

Reconditioning of extinguished fear after a one-year delay

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After fear-conditioning (light-shock) trials in one side of a two-compartment apparatus, subjects learned in the absence of shock to jump a hurdle to the other (safe) side, thereby escaping the fear-eliciting stimuli. Speed of hurdle jumping increased to a maximum and then gradually decreased until a strict extinction criterion was reached. Then a single reconditioning trial led to the reemergence of hurdle jumping. Speed of responding was at a high level immediately and then gradually declined until the extinction criterion was met once again. One year later, without further fear conditioning, 2 of the subjects were given hurdle-jumping training until responding ceased. The subsequent administration of one fear-reconditioning trial led to an immediate recovery of rapid hurdle jumping followed by a gradual decrease in speed, just as had occurred a year before. These findings demonstrate that the reconditioning effects may be observed when a year has elapsed since original conditioning.

It recently was reported by McAllister, McAllister, Scoles, and Hampton (1986) that following classical fear conditioning (light paired with shock), rats, *in the absence of shock*, were extremely persistent in making a hurdle-jumping response that led to an escape from the fear-eliciting stimuli. During training, speed of hurdle jumping increased from a low to a high level and then gradually decreased until an extinction criterion was reached (first extinction). The mean number of trials taken before responding ceased was 226. Then, *one* additional light-shock pairing resulted in an immediate reemergence of the hurdle-jumping response. Although responding had ceased less than 2 min earlier, speed of responding began at a high level, increased somewhat, and then gradually decreased until responding ceased again (second extinction) after a mean of 200 trials. On each of the next 2 days, without further shock, some recovery of responding, attributed to the spontaneous recovery of fear, was observed.

In the present paper, the data obtained in the McAllister et al. (1986) study from 2 subjects that were administered treatments beyond those outlined above are described. These subjects were given additional hurdle-jumping (HJ) trials during the subsequent 2-month period, and then, after 1 year, they were given further HJ trials until an extinction criterion was reached. Then, one fear-reconditioning trial was administered and HJ training was continued until the extinction criterion was again met.

METHOD

A brief description of the method employed in the original experiment and for the extended training follows. Further details are provided in McAllister et al. (1986).

This research was supported in part by Grants MH-29232 and MH-36610 from the National Institute of Mental Health. Requests for reprints should be sent to either author, Department of Psychology, Northern Illinois University, DeKalb, IL 60115.

Apparatus

The apparatus was a box consisting of two compartments separated by a partition with a guillotine door that rested on a hurdle. One compartment, white with a grid floor, served as the fear-conditioning box and as the start box for the HJ trials. The other compartment, gray with a solid floor, served as the safe box during the HJ training.

Subjects

The subjects were 2 naive female hooded rats that were given training in addition to that administered in the original experiment reported by McAllister et al. (1986). These were the first 2 of the 6 subjects in the EP-R condition described below. To provide a basis for interpreting the results obtained during the extended training, data from 4 representative subjects of the original experiment also will be presented.

Procedure

In the original experiment, all subjects, on the initial day, were handled and allowed to explore the apparatus. On the next day, they received 25 fear-conditioning trials in which a light of 6-sec duration was paired during the last 2 sec with a 125-V(ac) shock delivered through 100-K Ω resistance. On the following day (Day 1), HJ trials were administered in the absence of shock. On each trial, the subject was placed into the start box, and, after 10 sec, the guillotine door was opened simultaneously with the presentation of the conditioned stimulus (CS) and the activation of a Hunter Klockounter. If the subject jumped the hurdle, depression of the safe-box floor terminated the CS and stopped the Klockounter, thus providing a measure of the latency of the response in units of 0.01 sec. After a jump, the guillotine door was closed, and the subject remained in the safe box for 10 sec before being placed in a holding box for the 30-sec intertrial interval (ITI). If no jump occurred, the subject was removed from the start box after 60 sec and placed in the holding box for the ITI. Training was continued until the subject reached a strict extinction criterion, failure to jump the hurdle within 60 sec on 10 consecutive trials. Following the ITI after the 10th criterion trial, subjects in the two groups that are of interest here were given one additional CS-US pairing. Immediately after this pairing, the subjects in Group EP-NR (extra pairing-no response) were placed in the holding box for the ITI, whereas the subjects in Group EP-R (extra pairing-response) were first allowed to jump the hurdle. Following these treatments, after 30 sec in the holding box, HJ training continued until the extinction criterion was again met. On each of the next 2 days, training was continued until the extinction criterion was reached or for a maximum of 50 trials.

For the 2 subjects given extended training, an additional 50-trial HJ session occurred 20, 41, and 62 days following Day 1. On Days 41 and 62, the first 25 trials were given without the CS and the second 25 trials

with it. Performance was not related to this manipulation, probably because accumulated extinction effects depressed the tendency to hurdle jump on later trials and thereby offset the usual facilitatory effect of the CS. For the remainder of a year, these 2 subjects were maintained in the laboratory animal room and were handled for 5 min every 21 days (± 2 days). On Day 365, HJ trials were reinaugurated, with 50 trials a day being administered until the extinction criterion was met. However, if the subject did not jump on the 50th trial of a day, additional trials were given until the criterion was reached or until a jump occurred. This procedure was followed for all subsequent HJ training days. After meeting criterion, 1 fear-reconditioning trial was given, according to the procedure used for Group EP-R in the original experiment, and was followed by 50 HJ trials. On each succeeding day, training continued, 50 trials a day, until the extinction criterion was again reached.

RESULTS

Original Training

The mean speed of HJ (reciprocal of latency in seconds) for 4 individual subjects is presented in Figure 1 for the trials to the first extinction and in Figure 2 for the trials to the second extinction on Day 1 of the original experiment. In each case, the last plotted point for each subject represents five of the criterion trials. These particular subjects were selected to minimize the overlap of the data points and thereby to display most clearly the trends of performance. The curves in both figures are representative of the group data presented in McAllister et al. (1986). Figure 1 shows the original acquisition of the HJ response and the gradual decline in performance as trials progressed until the first extinction criterion was reached. Figure 2 shows the immediate recovery of the HJ response following the single fear-reconditioning trial and the gradual decrease in performance for 3 of the subjects until the extinction criterion was reached a second time. For

Subject 6 of Group EP-R, the criterion trials did not begin until Trial Block 85.

Note that Subject 1 of Group EP-R was 1 of the 2 subjects that were given extended training. The performance of Subject 2 of Group EP-R, the other subject that was given extended training, (not shown in Figure 1), was similar to that of Subject 6 of Group EP-R through Trial Block 31. Thereafter, the performance of Subject 2 persisted at that level for a number of trial blocks and declined only gradually to a mean speed of 0.48 on Trial Block 60. The criterion trials for Subject 2 did not begin until Trial Block 132. If this subject's performance were plotted in Figure 2, it would look like that of Subject 6 of Group EP-R over the 60 blocks of trials. The criterion trials for Subject 2 began on Trial Block 64. Note that Subject 2 persisted in hurdle jumping for almost 19 h before the Day 1 treatments were completed.

Extended Training

The mean HJ speeds over the 50 trials on Days 20, 41, and 62 following the initial training day were, respectively, for Subject 1, 0.64, 0.34, and 0.17, and for Subject 2, 0.39, 0.45, and 0.44. For Subject 1, performance tended to increase over the trial blocks on Days 20 and 41 and to increase and then decrease on Day 62. For Subject 2, performance generally decreased over trial blocks on 2 days. Neither subject met the extinction criterion on any of these days. In fact, over the 150 trials, Subject 1 had only 11 trials with latencies of 60 sec, whereas Subject 2 had only 15 such trials.

On Day 365, 1 year after the original fear-conditioning trials, performance started at a moderate level for each

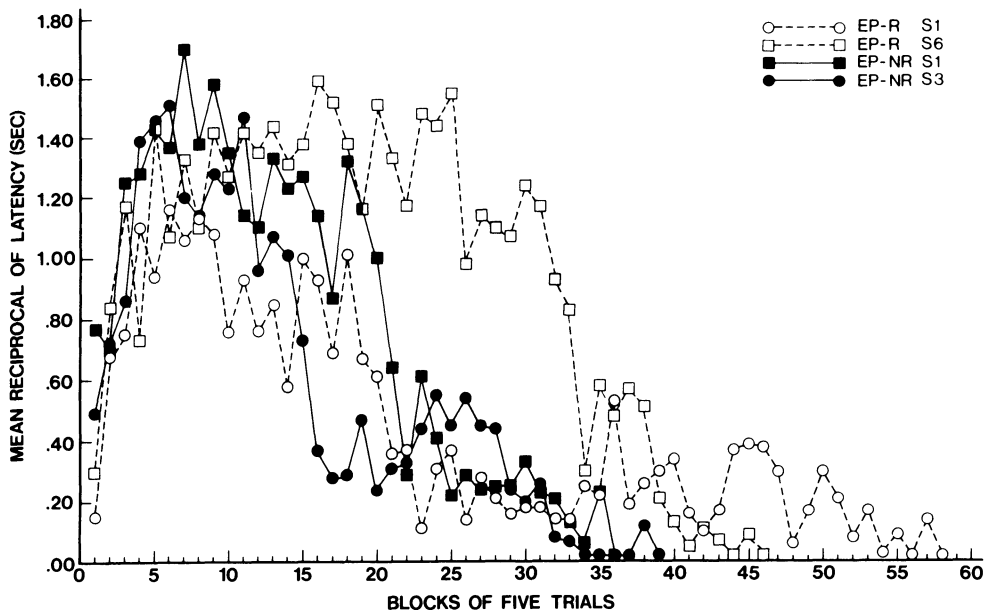


Figure 1. Mean speed of hurdle jumping in blocks of five trials to the first extinction criterion for representative subjects from Groups EP-R and EP-NR from the McAllister et al. (1986) study.

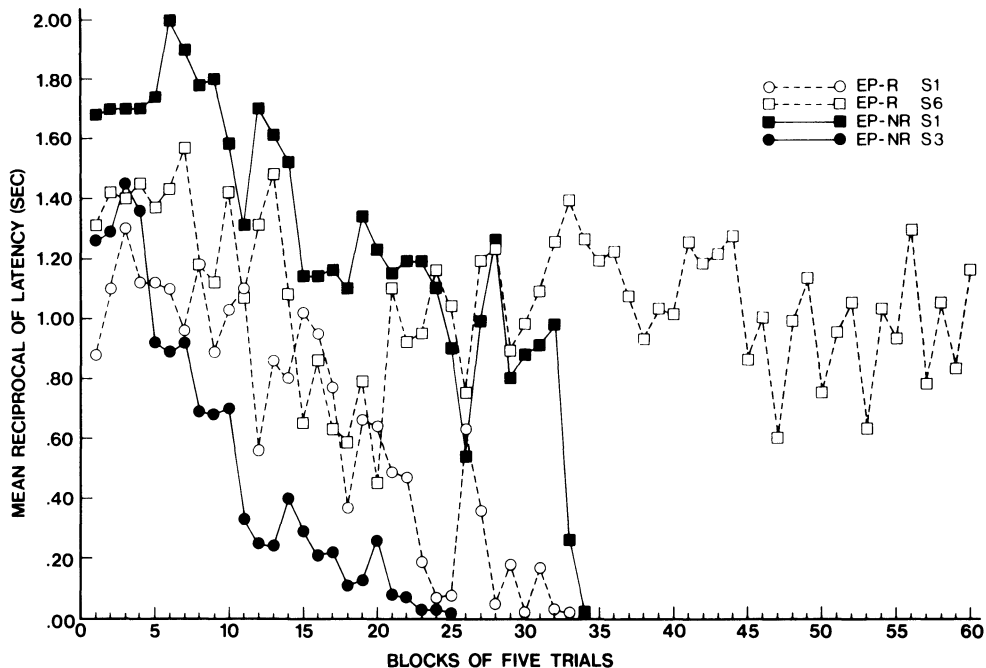


Figure 2. Mean speed of hurdle jumping in blocks of five trials to the second extinction criterion for representative subjects from Groups EP-R and EP-NR from the McAllister et al. (1986) study.

subject. For Subject 1, the speed of HJ was 0.55 on the first single trial, and the mean speed was 0.34 on the first block of five trials. Thereafter, performance declined steadily until the criterion trials began, with the last response occurring on Trial 19. For Subject 2, the speed of HJ was 0.20 on the first single trial, and the mean speed was 0.61 on the first block of five trials. Performance then decreased rapidly so that on the remaining nine blocks of trials on Day 365, the speed of responding hovered around a mean of 0.08. On the next 8 days, responding continued at a somewhat higher level, but with a great deal of variability, before the criterion trials began, with the last HJ response occurring on Trial 420.

Upon reaching the extinction criterion, the EP-R treatment was administered, followed by 50 HJ trials. This one reconditioning trial led to prolonged hurdle jumping for both subjects before the extinction criterion was again met. Subject 1 took 467 trials before its criterion trials began, whereas Subject 2 took 716 trials. For each subject, the number of trials was greater than that taken to the first and second extinction criterion the year before. These values were, respectively, 284 and 157 trials for Subject 1 and 655 and 315 trials for Subject 2. Probably this indication of increased resistance to extinction after a year resulted from the distribution of the HJ trials over days (50 per day), whereas in the original training, all trials were administered on the same day.

Speed of hurdle jumping began at a high level immediately following the EP-R treatment, just as it did after the

similar treatment given a year earlier. On the first single trial, the speed was 0.63 for Subject 1 and 1.45 for Subject 2, and the mean for the first block of five trials was 0.71 and 1.40, respectively. As was the case a year before, speeds increased over several trial blocks. In fact, the fastest speed in a block of five trials occurred on Block 7 for Subject 1 (1.26) and on Block 4 for Subject 2 (1.72), which suggests that some relearning of the HJ response occurred. For Subject 1, there was a remarkable similarity in the mean speed of HJ over the first 20 trial blocks that followed the EP-R treatments given on Day 1 (see Figure 2 for these data) and on Day 365. Thereafter, the performance curves diverged, with response speeds decreasing until the extinction criterion was met on Day 1 but being maintained for many more trial blocks after a year. For Subject 2, the mean speeds of HJ on the first 4 trial blocks after the EP-R treatment that was given on Day 1 and a year later were highly similar. However, on the subsequent trial blocks common to the two occasions, response speeds were generally much lower after a year than on Day 1.

DISCUSSION

There are striking similarities between the data from Day 1 shown in Figure 2 and the data described herein that were obtained a year later from the 2 subjects that were given extended training. On each occasion, after a subject failed to make the instrumental HJ response on 10 consecutive trials, one light-shock pairing immediately reactivated responding, which then persisted over a large number of trials. Fur-

thermore, response speed was at a high level immediately. The importance of the present results is the demonstration that these reconditioning effects can occur when a year has elapsed since the original fear conditioning.

The decrease in instrumental performance that eventually occurred as trials progressed, following both the original fear conditioning and each of the later single fear-reconditioning trials, is assumed to be due to the extinction of fear rather than to a loss of response strength for hurdle jumping. This interpretation is based on the fact that, on the very first HJ trial following each of the single reconditioning trials, speed of responding was extremely fast, whereas normally in this task, at the outset of learning, response speed is relatively slow. Therefore, the rapidity of responding in these instances implicates the presence of a substantial amount of instrumental response strength. Given that this response strength was present, the cessation of hurdle jumping immediately prior to each of the single fear-reconditioning trials suggests that fear had extinguished and, thus, that motivation was absent. With the reconditioning of fear, the source of motivation was restored, and hence the instrumental response was activated.

The HJ response may be considered analogous to some neurotic (symptomatic) behavior in that in both cases the behavior does not prevent a primary aversive event, but simply reduces fear or anxiety. To the extent that this analogy holds, the present results suggest that, for complete success, psychotherapeutic intervention must extinguish the symptomatic behavior as well as fear. If only fear is extinguished, one fear-arousing experience, even if it occurs many months later, would reestablish the symptomatic behavior.

REFERENCE

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(Manuscript received for publication March 8, 1988.)