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ESCAPE LEARNING AS A FUNCTION OF AMOUNT OF SHOCK REDUCTION [1]

G. H. BOWER, H. FOWLER, AND M. A. TRAPOLD [2]

Yale University

Several studies (Crespi, 1942; Zeaman, 1949) have shown that performance in instrumental appetitive conditioning is directly related to the magnitude of reward contingent upon the response. Moreover, these studies have indicated that shifts in amount of reinforcement (amount of food or water) lead to rapid and appropriate changes in performance level.

The results of a study by Campbell and Kraeling (1953) provide evidence that magnitude of reward is an important variable affecting performance in instrumental escape conditioning. Rats were run in a straight alley in which the startbox and runway provided a continuous 400-v. shock and the goalbox either 300-, 200-, 100-, or 0-v. shocks. Running speed was faster the greater the reduction in shock intensity at the goal.

The present study sought to extend these findings on the role of magnitude of reinforcement in escape learning. Specifically, the purpose was to determine whether shifts in the amount of shock reduction would produce changes in escape performance similar to those found in appetitive conditioning with shifts in the amount of goal substance. This question was assessed by training rats initially at one level of shock reduction and then shifting them to different levels during a subsequent testing phase.

[1] This experiment was performed while G. H. Bower and H. Fowler held predoctoral fellowships from the National Institutes of Mental Health.

[2] Now at the State University of Iowa.

METHOD

Subjects.—The *S*s were 35 male, Sprague-Dawley rats, approximately 120 days old. The *S*s had previous experience (30 days prior to testing) in an unrelated experiment on avoidance learning in a bar-pressing situation. Food and water were continuously available in *S*s' living quarters.

Apparatus.—A straight alley, 68 in. long, 3 in. wide, and 4 in. high, served as the test apparatus. The alley was constructed of two L-shaped strips of galvanized sheet metal and was covered with a transparent, Plexiglas top. One of the sheet metal strips formed one side and half of the floor of the apparatus; the other strip formed the other side and other half of the floor. A 1-in. gap separated the two strips at the floor.

The alley was divided into three sections: a startbox 8 in. long, a middle section 48 in. long, and a goalbox 12 in. long. Raising the startbox door operated a microswitch which closed a shock circuit to the alley and started a Standard Electric timer. The clock stopped when *S* broke a photobeam 2 in. inside the goalbox. Running times were recorded to the nearest .01 sec. and were converted to speed scores (1/time).

Two identical but independent shock systems were employed. One provided shock for the startbox and middle sections of the alley, and the other for the goalbox. In each shock system the galvanized metal plates forming the halves of the alley were connected across the output of an AC transformer through a voltage divider which provided variation in the applied voltage. In addition, a .25 meg-ohm resistor was placed in series with *S*. The *S* received shock as long as its feet touched the two strips of sheet metal forming the alley. The narrowness of the alley prevented *S* from avoiding shock by running along only one side of the alley.

Procedure.—The *S* was placed in the startbox with the startbox door closed and the goal box door open. When *S* oriented toward the goal, the startbox door was raised, turning on the shock, and *S* could run to the goal end of the alley. When *S* entered the goalbox and broke the photobeam, which stopped the clock, the goalbox door was lowered. The S was left in the goalbox with the appropriate goal shock for a period of 20 sec. Each S received a total of 30 trials. The trials were massed; immediately following removal from the goalbox, S was reinserted into the startbox for the next trial.

Experimental design.—The 35 Ss were randomly assigned to seven groups of five Ss each. For all groups, and over the entire 30 trials, the shock in the startbox and middle section of the alley was 250 v. The shock in the goalbox was varied across groups and was either 50, 150, or 200 v. After Trial 15, the goal shock for four of the seven groups was shifted from one to another of these voltages. The goal shock voltage for each group on Trials 1–15 and 16–30 is indicated in Table 1.

Results

Speed performance curves are presented in Fig. 1. The group median speed over blocks of three trials was used to yield smooth curves. All statistical analyses were performed on group mean speeds over Trials 10–15 or 25–30.

Group mean speeds for these trials are presented in Table 1. The score to the left in each cell is for Trials 10–15; the score to the right is for Trials 25–30. As may be seen in Table 1, the three subgroups initially on the 50-v. condition did not differ on Trials 10–15 ($F < 1$); similarly, the subgroups initially on the 200-v. condition during Trials 1–15 did not differ on Trials 10–15 ($F < 1$). These results indicate that the randomization was effective and that the subgroups within a given condition were equated prior to the shift in goal shock after Trial 15. Thus, these subgroups are pooled in all relevant comparisons over Trials 1–15.

TABLE 1

GROUP MEAN SPEEDS (1/TIME) ON TRIALS 10–15 AND 25–30

Goal Shock on Trials 1–15	Goal-shock on Trials 16–30: 50		150		200	
	Tr. 10–15	Tr. 25–30	Tr. 10–15	Tr. 25–30	Tr. 10–15	Tr. 25–30
50	.65	.69	.67	.43	.65	.25
150			.43	.43		
200	.20	.67	.17	.41	.11	.22

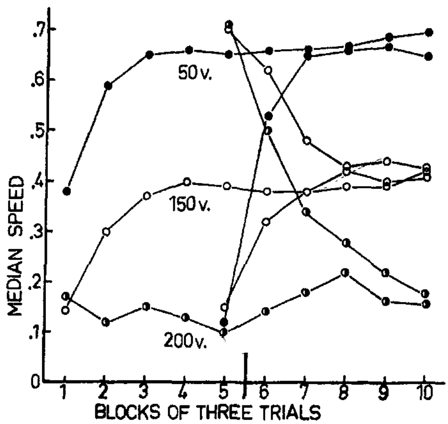

FIG. 1. Group median speed as a function of goal-shock voltage. See text for further explanation.

The acquisition curves for groups receiving 50, 150, or 200 v. in the goalbox during Trials 1–15 are shown in the left half of Fig. 1. The curves diverged over training, and reached different asymptotes. The differences in asymptotic performance (Trials 10–15) are statistically significant ($F = 29.02$, $df = 2,12$, $P < .001$). The asymptotic mean speeds were linearly related to the log percentage reduction in shock (linear $F = 57.34$, $df = 1,12$, $P < .001$); residual component effects were not significant ($F < 1.00$).

As may be seen in the right half of Fig. 1, the groups shifted in goal-shock voltage showed rapid changes in speed, approaching the appropriate asymptotic levels of performance of the nonshifted groups. By Trials 25–30, the effect of initial training condition had disappeared ($F < 1.00$) and performance was determined solely by present goal-shock intensity ($F = 25.52$, $df = 2{,}24$, $P < .001$). Again, mean speeds were linearly related to the log percentage reduction in shock level (linear $F = 50.47$, $df = 1{,}24$, $P < .001$); and residual effects were nonsignificant ($F < 1.00$). No "elation" or "depression" effects appeared during the 15 trials following the shift in amount of shock reduction.

Discussion

The results presented in the left half of Fig. 1 confirm those of Campbell and Kraeling (1953) in showing faster escape performance for larger amounts of shock reduction. The magnitude of reward appears to be linearly related to the log percentage reduction in shock level over the range of values studied. This conclusion is essentially that reported by Campbell and Kraeling.

The results presented in the right half of Fig. 1 show that appropriate and rapid changes in performance occur following shifts in the amount of shock reduction. These results parallel those of Crespi (1942) and Zeaman (1949) obtained with appetitive rewards and suggest that similar molar laws operate for magnitude of reward in both instrumental appetitive and escape conditioning.

In the context of the behavior theory developed by Hull (1952) and Spence (1956), the results of this study suggest that magnitude of shock reduction can be handled by an intervening variable which bears the same relation to habit strength and drive as does the incentive motivation variable (K) in instrumental appetitive conditioning. Thus, the diverging curves in Fig. 1 indicate that the magnitude of shock reduction combines multiplicatively with trials (N) to determine speed. The performance shifts following changes in the magnitude of shock reduction are also consistent with this formulation. In instrumental appetitive conditioning the incentive motivation variable is closely related to the $r_g - s_g$ mechanism (Spence, 1956). However, no analogous mechanism is obvious in the case of escape conditioning.

Summary

Rats ran from an alley where they received a continuous shock of 250 v. to a goalbox where they received a continuous shock of either 50, 150, or 200 v. for 20 sec. The amount of shock reduction on Trials 1–15 and Trials 16–30 was varied according to an incomplete factorial design. The results showed that escape performance was an increasing function of amount of shock reduction, and that shifts in amount of shock reduction led to rapid and appropriate changes in level of performance. The results are analogous to those obtained by Crespi (1942) and Zeaman (1949) with appetitive rewards and suggest that similar behavioral laws underlie both instrumental appetitive and escape conditioning.

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