Extinction following the differential control of a conditioned positive reinforcer

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Rats were given continuous reinforcement in a lever chamber with water as a primary reinforcer and a water-dipper click as a secondary reinforcer. They were then given extinction with no primary or secondary reinforcement. The lever was then removed. Ss were divided into five groups which experienced the following contingencies: placement in the chamber without shock, dipper-click presentations, shock presentations, click and shock presentations that were not contingent on each other, and forward conditioning click-shock pairings. All groups were then given extinction with the click following each response. The groups aligned themselves in extinction in the order given above (the forward-conditioning click-shock group showed the least resistance to extinction). Significant differences in extinction were found between groups that experienced shock and groups that experienced no shock.

Kelleher (1961) has shown that response patterns can be controlled by the schedule on which a conditioned reinforcer is presented and that these response patterns are similar to those obtained when primary reinforcers are presented on operant schedules. After pairing a magazine click with primary reinforcement to pigeons, Kelleher reinforced the pigeons with the magazine click on a fixed-interval schedule, a fixed-ratio schedule, and a differential reinforcement of pausing schedule. The same patterns of responding developed under these schedules as were developed by the use of a primary reinforcer. Marx (1958) and Zimmerman (1959) also found characteristic response patterns for secondary reinforcers.

The similar results obtained with primary and secondary reinforcers suggest that secondary reinforcers can also be used to eliminate responses from an S's repertoire, independent of its response to the secondary reinforcer. Several studies (e.g., Rozeboom, 1957; Evans, 1962) have suggested that a stimulus associated with shock leads to decreased resistance to extinction if the stimulus had been a secondary reinforcer prior to the stimulus-shock pairings. Rozeboom (1957) established a water-dipper click as a secondary reinforcer in a leverpress situation. Some of his Ss were then given click-shock pairings with no lever available in the chamber (other Ss did not receive such pairings). The Ss were then extinguished without the secondary reinforcer. Finally, the Ss were extinguished with each leverpress, producing the empty water dipper and its distinctive click (the secondary reinforcer). Pairing the click with the shock in the second phase of the study reduced the number of responses in the final phase of the experiment. Rozeboom's study was the

only investigation that employed many extinction sessions. However, Rozeboom's Ss were still responding at a relatively high rate at the end of the extinction sessions with the secondary reinforcer present. It is possible that the decrease in resistance to extinction was the result of a temporary response suppression caused by the shock that was paired with the secondary reinforcer (Estes & Skinner, 1941). The present study is an attempt to ascertain if the decrease in responding caused by pairing a secondary reinforcer with shock is a temporary response suppression or a relatively permanent decrease in response rate. The study also employs more control groups than did the previous studies (e.g., Rozeboom, 1957). These groups were added to ascertain the relative contributions of the shock, the secondary reinforcer, and combinations of the shock and secondary reinforcer in controlling response rate.

METHOD

Sixty 110-day-old naive male rats of the Sprague-Dawley strain served as Ss. The experimental chamber was a Lehigh Valley sound-attenuated rat box. The chamber was equipped with a response lever, Lehigh Valley water dipper, and a fan that provided masking noise. Timing circuitry controlled an ac transformer that was capable of delivering a 2-sec scrambled shock of 1.0 mA to the grid floor of the chamber.

Each S was adapted to a 23-h water-deprivation schedule for 7 days prior to the start of the experiment. Ss were shaped to press the lever on a continuous-reinforcement schedule. Following the shaping procedure, all Ss were given 5 days of reinforcement on a continuous-reinforcement schedule (one 15-min session each day). Leverpresses during the 15-min sessions were cumulated.

Reinforcement consisted of access to the dipper, which contained .02 cc of water. The dipper remained up until the next leverpress caused it to lower, fill up, and return to the reinforcement position.

Following the 4 days of continuous-reinforcement training, the dipper was inactivated so that water delivery and the distinctive click of the dipper did not occur when the lever was pressed. Each S was then given 4 days (one 15-min session each day) of extinction. Thus, while the S's responses were recorded on the digital counter, water delivery and the magazine click of the dipper did not follow any response.

Ss were then ranked according to the total number of responses emitted during the 4 days of extinction and assigned to one of five groups in the following order: NS, C, SC, CS, S (i.e., 1, 2, 3, 4, 5, 5, 4, 3, 2, 1, 1, 2, etc.). Thus, Ss were divided into five groups that had produced a similar number of responses during the 4 days of extinction.

The lever was then retracted and each S was placed in the operant chamber for 2 days (one 15-min session per day). The five groups experienced the following conditions: (1) Each S in Group NS (no-shock control group) was placed in the chamber and removed after 15 min. (2) The dry dipper, which produced a distinctive click, was activated 30 times per session for every S in Group C (click). Dipper presentations were on a variable-interval schedule that had a range of 10 to 50 sec. (3) Each animal in Group S was shocked without the dipper being activated. Shock presentation occurred on the same schedule employed for dipper activation in Group C. (4) Group SC had 30 presentations per session of both shock and click. The interval between the presentation of a click and the presentation of a shock ranged

Fig. 1. Mean cumulative response curves for the different groups during click extinction.

from 15 to 20 sec. The interval between the shock and click ranged from 5 to 10 sec. (5) Group CS received 30 pairings of the click and the shock. The interval between the click and the shock was always .5 sec. The interval between successive click-shock pairings ranged from 10 to 50 sec.

The above procedure was followed by 8 days of extinction with the dipper activated; that is, every leverpress produced both the unloaded dipper and the distinctive click. Each of the eight extinction sessions was 15 min.

RESULTS

An analysis of variance was performed on the mean number of responses per S for the last day of acquisition. No significant differences were found ($F = 0.173$, $df = 4/55$, $p > .05$). Since Ss were assigned to groups on the basis of their first extinction (nonclick), it is not surprising that the terminal rate of responding (Day 4 of extinction) was very similar for the five groups ($F = 0.443$, $df = 4/55$, $p > .05$). Ss in all groups averaged less than 12 leverpresses on the last day of extinction without the water dipper.

The mean of the cumulative responses emitted by the five groups during the 8 days of extinction that produced the empty dipper is shown in Fig. 1. Groups NS and C showed a typical decrease in response rate as extinction progressed. Groups S, SC, and CS, however, show virtually no responding on the first day of extinction, with an initial increase in response rate during extinction, which is subsequently followed by a decrease in response rate. Analysis of variance of the mean response output for each group during the 8 days of extinction shows a significant difference among the groups ($F = 6.515$, $df = 4/55$, $p < .01$).

The Newman-Keuls test was used to determine the mean differences that were significant. Differences between Groups C and CS [$a = 4$, $f = 55$, $Q(.01) = 5.6$], NS and CS [$a = 4$, $f = 55$, $Q(.01) = 5.1$], and NS and SC [$a = 4$, $f = 55$, $Q(.05) = 4.0$] were significant. The difference between Groups S and SC fell short of significance [$a = 3$, $f = 55$, $Q(.05) = 3.0$].

DISCUSSION

Assigning Ss to groups on the basis of their extinction patterns during extinction sessions without the secondary reinforcer insured that Ss had a low response rate before the final stages of the study were initiated. Thus, responses that produced the secondary reinforcer in the last phase of the study were in large part determined by the presence of the secondary reinforcer, rather than high resistance to extinction for the primary reinforcer. All Ss produced less than 12 responses on the

last day of nonclick extinction. This supports the contention that the eight subsequent days of secondary reinforcement extinction were sufficient to differentiate between temporary response suppression and a relatively permanent decrease in responding. The data from the groups experiencing shock between the two extinction sessions suggests response suppression had some effect on the early extinction sessions. Later extinction sessions for the shock groups produced the more typical decrease in response rate across extinction sessions. This decrease, coupled with the low terminal rate of responding for Ss in all groups at the end of the second phase of extinction, implies that additional extinction sessions would not have changed the relative number of responses in the five experimental groups.

It is interesting to note that all groups receiving shock between the first and second extinction produced fewer extinction responses than groups receiving no shock. In addition, both groups that experienced the click and the shock between the extinction sessions (CS and SC) had lower response rates than groups that experience only one of the stimuli (C or S) during the intermediate phase. Pairing the click and the shock produced fewer

responses in the final extinction session when the pairings were those of a typical forward classical-conditioning paradigm. It must be noted, however, that the only statistically significant differences occurred between groups that received no shock and groups that received shock between the two kinds of extinction; i.e., the statistically significant differences were between Groups NS and CS, NS and SC, and C and SC.

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Atypical effects of electroshock on emotionality in rats*

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The present study examines a unique property of shock, i.e., the absence of a clearly perceivable source of the stimulus. Twenty-four male and female Sprague-Dawley rats were divided into three groups: object alone, shock alone, and shock plus object. Using three open-field measures of emotionality, it was found that the group shocked without an object present was significantly more emotional than the group shocked with an object present or the group presented with the object only.

Electroshock has been the most widely used stressful stimulus in many areas of psychological investigation. Shock, however, may have some undesirable and long-term effects. Solomon, Kamin, & Wynne (1952), for example, demonstrated that shock-induced fear, once acquired, could elicit avoidance behavior over long periods of time and that both fear and avoidance behavior were not susceptible to standard extinction procedures. Furthermore, Walters & Rogers (1963)

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found that previous exposure to an intense shock increased the suppressive effects of the punishment in a situation occurring 1 year after the initial shock.

Most studies employing shock make the implicit assumption that it is typical or representative of noxious stimuli in general, and it is used as the noxious stimulus of choice primarily because of the degree of control that can be exerted on its administration. There are, however, at least two unique properties of electroshock that may result in differences in behavior from those resulting from other forms of noxious stimuli that do not share these