

# Resistance to extinction following shifts in reward magnitude<sup>1</sup>

ROGER W. BLACK AND STEPHEN FEIG  
UNIVERSITY OF SOUTH CAROLINA

*Three groups of 12 rats each were trained to run a straight alley for four trials per day for 12 days with reward being three food pellets, followed by 10 additional days of training (4 trials/day). During the latter period, Ss in Group 3-3 continued to receive three pellets as reward on each trial. For the remaining Ss three of the four daily training trials were also followed by three pellets reward, but for Group 3-9 one daily trial was reinforced with nine pellets while for Group 3-1 one daily trial was reinforced with a single pellet. During a final single day of 20 extinction trials, Ss in Group 3-1 performed at a higher level than Ss in either Group 3-9 or 3-3, while no significant difference in resistance to extinction was observed for the latter groups. These results were interpreted as consistent with the frustration theory of extinction and partial reinforcement.*

That partial reinforcement (PR) results in greater resistance to extinction (Rn) than consistent reinforcement (CR) is one of the most well established facts of conditioning and several theories regarding the source of this effect have been advanced. For example, Amsel (1958) and Spence (1960) have argued that nonreinforced trials interspersed among reinforced trials result in the evocation of a frustration response (Rf) which initially tends to elicit other overt Rs which interfere with the instrumental R. When Ss are trained on a schedule of PR, however, these competing Rs tend to be eliminated and, thus, such Ss show less disruption of performance during extinction than those which were initially trained with CR and which encounter nonreinforcement and Rf for the first time during extinction. On the other hand, it may be the relatively greater variability of the conditions of reward associated with PR as compared with CR during acquisition which enhances the Rn of the Ss trained on the former schedule. Thus, Ss which have experienced more than one magnitude of reward during acquisition (e.g., "some reward" on some trials and "no reward" on others) may find it more difficult to discriminate the transition from acquisition to extinction than Ss which consistently received a single magnitude of reward during acquisition (cf. Mowrer & Jones, 1945).

In the present experiment an attempt was made to manipulate independently the variability of acquisition reward magnitude and the potential for the occurrence of frustration. A control group (Group 3-3) received three pellets as reward on each of 88 trials of the acquisition of a simple locomotor R in a straight runway, followed by 20 extinction trials. Group 3-9 also received three pellets reward on each of the first 48 acquisition trials as well as on three of each of the

four daily training trials prior to extinction. On one trial of each of these last 10 days, however, these Ss received nine trials as reward. Group 3-1 was treated in an identical manner except that one of each of the last 10 days' trials was followed by a single pellet as reward. Thus, both of the experimental groups experienced variability during acquisition in reward magnitude, while this variability would be expected to result in frustration only in the case of Group 3-1. According to the frustration interpretation of extinction, it would be anticipated that Ss in Group 3-1 would show the greatest Rn.

## Method

The Ss were 36 female albino rats about 100 days old at the beginning of training. Seven days before and throughout the course of training all Ss were maintained on 9 g of lab chow per day with water continuously available. The apparatus consisted of a 3 ft straight alley painted flat black and equipped with a 10 in. start section and 12 in. goal section, each of which could be separated from the alley by sliding aluminum doors. Photoelectronic circuitry provided measures of starting time (measured from the time the start door was opened until S had reached a point 6 in. within the alley) and running time measured over the next 12 in. of the alley.

On Days 1-12 the goal box was baited with three 97 mg Noyes pellets on each of the four daily training trials. On each trial S was placed in the start box and the start box door was opened. When S entered the goal section, the goal box door was closed and S remained in the goal box for 30 sec or until it had consumed its reward. The Ss were run in rotation within squads, thus maintaining an intertrial interval of about 10 min. On Day 13 Ss were randomly assigned to one of three groups. While Ss in Group 3-3 continued to receive three pellets on each trial, those in Groups 3-9 and 3-1 received three pellets on only three of their four daily training trials. On one trial each day the former Ss received nine pellets while the latter were given only a single pellet. For both of these groups either Trial 2 or 3 was randomly designated the "shifted reward trial" each day of the final 10 days. On Day 23 all Ss were given 20 nonreinforced extinction trials with the intertrial interval remaining at about 10 min.

## Results and Discussion

Before analysis all latencies were converted to speed scores (ft/sec). Since the data for starting and running speeds were essentially identical, only the former are presented here. Analysis of variance of the last two

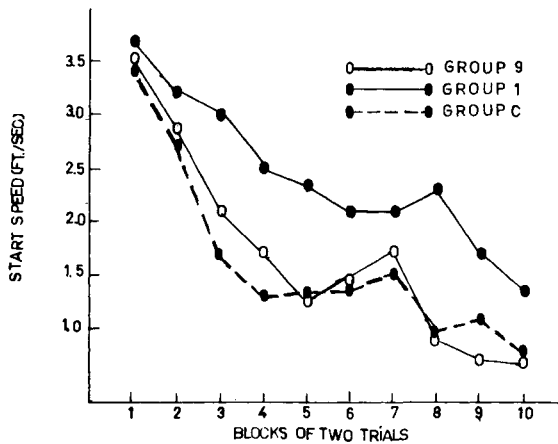


Fig. 1.

days of acquisition indicated that starting speeds for the groups did not differ reliably ( $F = 1.97, df = 2/33, p > .10$ ). Differences in starting speed did occur, however, during the 20 trials of extinction and are presented in Fig. 1. Inspection of this figure indicates that the performance of Ss in Group 3-1 diverged from that of the other two groups and remained consistently higher throughout extinction. Groups 3-3 and 3-9, however, did not appear to differ. These observations were supported by a significant main effect of Groups ( $F = 7.11, df = 2/33, p < .01$ ) and a significant Groups by Trials interaction ( $F = 4.83, df = 2/19, p < .01$ ) during extinction.

The fact that Ss in Group 3-1 showed greater Rn than those in either Group 3-3 or 3-9 in the present experiment was presumably not the result of variability in acquisition reward magnitude per se. Thus, such variability was at least as great for Ss in Group 3-9 as for those in Group 3-1, although Groups 3-9 and 3-3 were equal and both were inferior to Group 3-1 in terms of Rn. If it is assumed that Rn is an inverse function of acquisition reward magnitude, then it might be argued that the superior extinction performance of Group 3-1 resulted from the fact that these Ss received the smallest average number of pellets during acquisition of any of the groups (2.8 vs 3.0 and 3.6 respectively). These dif-

ferences in average reward magnitude were, however, quite small and failed to produce a reliable difference among the groups in acquisition starting or running speeds. Thus, this variable would seem to constitute an unlikely explanation of the present results.

In the opinion of the writers, the most plausible interpretation of the data presented in Fig. 1 is provided by the frustration hypothesis (Amsel, 1958; Spence, 1960) briefly discussed earlier. If this hypothesis is extended to include the assumption that a reduction in reward as well as a nonreward will result in Rf, then the present data can be readily handled (cf. Black, 1964, 1968). Following a series of trials involving a consistent reinforcement of three pellets, a shift to one pellet as reward should result in the occurrence of Rf in Group 3-1. For Ss consistently trained with three pellets (Group 3-3), or shifted to a larger reward (Group 3-9), no such Rf should occur during acquisition. Thus, when extinction is initiated, only Ss in Group 3-1 will have had the opportunity to eliminate the competing Rs elicited by frustration and this group should show substantially more Rn than Ss which had not experienced downward shifts in reward magnitude during training. In other words, Group 3-1 should exhibit Rn analogous to that observed with Ss trained under PR, while the extinction performance of the other Ss should resemble that of groups trained with CR. This was, of course, the result obtained in the present experiment.

#### References

- AMSEL, A. The role of frustrative nonreward in noncontinuous reward situations. *Psychol. Bull.*, 1958, 55, 102-119.
- BLACK, R. W. Differential conditioning, extinction and secondary reinforcement. *J. exp. Psychol.*, 1964, 69, 67-74.
- BLACK, R. W. Shifts of magnitude of reward and contrast effects in instrumental conditioning and selective learning: A reinterpretation. *Psychol. Rev.*, 1968, in press.
- MOWRER, O. H., & JONES, HELEN M. Habit strength as a function of the pattern of reinforcement. *J. exp. Psychol.*, 1945, 35, 293-311.
- SPENCE, K. W. *Behavior theory and learning*. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1960.

#### Notes

1. This research was supported by a grant from the Committee on Research and Productive Scholarship of the University of South Carolina.
2. S. F. is now at the college of Medicine, University of Maryland.