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Effects of percent relief and number of N-R transitions on extinction in relief conditioning

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Forty rats were trained for 10 acquisition and 20 extinction trials in a cold-water relief conditioning apparatus. Two levels of percent relief (30% vs. 70%) and number of transitions from nonrelief (N) to relief (R) trials (1 vs. 3) were factorially combined. Resistance to extinction was found to be a function of percent relief rather than number of N-R transitions.

Principles of animal learning are primarily based upon data obtained in appetitive conditioning procedures (Woods, 1974). Behavioral similarities have been observed between analogous appetitive and aversive stimulus operations (e.g., Campbell & Kraeling, 1953; McAllister & McAllister, 1967; Millard & Woods, 1975; Woods, 1967, 1973). Yet, such generality has not been found consistently (Millard & Woods, 1975; Woods, Markman, Lynch, & Stokely, 1972). This experiment contributes to our limited knowledge of this problem and examines the relative predictive power of two theories of extinction performance based on either sequential variables (Capaldi, 1964, 1967) or nonsequential variables (Amsel, 1951, 1958) in a relief conditioning analog of Spivey's (1967) small-trial appetitive conditioning procedure.

METHOD

Subjects

Naive male Long-Evans descendents (N = 40) were obtained in two shipments from Flow Research, Inc., Dublin, Virginia. The subjects weighed approximately 250 g at the beginning of the study. Water and food were freely available in each rat's home cage throughout the experiment.

Procedure

The basic cold-water relief conditioning apparatus has been fully described previously (Woods, 1964). Briefly, it consists of a 168-cm straight alley with two attached tanks. Water temperature of the alley defined the degree of aversiveness; the temperature differential between alley and goal tanks specified the magnitude of relief. Water circulated through reservoirs in which the temperature could be maintained within ±.5°C by presetting Bronwill constant-temperature circulators operating in conjunction with a Forma scientific refrigerated bath.

Underwater photobeams 92 cm apart and 38 cm from each end of the alley were used to control clocks equipped with reciprocal faces, enabling the direct reading of overall and midsection speed scores (10/sec). The experimenter manually started the first clock as a subject was lowered into the alley, while the second clock started when the first photobeam was interrupted. Additionally, the experimenter noted the frequency of competing responses in the alley midsection. Between trials the subjects were housed in a Plexiglas detention cage maintained at approximately 34°C by forced-air electric heaters.

The design of this experiment was similar to that described in Spivey's (1967) study of the effects of sequential and nonsequential variables on extinction in a reward training procedure. Two levels of percent relief (30 vs. 70) were factorially combined with two levels of number of transitions from nonrelief (N) to relief (R) trials (1 vs. 3). The training trial sequences for the experimental groups and the control group are presented in Table 1.

The alley temperature was maintained at 15°C throughout the experiment. Based on prior psychophysical scaling of this aversive dimension, it is known that this temperature is relatively high on the aversive continuum (Woods, Griffith, Page, & Rodier, 1967). On relief trials subjects in all groups escaped to a goal tank containing water maintained at 40°C. On nonrelief trials during training and extinction the subjects escaped to a second goal tank containing water at 15°C (i.e., 0° relief magnitude).

For a trial, the experimenter removed the subject from the detention cage and gently lowered it into the starting end of the alley; when it reached the far end of the alley it was placed in the appropriate goal tank (see Table 1). Conditions during extinction were identical for the five groups. The experiment was initially conducted with four subjects in each group and then completely replicated.

Table 1
Sequence of Relief (R) and Nonrelief (N) Trials in Training

Group: Percent Relief	Group: N-R Transitions	Trials
30	1	R R N N N N N N N R
30	3	N N R N N N R N N R
70	1	R R R N N N R R R R
70	3	R N R R R N R N R R
100	0	R R R R R R R R R R

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RESULTS

Comparisons of speeds during extinction are difficult to interpret because of the differences among groups in terminal acquisition performance. In the present experiment the mean overall speed scores over the last training trial and the first extinction trial were significantly slower for the two 30% groups as compared to the two 70% groups [$F(1,28) = 9.62$, $p < .05$]. The number of N-R transitions factor and the interaction term were not significant ($p > .10$). Additionally, the combined 70% groups were significantly slower than the 100% control group [$t(22) = 3.62$, $p < .05$]. In order to adjust for such differences in acquisition, specialized transforms were required. The absolute overall speed scores were made relative to terminal acquisition and terminal extinction performance by the use of Anderson's (1963) shape-function method. The extinction analyses will focus on the overall speed measure rather than the midsection speeds, for previous reports have indicated the latter are a less sensitive measure of performance (e.g., Woods, 1967; Woods & Schutz,1965).

Mean shape-function scores are presented in Figure 1 for the first 10 extinction trials. Note that the scores have been combined for the four partial reinforcement groups according to number of N-R transitions (upper panel) and according to percent reinforcement (lower panel). By visual inspection it appears that resistance to extinction was primarily a function of percent reinforcement.

For the statistical analysis a three-factor (percent relief, N-R transitions, and trials) analysis of variance was computed for the shape-function scores. The first extinction trial was omitted in these computations because performance on this trial occurred prior to the first nonrelief trial in extinction. The results of this analysis indicated that the two 30% groups showed greater resistance to extinction than did the 70% groups [$F(1,28) = 12.72$, $p < .05$] and that the number of N-R transitions did not significantly affect the rate of extinction [$F(1,28) = 1.42$, $p > .05$]. Consistent with Figure 1, the within-subjects analysis indicated that shape-function scores of the partially reinforced groups decreased over trials in extinction for all groups [$F(8,224) = 4.38$, $p < .05$] and significantly interacted with the percent relief factor [$F(8,224) = 2.47$, $p < .05$]. All other interactions were not significant. When compared to the 100% control group, the combined 70% groups showed greater resistance to extinction [$t(22) = 2.15$, $p < .05$]. Analyses of the competing response data indicated that the frequency was high throughout training and extinction but not significantly related to either percent relief or number of N-R transitions.

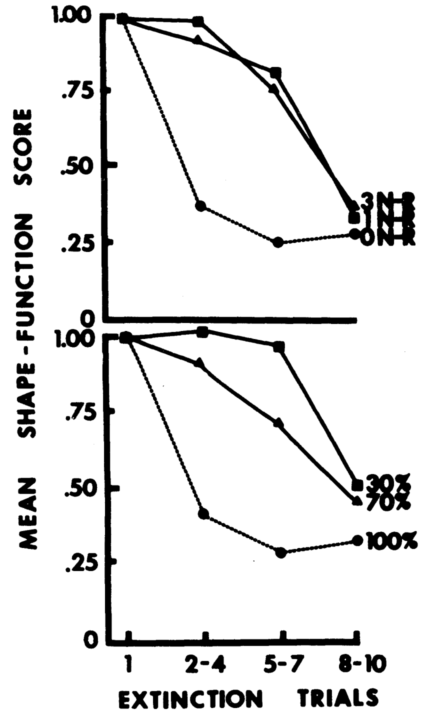

Figure 1. Mean shape-function scores during extinction plotted by number of N-R transitions (upper panel) and percent relief (lower panel).

DISCUSSION

The results of this experiment indicate that resistance to extinction following a small number of patterned relief conditioning trials is primarily a function of percent relief rather than the number of transitions from nonrelief to relief trials. Therefore, these data are not consistent with the results of Spivey (1967) which indicated that resistance to extinction in an appetitive conditioning procedure increased as a function of the number of N-R transitions. Thus, the present results are consistent with Amsel's (1958) nonsequential theory of extinction performance and differ from the outcome predicted by the sequential effects hypothesis (Capaldi, 1964, 1967). The results of the present experiment also differ from those reported by Seybert, Mellgren, Jobe, and Eckert (1974). In their small-trial shock-escape experiments, it was found that the number of N-R transitions and N-length, both sequential variables, affected resistance to extinction. Regretably, differences in procedures (e.g., number of training trials and the aversive stimulus) and the absence of other research reports preclude comments on the origins of these differential results. Clearly, further research is required to establish the relative importance of sequential and nonsequential variables in aversive stimulus conditioning.

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