Resistance to extinction as a function of amount of reinforcement and reinforcement schedule¹

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Sixty rats were run in an experimental design that factorially combined large and small amounts of reinforcement with 0, 12, 24, and 56 partial-reinforcement trials given after 28 continuous-reinforcement trials in a runway. Resistance to extinction was an increasing function of number of partial-reinforcement trials under large reinforcement; under small reinforcement, the partial-reinforcement groups did not differ in extinction. The results were discussed within the framework of frustration theory.

When continuous reinforcement (CR) is interpolated between partial reinforcement (PR) and extinction (PR-CR) in a runway, the partial reinforcement effect is obtained (Theios, 1962). Donin, Surridge, & Amsel (1967) have shown that this same effect is obtained when immediate reinforcement trials are interpolated between a series of partial delay-of-reinforcement trials and extinction. These findings can be interpreted (Deese & Hulse, 1967; Donin et al, 1967) in terms of Amsel's (1958, 1962) frustration theory.

Recently, Sutherland, Mackintosh, & Wolfe (1965) reported that when PR is interpolated between CR and extinction (CR-PR), resistance to extinction (Rn) is greater than that found with a CR-only condition, yet less than that found with either a PR-only condition or a PR-CR condition. Although Hothersall (1966) viewed the findings of the Sutherland et al experiment as incompatible with frustration theory, others (Theios & McGinnis, 1967) have expressed the belief that the CR-PR paradigm can yield results that are consistent with this theory. The present experiment attempts to extend the analysis of the CR-PR paradigm in terms of frustration theory. The theory suggests that CR and PR are the lower and upper limits, respectively, for the conditioning of frustration cues to the instrumental runway response. Since the conditioning of these cues to running is assumed to directly control Rn, it follows that Rn should increase as the number of PR trials given after CR training is increased. Furthermore, since the motivational intensity of frustration is assumed to increase as incentive increases, the effect on Rn of increasing the number of PR trials after CR should be greater under a large reinforcement conditions (LA) than under a small reinforcement condition (SM). The design factorially combined LA and SM with 0, 12, 24, and 56 PR trials given after 28 CR trials. The 0-PR condition represents CR-only training; frustration theory predicts, and studies (e.g., Hulse, 1958; Wagner, 1961) have confirmed, that SM will show greater Rn than LA. As PR training is increased, Rn is expected to increase, and this effect should

appear more readily under LA than SM. This analysis, then, leads to the expectation of an interaction between reinforcement and PR conditions with regard to the Rn measure.

Method

The Ss were 64 male albino rats of the Holtzman strain, 93 days old at the beginning of the adaptation period of the experiment. Eight Ss were randomly assigned to each of the eight groups formed by the factorial combination of LA (10 .045 g Noyes pellets) vs SM (1 .045 g Noyes pellet) and number of PR trials (0, 12, 24, and 56) following CR training. Two Ss were lost from the SM, 12-PR group; to maintain proportionality, two randomly selected Ss were discarded from the LA, 12-PR group.

The apparatus was a straight unpainted wooden runway, 4 in. wide, with a 12 in. start box, a 48 in. alley, and a 12 in. goal box. Sliding doors separated the runway into three sections. Photocell circuits provided measures of starting and running time. Starting time was measured from the opening of the start box door to a beam located 6 in. from the door. Running time was measured from the first beam to a second beam 18 in. from the end of the goal box.

Ten days prior to acquisition, the adaptation period started. Ss were placed on a 23 h food deprivation schedule, with free access to water but only 1 h access to food each day. Ss were handled daily and were allowed to explore the runway individually for 5 min on each of the last three adaptation days. All Ss then received 28 CR trials. On Day 1 of CR acquisition, each S was given one trial. On Day 2, each S received three trials. Four trials a day were given thereafter. An intertrial interval of 10 min was used throughout the experiment; during this interval, S remained in a compartment of a carrying case. Following 28 CR trials, the 0-PR groups started extinction while the remaining groups received the appropriate amount of PR acquisition prior to extinction. The PR Ss received two reinforced (R) and two nonreinforced (N) trials each day. On R trials, S was removed from the box after eating, and on N trials, S was removed after a 20 sec confinement. All groups received four extinction trials a day for 10 days. On each trial, S was removed after 20 sec in the goal box.

Results and Discussion

Starting and running times were transformed to speeds in ft/sec; only the running speed measure is reported. The main interest involves performance during extinction. Since acquisition data showed a con-

Fig. 1. Running speed in extinction as a proportion of terminal acquisition performance.

sistent superiority of LA over SM for all PR conditions, extinction speed for each S, for each trial, was expressed as a proportion of the mean speed S had reached over the last four acquisition trials and the first extinction trial. Figure 1 presents mean proportion running speed for 39 extinction trials. Analysis of variance yielded a significant reinforcement by PR interaction ($F = 6.89$, $df = 3/52$, $p < .001$). The nature of the interaction was evaluated by individual group comparisons. For 0 PR, LA showed less Rn than SM ($p < .001$), while for 56 PR, LA showed greater Rn than SM ($p < .025$). For 12 and 24 PR, no difference between reinforcement conditions was found ($p > .05$). For SM, there were no differences between any of the PR groups ($p > .05$). For LA, 0 PR showed less Rn than each of the other groups ($p < .01$); the 12- and 24-PR groups did not differ ($p > .05$); and 56 PR showed greater Rn than 24 PR ($p < .01$).

The data thus showed the expected interaction between reinforcement and PR conditions. However, failure to find variations in the SM groups as a function of PR trials was not anticipated, although it has been noted (Black & Spence, 1965) that effects of PR variations are not easily demonstrated with small reinforcement. Strict interpretation of the increasing Rn shown by the LA groups as reflecting the conditioning of frustration cues to running would be aided by Rn measures on CR-only control groups given the same

total numbers of acquisition trials. It seems well established, however, that Rn decreases with increasing numbers of CR trials and increasing amounts of reinforcement (e.g., Armus, 1959; Ison & Cook, 1964). It is concluded that the results under LA reflect the development of frustration and that the CR-PR paradigm offers a useful means of studying this process, at least under conditions of relatively large incentive.

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Notes

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