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concurrent with operant responding (lever present), subsequent extinction was more advanced as compared to lever-absent conditions during initial CER extinction. Since both groups were given CER training with lever removed, there was no opportunity for response-shock contingencies to develop.

Jackson explained his results in terms of a counterconditioning mechanism. That is, reinforcement produced during early CER extinction served to inhibit the emotional response elicited during the CS. He further suggested that the act of responding might not be necessary. That is, water reinforcement delivered independently of responding might have been just as effective. The present study, then, attempted to assess the relative roles of responding and reinforcement and provided a further test of the counterconditioning hypothesis.

SUBJECTS AND APPARATUS

The Ss were 32 male Sprague-Dawley rats weighing an average of 307 g at the beginning of experimentation. The experimental chambers used for barpressing, CER training, and CER extinction were two identical Foringer Skinner boxes with automatic programming equipment. They were housed in sound-attenuating, blower-ventilated enclosures isolated from both the home-cage area and the programming apparatus. Each chamber contained a removable lever and normally recessed dipper that delivered 0.1 cc of water upon activation. The CS used throughout the experiment was a 2-min, 90-dB clicker. The US used only during CER training was a 0.5-sec, 1.0-mA scrambled shock delivered through grid floors.

PROCEDURE

Preliminary Operant Training

The experimental procedure was divided into four phases, the first of which was designed to produce stable operant responding on a VI 1-min schedule for water reinforcement. Upon arrival from their supplier, Ss were assigned randomly to four groups of eight animals each, and then individually housed in home cages where food (Purina Lab Chow) was available ad lib throughout the experiment. With the exceptions of the first and second days, water was available for 10 min daily, beginning 5 min after the conclusion of each daily experimental session. On the first day, water was available ad lib, and on the second, Ss were completely deprived. On the third day, Ss were magazine trained and shaped to a criterion of 40 reinforcements on a CRF schedule or 28 min in the chamber, whichever came first. On the next day, dipper presentations

Reinforcement and response factors in the extinction of conditioned suppression*

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Following CER training, 32 rats began initial CER extinction under: (1) normal (lever present), (2) yoked with normals (lever absent), (3) nonoperative lever, or (4) no-lever/no-water conditions. After 4 days, CER extinction continued with lever returned for all Ss. Analysis of suppression ratios indicated that water availability was the major factor differentiating groups.

At least two studies have found that lever presence during CER training results in differential suppression during CER extinction when compared with lever-absence training conditions. Wagner, Siegel, & Fein (1967), for example, obtained a partial reinforcement effect only if the lever was present during CER training. Similarly, while Hilton (1969)

found PREs for groups trained under both lever conditions, groups given CER training with lever present exhibited greater resistance to extinction than did their lever-absent counterparts, regardless of CS duration or reinforcement schedule employed. One possible explanation for these findings is that under lever-present conditions, accidental response-shock contingencies develop.

Only one study to date has compared lever-in with lever-out conditions during CER extinction. Jackson (1970) found that if initial CER extinction was

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Fig. 1. Mean suppression ratios during CER extinction.

were contingent upon barpressing on a VI 20-sec schedule for 18 min, followed by a VI 1-min schedule for 10 min. During the next seven 28-min sessions, barpressing was stabilized on the VI 1-min reinforcement schedule.

CER Training

The lever was then withdrawn from each chamber and three clicker-shock pairings were given during each daily 28-min session for 2 days (a total of six CS-US presentations). CS onsets were 4, 14, and 24 min into each session, terminating each time with shock onset.

Operant Recovery

Two recovery days were given following CER acquisition to allow operant responding to return to pre-CER-acquisition levels. During this phase, each lever was replaced and Ss were given 25-min daily sessions with water available on the original VI 1-min schedule.

CER Extinction

CER extinction was then begun on the following day. All Ss were given two clicker/no-shock presentations daily for 10 days (a total of 20 CS presentations), commencing 10 and 22 min into each 25-min daily session. During the first four CER extinction days, the four groups were subjected to differing conditions of response (lever) and reinforcement (water) availability. Control Ss were subjected to "active" extinction, i.e., the lever was present and water response contingent on the original VI schedule. A second group was yoked with the control group; the lever was removed, but yoked Ss received water when paired control Ss did who were actually responding. A third group, B-NW (bar/no water), was allowed to respond without reinforcement, i.e., barpresses did not activate the dipper. The remaining group, NB-NW (no bar/no water), was given "passive" extinction, during which the lever was removed and water was

unavailable. Beginning with the fifth CER extinction day, all groups were subjected to "active" extinction with the lever replaced and water response-contingent on the original VI 1-min basis.

SUPPRESSION INDEX

Following the method employed by Kamin (1961), suppression was indexed by the commonly used ratio, $B/(A + B)$, where "B" represents the number of barpresses during the CS and "A" the number during the immediately preceding 2-min interval (pre-CS period). Daily CER extinction ratios were calculated for each S by averaging the two ratios obtained during each daily session.

RESULTS

Figure 1 displays the CER extinction curves of the four groups. As may be seen, control Ss exhibited normal (negatively accelerated) extinction of conditioned suppression, ranging from nearly complete suppression on Day 1 ($M = .01$) to slight elation on Day 10 ($M = .52$). A 2 by 2 by 6 analysis of variance of the data obtained during CER Extinction Days 5-10 yielded highly significant effects of days ($p < .01$) and reinforcement availability ($p < .05$). Neither the effect of response availability nor any of the interaction effects was significant.

The absence of significant interaction effects indicates that the extinction curves of the four groups were similarly shaped. The significant day effect reflects a significant decrease in conditioned suppression across Days 5-10. Of greatest importance, however, is the clear effect that reinforcement had upon CER extinction. The groups receiving water during CER Extinction Days 1-4 showed significantly more advanced extinction during Days 5-10 than did the groups from which it was withheld. Furthermore, the act of responding was in no way critical, being neither necessary nor sufficient to accelerate extinction of conditioned suppression.

An analysis of barpressing rates prior to CER Extinction Day 5 revealed no significant differences between the groups. The results of a 4 by 4 analysis of variance of these data for the last three operant stabilization days and last recovery day indicated no significant effects of days, groups, or their interaction. Operant rates, therefore, were both stable and similar for all groups prior to CER extinction. A one-way analysis of variance of these data for the pre-CS periods on CER Extinction Day 5 revealed no differences between groups prior to CR presentations on CER Extinction Day 5.

DISCUSSION

The results of this study add to the existing studies that suggest that CER

extinction, as reflected by conditioned suppression procedures, is not entirely the result of the assumed internal, classically conditioned emotional response to a CS. A comparison of the control and NB-NW groups indicates that operant responding during initial CER extinction accelerates subsequent extinction, thus confirming Jackson's (1970) earlier finding.

The results also provide evidence in support of the hypothesis raised by Jackson (1970) that acceleration of extinction may be mediated by a counterconditioning mechanism based upon receipt of reward. A comparison of the yoked and B-NW groups with the above groups indicates that acceleration was contingent, not upon actual barpressing, but upon CS presentations in a situation where only the aftereffects of reward (in this case, water) were significant aspects of the stimulus complex. Apparently, the receipt of reward elicited a response antagonistic to the emotional response evoked by the CS. The Ss in the yoked group displayed extinction curves almost identical to those of the "actively" extinguished control Ss, while B-NW Ss were most similar to the "passively" extinguished NB-NW Ss.

However, the absence of parametric operations on such a reinforcement factor and more direct measurements of the internal state of Ss during conditioned suppression experiments presently preclude a complete evaluation of its effects. Before this issue can be resolved for CER extinction alone, investigations of the relative effects of reinforcement during CS and non-CS periods should be undertaken. In addition, the effects of both reward magnitude and frequency should be determined. In the final analysis, it is quite possible that many of the conclusions found in the CER literature are confounded by heretofore unaccounted-for factors, since they are based on studies that have used conventional conditioned suppression procedures in which CER training and extinction have been concurrent with response-contingent reinforcement.

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