An inverse performance pattern in a discrimination based on differential magnitudes of reward

JOHN R. MacKINNON AND JOSEPH S. RUSSOTTI

CONNECTICUT COLLEGE

In a black-white successive discrimination, rats received a large reward (500 mg) in one alley, and a smaller reward (250 mg) in an alley of a different brightness. Results indicated nondifferential responding in the start segment, but superior performance to the stimulus associated with the smaller reward in the running and goal measures.

Numerous investigations (e.g., Bower, 1961; Goldstein & Spence, 1963; Porter, 1964; Ludvigson & Gay, 1966) have shown that rats can readily learn to respond "appropriately" in a successive discrimination based on different reward magnitudes. Moreover, with the exception of the experiment by Goldstein & Spence (1963), these studies clearly indicate that performance to a given reward magnitude is influenced by the reward associated with the comparison discriminandum.

In a recent magnitude discrimination experiment (MacKinnon, 1967), performance to one stimulus (S_1) was examined as a function of the reward magnitude coupled with the other stimulus (S_2) in the discrimination. $S_1:S_2$ reward magnitudes (in mg) were 500:500, 500:250, 500:90, 500:37, 500:0. The results clearly supported a "reward context" interpretation. That is, performance to S_1 was not independent of the reward magnitude associated with S_2 . Of particular interest was the overall runway performance of Ss in the 500:250 group. Although start speed curves indicated only a slight tendency towards "appropriate" differential responding, there was a significant performance superiority to the small reward stimulus in the final two runway segments (running and goal measures).

The present study constitutes a replication of the 500:250 condition in the MacKinnon (1967) experiment and was designed to further investigate this paradoxical finding of higher running and goal speeds to the stimulus signalling lesser reward.

Subjects

Ss were 10 naive, male albino rats of the Wistar strain, approximately 110 days old at the start of the experiment.

Apparatus

The apparatus consisted of two parallel straight alleys, one of which was painted flat black and the other flat white. A sliding, neutral gray, prestart box (PSB) and start box (SB) section could be moved into alignment with either alley. The PSB (11 in.) and SB (10-1/2 in.) were separated by a gray metal guillotine-type door. A clear Plexiglas door separated

the SB from the alley proper. The length of each alley, from start door to food cup, located on the end wall of the goal box (GB), was 39 in. The length of the GB section was 13 in. Inside dimensions of each alley were 3-3/4 in. x 3 in. Response times, over three successive 1-ft. segments of the alley, were recorded by means of 1/100 sec. clocks activated by a photoelectric system.

Procedure

Ss were maintained on a 23-hr. deprivation schedule for a 20-day period prior to the beginning of training. The Ss received a daily ration of 10 gm Purina checkers, which during the experiment proper, included the weight of pellets given as reward.

Differential magnitude discrimination training involved 144 trials (72 trials to each alley brightness). The reward magnitude associated with one discriminandum (S_1) was one 500 mg Noyes pellet, whereas reward to the alternative stimulus (S_2) consisted of one 250 mg pellet. Ss were run, six trials per day, three trials to S_1 and three to S_2 . The orders of presentation of S_1 and S_2 were randomized and varied from day to day for each S. Color conditions were

Fig. 1. Mean median start, running and goal speeds to S_1 (500 mg stimulus) and S_2 (250 mg stimulus) plotted in 6-trial blocks.

counterbalanced so that for a random half of the Ss, S_1 was black and S_2 was white, and for the other five Ss, S_1 was white and S_2 was black. After the first two days of training, the intertrial interval averaged 16 min. Minimum GB detention time on all trials was 20-25 sec.

Results

Time measures were converted to reciprocals to yield speed scores. Mean median start, running, and goal speeds to the differentially rewarded stimuli are plotted in Fig. 1. Variance analyses on the three sets of speed scores over the final six days of training (Blocks 10-12) included Magnitude, Days, and Alley Brightness as main effects.

Examination of the start curves indicates an increased vigor to the 250 mg stimulus early in the discrimination, with a subsequent reversal. Speeds to the two stimuli at the end of training, however, were not significantly different ($F=1.61$, $df=1/8$). On the other hand, the superior performance to the small reward stimulus was reliable at better than the .01 level in both running ($F=40.70$, $df=1/8$) and goal ($F=33.92$, $df=1/8$) measures. A significant Magnitude by Brightness interaction ($F=5.45$, $df=1/8$, $p<.05$) indicated a color effect in the mid-section of the runway. Subsequent reanalysis revealed a larger absolute difference in performance to the two stimuli when the 250 mg reward was associated with the white alley. A significant main effect of Days ($F=15.55$, 6.37 , 2.85 , $df=5/40$, for start, run, and goal, respectively) in all measures, indicated that Ss were responding at other than an asymptotic level over the final six days of discrimination training. The sharp overall decrease in start speeds, and the concurrent increase in running speeds at Block 9, are due to inaccurate time recordings as a result of a malfunction in the photo relay equipment.

Discussion

The results are clearly in agreement with those reported earlier by MacKinnon (1967), where, with a 2:1 large to small reward ratio, higher running and goal speeds were obtained to the stimulus signalling the lesser reward. Higher reward ratios have typically yielded conventional discrimination curves in all segments of the runway (e.g., Bower, 1961; Goldstein & Spence, 1963; Ludvigson & Gay, 1966). Presumably, the ratio of large to small reward is a crucial factor in determining the overall performance pattern in a differential magnitude discrimination.

Working within the context of Amsel's (1958, 1962) frustrative nonreward theory, a number of investigators (e.g., Bower, 1961; Davenport, 1962) have postulated the operation of frustrative mechanisms in reward magnitude discrimination situations. Frustrative responses are generated to the small reward stimulus through the generalization of anticipatory goal reactions (r_{GS}) from the large reward discrim-

inandum. Where the absolute difference between the two magnitudes is large, the typical performance decrement which occurs to the small reward stimulus is assumed to be due to the conflict between the anticipation of reward (r_R) and the small-reward-produced frustration. The present results suggest that in discriminations involving decreased $S_1:S_2$ reward ratios, an opportunity is provided for the facilitative effects of frustration (i.e., s_F conditioned to approach) to develop to the small reward stimulus.

The question still remains as to why other experiments (Goldstein & Spence, 1963; Porter, 1964) involving 2:1 reward ratios have failed to demonstrate small reward facilitation. It has been shown (MacKinnon & Amsel, 1964) that time spent by S in the frustrating situation is an important variable determining the development of frustration effects. Apart from other minor procedural differences, these experiments involved immediate removal of S from the GB on small reward trials, which may have acted to retard the development of frustrative factors.

The present finding of increased vigor to the small reward stimulus is not dissimilar to certain patterns obtained to the partial stimulus in within-S partial reinforcement experiments (Amsel, Rashotte, & MacKinnon, 1966). However, the development of superior performance in these two situations occurs in different segments of the response chain. Currently, research is underway to examine similarities in the overall runway patterns in the within-S magnitude and partial reinforcement situations.

References

- Amsel, A. The role of frustrative nonreward in noncontinuous reward situations. *Psychol. Bull.*, 1958, 55, 102-119.
- Amsel, A. Frustrative nonreward in partial reinforcement and discrimination learning: some recent history and a theoretical extension. *Psychol. Rev.*, 1962, 69, 306-328.
- Bower, G. H. A contrast effect in differential conditioning. *J. exp. Psychol.*, 1961, 62, 196-199.
- Amsel, A., Rashotte, M. E., & MacKinnon, J. R. Partial reinforcement effects within subject and between subjects. *Psychol. Monogr.*, 1966, 80 (20, Whole No. 628).
- Davenport, J. W. The interaction of magnitude and delay of reinforcement in spatial discrimination. *J. comp. physiol. Psychol.*, 1962, 55, 267-273.
- Goldstein, H., & Spence, K. W. Performance in differential conditioning as a function of variation in magnitude of reward. *J. exp. Psychol.*, 1963, 65, 86-93.
- Ludvigson, H. W., & Gay, S. E. Differential reward conditioning: S- contrast as a function of the magnitude of S+. *Psychon. Sci.*, 1966, 5, 289-290.
- MacKinnon, J. R. Interactive effects of the two rewards in a differential magnitude of reward discrimination. *J. exp. Psychol.*, 1967, in press.
- MacKinnon, J. R., & Amsel, A. Magnitude of the frustration effect as a function of confinement and detention in the frustrating situation. *J. exp. Psychol.*, 1964, 67, 468-474.
- Porter, J. J. Effects of differential reward magnitude on simple brightness discrimination with free and forced trials. *Psychol. Rep.*, 1964, 15, 279-286.