FACILITATION OR BAR-PRESS AVOIDANCE BY HAND DURING THE INTERTRIAL INTERVAL

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Abstract:
Experiment 1 demonstrated that handling rats prior to the start of a trial greatly facilitated bar-press avoidance learning. Although Ss which were also allowed to escape the training chamber following a bar press performed well, they were not significantly better than those Ss receiving handling only. Experiment 2, using concomitant measures of freezing and bar holding, investigated the effect of the interval between handling and the start of a trial. The resulting analysis provided evidence against bar holding and CS discriminability explanations of poor bar-press avoidance, while supporting the idea that conditioned freezing responses interfere with bar pressing.

Article:
There are currently several hypotheses to account for the difficulties generally encountered in establishing discriminated bar-press avoidance in rats. One hypothesis maintains that *Ss* hold the bar following the previous press and that this bar holding is incompatible with subsequent pressing. Supporting this notion are the findings that punishing bar holding (Feldman & Bremner, 1963; Jones & Swanson, 1966), removing the bar during the intertrial interval (Cole & Fantino, 1966), and removing *S* from the bar (Fantino, Sharp, & Cole, 1966) facilitate avoidance responding.

A second hypothesis is that incompatible freezing responses become conditioned to the CS by virtue of pairing the CS with a painful shock (D'Amato, Fazzaro, & Etkin, 1967; Meyer, Cho, & Weseman, 1960). However, most of the articles which offer freezing as a possible cause of poor avoidance have neither directly manipulated nor measured the freezing response itself. There are some instances in which the freezing response was presumably disrupted. Feldman and Bremner (1963) punished crouching between trials and found a resultant improvement in avoidance. In two other studies it was concluded that a highly discriminable intense CS enhanced avoiding because the CS caused a startle response which broke up freezing (Erickson, 1967; Fantino et al., 1966). None of these studies measured the amount of freezing under the various experimental conditions. In order to evaluate the bar holding and freezing hypotheses, it is imperative that direct measures of these responses be taken in the course of avoidance learning because any manipulation intended to affect bar holding would very likely affect freezing as well.

A third explanation of poor bar-press avoidance, that termination of the CS in this case is insufficient to reinforce the learning of a avoidance response because the fear is primarily conditioned to the more prepotent environmental cues present at the time of shock, was suggested by Brush (1962). In the one-way avoidance situation such conditioning of fear facilitates learning because *S* may escape the aversive cues upon avoiding. In the bar-press situation, on the other hand, *S* always remains in the presence of the aversive apparatus cues.

The first experiment in the present study tested the "apparatus fear" hypothesis by making a bar press both terminate the CS (or CS plus US) and allow *S* to escape the aversive environmental stimuli by opening a door leading to a safe compartment. Since Ss that left the shock compartment required handling to return them there, a control group was run which was handled in manner but never allowed to leave the shock compartment.

EXPERIMENT 1

Method

Subjects. Thirty-two Sprague-Dawley albino rats, supplied by the Charles River Co., weighed 250-500 gm. The 8 females and 24 males had no previous experience with either bar pressing or aversive conditioning. The *S*s were assigned to four groups, equated for weight and sex.

Apparatus. The apparatus consisted of a shock chamber and a "safe" chamber separated by a motor-operated guillotine door. The shock chamber was a 15 × 6 × 7-in. box with a floor of 1/8-in. steel bars 1/2 in. apart. The floor was hinged and rested on microswitch at one end. A microswitch bar, requiring about 15 gm. to operate, was located 2 in. from the grid and 2 1/2 in. from the door. Centered on the back wall 6 in. from the grid was a 15-w. frosted light bulb. The safe chamber was a 12 × 6 × 7-in. box with a wooden floor. A photocell was placed 1 in. above the floor and 5 in. from the door. Both chambers had Plexiglas fronts, hinged tops, and gray paint on the wooden surfaces.

The shock source was 650 v. ac through 1 megohm of resistance, giving a constant current shock of .65 ma. The current was discontinuous, occurring in 300-msec. pulses, 100 per minute, and was applied so that adjacent bars were of opposite polarity. Programming was done with operant relay equipment. Latencies were measured to the nearest .01 sec. with a Standard Electric timer.

Procedure. All groups received a 5-sec. CS-US interval, 30-sec. ITI, and 25 trials per day for 4 days. The CS for each group was onset of the 15-w. light. Latency of bar pressing was measured from CS onset.

For Group B (bar press), a bar press terminated both light and shock or avoided shock and terminated light. The *S* had to release the bar to make another press. At no time during the 25 daily trials did *E* handle *S*.

Group HB (handle-bar press) was similar to group B, except the *S* was picked up by *E* at the end of each ITI and replaced in the shock box,, facing away from the bar. The CS was started by the action of *S's* weight on the microswitch under the grid. The handling operation took 2-3 sec.

Group HBE (handle-bar press-escape) also had a trial started by placing *S* on the grid facing away from the bar, but a bar press was followed by the raising of the guillotine door as well as by termination of CS and US or avoidance of US. When *S* entered the safe box far enough to break the photocell beam, the door was lowered and the ITI timer started. At the end of the ITI, *S* was taken from the safe box and placed in the shock box, starting the next trial. In the event that *S* did not enter the safe box within 60 sec., *S* was removed by *E*, the door was lowered, and the next trial was started.

Group C (control), was the same as Group HBE, except there was no shock. This group was included to evaluate any possible reinforcing effects of door-raising itself.

Results

The mean total avoidances in 100 trials for *Ss* in Groups C, B, HB, and HBE were 12.5, 11.7, 57.0, and 64.5, respectively. Figure 1 shows the percentage of avoidances across days for the four groups. Since Group C demonstrated no learning of the bar-press response and was theoretically uninteresting, it was eliminated from all further analyses. An analysis of variance was performed on avoidances for the three remaining Groups, with repeated measures on Trials and Days. Significant main effects were found for Groups (F = 26.5, df = 2/21, p < .001), Trials (F = 35.2, df = 4/84, p < .001), and Days (F = 4.62, df = 3/63, p < .01). The Groups × Trials interaction was significant (P = 4.57, df = 8/84, p < .005). The main effect for Groups can be accounted for primarily by the difference between the no-handle Group B and the handled Groups HB and HBE (F = 52.4, df = 1/21, p < .001). There was no significant difference between Group HB and Group HBE (F < 1.0). The only indication that the escape from the shock box facilitated learning was that Group KBE had more avoidances than Group HB on Day 1 (t = 2.64, df = 14, p < .01). However, this difference disappeared on Day 2 (t < 1.0).

It is difficult to determine precisely how the handling operation facilitated avoidance learning. One possible mechanism is suggested by a comparison of the distributions of response latencies for the four groups, graphed in Figure 2. For Group C, most "avoidances" were of long latency. When the shock and avoidance contingencies were introduced, the mode shifted towards the beginning of the interval, but this did not occur in the same way for the handled and nonhandled groups. Of particular interest was the fact that 17% of Group B's avoidances occurred in less than 500 msec. while only .9% and 1% occurred this rapidly in Groups HB and HBE, respectively. This suggests that *Ss* in Group B were resting on the bar and that these avoidances constituted startle responses to the CS. Such short latencies for handled *Ss* were highly unlikely because *S* began each trial at a considerable distance from the bar and facing away from it. The handling operation for these groups required that they make a rapid turn, approach the bar, and press in order to avoid.

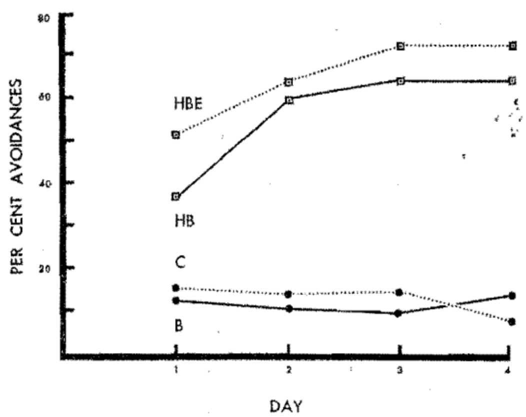

FIG. 1. Percentage of avoidances across days for Groups C, B, HB, and HBE.

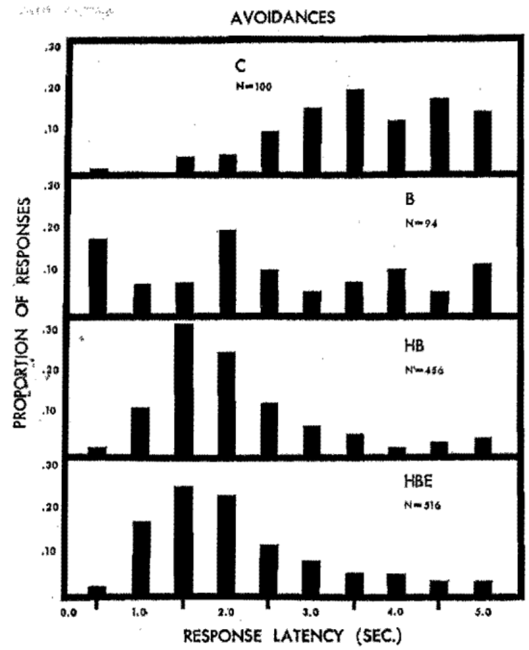

FIG. 2. Distributions of avoidance latencies for Groups C, B, HB, and HBE. (N = total number of avoidances in 100 trials for eight *Ss* in each group.)

Discussion

The hypothesis concerning the inadequate reinforcing effects of CS termination is clearly not supported by these data. The Ss in Group HB learned quite well when a bar press terminated the light. Allowing escape from environmental cues may have facilitated learning slightly on the first day, but its effect was very small compared to the important facilitation due to the handling operation. Perhaps the handling facilitated avoidance performance because it simply kept *S* away from the bar. This is consistent with the bar holding hypothesis.

However, the results are also consistent with a freezing interpretation; handling might simply reduce freezing to the CS. Another possible effect is that being dropped on grid produces a substantial increase in the cues comprising the CS and thus makes it more discriminable, a factor found important Fantino et al. (1968).

EXPERIMENT 2

In Experiment 1 the results for the handled vs. nonhandled groups were found to be consistent with freezing, bar holding, and criminative interpretations of the difficulty in obtaining bar-press avoidance. Experiment 2 attempted to manipulate the relative importance of these factors by subjecting independent groups to different intervals of time between handling and CS onset. Since this interval was 0 sec. in Experiment 1, the contribution of handling cues to the CS was presumably maximum; for longer intervals these cues would become less relevant. It was also suspected that there would be less freezing to the CS after short handle intervals.

Other innovations were that the distance of *S* from the bar at CS and US onsets was measured on each trial and bar holding corded. These data were collected to direct measurement of the freezing and bar holding responses. Possessing this information can compare probabilities of avoiding as a function of various pre-CS conditions (holding or not holding the bar, being near the bar at CS onset, etc.).

Method

Subjects. Twenty-five male Sprague-Dawley albino rats, naive with respect to electric weighed 250-350 gm. at the start of the experiment. The *S*s were obtained from the Simonsen Laboratories.

Apparatus. All training was given in 14 × 7 × 8-in. box which had a hinged Plexiglas top, aluminum walls, and a grid floor made of 7/8-in. steel bars spaced ¾-in. apart. A 1 1/2 × ¾-in. microswitch bar was centered at one end of the box 3-in. above the grid. The microswitch was operated by a 24-gm. force. The clear portion of the chamber's top was marked at 1-in. intervals to provide a scale of distances from the bar.

The CS was the diffused light from two 15-w. bulbs built into the Plexiglas top. The US was 650 v. ac through a 330 K ohm resistor to provide a 2-ma. shock through the grid. The shock was scrambled through a Lehigh Valley Model 1311 shock scrambler and pulsed at 100 pulses per second.

Programming and timing of events were controlled by operant relay equipment. Response latencies were recorded to the nearest .01 sec. using a Standard Electric timer. The occurrence of the CS, US, bar press, and top closing were recorded on a Lehigh Valley Model 1321 event marker moving at 1 mm/sec.

Procedure. Pilot animals did not readily learn the bar press to escape shock. Therefore, each *S* was given pretraining in which shock trials were given every 30 sec. until *S* met a criterion of five consecutive escape latencies of less than 10 sec. The *E* observed *S* and manually terminated the US in a shaping procedure until *S* began pressing unassisted. Following pretraining, *Ss* were assigned to groups so as to equate for trials to the escape learning criterion. The CS was never presented during pretraining and *S* was never handled. Illumination in the experimental chamber was provided by the room lights.

On the day following escape pretraining, each *S* was run under one of the five experimental conditions. Each group received a 5-sec. CS-US interval and 30-sec. ITI for a single session of 50 trials. The light CS was now employed and room lights were out.

Group NH (no-handling) was given the usual bar-press avoidance training. A bar-press response terminated the CS and US or avoided the US. The *S* was never handled during the 50 trials. The ITI was initiated by *S's* response.

The experimental groups were handled at different points in the ITI. The time between handling and the start of the next trial was 0, 5, 15, .and .25.seC. for groups H0, H5, H15, and H25, respectively. The *S* was handled following the previous trial at a time such that the total time between trials would be a constant 30 sec. The handling operation consisted in *E* gently picking up *S*, removing him from the box, and replacing him facing away from the bar at a point where *S's* head was about 10 in. from the bar. The handling-CS interval timer was started by the closing of the top following handling.

For each *S*, three measures were recorded during each trial: the latency of bar pressing following CS onset, the distance of *S's* head from the bar at CS onset (D1), and the distance of his head from the bar at US onset (D2). In the case of an avoidance, D2 was defined to be the distance at the moment of pressing. Distances were estimated by *E* using the scale marked on the top of the box.

Results

The mean percentages of avoidances in 50 trials were 31.6, 22.0, 23.2, 35.6, and 2.4 for Groups H0, H5, H15, H25, and NH, respectively. Clearly, handling, regardless of the time prior to CS onset, yielded avoidance vastly superior to that of Group NH. Since the variance within Group NH was much smaller than that of the four handling groups, a Kruskal-Wallis analysis of variance by ranks was used to compare the level of avoiding of Group NH with the four handled groups. The difference in ranks was statistically significant (H = 7.3, *df* = 1, p < .01). A one-way analysis of variance comparing the four handled groups revealed no differences among them (*F* <1.0).

The four handled groups were also com-pared with respect to the mean latency of avoidance responses. Group H0 was found to have significantly shorter latencies than the other handled groups (*F* = 6.3, *df* = 1/15, *p* < .025). The avoidance latencies of the other handled groups did not differ significantly from each other (*F* <1.0).

The results for the distance measure, taken in conjunction with the information concerning the number of avoidances, suggest some of the mechanisms at work to retard bar-press avoidance learning in Group NH. Keeping in mind that D1 was the distance of *S's* head from the bar at CS onset, and D2 was the distance at US onset (or avoidance), several aspects of Ss behavior, in addition to whether or not he avoided the US, can be defined. First, being near the bar was defined as a distance of less than or equal to 2 in. Using this criterion, the *anticipate* response was said to occur if *S* moved near the bar following handling, but prior to CS onset, so that D1 ≤ 2. An *approach* occurred if D1 ≥ 3 and D2 ≤ 2, i.e., *S* moved close to the bar between CS onset and US onset. A *freeze* response occurred if D1 = D2. Since a freeze might occur when *S* hovered over the bar and avoided also, it was meaningful only when *S* was away from the bar at CS onset. A *hold* was recorded if the bar was depressed at CS onset.

Some of the relationships based on the responses defined above are presented in Table 1. Each group probability value represents the ratio of the total occurrences of a response for that group to the total opportunities for it to occur. For example, the probability of an avoidance, given that an anticipate response occurred, was .416 for Group H25. This was calculated from the standard formula for conditional probabilities and the fact that there were 36 anticipates, 15 of which resulted in an avoidance. For convenience of exposition, each relationship in Table 1 is given a number to be used as a reference in later discussion. In testing the significance of the differences in Table 1, a. probability was found for each *S* and then groups were compared on the basis of this score using a Kruskal-Wallis analysis of variance an ranks.

TABLE 1

CONDITIONAL PROBABILITY RELATIONS BASED UPON DISTANCE DATA

Relation	Group				
	HO	H5	H15	H25	NH
1. Pr(Anticipate)	—	.240	.220	.144	.796
2. Pr(Avoid, if Anticipate)	—	.083	.273	.416	.032
3. Pr(Avoid, if D1 ⩾ 3)	.360	.279	.205	.299	.000
4. Pr(Hold)	—	.048	.044	.036	.480
5. Pr(Avoid, if Hold)	—	.000	.091	.444	.032
6. Pr(Freeze, if D1 ⩾ 3)	.150	.206	.308	.308	.765
7. Pr(Approach, if D1 ⩾ 3)	.610	.537	.338	.524	.059
8. Pr(Avoid, if Approach)	.572	.606	.520	.589	.000

Note.—Impossible event indicated by —.

Referring to Relation 1 in Table 1, it is apparent that *S*s which were not handled were much more likely to be near the bar at CS onset *(H* = 9.5, *df* = 1, p < .01). The fact that the poorly avoiding Group NH *Ss* stayed close to the bar more often is consistent with the response incompatibility hypothesis. However, from Relations 2 and 3 it can be seen that an avoidance was actually more probable for these *Ss* when they did start the trial near the bar, although the differences were small. Moreover, the few avoidances which did occur for Group NH all took place when D1 ≤ 2. Data on the hold responses also contradicted the response incompatibility hypothesis. Although Group NH *Ss* were more likely to hold the bar (Relation 4), *Ss* in the handled groups were more likely to avoid, given that they were holding the bar (Relation 5). In fact, the five *Ss* in Group H25 had as many avoidances (6) after a hold as Group NII had under any circumstances. Thus, the high frequency of being near the bar and holding it at CS onset cannot, by itself, account for the poor performance of Group NH.

Relations 6, 7, and 8 indicate some large differences between the handled and nonhandled *S*s, given that *S* began the trial away from the bar. Compared to the handled groups, when D1 ≥ 3, *Ss* in Group NH were much more likely to freeze (H = 10.2, df =- 1, p < .01) and much less likely to approach (H =9.3, df = 1, p < .01). In view of these findings, it seems reasonable to suppose that Group NH *S*s also had much more freezing when near bar, thus yielding the low probability of avoiding if D1 ≤ 2, although this relation cannot be tested directly.

None of the group differences among the four handled groups for the eight relationships were significant.

Discussion

Results of Experiment 2 contradicted the CS discriminability hypothesis. Handling *S* immediately after a trial gave performance equivalent to handling just before the start of a trial. The bar-holding hypothesis was also found to be inadequate. Although handled *S*s did in fact hold the bar less often, they were still more likely to avoid than nonhandled *S*s, given that the bar was held. The same relation was observed when *S* was simply near the bar. The data were consistent with the freezing hypothesis. Handled *S*s were much less likely to freeze during the CS when *S* began the trial away from the bar. Freezing was probably also less likely for handled *S*s when they were near the bar at CS onset, although the freeze could not reliably be detected by the present measuring technique in such a case. The longer handling intervals appeared to result in more freezing to the CS, but the differences were not significant.

Although the freezing hypothesis has better accounted for differences in avoiding between handled and nonhandled *S*s than has the bar holding hypothesis, caution should be exercised because the handling operation did modify both the bar holding and freezing responses themselves. Another problem with freezing as an explanation of poor bar-press avoidance is that freezing is certainly incompatible with the running response, yet one-way and shuttle avoidance tasks are learned relatively quickly. Perhaps the running response is learned more quickly than freezing, while bar pressing is learned more slowly. Comparisons of rates of learning to escape shock prior to avoidance training would indicate which responses were learned fastest when freezing was minimal. It would then be expected that those learned fastest would also be the least influence freezing during avoidance learning.

Concerning the status of handling as an independent variable in avoidance learning it has been shown to have a reliable effect on bar-press avoidance using different apparatus, shock source, and animal supplier. These findings also point out the need to control for the effects of handling in avoidance learning.

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