THE ACQUISITION AND EXTINCTION OF CONDITIONED SUPPRESSION AS A FUNCTION OF THE BASE-LINE REINFORCER

IRVING GELLER

WYETH INSTITUTE FOR MEDICAL RESEARCH

In the conditioned-suppression procedure of Estes and Skinner (1941), operant behavior is suppressed during the presentation of an originally neutral stimulus that has been paired previously with a pain shock. Recently, some attention has been given to variables that seem to influence conditioned suppression because of their more direct effect on the operant-behavior base line. Brady (1955) studied the rate of extinction of conditioned suppression as a function of the positive-reinforcement schedule used to maintain the base-line behavior in extinction. Essentially, his study showed that the rate of extinction of conditioned suppression was increased for reinforcement schedules that provided a relatively high density of positive reinforcement. Fixed-ratio base lines of 6:1 and 12:1 gave faster extinction of conditioned suppression than did 30- and 60-second, variable-interval base lines.¹

Stein et al. (1958) manipulated the durations of the conditioned stimulus and the interval between the conditioned stimuli. They found that the most important determiner of suppression was the ratio of the durations of the conditioned stimulus to the between-stimulus intervals. Also, they observed that the rats earned a constant number of reinforcements in each session regardless of the conditioned stimulus and between-stimulus durations, and despite wide differences in the degree of behavioral suppression induced by these variables. On the basis of these and other findings, Stein and the other investigators concluded that "... after sufficient training, animals will suppress in the stimulus period only to an extent that does not markedly reduce opportunities for positive reinforcement."

Thus, both studies indirectly implicated the base-line reinforcer as a critical determiner of the strength of conditioned suppression. In the present study the base-line reinforcer was explicitly manipulated by comparing the effects of sweetened milk and water reinforcers on the acquisition and extinction of conditioned suppression.

METHOD

General

Two groups of rats were trained on a conditioned-suppression procedure. One group was reinforced with sweetened condensed milk on a 2-minute, variable-interval schedule, and the other was reinforced with water. After all the rats had exhibited a specified strength of conditioned suppression, extinction of the suppression was begun by omitting the pain shocks. In the extinction phase of the experiment, half the animals in each group were continued on the positive reinforcer used during acquisition, and half were switched to the other reinforcer. Between the acquisition and extinction phases, a period of 2-minute, variable-interval training with the extinction-phase reinforcer was given, so that the rats whose reinforcers were switched would have stable operant-behavior base lines in extinction. Thus, in addition to providing information about the effect of the base-line reinforcer on the ac-

¹The rate of extinction with a continuous-reinforcement base line fell below the fixed-ratio base lines even though the density of reinforcement under conditions of CRF may be presumed to have been greater. This apparent discrepancy may reflect, in part, a satiation effect, since in the 4 minutes prior to the onset of the conditioned stimulus, the animals on continuous reinforcement could have acquired enough reinforcements.

quisition and extinction of conditioned suppression, this design permits a determination of the extent to which suppression acquired under one reinforcer will transfer to another.

Apparatus and Subjects

The apparatus was a small sound-resistant chamber with a lever, an automatic liquid feeder, a small 2-inch speaker for the presentation of auditory stimuli, and a grid floor for the delivery of pain shocks to the animals' feet. The shock level was calibrated prior to each experimental session. The entire experiment was programmed by a series of relays and timing circuits, and recorded automatically by electrical-impulse counters and cumulative-work recorders.

The subjects were 12 male albino rats of Holtzman Sprague-Dawley strain, 150 days old at the start of the experiment.² Six animals were maintained on a 23.5-hour food deprivation, and given 0.5-hour free feedings after each experimental session. The other six were maintained on a 23.5-hour water deprivation, and given water for 0.5-hour periods after each experimental session.

Procedure

The rats were trained to lever press for either liquid food or water on a continuous reinforcement schedule (approximately 100 reinforcements). They were then given 20-minute sessions each day on a 2-minute, variable-interval schedule. When the lever-pressing rates for all animals appeared to be stable, conditioning trials were begun. Twelve minutes after the start of the session, a 3-minute tone was presented. This tone was terminated contiguously with a brief (0.25 second) 0.75-milliampere pain shock. The animals were given one trial per day for a total of 27 conditioning trials, at the end of which time all animals had met a conditioned-suppression criterion. The suppression was expressed as the ratio of the response rate during the tone period to the rate in the 3-minute period just preceding. When all animals simultaneously achieved suppression scores of 0.10 or less, the acquisition phase was terminated.

At this time the groups were divided into extinction subgroups roughly matched on the basis of the last suppression-ratio score. Half the animals in each group were maintained on their acquisition-deprivation schedule, and half were switched to the other. All animals had 14 sessions of 2-minute VI so that the switched animals could adapt to the new reinforcer. Extinction was begun on the following day.

The procedure in extinction was the same as that in acquisition except that the pain shocks were omitted. Extinction trials were given until the suppression ratio for each animal was 0.90 or higher. All animals received seven extinction trials.

RESULTS

Acquisition

The left-hand portion of Fig. 1 shows the mean daily suppression ratios for the two groups throughout acquisition. The rate of acquisition was clearly slower for the milk group. The individual cumulative records of lever pressing early in training are especially convincing. Figure 2 gives the records of all the animals for the third trial of acquisition: all the water-reinforced animals were nearly completely suppressed in the conditioned stimulus, but the food-reinforced animals were very slightly suppressed. In addition, the water-rein-

²One animal died early in conditioning.

Figure 1. Mean daily suppression ratios during the acquisition and extinction of the conditioned suppression for the milk-reinforced and water-reinforced groups.

forced animals tended to remain suppressed after the tone ended. The upper section of Fig. 3 gives sample records of representative animals for each group during their training. While the water-rewarded animal was nearly completely suppressed on Trial 6 (in fact, even on Trial 3; see Fig. 2), the food-rewarded animal had a reasonable high response rate in the tone as late as Trial 20.

Extinction

The right-hand portion of Fig. 1 shows the mean daily suppression scores in extinction for the four subgroups: the two upper curves are those for subgroups extinguished on a milk-reinforcement base line, and the two lower curves for subgroups extinguished under

Figure 2. Cumulative records for the food and water rats on Trial 3 of acquisition. The broken vertical lines (and the offset of the pen) denote the presence of the auditory conditioned stimulus.

Figure 3. Cumulative records for two of the switched animals illustrating varying degrees of suppression during acquisition and extinction. The broken vertical lines (and the offset of the pen) denote the presence of the auditory conditioned stimulus.

water reinforcement. Inspection of the individual cumulative lever-pressing records early in extinction indicates that extinction is more rapid for milk-reinforced animals. Figure 4 gives these records for all animals on Trial 3. Note that all animals extinguished on a water base line remained suppressed (except for Rat 27), while all food-rewarded rats showed little suppression.

It should also be observed that considerable, but not complete, transfer of suppression occurred when the base-line reinforcer was switched. Returning to Fig. 1 it may be seen that on the first extinction trial the mean suppression score for both subgroups with switched reinforcers approximates zero. It may be seen in addition that the milk-milk curve is below the water-milk curve and the water-water curve is below the milk-water curve. Since the unswitched member of each pair (matched for extinction reinforcer) extinguishes more slowly than the switched member, we may conclude that transfer is incomplete. In view of the small number of subjects in each subgroup, such an inference is suggestive and requires replication for confirmation.

Discussion

The present findings emphasize the importance of the base-line reinforcer in the elaboration of a conditioned suppression. One might assume that the poorer suppression exhibited by milk-reinforced animals is attributable to the superiority in reinforcing value of milk

relative to water. In other words, operant behavior reinforced with milk is harder to disrupt than that reinforced with water because the milk-reinforced behavior is stronger. For example, water-reinforced behavior on fixed ratio might be expected to strain at a smaller ratio than milk-rewarded behavior.

Unfortunately, the milk and water conditions of the present experiment differ in more than reinforcing value. The qualitative differences between food and water, entailing important differences in the deprivation regimen, make it difficult to single out reinforcement value as the critical differentiator.

An experiment is now in progress to elucidate this point. This experiment is similar in design to the present one, but different concentrations of milk reinforcement are used as the independent variable.

Figure 4. Cumulative records for the food and water rats on Trial 3 of extinction. The broken vertical lines (and the offset of the pen) denote the presence of the auditory conditioned stimulus.

SUMMARY

This investigation compared the rates of acquisition and extinction of conditioned suppression as a function of the positive base-line reinforcer used to maintain the operant behavior. The base-line reinforcers compared were sweetened milk and water. Acquisition of the suppression was slower for the milk-rewarded group than for the water-rewarded group. Food-reinforced animals extinguished more rapidly than did the water-reinforced animals.

Animals that acquired the suppression under one positive reinforcer and were switched to to other during extinction exhibited almost complete transfer of the conditioned suppression.

ACKNOWLEDGMENT

I want to thank Dr. Larry Stein for his helpful suggestions throughout the experiment, and also Mr. John T. Kulak, Jr., for his technical assistance.

REFERENCES

- Brady, J. V. Extinction of a conditioned fear response as a function of reinforcement schedules for competing behavior. *J. Psychol.*, 1955, **40**, 25-34.
- Estes, W. K., and Skinner, B. F. Some quantitative properties of anxiety. *J. exp. Psychol.*, 1941, **29**, 390-400.
- Stein, L., Sidman, M., and Brady, J. V. Some effects of two temporal variables on conditioned suppression. *J. exp. anal. Behav.*, 1958, **1**, 153-162.

Received February 29, 1960.