Group 10-L should run fastest, and Groups 5-H and 5-L should respond alike and at an intermediate level.

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METHOD

Subjects

The subjects were 32 male rats, 130 days old at the start of the experiment, bred in the laboratory from Holtzman stock.

Apparatus

The apparatus consisted of two parallel straight alleys, 105 cm long x 9 cm high and wide. The walls and floor of one

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alley were painted white, and the walls and floor of the other alley were painted black. The last 25 cm of each alley constituted a goalbox separated from the rest of the alley by a manually operated guillotine door. The doors and goalboxes were painted the same color as the alley in which they were located. Each goalbox contained an unpainted wooden goal cup. A gray startbox, 9 cm high and wide x 25 cm long, could be aligned to permit entry into one alley or the other. The startbox had a gray, manually operated guillotine door. Start times were recorded from the opening of the startbox door, which triggered a .01-sec clock, to a point 32 cm into the alley. Run and goal times were recorded over the next 40 and 30 cm, respectively, of the alley. The offset of the first clock and the operation of the run and goal clocks were controlled by photoelectric circuitry.

Procedure

Two weeks prior to the 1st day of experimental training, which began on Day 15, all food was removed from each rat's cage and a daily ration of 12 g of Purina Lab Chow was begun. The rats had free access to water at all times. On Days 12-14, the rats were handled in squads of four for 4 min/squad. After being handled on those days, the rats were fed 10 45-mg Noyes pellets in their home cage. Eight rats were randomly assigned to each of four groups.

Using procedures similar to those employed by Haggbloom (1980b, 1980c) to separate the effects of variations in reward sequence in S+ from variations in other sequential variables, each group received four trials in the S+ alley on each odd-numbered day of training and three nonrewarded trials in the S– alley on even-numbered days. For one half of the rats in each group, S+ was the black alley and S– was the white alley. Those conditions were reversed for the other half of each group. Groups differed with respect to the schedule of R and N trials received on S+ days. Over successive blocks of 4 S+ days, the reinforcement schedules experienced by each group were as follows: Group 0-H, RRRN, RRRR, RRRN, RRRR; Group 5-H, RNRR, RRRR, RRNR, RRRR; Group 5-L, RNRR, RRRN, RRNR, RRRN; and Group 10-L, RNRR, RRNR, RRNR, RNRR. These schedules provide reinforcement for Groups 0-H and 5-H on 87.5% of their S+ trials and for Groups 5-L and 10-L on 75% of the trials in S+. The reinforcement schedules experienced by Group 0-H did not contain N-R transitions, Groups 5-L and 5-H both received a total of 5 N-R transitions, and Group 10-H received 10 N-R transitions.

On R trials, the rats were removed from the goalbox after the times were recorded (after approximately 10 sec) unless the reward had not yet been consumed. All reinforcements consisted of 10 45-mg Noyes pellets. On N trials the rats were confined to the unbaited goalbox for 20 sec. There were 20 days of discrimination training, 10 S+ days alternated with 10 S– days. A trial was begun by placing a rat in the startbox and opening the startbox door after approximately 3 sec regardless of the rat's orientation. The rats were run in squads of four containing one rat from each group. The order in which trials were administered within a squad varied randomly from day to day, but the order of successive squads was held constant across days. The intertrial interval was 3-4 min. A maximum time of 30 sec was allowed in each alley section. If 30 sec was exceeded in any alley section, the additional time was added to the time score of the next section forward. If the rat did not enter the goalbox within 90 sec, it was placed in the goalbox.

RESULTS AND DISCUSSION

All time scores were converted to speeds in centimeters per second. Only total speeds, which are representative of responding in each alley section, are reported here. As in previous experiments (Haggbloom, 1980b, 1980c), differences in resistance to discrimination due to S+ reinforcement conditions were manifested primarily in S– behavior. Figure 1 shows the mean speed of each group in blocks of 2 S– days.

As can be seen in Figure 1, resistance to discrimination was inversely related to percentage of reward in S+; that is, Groups 0-H and 5-H, given a high percentage of reinforcement in S+, ran slower in S– than Groups 5-L and 10-L, given a low percentage of reinforcement in S+. In addition, resistance to discrimination was greater in the three groups given N-R transitions in S+ than in Group 0-H, given no N-R transitions in S+. There were no differences among groups within S+ (data not shown), and all groups ran substantially slower in S– than in S+.

These observations were supported by a between/within analysis of variance with groups (4) and brightness (2) as between-subjects variables and trials (3) and days (8) as within-subjects variables applied to speeds in S– over the last 8 S– days. The analysis yielded a highly significant main effect of groups [$F(3,24) = 6.34$, $p < .01$]. Planned comparisons between the pooled means of Groups 5-H, 5-L, and 10-L vs. Group 0-H showed that the three groups given N-R transitions ran reliably faster in S– than Group 0-H did [$F(1,24) = 16.10$, $p < .01$]. Planned comparisons between the pooled means of Groups 5-L and 10-L vs. Groups 0-H and 5-H showed that resistance to discrimination was greater in groups given a low percentage of reinforcement in S+ than in groups given a high percentage of reinforcement [$F(1,24) = 13.42$, $p < .01$]. A similar analysis of variance applied to S+ speeds showed that there were no differences among groups in S+ [$F(1,24) = 1.24$].

The finding here that resistance to discrimination was greater in groups given N-R transitions in S+ than in

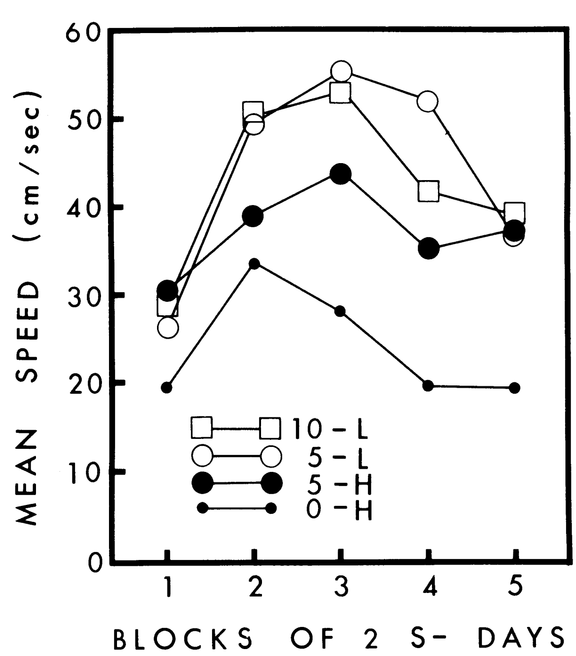

Figure 1. Mean speed of each group in blocks of 2 S– days.

groups given no N-R transitions in S+ is in agreement with the results of previous investigations of the effects of S+ reward sequence on S– behavior (Haggbloom, 1980a, 1980b, 1980c; McHose & Blackwell, 1975). On a more general level, the sequential effects obtained here lend additional support to the view that partial reinforcement and discrimination learning situations are highly interrelated (e.g., Capaldi, 1979; Haggbloom, 1980b; McHose & Blackwell, 1975).

The finding that resistance to discrimination was inversely related to S+ reward percentage is in agreement with the results of McHose and Peters (1973). More generally, it supports the prediction that can be derived from reinforcement level theory (Capaldi, 1974) or the incentive averaging view (McHose, 1970) that speed of running in S– is inversely related to the size of the discrepancy between average reward in S+ and S–. Taken together, the two major findings in this experiment are in agreement with the notion (Haggbloom, 1980c) that S– behavior can most accurately be forecast by basing predictions on sequential theory that has incorporated the reinforcement level principle.

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