

Learning During Extinction

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The various theories which have been advanced to explain extinction appear, superficially at least, to be unique. Yet a closer examination of these views reveals many commonalities which, if exploited, may permit the development of a more general and adequate theory of extinction. Even some of the phraseology is common or translatable. More important than the common language is the constantly recurring concept that the extinction process is adaptive. For example, Humphrey (5) and others talk about the learning of new expectancies when the old expectancies are no longer confirmed. Hull (4) uses reactive and conditioned inhibition concepts to explain how the organism learns to rest or not to respond when an old response ceases to reduce drives. According to Guthrie (2), a response to a stimulus is extinguished when a new response is associated with that stimulus. Bugelski (1, p. 374) summarizes the similarities between the various extinction theories by saying, "Learning and extinction seem to be different aspects of the same process."

Indeed, most theories which purport to explain extinction do invoke some kind of new learning. However, almost all extinction experiments have been designed to record only the reduction in strength of the old response. Bugelski (1, p. 369) says ". . . the point cannot be made too strongly that most studies of extinction have ignored other behavior in which the animal indulges while undergoing extinction . . . if we only observe the original CR by means of some recording device, evidence of other behavior replacing the old will not be forthcoming." According to most theorists, new learning occurs during the extinction of an old response, yet apparently none have attempted to provide evidence that new learning is actually occurring.

It might well be that Bugelski has pointed the way toward an integrative theory of extinction. However, if learning and extinction are to be considered as two aspects of the same process, experimental evidence must be provided. In extinction experiments, responses other than the original CR must be measured. The effect of the addition of new adaptive responses on the extinction of an old CR must be investigated.

This paper reports data from a larger investigation (6) which permitted the recording of new responses during extinction training.

PROCEDURE

Subjects and Apparatus

The Ss were 48 native rats. The apparatus was a box divided into three compartments, the starting box, the response box, and the goal box. The three compartments were separated by vertical sliding doors. The response box contained three manipulanda, a chain, and a horizontal bar and a vertical bar, each of which, when operated under the appropriate circumstances, caused the door to the goal box to open. When this door opened the rat could enter the goal box, where a primary reward was placed. Selector switches enabled the experimenter to determine which manipulandum, when operated, would open the door.

The electrical wiring of the apparatus permitted automatic recording of response characteristics. All manipulandum responses were followed by a relay click. All responses made on manipulandum with selector switch "on" were followed by the click of a counter.

PROCEDURE

After the first day of preliminary training the subjects were under approximately 21½ hours' food and water deprivation. Preliminary training, identical for all groups, lasted for 4 days.

Acquisition Training

For all groups, acquisition training began the day after preliminary training ceased and lasted for 7 days. All manipulanda were uncovered for all trials, but only one manipulandum was "on"; consequently, a response had to be made on the manipulandum which was "on" in order to open the door to the goal box.

The Ss were assigned to three groups of 16 each. Acquisition training varied between groups in that Group 1 was trained on one manipulandum, Group 2 on two manipulanda, and Group 3 on three manipulanda. All groups were given 90 reinforced trials. For Group 1 chain pulling was reinforced 90 times; for Group 2 each of chain pulling and bar pressing was reinforced 45 times; for Group 3 each of chain pulling, bar pressing and bar pushing was reinforced 30 times. For Groups 2 and 3 the manipulandum designated to operate was predetermined, and no regular pattern was followed.

On each acquisition trial, the rat was placed in the starting box and the door from the starting box was opened. When the response appropriate for that trial was made the door to the goal box opened. The rat entered the goal box and remained in it for 20 seconds. After the completion of the required number of trials for the day, food and water were placed in the home cages for 10 minutes.

Extinction Training

Extinction training began the day after acquisition training was completed. The extinction procedure was identical for all groups. Each rat was given 10 two-minute spaced extinction trials per day. Extinction training was continued in 10-trial daily sessions until the criterion of four consecutive two-minute trials with no responses on appropriate manipulanda was met on two successive days.

Since all manipulanda were uncovered during all acquisition and extinction trials, it was possible for the rat to make responses on a manipulandum other than the one designated to operate. A response made on a manipulandum which, during acquisition, was sometimes instrumental for that particular rat in opening the door to the goal box, is referred to as an "appropriate" response. Responses made on manipulanda which were never associated with primary reinforcement are called "irrelevant" responses. Since Group 3 received acquisition training on all three manipulanda, there were no irrelevant responses for this group. For Group 1 there were two manipulanda on which irrelevant responses could be made, while Group 2 could make irrelevant responses on only one manipulandum.

RESULTS

During acquisition, irrelevant responses, i. e., responses made on manipulanda never associated with primary reinforcement, were very rare and occurred early in acquisition training. It would seem reasonable to explain these few irrelevant responses in terms of the random activity of rats deprived of food and water for 21½ hours. During extinction, however, the number of irrelevant responses was too large to be accounted for in terms of random activity.

The number and distribution of irrelevant responses during extinction is of primary interest in relation to Bugelski's suggestion. Table 1 presents

TABLE I

**MEANS AND STANDARD DEVIATIONS FOR APPROPRIATE AND
IRRELEVANT RESPONSES DURING EXTINCTION TRIALS**

		Group 1	Group 2	Group 3
Appropriate responses	Mean	257.31	631.13	1105.44
	S. D.	194.50	322.25	835.91
Irrelevant responses	Mean	74.25	15.60
	S. D.	57.65	19.74
Total responses	Mean	331.58	646.73	1105.44
	S. D.	224.81	336.59	835.91

the means and standard deviation for both the appropriate and irrelevant responses during extinction. The fact that the mean number of irrelevant responses recorded for Group 1 is as high as 74.25 would seem to have both theoretical and methodological significance. Figure 1 is a vincent

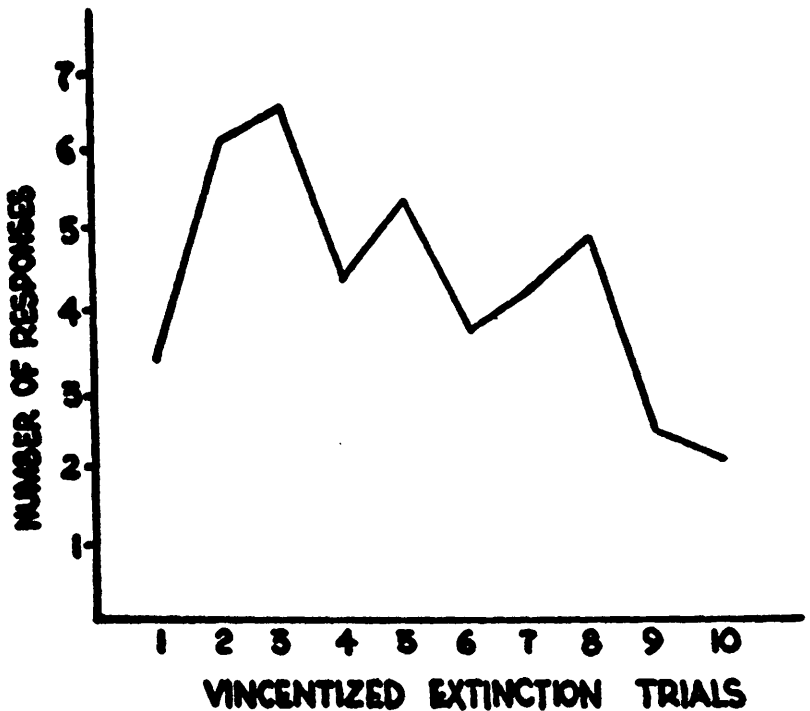


FIG. 1. Mean number of irrelevant responses per vincent trial made by 32 rats (Groups 1 and 2) during extinction. Group 1 had two manipulandum upon which irrelevant responses could be made.

curve showing the mean number of irrelevant responses made per tenth of extinction by the rats in Groups 1 and 2. The curve indicates that, in general, irrelevant responses first increased and then decreased as extinction training proceeded. The mean number of irrelevant responses per vincent trial started at 3.38, increased to 6.47, and terminated at 2.09

DISCUSSION

This experiment differs from most investigations of extinction in that irrelevant responses were recorded. Instead of recording only the decrement in the original CR, observations were made concerning new activity in which the animals indulged. However, the research was not designed to investigate irrelevant responses *per se* and permits only tentative conclusions concerning them.

Probably the most interesting aspect of these data is the distribution of irrelevant responses during extinction. Figure 1 indicates that the number of irrelevant responses increased during the first three-tenths of the extinction trials. The initial rise in number of irrelevant responses would seem indicative of the ordinary acquisition process. Apparently, when the old CR was no longer reinforced, the rat again indulged in random activity which had been limited when the successful CR had been established. During the random activity, the new manipulandum, i. e., manipulandum never associated with primary reinforcement, was operated. Operation of any manipulandum caused a click to occur. The click had previously been followed by primary reinforcement so probably had acquired secondary reinforcing value. Because of the secondary reinforcement, the S learned to operate the new manipulandum. However, since no primary reinforcement was provided, the click would gradually lose its secondary reinforcing value, and the new manipulandum response would be abandoned. The subsequent decline in number of irrelevant responses apparent in Figure 1, is thus explicable.

This analysis is not at variance with suggestions made by Bugelski (1, p. 378). He points out that during extinction training "no new sources of reinforcement are provided; no new response is singled out; the animal may learn a succession of reactions, none of which is repeated frequently enough to become established." In our experiment secondary reinforcement was provided temporarily and new responses were singled out. It is most unfortunate, however, that no records were kept of what the rat did when he ceased to make manipulandum responses. The records of the manipulandum responses do, however, seem to provide rather definite evidence that when the rat was learning not to make the old CR he was also learning to make a new response.

The large number of irrelevant manipulandum responses provide evidence supporting Hilgard's (3, p. 116) statement that "careful observation often reveals that the subject is not merely withholding the conditioned response but instead is actively engaged in doing something else." Had that something else been reinforced, it is probable that the number of CR's made until the extinction criterion was reached would have appreciably diminished.

The availability of irrelevant or additional responses has been discussed from the methodological point of view elsewhere (7). It would seem that two extinction studies may not be comparable if the availability of responses other than the CR differed.

Although the data presented in this paper seem to support the hypothesis that learning and extinction are two aspects of the same process, further investigation is required. For example, if this hypothesis is tenable, a situation in which a new adaptive response is available, when compared with the usual extinction situation, should produce rather rapid elimination of acquisition of the old and new CR's, as well as comparisons between of a non-reinforced CR. Also comparisons are needed concerning the rate the rate of acquisition and rate of extinction of the same CR.

SUMMARY

Bugelski suggested that an integrated theory of extinction might be possible if learning and extinction were considered as two aspects of the same process. He points out that in most studies of extinction experimenters have ignored other behavior in which the animal indulges. Our experiment permitted the recording of "irrelevant" responses made on manipulanda which had not been reinforced during acquisition. The number of these irrelevant responses at first increased, as would be expected in an acquisition situation, and then decreased, as would be expected in extinction. These data seem to support Bugelski's suggestions. The irrelevant response phenomenon, which has not yet been specifically investigated, would seem to have theoretical and methodological significance.

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