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Effects of inescapable shock on low-activity escape/avoidance responding in rats

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Exposure to inescapable shock proactively interferes with the acquisition of shuttle or barpress escape responding. The learned inactivity hypothesis proposes that this deficit results primarily from the active nature of the test escape response. In support of this position, it has been demonstrated that inescapable shock not only fails to interfere with but also actually facilitates the acquisition of a low-activity escape/avoidance response. However, in this demonstration, it is unclear whether the response was emitted by the animal or elicited by the test procedure employed. The present experiment examined the effects of inescapable shock on the acquisition of a low-activity response in a context that precluded the possibility of recording elicited responses as escape/avoidance responses. We found no evidence of facilitated acquisition of the low-activity response as a result of inescapable shock. This finding, in conjunction with others, questions the data base for the learned inactivity hypothesis.

Exposure to inescapable shock has been shown to interfere with subsequent escape learning in a variety of organisms (Maier & Seligman, 1976). This deficit results specifically from the uncontrollability of shock, since organisms exposed to equivalent amounts of escapable shock do not show such a deficit, compared with naive controls. Maier and Seligman (1976) have proposed that this learned helplessness phenomenon results from the animal's acquiring the expectancy, during exposure to uncontrollable shock, that responding and shock termination are independent. This expectancy is held to produce: (1) a motivational deficit–lowered incentive for initiating responding, and (2) an associative deficit–proactive interference with learning that shock termination is contingent on responding.

An alternative explanation for this phenomenon has been suggested by Glazer and Weiss (1976a, 1976b). They argue that an inescapably shocked animal performs poorly on the typical escape learning test because it has learned to be inactive during exposure to inescapable shock. This learned inactivity is presumably incompatible with performance of the escape response required on the test, such as fixed-ratio (FR) 2 shuttle (Maier, Albin, & Testa, 1973) or an FR 3 barpress escape test (Seligman & Beagley, 1975). The learned inactivity hypothesis (Glazer & Weiss, 1976a, 1976b) states that if a subject has learned to be inactive during inescapable shock pretreatment, it should not show a deficit in the acquisition of a low-activity escape response. Indeed, such a test may demonstrate that inescapable shock facilitates the acquisition of this low-activity response, since such an animal has already learned to be inactive. In order to test this, animals were placed in a restraining tube in which they were required to nose-poke to escape/avoid shock. In this situation, inescapably shocked animals showed a faster acquisition of the escape/avoidance response than either escapably shocked or nonshocked controls (Glazer & Weiss, 1976b, Experiment 1). They reported that a typical inescapably shocked animal "would come to remain with its nose pressed against the door that covered the hole so that when the door was drawn at the beginning of the trial, its head followed the door accomplishing a rapid correct response" (Glazer & Weiss, 1976b, p. 205). From this description, it is unclear whether an escape or avoidance response in this context is emitted by the animal or elicited by removal of the door at the beginning of a trial.

The purpose of the present study was to replicate the Glazer and Weiss (1976b) study using a modified test procedure that should preclude the possibility of recording responses elicited by movement of the door. In the present study, the response manipulandum was available throughout the test session. The escape/avoidance response was defined, then, as the animal's either removing its nose from or inserting it in front of the response sensor, depending on the animal's location at the start of the escape/avoidance test trial.

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METHOD

Subjects

The subjects were 35 male Holtzman albino rats approximately 110 days of age at the start of the experiment. All animals were maintained on ad-lib food and water and were run during the light phase of a 12-h-dark/12-h-light cycle.

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Apparatus

Four shuttleboxes were used for shock training. Each chamber was 45.7 cm long, 24.5 cm high, and 21.6 cm wide. The side walls were constructed of aluminum and the ceiling was constructed of clear Plexiglas. The floor was constructed of stainless steel rods 6.35 mm in diameter and spaced 19.05 mm apart. The chamber was divided in half by an aluminum wall that had a 10.8 cm high X 6.35 cm wide opening in the center at floor level. A cue light was centered 20.3 cm above the grid floor on each end wall of the box. Each box was housed in a sound- and light-attenuating container that was equipped with a 28-V dc houselight, a speaker, and a ventilating fan.

Four restraint boxes were used for the nose-poke test. Each box was 46 cm long, 16 cm high, and 14 cm wide. Starting at 33.5 cm from the rear of the box, the ceiling and floor were sloped at a 45-deg angle and joined to form the front of the chamber. The front of each chamber contained an 8 cm X 7 cm opening. Photocells were mounted on each side wall immediately behind the apex of the triangle forming the front of the chamber. Thus, the photocells were located 34 cm from the rear of the chamber. For testing, the center barrier was removed from each shuttlebox. Each restraint box was mounted on a wooden platform and centered inside the shuttlebox, facing one end wall.

Shock was delivered by a Coulbourn solid state shock source (Model E13-16) for both training and testing. During training, shock was delivered through a scrambler to the grid floor of the shuttlebox. During testing, shock was delivered via tail electrodes.

Procedure

Shock training. On the 1st day of the experiment, the three experimental groups were given differential shock training. The first group (N = 11) was trained to escape shock (Group E). Training consisted of one session of 80 trials of up to 30 sec of .90-mA shock. For the first five trials, shock could be terminated by an animal's crossing from one side of the shuttlebox to the other (FR 1). On the remaining 75 trials, an FR 2 contingency was in effect in which the animal was required to cross from one side to the other and then back to the original side. Escape trials were presented on a variable-time (VT) 60-sec schedule (range = 5-115 sec). The training session was therefore approximately 90 min long. Each animal in the second group (Group Y, N = 12) was yoked to an animal in the escape group. Thus, each pair of animals received an identical pattern and duration of shock. However, the shock for Group Y animals was inescapable, since its termination was contingent not on their behavior but on the behavior of the Group E animals. The animals in the third group (N = 12) were used as controls (Group C). They were placed in the training chambers for yoked durations of time, but they were not exposed to electric shock.

Nose-poke test. The nose-poke escape/avoidance test was conducted for two sessions. The first session was administered 24 h after training, with an additional session 24 h later. Each session consisted of 25 trials presented on a fixed-time (FT) 60-sec schedule. Each trial was maximally of 25 sec duration. A trial started with the onset of an 80-dB 1,000-Hz tone and a 28-V dc .8-A light warning stimulus. An escape/avoidance response was defined as a change in the state of the photocell. This could be accomplished by the animal's either placing its nose in front of or removing it from the photocell, depending on the position of the nose at the start of the trial. If the animal responded within 5 sec of trial onset, the warning stimulus was terminated and shock was not presented. A failure to respond within this period resulted in shock onset. A response within the remaining 20 sec was therefore an escape response.

RESULTS

Shock Training

All rats in Group E learned the FR 2 shuttle response to escape shock. No failures to escape were observed for any of these animals on the last 20 trials of training. The mean amount of shock per trial received by this group, and therefore by Group Y, was 7.78 sec (SD = 5.29).

Nose-Poke Test

All groups showed decreasing response latencies across trials for both Session 1 and Session 2 of the test. More important, the groups did not show differential acquisition of the low-activity nose-poke response as a function of prior shock training on either Session 1 or Session 2.

The top panel of Figure 1 shows the response latencies for the escape, yoked, and control groups for each of the 25 trials of the two-session test. As can be seen, the groups showed acquisition of the nose-poke escape response as indicated by the decreasing latencies across trials. However, there was little evidence of the acquisition of the avoidance response, even by the last 10 trials of the first session. Session 2 of the test showed a similar pattern of results. All groups acquired the escape response, as demonstrated by decreasing response latencies across trials. However, they show little evidence for the acquisition of the avoidance response. Only the group exposed to escapable shock showed latencies below 5 sec. However, even in this group,

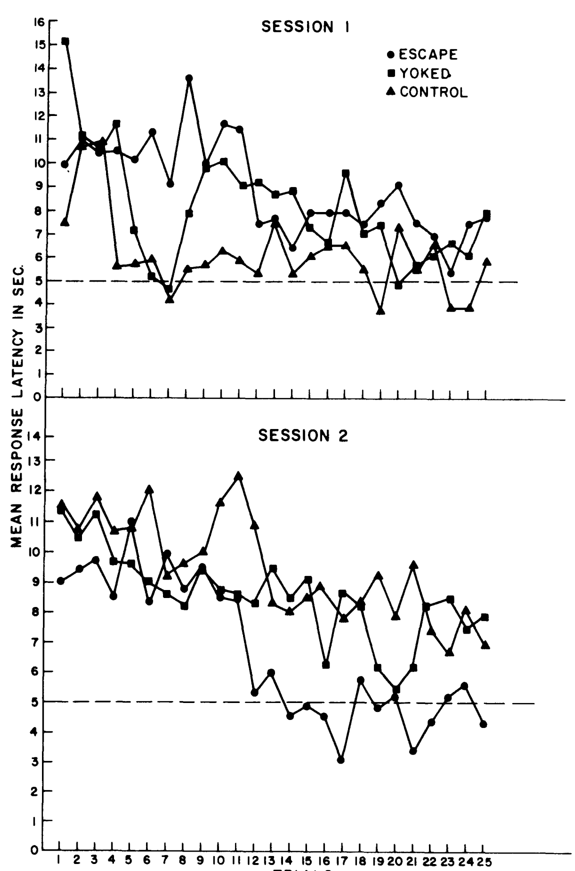

Figure 1. Mean escape/avoidance latencies for the three shock training conditions on each of the 25 test trials for Sessions 1 and 2.

avoidance responses were given on only 6 of the 25 trials. In addition, the sequencing of these avoidance responses does not suggest the acquisition of avoidance, since they were interspersed with escape responses.

Statistical analyses of these data supported the above impressions. A groups (3) by trials (25) analysis of variance performed on the response latencies showed no significant differences between the groups on the acquisition of the response for either Session 1 or Session 2 [$F(2,32) < 1.0$, $p > .63$, and $F(2,32) < 1.0$, $p > .64$, respectively]. The Group by Trial interaction was not significant for either session of the test [$F(48,768) = 1.03$, $p > .42$, and $F(48,768) < 1.0$, $p > .93$]. The general impression of an acquisition function given in Figure 1 was supported by these analyses. The trials factor was significant for both Session 1 and Session 2 [$F(24,768) = 2.69$, $p < .001$, and $F(24,768) = 3.91$, $p < .001$]. Trend analyses for the trials effect showed the linear component to be significant for both Session 1 and Session 2 [$F(1,32) = 10.59$, $p < .003$, and $F(1,32) = 15.19$, $p < .001$].

DISCUSSION

Prior exposure to inescapable shock did not facilitate the acquisition of a low-activity nose-poke escape/avoidance response compared with exposure to either escapable shock or no shock. This finding is inconsistent with the results reported by Glazer and Weiss (1976b). However, this discrepancy in results may be resolved if we compare the test procedures employed by Glazer and Weiss and those employed in the present experiment.

Glazer and Weiss (1976b) initiated an escape/avoidance trial by retraction of a door that had prevented access to the response manipulandum during the intertrial interval. This may have allowed for the possibility that an animal could rest its nose against the door during this period and accomplish a rapid escape/avoidance response when the door was retracted at the start of the trial. Thus, responses that may have been elicited by movement of the door may have been recorded as emitted escape/avoidance responses. Glazer and Weiss' description of their inescapably shocked animals is certainly consistent with this view. Furthermore, the acquisition of the avoidance response in the inescapably shocked animals was extremely rapid, which also may be supportive of the above suggestion. In Experiment 1, the mean escape latencies for the inescapably shocked animals was under 6 sec for the first block of five trials. In Experiment 2, these animals showed mean escape latencies of approximately 5.2 sec. In Experiment 3, inescapably shocked animals appear to have received almost no shock during the first block of five trials. In each of these experiments, escapes were followed by progressively shorter latency avoidance responses on all subsequent blocks of trials.

In the present study, we specifically employed a procedure that precluded the possibility of recording such elicited responses as either escape or avoidance responses. To escape or avoid shock, our animals had to either remove their nose from or place it in front of the response sensor, depending on the location of the nose at the start of the trial. With this procedure, we found no differential effects of prior shock training on the acquisition of the escape/avoidance response.

These findings, in conjunction with those of Altenor, Volpicelli, and Seligman (1979) and Kelsey (1977) seriously question the generality of the data base for the learned inactivity hypothesis. This learned inactivity hypothesis predicts that short-duration inescapable shock should not produce a deficit in the acquisition of an "active" escape response, since animals should not have the opportunity to learn to be inactive. In addition, long-duration inescapable shock should not produce deficits in, and indeed should facilitate, the acquisition of a "low-activity" escape/avoidance response. The generality of the first point has been questioned by the findings of Altenor et al. (1979) and Kelsey (1977), who found that short-duration inescapable shock does interfere with the subsequent acquisition of a shuttle escape response or the acquisition of a barpress escape response, respectively. The generality of the second point is questioned by the findings of the present study. We found no evidence of facilitated acquisition of a low-activity escape/avoidance response following exposure to inescapable shock.

In conclusion, it should be noted that inescapable shock did not interfere with the acquisition of this low-activity response. This result is not embarrassing to learned helplessness theory, since the observance of a learning deficit depends on the nature of the response contingency in effect during the test. Maier et al. (1973) and Seligman and Beagley (1975) did not find inescapable shock to interfere with the acquisition of an FR 1 shuttle or barpress escape response. Since the test in the present experiment also employed an FR 1 schedule, we would not have expected to observe a learning deficit.

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