Extinction of rats' barpressing in the presence of free food*

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In two experiments, hungry rats received four extinction sessions in the presence of free food. When the free food was removed for eight subsequent extinction sessions, the animals made significantly fewer responses than did control groups which received no intervening sessions. The results are contrary to those of Enkema et al (1972). From the results of additional groups of rats which received four intervening sessions of free food only, empty chamber, or time in home cage, it was concluded that the presence of free food caused the diminution in extinction responding.

Enkema, Slavin, Spaeth, and Neuringer (1972) conducted a study in which pigeons, on VI schedules, were placed on extinction in the presence of freely available food identical to that used for earlier reinforcement. Responding extinguished rapidly in the presence of free food. After four sessions, the free food was removed and many more responses were emitted. The total number of extinction responses approximated the number made by a control group of birds that never received free food in the chamber. Free food temporarily suppressed responding during extinction. Enkema et al concluded that four conditions cause suppression of extinction responses: (1) punishment of responses (Skinner, 1938; Estes, 1944); (2) decreased drive level (Barry, 1958); (3) the presence of a similar, competing response (Leitenberg, Rawson, & Bath, 1970); and (4) the presence of a dissimilar, competing response (Enkema et al, 1972).

The present study was conducted to determine if a different organism under different experimental conditions would manifest the same results of Enkema et al—suppression of extinction responses in the presence of free food followed by a rise in responding to the level of a control group when the free food was removed. From pilot work, it is suggested that rats on continuous reinforcement (CRF) schedules would behave very unlike pigeons on variable interval (VI) schedules.

EXPERIMENT I

Method

Subjects. Eight naive rats were used. The rats were Wistar strain males, weighing approximately 275 g at the time of the experiment. Animals were housed two to a cage.

Apparatus. Four Lehigh Valley rat test cages, Model 143-03, were used in the experiment. The chambers were 20.3 cm wide, 22.9 cm long, and 18.4 cm high. An LVE mouse lever,

Model 1535, was mounted on the back wall of each chamber. The 1.9-cm-wide, .79-cm-thick paddle projected through the right-hand side of the wall, a distance of 2.54 cm. The center of the paddle was 2.54 cm from the right wall and 2.54 cm above the floor of the cage. The lever required a throw of .16 cm.

LVE pellet feeders, Model 114-20, were mounted on each cage and deposited 45 mg Noyes food pellets through a straight, open-ended metal tube mounted in the center of the rear wall. The end of the tube was 1.3 cm above the bottom of the 7.2-cm-diam, 1.9-cm-high, metal food dish. The food dish was bolted, through the center, to the floor grids. When free food was available, an identical metal dish permanently attached to the left, front corner of the chamber was filled with 1,000 45-mg pellets. The operant chambers were contained within individual sound-attenuating enclosures. LVE electromechanical control and counting modules were utilized in conjunction with Harvard C-3 cumulative recorders to operate the chambers and record responses.

Procedure. The eight rats were placed on 23-h/day food-deprivation schedules for 7 days prior to beginning the experiment. The animals received 6 days of barpress training on CRF schedules for 1 h/day. All animals made at least 1,000 barpresses during acquisition, varying from 1,044 barpresses for the rat which responded the least to 1,596 responses for the most productive animal. The mean number of responses for the eight rats was 1,398 for the 6 days of barpress training. Following all sessions, the rats received food in the home cages for ½ h. After acquisition, the eight rats were divided into two matched groups, according to numbers of barpresses. The experimental group was placed on extinction in the presence of free food. The animals were put in the chambers with the free dishes already full of pellets. Responses to the bar still activated the feeder mechanism, but the food hopper was now empty, so no pellets were delivered. Extinction in the presence of freely available food lasted for four daily 1-h sessions, after which the free food was removed for eight daily 1-h sessions of extinction. Except for the removal of the free food, the extinction conditions were identical to the extinction/free-food sessions.

The control group simply received eight extinction sessions, beginning on the day following acquisition, identical to the eight extinction sessions of the experimental group.

Results and Discussion

Enkema et al (1972) found that pigeons made few extinction responses in the presence of free grain, but when the free grain was removed for seven sessions, the experimental group made approximately the same total number of responses in extinction as the control group.

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Fig. 1. Means of the experimental and control groups' responding during extinction sessions.

Figure 1 shows the results of the present experiment. The data are plotted similarly to those of Enkema et al. In this case, rats also responded little to the bar in the presence of free food, except possibly for Day 1, in which the rats made a mean number of 30 barpresses per animal. However, contrary to the Enkema et al findings, when free food was removed for the experimental group, many fewer extinction responses were made in the 8 days than were made by the control group. The difference is mainly due to the relatively low level of responding by the experimental group in the first 2 days of extinction. A *t* test was calculated to test the difference between the means of the total number of extinction responses for the two groups. Even when the extinction/free-food responses of the experimental group were included in this analysis, the difference was statistically significant at less than the .01 level ($t = 4.46$, $df = 6$, two-tailed).

Each animal in the experimental group consumed a mean number of 243 free pellets per session during the 4 intervening days. The mean number of free pellets eaten was consistent over the 4 days. The mean number of free pellets consumed for the four sessions per rat varied from a low of 205 to a high of 291. The numbers of free pellets consumed were not related to the numbers of

barpresses in the presence of free food, nor were they related to subsequent barpressing with no free food present.

In this experiment, extinction in the presence of free food did not merely suppress responding, but decreased the ultimate number of extinction responses when compared with the control group. There were a number of differences between the Enkema et al study and Experiment I here—most importantly, the use of different species, different methods of obtaining and receiving “earned” food, and different schedules of reinforcement. Nevertheless, the Enkema et al general statement that “extinction responses are suppressed when . . . a dissimilar competing response is made available” [Enkema et al, 1972, p. 269] is seriously questioned.

EXPERIMENT II

The second experiment was devised to attempt to discover the reason for the discrepancy between the results of Enkema et al and those of Experiment I, and to account for the rats' behavior. The experimental group of rats may have made fewer extinction responses than the control group because of the presence of free food, because they spent four sessions in the operant chambers between acquisition and extinction, or merely because of the intervening time. Therefore, Experiment II replicated Experiment I and added three groups of animals which received (between acquisition and extinction): (1) four intervening sessions of free food without the bar present, (2) four intervening sessions in the chambers with neither free food nor the bar present, or (3) 4 intervening days in the home cages.

Method

Subjects. Twenty naive male albino rats, of Wistar-strain, were used. The animals weighed approximately 275 g at the time of the experiment, and were housed two to a cage.

Apparatus. The apparatus, food pellets, and method of delivering food were the same as used in Experiment I.

Procedure. The deprivation schedules and acquisition training were identical to Experiment I for all 20 rats. The animals made from 1,056 to 1,638 barpresses for the 6 days of training. The mean number of responses during acquisition was 1,314 per rat. After initial shaping, all animals spent nearly the entire acquisition sessions barpressing, for at least 50 min. Following bar training, the animals were divided into five groups of four animals each, matched according to numbers of acquisition responses.

The conditions under which the five groups of animals were run following acquisition were as follows: (1) Experimental Group 1: four daily sessions of extinction in the presence of freely available identical food. This group is identical to the experimental group of Experiment I. (2) Experimental Group 2: four daily sessions of free food in the operant chambers with the bars removed. (3) Experimental Group 3: four daily sessions in the chambers without free food or the bars present. (4) Experimental Group 4: 4 days in the home cages. These animals were handled daily as they would have been if they had been placed in the operant chambers, but they were never put in the chambers during the 4 days. (5) Control Group: eight daily

extinction sessions with no free food ever available in the experimental chambers. This group was identical to the control group of Experiment I.

The four experimental groups received eight daily sessions of extinction, identical to those of the control group, following the various conditions for the 4 intervening days after acquisition. As in Experiment I, the food hopper was emptied during extinction so that a barpress activated the food mechanism, but no pellet was delivered.

Results

The results of Experiment I were replicated. That is, the results of Experimental Group 1 and the control group were the same as the corresponding groups of Experiment I. Once again, except for the first day, there was little extinction responding in the presence of free food, and Experimental Group 1 made significantly fewer total responses to extinction than the control group, even when the extinction/free-food responses were included in the analysis ($t = 4.92$, $p < .01$ $df = 6$, two-tailed). The effect is mainly due to the relatively low level of responding of Experimental Group 1 in the first 2 days of extinction. Further, both groups' data over the sessions look practically identical to those of the groups in Experiment I. There was, again, not merely a response suppression, but a diminution in the total number of extinction responses following extinction in the presence of free food, as compared to the control group.

The results are shown in Fig. 2. The results of Experimental Group 1 are plotted in two ways, including and excluding the extinction/free-food responses in the cumulative curves. A one-way analysis of variance was applied to the data, resulting in statistical significance at less than the .01 level between groups ($F = 4.90$, $df = 4/15$). Therefore, a Newman-Keuls test was calculated which showed that the the control group was significantly different from Experimental Group 1 (extinction in the presence of free food) and Experimental Group 2 (free food without the bar being present) at less than the .05 level.

Rats in Experimental Groups 1 and 2, which ate free food in the operant chambers during the four intervening sessions, consumed mean numbers of 252 and 217 free pellets, respectively, per animal, per session. The numbers of free pellets consumed per session remained constant for both groups. The mean numbers of free pellets consumed per animal during the four sessions varied from 214 to 300, for Experimental Group 1, and from 175 to 252, for Experimental Group 2. There were no significant relationships between numbers of free pellets consumed and barpressing, with or without free food present.

There were great individual differences in numbers of responses during extinction among the 20 animals, ranging from a total of 115 to 499 responses. However, within groups, there were apparent consistencies. For example, there was no overlap between the control

Fig. 2. Cumulative extinction curves of the five groups of rats. Group E_1 received four intervening sessions in chambers with free food and bar present; Group E_2 : free food only; Group E_3 : neither free food nor bar present; Group E_4 : four days in home cages; Group C: no intervening sessions or time. E_1 is plotted including and excluding free-food extinction responses.

group (310 to 474 responses) and either Experimental Group 1 (115 to 255 responses) or Experimental Group 4 (290 to 499 responses), in terms of numbers of extinction responses for individual animals. Only Experimental Group 3, which spent four sessions in the chambers with neither free food nor the bar present, and which made the median number of extinction responses as a group, showed great within-group variability for individual animals—from 117 to 460 responses.

Cumulative records of barpressing were maintained. Animals exhibited typical extinction curves, both during the four intervening sessions for Experimental Group 1 and during the eight subsequent sessions for all five groups; i.e., animals made the bulk of their responses at the beginning of sessions and then occasionally made a few barpresses, the numbers decreasing to near zero by the eighth extinction session.

DISCUSSION

In two experiments, it has been demonstrated that hungry rats, trained on CRF schedules, emit fewer

extinction responses following extinction in the presence of freely available food than do control animals without the intervening free-food sessions. The effect appears mainly to be due to the presence of free food in the chambers during the intervening sessions. The two groups that had free food present with and without the bar present, did not return to high response rates when the food was removed. The two groups which received no intervening sessions in the chamber did produce many responses to extinction. The group which spent four intervening sessions in the chambers without free food or the bar present emitted intermediate numbers of extinction responses.

Using pigeons on VI schedules, Enkema et al (1972) found that intervening sessions in an experimental chamber in the presence of free grain merely suppressed responding. When the free food was removed, the pigeons emitted many responses, like the control birds which receive no intervening sessions. There are a number of obvious differences between the Enkema et al study and the present ones. Enkema et al used pigeons on VI 30-sec schedules of reinforcement; disk-pecks produced 3 sec of access to a hopper, either empty or filled with grain. The present studies employed rats on CRF schedules; barpresses either produced single 45-mg food pellets or activated the feeder mechanism but resulted in no pellet. Any of these differences might have caused the difference in results. In addition, Enkema et al employed a different criterion for terminating sessions. During training, birds received 31 reinforcements/session on VI 30-sec schedules, so that the average session length must have been about 15 min. During extinction in the presence of free grain for the experimental group, sessions were terminated after 31 hopper presentations or 60 min, whichever occurred first. It is unclear how long these sessions actually lasted, but it appears, from the data, that the four sessions progressively became longer as the birds decreased their responding, possibly reaching 60 min. For the extinction sessions for both groups, it is unclear how long they lasted, but, here too, it appears that the sessions probably became progressively longer as responding

decreased. In the present studies, all sessions lasted 60 min. It appears, then, that the training sessions and at least some of the extinction sessions were shorter in the Enkema et al study than in the ones reported here. The shorter sessions may account for the different results. There probably was less exploration in shorter sessions. Enkema et al report that the pigeons ate for 10 to 20 min and then stood quietly for the remainder of the time in the latter extinction sessions. The rats, conversely, ate during nearly the entire training and free-food periods, and explored a great deal during extinction. In addition, it is obvious that the pigeons made many more total responses under all conditions than the rats, possibly affecting the results. It should also be noted that Enkema et al utilized a different method for producing food deprivation (body weight), such that their animals had 3 or 4 days separating extinction sessions in the presence of free food. Thus, in the intervening sessions, at least 13 days elapsed in the Enkema et al study. There are, then, many variables which could have caused or affected the disparate results between the Enkema et al and the present study. Further research may help to elucidate the differences. Nevertheless, a general law that responding during extinction is suppressed when a dissimilar competing response is available does not prove valid in all cases, at least not with rats as used in the present studies.

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