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NOTES

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The effect of delay of punishment on choice behavior[1]

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Twenty-four rats were trained to respond to two bars for reward delayed 30 sec. Shock was introduced contingent upon a response to the preferred bar during 120 choice trials during test. Group 1 received immediate shock, Group 2 received shock 24 sec after responding, and Group 3 received the 24-sec delayed shock, plus a signal between response and shock. Group 4 received Group 3 training plus 40 signal-shock pairings before testing. Response shift away from the preferred bar was significantly less in Group 2 than in the other groups, which were virtually indistinguishable.

The present experiment compared the effects of immediate punishment with three conditions of delayed punishment of a choice response. A choice response was selected for study because it is assumed that any general inhibition of activity from conditioned suppression, or a conditioned emotional response, affects pressing each of two bars equally. Thus, the only effect of the punishment on the choice measure is assumed to be weakening of the response tendency through a negative law of effect, the opposite of the reinforcing effect of a reward (Perkins, 1968).

Using a procedure which was modified only slightly for the present experiment, Tedford (1969) has shown that when there are mediating stimuli between the response and reward the specific (law of effect) suppressive effect of delayed punishment may be attenuated. Cairns (1969), using a similar procedure and a distinctive set of cues between the response and punishment, found that delay of punishment decreased the rate of change in choice but had no effect on percent choice at asymptote.

In the present experiment, one of the three delay groups had no external mediating stimuli between response and punishment. The other two delay groups had mediating stimuli between response and punishment. One of the latter two groups had received pretraining consisting of signal-shock presentations on which the warning signal was identical to the delay stimuli used subsequently.

METHOD

Data are reported from 24 naive Wistar rats between 130 and 300 g in weight. Half of the Ss in each group were males and half females. Six other Ss were discarded during the experiment because of E errors.

Standard Lehigh Valley apparatus employed included a two-retractable-bar test chamber (Model 1417F) with three jeweled lights over each bar, a Model 1531 constant-current shock source with scrambler, and a one-bar chamber. Other control and recording equipment was used as required by the fully automated procedure.

The Ss were reduced to 85% body weight and then shaped to barpress in the one-bar chamber. During this training and throughout the experiment, reward was .02 cc of 50% Borden's Eagle Brand sweetened condensed milk and 50% water, delivered by a dipper.

After the completion of preliminary training, all Ss were switched to the two-bar chamber and the delay of reward was gradually increased to 30 sec by a standard procedure. During this procedure, each block of three trials included one forced trial to each bar and one choice trial. At the end of this training, the sequence of events following a response to either bar was as follows: off-set of all lights, bars retract and dipper lowers into reservoir with audible click; 30 sec after the response, the houselight is turned on and the dipper starts to rise, taking 1.5 sec; 60 sec after the response, the bars are presented, the red jeweled lights above and to the right of each bar are turned on, and the houselight is turned off. Ss were then given a training day of 31 free-choice trials and were required to meet a criterion of completing the trials within 1 h with at least two responses to each bar. This criterion was usually met on the fifth day of training in the two-bar chamber.

Before the beginning of testing, Ss were assigned at random to one of four groups. The treatment for all Ss was the same on the 3 days of testing except for shock delay and associated cues. Shock was delivered following each response to the bar on which a majority of responses had been made on the criterion day. Shock was set for .3 mA and lasted .75 sec. On the first test day, each S received, in order, one forced trial to the preferred (shock) side, one forced trial to the nonpreferred side, and 40 free-choice trials. Forty choice trials were given on each of the following 2 days.

Group 1 received shock 1.5 sec after barpress, i.e., just as the bars had been completely withdrawn. For Group 2, shock was delayed by 24 sec. Group 3 had a 24-sec delay of shock and distinctive visual and auditory cues during the interval between barpress and shock. A pulsating

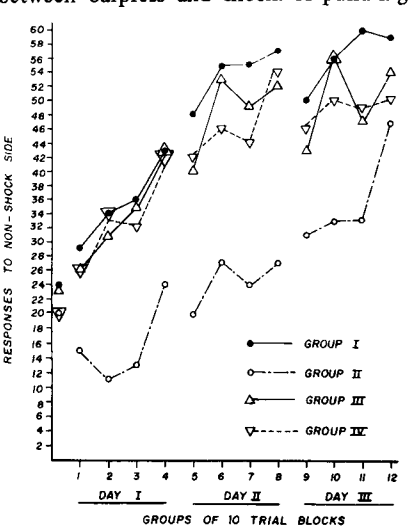

Fig. 1. Acquisition of preference to the originally nonpreferred bar for each group as a function of number of trials.

1,000-Hz tone was accompanied by the flashing of the green jeweled lights to the left of each bar, at the rate of once per second. These stimuli began 1.5 sec after a response to the originally preferred bar and continued until shock onset. Group 4 was tested identically to Group 3. However, between acquisition of the barpressing response and the beginning of delay training, Group 4 also received cue training in the two-bar chamber with the bars retracted and the lights off. This cue training consisted of a 10-h session, during which the visual and auditory cues came on at irregular intervals, were of 22.5-sec duration, and terminated with shock. There were 40 cue-shock presentations.

RESULTS

The percentage of responses to the nonshock bar, in blocks of 10 trials, is plotted for each group in Fig. 1. Preferences on the final day of training, for all groups, are indicated to the left of Day 1. It will be noted that Group 2 did not shift from the punished response as rapidly as the other groups and that all the other groups responded about equally to the nonshock bar. A Groups by Sex by Days analysis of variance, using number of responses to the nonshock bar as the unit of measure, indicates that each of these variables was significant: groups, $F = 7.69$, $df = 3/16$, $p < .01$; sex, $F = 5.60$, $df = 1/16$, $p < .05$; days, $F = 36.11$, $df = 2/32$, $p < .01$. No interactions approached significance. When analysis of covariance was employed, using original side preference as the covariate, significance levels did not change. Multiple t tests revealed that Groups 1, 3, and 4 did not differ significantly from each other, but that each of them differed significantly from Group 2.

DISCUSSION

The effect of delay of punishment when no external mediating cues are provided is in line with Tedford's (1969) results, as is the tendency for delay cues to minimize the attenuating effects of delay of punishment.

The similarity of the results for Groups 3 and 4 was not expected. We had assumed that it would take a number of trials for the warning cues for Group 3 to become aversive and that until this happened these cues would have no effect. Since the warning signal had been made aversive by signal-shock presentation to Group 4, the shift away from the punished response was expected to start upon the introduction of punishment.

In retrospect, however, it is hardly surprising that the results were essentially the same for these two groups. Presumably the cues that followed a bar press during training had acquired secondary reinforcing properties. The stimulus conditions during the warning signal on test trials were quite different and presumably were not attractive, i.e., had no secondary reinforcing properties. Thus, a response to the shock bar for both Groups 3 and 4 was followed immediately by a negative reinforcer, and thus could be considered an extinction trial. Extinction of this response would, of course, produce a shift in preference towards selection of the other bar. It appears that introducing a novel neutral stimulus that is less attractive than the stimulus situation that had followed the barpress on antecedent trials produces a decrement in the tendency for the antecedent response to occur. It is hoped that other investigators will be more aware than the present authors were of the effect novel stimuli have when they are introduced following a response that has regularly been reinforced by cues preceding a delayed reward.

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