The effect of lever retraction on resistance to extinction of a response rewarded with electrical stimulation of the brain¹

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Two experiments assessed the effect of lever retraction on resistance to extinction of a response rewarded with electrical stimulation of the brain. The results showed that responding during extinction increased following training with lever retraction.

Pliskoff, Wright, & Hawkins (1965) used a two-bar situation to investigate the effects of response chaining on behavior rewarded with electrical stimulation of the brain (ESB). A given number of responses on a permanent bar brought out a second (retractable) bar. Responding on the retractable bar was rewarded with ESB. The permanent bar was programmed on a variety of intermittent schedules. This situation produced partial reinforcement responding and increased resistance to extinction approximating that found with conventional rewards such as food and water.

This study is designed to further assess the effect of lever retraction on resistance to extinction of ESB rewarded responding. Using a modified two-bar situation, extinction responding was compared under various contingencies of reward and lever withdrawal.

Experiment 1

Subjects. Fifteen male Charles River albino rats were used. The Ss were previously employed in a brain stimulation experiment in which they received one extinction session. Each condition in that study was counterbalanced over groups in the present investigation. Each S had two stainless steel monopolar electrodes 0.25 mm in diameter implanted with coordinates establishing placement in the medial fore-brain bundle.

Apparatus. Tests were run in an 18 x 24 x 18 in. high box. A permanent and retractable lever were mounted, 2 in. apart, upon one side wall. Standard relay equipment permitted S to receive stimulation concurrent with a bar press. Responses per minute on each lever were recorded.

The electrical stimulus consisted of 0.5 sec of 60 cycle, sine-wave current. The current was regulated by a micropot used as a voltage divider and was monitored by an AC microammeter in series with S.

Procedure. The Ss were divided into the following groups of five Ss per group: (1) animals for which one response on the permanent bar brought out the retractable bar for five reinforced responses, whereupon it withdrew (Group Chain)²; (2) animals for which the retractable bar was withdrawn for 2.8 sec (the average shuttle time between bars of the Chain Ss) after the

occurrence of five reinforced responses (Group Retr-1); (3) animals for which responding on the retractable bar was continuously rewarded (Group Cont). Two bars were present for all groups. Responses on the permanent bar for Groups Cont and Retr-1 produced neither lever withdrawal nor ESB.

Three days of 1000 reinforced responses per day were given. Day 4 consisted of 500 reinforced responses followed by 30 min of extinction. The same contingencies of response and lever withdrawal which existed during acquisition also existed during the extinction session.

Results. Figure 1 shows the extinction scores of the three groups. Resistance to extinction was clearly a function of the training procedure. Group Chain had significantly greater resistance to extinction ($p < .03$) than Group Cont.³ Although Group Retr-1 did not differ significantly ($p > .15$) from Group Chain or Group Cont, its average extinction score was situated midway between the extinction scores of those groups.

The extinction score of each group was broken down into responses on the permanent lever and responses on the retractable lever (Fig. 1). Group Chain had significantly more responses ($p < .05$) on the permanent lever than either Group Cont or Retr-1, which did not differ ($p > .15$). Extinction responding on the retractable lever did not differentiate ($p > .2$) between Groups Chain and Retr-1. Both of these groups, however, could be dif-

Fig. 1. Mean number of extinction responses on the permanent and retractable levers.

ferentiated from Cont Ss on this measure. Group Chain had significantly greater ($p < .03$) resistance to extinction on the retractable lever than Group Cont, while the difference between Group Retr-1 and Group Cont approached significance ($p < .08$).

Discussion. Two independent factors seem to account for the increased resistance to extinction of Group Chain over Group Cont: (1) retraction of the bar, and (2) the chaining of responses. Group Retr-1 showed more resistance to extinction than Group Cont since the first factor was operative. The data confirm the finding of Pliskoff et al (1965) that when the contingencies of response and reinforcement in an ESB situation are made similar to the food reinforced situations, extinction responding is prolonged. Pliskoff et al measured responding only on the permanent lever during extinction. When extinction responding was allowed on both levers, responding on the first lever was not sufficient to differentiate between Groups Chain and Cont. Thus it appears that the responses that would have occurred on the permanent lever occurred on the retractable lever.

It has been previously demonstrated that retraction of the bar during acquisition affects extinction responding for ESB (Pliskoff & Hawkins, 1963). This manipulation has been reported to have eliminated the ability to elicit extinction without responding from self-stimulating animals. The present data show that retraction of the bar during acquisition increases resistance to extinction in animals responding for ESB. An explanation of this effect could be derived from frustration theory. During acquisition, Ss in Group Retr-1 had learned to approach the bar after cues of frustration (removal of stimulation by retraction of the bar). Hence, during extinction, the drive due to frustration engendered by nonreward energized responding. In Group Cont, however, the drive due to frustration energized extraneous behavior and thus led to rapid extinction. Another possible cause of the increased resistance to extinction of Group Retr-1 may have resulted from the cue properties of the retractable bar signaling the availability of ESB.

To test these possibilities the following experiment was run. Resistance to extinction was compared between animals treated as Group Retr-1 and a group of Ss that received free brain stimulation during the period that the bar was retracted. It was reasoned that the free stimulations during lever retraction would reduce frustration due to nonreward, but leave the cue properties of bar retraction intact. It was hypothesized that if frustration caused the increased resistance to extinction of Group Retr-1, Ss receiving free stimulation during bar retraction should show faster extinction than Ss receiving no such stimulation. If extinction scores are equivalent then the cue properties of lever retraction should be sufficient to explain the increased resistance to extinction.

Experiment 2

Subjects. Ten male Charles River albino rats were used. The Ss were previously employed in an experi-

ment in which they received two extinction sessions. Each condition in that study was counterbalanced over groups in the present investigation. Each S had one bipolar electrode implanted with coordinates establishing placement in the medial forebrain bundle.

Procedure. Ss were divided into two groups of five Ss each. The first was identical to Group Retr-1 of Experiment 1 (Group Retr-2). The second (Group Retr-S) consisted of Ss which were permitted five reinforced responses on the retractable bar whereupon it withdrew. When the bar was out of the box Ss received five free bursts of stimulation, after which the bar reentered the box. As in Experiment 1, two bars were present for both groups.

Each S was allowed 1000 reinforced responses for three days. On Day 4, after 500 reinforced responses, extinction responding was recorded for 30 min. The same lever retraction contingencies used during acquisition were used during extinction.

Results and Discussion. Total responses in extinction did not differ significantly between the two groups ($p > .50$). This would suggest that some cue property of retraction, rather than hypothesized frustration engendered by the nonreward during lever withdrawal, caused the increased resistance to extinction of Group Retr-1 over Group Cont.

Incidental observation suggested, however, that these results may be due to factors other than the cue properties or frustration associated with retraction of the lever. Group Retr-S, though having the same temporal pattern of bar retraction as Group Retr-2, had a significantly slower overall rate of responding ($p < .005$) than Group Retr-2. This difference in rate was due to Ss in Group Retr-S running around the training chamber during the free stimulations. Hence, after each series of free stimulations, the Ss of Group Retr-S had to reapproach the bar. The possibility remains that the equivalent extinction scores of the two groups were caused by this strong approach tendency. Furthermore, the tendency to leave the area of the bar during free stimulation invalidated the initial assumption that the cue properties of bar retraction would remain equivalent for both groups. Animals in Group Retr-2 attended to the bar retraction whereas Ss in Group Retr-S did not. The cause of the increased resistance to extinction of Group Retr-1 over Group Cont in Experiment 1 remains to be defined.

References

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Note

1. This research was supported by Public Health Service Grant MH 13155-01.
2. It was possible for Ss to obtain two additional reinforcements if they bar-pressed as the bar was withdrawing from the box.
3. All statistical comparisons were made with the Mann-Whitney U test.