

Synthesis of differential conditioning and double alley data: Performance to S+ as a function of intertrial interval and antedating reward events¹

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In each of the two studies, one group of rats received differential reward conditioning in a black-white discrimination apparatus, while a second group received the S+ reward in both discriminanda. Contrast effects to the S+ stimulus varied with antedating reward events and the intertrial interval.

The present studies were concerned with the possibility that a variety of behavioral phenomena obtained in the double-alley apparatus may be attributed to the same variables as are implicated in the occurrence of contrast effects in differential conditioning experiments. For example, certain procedural and functional similarities between the two situations may be explicated by reference to performance to the smaller of two experienced rewards: In the double alley, speeds to small reward in the second alley (S₂) are slower for groups receiving large as compared with small reward in the first alley (S₁) (McHose & Ludvigson, 1965). Similarly, speeds to a small-reward S- (S₂) in differential conditioning are depressed by large as compared with small reward in S+ (S₁). While a number of other functional similarities may be seen between double-alley and differential-conditioning data (cf. McHose, in press), one apparent discrepancy between the two literatures, concerning speeds to the larger of two experienced rewards, does exist.

In the double alley, speeds to large reward in the second alley (S₂) decrease as the smaller reward magnitude in the first alley (S₁) increases (Daly, 1968). In differential conditioning studies, speeds to S+ (S₂) increase as the S- (S₁) reward magnitude increases (MacKinnon, 1967). Rather than reflect any basic difference between the two situations, this discrepancy may result from the peculiar mode of S₁ and S₂ presentations in the double alley. Indeed, recent differential conditioning data suggest that when the mode of discriminandum presentations is similar to that employed in the double alley (S₂ at short intertrial intervals following S₁ at long intervals), positive S+ contrast is obtained (McHewitt et al,

1969). While these data provide a tentative link between the two experimental situations, the design of the McHewitt et al study precludes isolation of the specific variables contributing to the positive S+ contrast effect as opposed to the more typical finding of negative S+ contrast effect (MacKinnon, 1967; Matsumoto, 1965). The present studies were concerned with the role of the intertrial interval and the nature of the trial preceding the measurement trial in producing positive S+ contrast effects.

METHOD

In Experiment 1, 30 naive male albino rats received 100 trials in a differential-conditioning apparatus comprised of a gray startbox (SB) and parallel flat black and flat white alley-goal sections. The SB could be aligned adjacent to either the white or black alley-goal section. The SB, alley, and goal sections were 13, 21, and 12 in. long, respectively, with the interior width and height of the apparatus 3½ in. each throughout. Opaque doors separated the SB and goal sections from the alley segment of the apparatus. Photocell-clock circuitry provided traversal times over the first 8-in. and second 12-in. segments of the alley section.

Thirteen days prior to the first training day (Day 14), Ss were placed on a 23-h food-deprivation schedule maintained throughout the experiment. On Days 11, 12, and 13, each S was handled for approximately 5 min, allowed 3 min exploration of the alley section of the apparatus, and fed 10 45-mg Noyes pellets, identical to the subsequent reinforcement pellet, in addition to its regular 1-h feeding.

Ten Ss were assigned to each of two groups, designated according to the number of 45-mg pellets received on odd- and even-numbered daily trials, respectively: Groups 1-10 and 10-10. The alley-goal brightness associated with odd-numbered trials (S-) was counterbalanced between groups. Trials were administered at the rate of four per day, with an intertrial interval (ITI) of approximately 5 min.

In Experiment 2, 24 Ss received 96 trials in a differential-conditioning apparatus that differed only in minor detail from the apparatus used in Experiment 1 and that is described in detail elsewhere (cf. McHewitt et al, 1969). Photocell-clock circuitry

provided traversal times over the first two 12-in. segments of the alley.

Prefeeding and habituation procedures were identical to those of Experiment 1. Twelve Ss were assigned randomly to each of two groups, designated according to the number of 45-mg pellets received in S- (e.g., black alley-goal section) and in S+, respectively: Groups 1-10 and 10-10. The brightness of S+ was counterbalanced within each group. Trials in the black (B) and white (W) alley-goal sections were administered at the rate of four per day according to the following recursive cycle: BWBW, WBBW, BBWW, WBWB, BWBW, WWBB. Each S received two trial couplets per day. The first trial of each couplet for each S occurred at a relatively long ITI (24 h and 8 min for Daily Trials 1 and 3, respectively), and the second trial of each couplet (Trials 2 and 4) occurred at short (15-sec) ITIs. Within each group, then, preceding trial event (S+ vs S-), S+ vs S-, and ITI were factorially manipulated.

In both experiments, daily trials were administered to Ss within squads so that each S received its first trial (or trial couplet) before any S received its second trial. The running order of Ss within a squad was randomized from day to day.

In both experiments, the door separating SB from the alley was opened after S oriented toward the door for 3 sec. The doors separating the alley from the goal segments were closed after S entered GB, and S was removed from GB immediately after consuming the allotted pellets.

RESULTS

Experiment 1

Group mean start and run speeds for Groups 1-10 and 10-10 are plotted as a function of blocks of 20 trials in Fig. 1. For Group 1-10, the speeds on 10-pellet (S+) trials are plotted separately from those on 1-pellet (S-) trials. Similarly, the speeds of Group 10-10 on odd-numbered (S-) trials are plotted separately from those on even-numbered (S+) trials.

As may be seen in Fig. 1, Group 1-10 ran faster on S+ as compared with S- trials in both segments of the alley, while the nondiscrimination group, Group 10-10, showed approximately equivalent speeds on S+ as compared with S- trials. Variance analysis of the data for both groups at Block 5 yielded a significant ($p < .01$) S+ vs S- by Group interaction in both start and run measures ($F_s = 8.87$ and 7.32 , respectively, $df = 1/22$).

Further inspection of Fig. 1 shows that in the start measure the S+ speeds of Group 1-10 were slightly depressed relative to those of Group 10-10, but this depression was not present in the running-speed data. Variance analyses of the S+ data at Block 5 yielded a

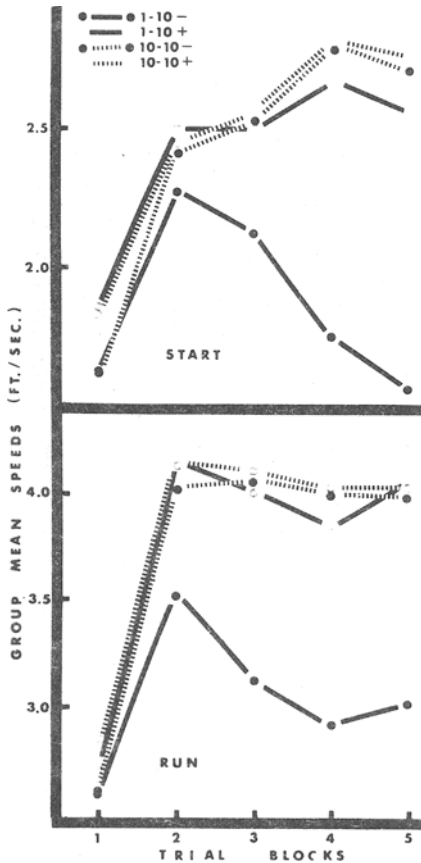


Fig. 1. Response speeds to S+ and S-.

nonsignificant ($.10 < p < .20$) groups effect in the start data and an F ratio less than unity in the run measure.

Experiment 2

Preliminary analysis of the S+ and S- data for Groups 1-10 and 10-10 of Experiment 2 yielded a significant S+ vs S- by Groups interaction in which only the discrimination group (1-10) ran faster to S+ than to S- over Trials 73-96 ($F_s = 102.97$ and 9.43 , $dfs = 1/20$, for the start and run measures, respectively). Of primary interest, however, are the relative performance levels of Groups 1-10 and 10-10 on S+ trials as presented in Fig. 2. The speeds of Group 1-10 under each of the various ITI and antedating reward-event conditions are plotted relative to a baseline representing the performance level of Group 10-10 under similar conditions. For example, the S+ speeds of Group 1-10 following, at short ITI, an S- trial are plotted relative to the performance level attained by Group 10-10 on the same daily trials. While these trials were short ITI trials for Group 10-10, the S+ vs S- factors are, of course, pseudovariables for Group 10-10.

Looking first at the starting speed data, it may be seen in Fig. 2 that the S+ speeds of Group 1-10 were depressed relative to those of Group 10-10 under all conditions except on short ITI trials preceded by an S- trial. Separate variance analyses of the S+ data for both groups at each ITI by antedating reward event condition yielded significant ($p < .01$) groups effects following S+ trials at both long ITI ($F = 8.94$, $df = 1/20$) and short ITI ($F = 6.50$, $df = 1/20$). Following S- trials, Group 1-10 speeds were significantly depressed relative to those of Group 10-10 only on long ITI trials ($F = 11.82$, $df = 1/20$).

Looking next at the run-speed data, it may seem in Fig. 2 that, like the start data, the S+ speeds of Group 1-10 relative to those of Group 10-10 were fastest at short ITIs after an S- trial. While the short ITI start speeds following an S- trial for Group 1-10 uniquely showed no S+ depression, this particular condition uniquely produced facilitation of Group 1-10 speeds in the run measure. Separate variance analyses of the various ITI by antedating reward event conditions yielded a significant ($p < .05$) groups effect only after S- trials at short ITI ($F = 4.94$, $df = 1/20$).

DISCUSSION

Several previous studies (e.g., Henderson, 1966; MacKinnon, 1967; Matsumoto, 1965) have shown that performance to the positive discriminandum (S+) in differential conditioning is influenced by the reinforcement contingencies associated with negative discriminandum (S-). Generally, these studies demonstrate that the S+ performance of differentially reinforced (discrimination) groups is depressed relative to that of nondiscrimination control groups receiving the S+ reinforcement in both S+ and S-. In the present experiments, such negative S+ contrast effects were obtained in the conditions most similar to those of previous studies. Thus, at long ITIs in Experiment 2, the S+ speeds of Group 1-10 were depressed relative to those of Group 10-10. A similar, albeit statistically unreliable, depression was obtained in Experiment 1. Moreover, these S+ contrast effects were evidenced only in the early segment of the runway, a pattern again consistent with previous data (Henderson, 1966; MacKinnon, 1967).

While the present data suggest that performance to S+ at long ITIs is independent of whether the S+ (measurement) trial was preceded by an S+ or an S- trial, performance to S+ at short ITIs depends in part upon the nature of the trial preceding the measurement trial.

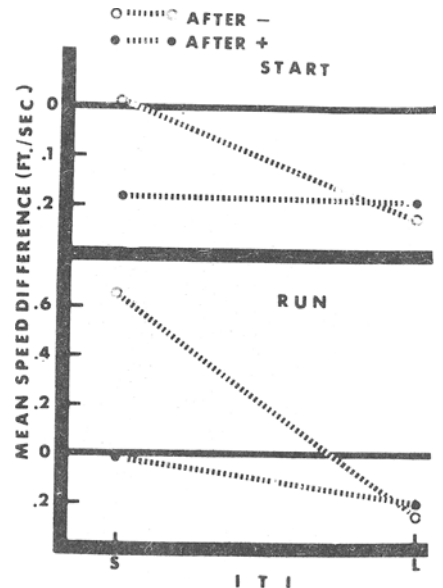


Fig. 2. Response speeds to S+ for Group 1-10 plotted relative to control (Group 10-10) speeds at each condition.

Thus, a negative S+ contrast effect was obtained at short ITIs (Experiment 2) only when the amount of reward received on the preceding trial was controlled in comparisons between Group 1-10 and Group 10-10, i.e., only following S+ trials. Following S- trials, no negative contrast was obtained in the start measure and a positive S+ contrast effect, faster S+ speeds for Group 1-10 as compared with Group 10-10, was evidenced in the run measure. It should be noted that this apparent positive S+ contrast effect occurred only if the S+ trial followed shortly after an S- trial, a condition previously shown to produce positive S+ contrast (McHewitt et al, 1969).

Concerning the variables influencing speeds to S+, the present data in concert with previous findings suggest that a contrast (difference) between S+ and S- reward magnitude depressed speeds to S+, and that this effect of contrasted rewards dissipates distal to the start section of the alley. Moreover, this effect is apparently independent of ITI conditions. Speeds to S+ are also influenced by a nonrelational or absolute parameter of reinforcement, the amount of reward received on the trial preceding the measurement trial, such that, as the preceding reward magnitude increases, subsequent speeds decrease. The effects of this absolute magnitude variable apparently dissipate with time, influencing the short ITI data of Experiment 2 but not the long ITI data of either experiment.

From the present viewpoint, the primary significance of the present findings derives

from their implications for attempted syntheses of the L-shaped double alley and differential conditioning literatures. As previously noted (McHewitt et al., 1969), the assertion that the procedures used and the behavioral effects obtained in double-alley studies are analogous to differential conditioning contrast effects is seemingly contradicted by at least one set of data. Thus, in the double alley, speeds to large reward in the second alley (S+) decrease as the reward magnitude received in the first alley (S-) increases (Daly, 1968), while in differential conditioning studies speeds to S+ decrease as S- reward decreases (MacKinnon, 1967; Matsumoto, 1965). On the basis of the present data, this apparent disparity does not appear to reflect any basic difference between the two situations. Rather, the apparent positive S+ contrast observed in the double alley also occurs in discrimination situations when the measurement trial follows, at short ITI, an S- trial, as is the case in the typical double-alley study. The present data indicate that this apparent S+ contrast results from the effect of reward amount on the trial preceding the measurement trial such that S+ speeds vary inversely with reward amount on the preceding trial. It should be noted that just such an effect must be assumed to operate in the double alley in order to account for some behavioral phenomena not

attributable to contrast effects, e.g., the frustration effect, or FE (cf. McHose, in press).

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NOTES

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2. Now at Washington State University, Pullman, Wash. 99163.

A facilitating effect of latent extinction: Further evidence

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An earlier article reported that one 30-sec nonreinforced goal placement resulted in a facilitation of subsequent runway performance. The present experiment indicated that the effect was reliable, but it greatly modified the interpretation offered in the earlier article.

Although direct, nonreinforced placements in a goalbox (latent extinction placements) usually result in a decrement in runway performance, Jones, Narver, & Bridges (1967) found that one 30-sec latent extinction placement resulted in a

facilitation of subsequent runway performance. The effect was attributed to an increase in frustration after frustration had become attached to the running response as a result of training on a partial reinforcement schedule. The present experiment attempted to determine if the effect would be obtained with Ss trained on a consistent reinforcement schedule.

METHOD

The Ss were 20 male Sprague-Dawley rats, 80 days old at the start of the experiment. The Ss were trained in a straight runway that was 48 x 4½ x 6 in. high, excluding the goalbox. The goalbox was 10 x 4½ x 6 in. and contained a copper foodcup, 2 in. in diam and ½ in. deep. The runway floor was a bar grid.

All Ss were maintained on a 23-h food-deprivation schedule and were given

five trials per day for 8 days. All Ss received .5 ml of 16% sucrose solution in the foodcup on a 100% reinforcement schedule. They were confined in the goalbox for 30 sec on all trials. The intertrial interval was approximately 30 min. Training was interrupted for 15 days, during which time the Ss were maintained on their regular 23-h deprivation schedule.

On the 24th day of the experiment, the Ss were given two warm-up trials. Running speed on the second trial was used to rank order the Ss. The slowest four Ss were discarded, and the remaining 16 Ss were assigned to two groups according to a matched-groups design. The Ss in the experimental (E) group were placed directly into the goalbox, facing the foodcup, and were left for 30 sec. Within 15 sec of removal from the goalbox, the Ss were placed in the start of the runway and were given their first test trial. Ss in the control (C) group merely ran their regular test trials without any direct goal placement. Four test trials were given, maintaining a 30-min intertrial interval. The Ss in the two groups were run in a balanced order (ABBA).

RESULTS AND DISCUSSION

As indicated by Fig. 1, Ss in the E group ran faster over the four test trials than did the Ss in the C group. This difference was significant ($t = 3.51$, $df = 7$, $p < .005$). The results indicate that the facilitating effect of latent extinction, reported by Jones, Narver, & Bridges (1967), is a reliable phenomenon. It should be noted that the results were essentially the same as in the earlier article, despite the fact that the Ss in the experiments differed in age and sex; the reinforcer was a sucrose solution in the present experiment and food pellets in the earlier experiment.

Jones, Narver, & Bridges (1967) suggested that frustration becomes attached to the running response in the process of partially reinforced acquisition, and the strong frustration generated during the latent extinction placements serves to energize the running response. Since, in Experiment 1 of that article, the effect was still present 24 h following the placements, it would seem that the facilitation depends to some extent on a conditioned reaction that can reinstate arousal at a later time. Amsel's (1967) fractional anticipatory frustration (r_f) could fulfill this role.

However, this interpretation requires that the distinctive stimuli (s_f) produced by r_f would have to somehow become attached to the instrumental response *prior* to the first test trial. The Ss in the present experiment were given consistent reinforcement. Normally, Ss trained on consistent reinforcement should not be