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THE EFFECTS OF ESCAPE CONDITIONING AND SHOCK INTENSITY ON RESPONDING DURING INESCAPABLE SHOCK[1]

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Eight albino rats, conditioned to press a lever to escape shock, continued to lever press during short inescapable shocks presented subsequently. The rate of this behavior was found to be higher for higher shock intensities regardless of the order in which shock values were presented. Relative to the immediately preceding escape rate, responding during inescapable shock was higher following conditioning at higher fixed-ratio escape requirements. Four subjects not conditioned to escape shock pressed the lever very infrequently during inescapable shock and showed little change with changes in shock intensity. The escape conditioning effects suggest that responding during inescapable shock is superstitious escape behavior. The effects of shock intensity on this behavior appear to be similar to reported effects of shock intensity on escape behavior.

Several studies have reported lever-pressing during short inescapable shock in subjects with a history of escape conditioning (Domjan, 1969; Malott, Sidley, and Schoenfeld, 1963; Migler, 1963). In a recent study (Domjan, 1969), such responding was found to be highly resistant to extinction and inversely related to the duration of the inescapable shocks. These findings suggest that this lever pressing is maintained by fortuitous reinforcement of responses that occur as shock terminates. The behavior has therefore been referred to as superstitious escape behavior (Domjan, 1969; Migler, 1963).

If responding during inescapable shock is indeed superstitious escape, it may be expected that the strength of the behavior would be influenced by a history of escape conditioning. Furthermore, the effects of shock intensity on the behavior can be expected to be similar to effects of shock intensity on escape responding.

In one aspect of the present study, the effects of various fixed-ratio escape conditioning procedures were observed on subsequent responding during inescapable shock. In another aspect of the study, the effects of shock intensity on the behavior were investigated and compared to reported effects of shock intensity on escape responding.

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METHOD

Subjects

Twelve naive female albino rats, 95 to 105 days old at the start of the experiment, were housed individually with food and water always available in the home cage.

Apparatus

The experimental chamber measured 25.5 by 15.0 by 16.3 cm. Its four sides were constructed of metal; the floor was made of nine steel rods, 0.3 cm in diameter, placed longitudinally in the chamber, 1.6 cm center to center; the top was clear plastic. The experimental chamber was positioned in a sound-attenuating chest with white masking noise present. The response lever, 5.1 cm wide, protruded 2.3 cm into the experimental space, 6.5 cm above the floor. A 1.0-cm, 10-g depression of the lever was considered a response. Illumination was provided by a white jewel light, 2.5 cm in diameter, 5.5 cm above the lever. Shock, passed through a Davis Model 255 mechanical grid scrambler, was delivered by a matched impedance shock source (Campbell and Teghtsoonian, 1958). The grid floor, four walls, and response lever were included in the shock circuit. All events were scheduled and recorded using relay equipment.

Procedure

Eight of the 12 subjects were alternately exposed to sessions during which lever presses turned off a periodically presented shock

(Escape) and sessions during which short inescapable shocks were presented (No Escape). Five cycles of seven Escape sessions followed by seven No-Escape sessions were conducted.

During Escape sessions, escapable shocks were presented every 60 sec. If the subject failed to make the escape response, the shock was terminated after 25 sec. Subjects R- 153, 154, 157, and 158 were always required to make one response to turn off shock (FR 1). For subjects R- 151, 152, 155, and 156 the escape requirement was an FR 1 in the first cycle of the procedure and was increased by one response from FR 1 to FR 5 in each succeeding procedure cycle. The intensity of the shock in Escape was always 150 v.

During No-Escape sessions, 3-sec shocks were presented every 36 sec. Lever presses had no scheduled consequences: the shock was always terminated after 3 sec independently of the behavior of the subjects. During the last five sessions in each seven-day series of No-Escape sessions, five shock intensities were tested (50, 100, 150, 200, and 250 v). The intensity of the shock was changed each day. Shock intensities were presented in an increasing order for one group of subjects (R- 151, 152, 153, and 154) and in a decreasing order for the other group (R- 155, 156, 157, and 158). During the first two days of each series of No-Escape sessions, the first group of subjects was exposed to shock of 150 and 100 v and the other group was exposed to 150 and 200 v. These two shock intensities were presented so that No-Escape sessions would begin at intermediate shock values. Data for these two sessions are omitted from the shock intensity functions.

The remaining four subjects were never given escape conditioning. They were first exposed to seven No-Escape sessions in which a 150-v shock was presented every 35 sec. For T-1 and T-2 the duration of these shocks was 5.4 sec, which was the longest average shock duration of subjects in the first series of Escape sessions. For T-3 and T-4 the shock duration was 0.82 sec, the shortest average shock duration in the first Escape series. During the next seven sessions, all four subjects were exposed to 3-sec inescapable shocks presented every 36 sec, with the shock intensity changed each day in the order 150, 100, 50, 100, 150, 200, and 250 v.

Daily sessions consisted of 150 shock presentations for all subjects.

RESULTS

Shock Intensity Effects

The rate of responding during inescapable shock was observed to increase with increasing shock intensity in subjects previously conditioned to escape shock. This direct relationship between shock intensity and responding in No-Escape is shown in Fig. 1A for subjects exposed to increasing shock values. Figure 1B shows that the same function was obtained with subjects exposed to shock voltages in a decreasing order. The increase in No-Escape responses with higher shock values was statistically significant for each subject ($p < 0.01$; Friedman two-way analysis of variance).

Subjects without escape conditioning pressed the lever very infrequently during the inescapable shocks. Figure 1C shows further that little change in responding was observed after changes in shock intensity.

Escape Requirement Effects

The rate of escape behavior in successive procedure cycles is summarized in Fig. 2. For subjects R- 153, 154, 157, and 158 (FR 1-1 subjects) the escape requirement was one lever press in all five cycles of the procedure. Figure 2 shows that with these subjects no systematic changes were observed in the rate of the escape behavior ($p < 0.80$). For subjects R- 151, 152, 155, and 156 (FR 1-5 subjects) the escape requirement was an FR 1 in the first series of Escape sessions and was increased by one response each successive Escape series. Figure 2 shows that increases in the escape requirement were associated with decreases in the median escape rate for these four subjects ($p < 0.05$).

In order to assess relative changes in the rate of responding during Escape and No-Escape, the average rate of lever pressing during shock for a series of No-Escape sessions was divided by the average escape rate of the three immediately preceding Escape sessions. This ratio is shown for successive procedure cycles in Fig. 3 for both FR 1-1 and FR 1-5 subjects. The ratio increased for FR 1-5 subjects ($p < 0.05$) but remained essentially unchanged for the FR 1-1 subjects ($p < 0.50$). The two functions in Fig. 3 show that relative to the immediately preceding escape rate, the rate of responding during inescapable shock increased after conditioning at higher fixed-ratio escape requirements.

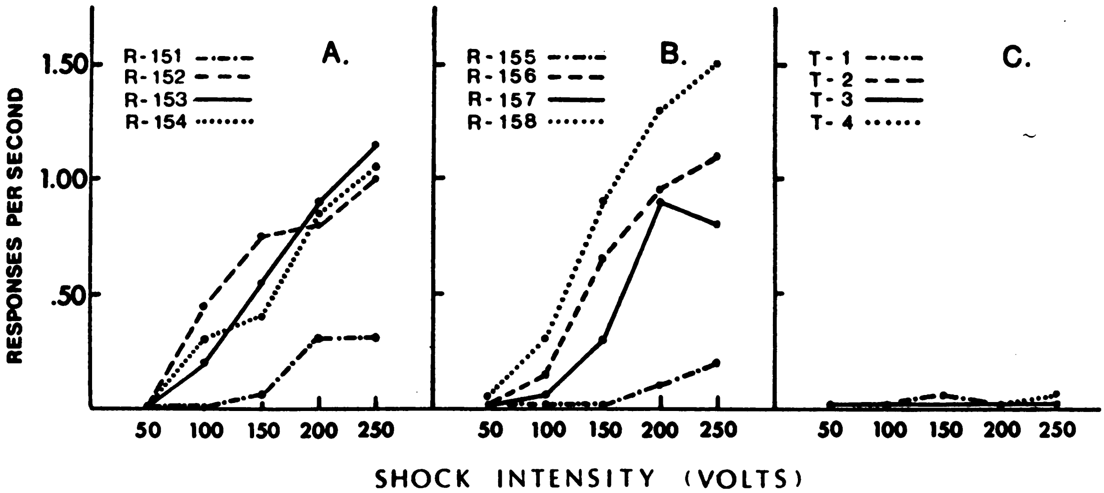

Fig. 1. Rate of responding during inescapable shock as a function of shock intensity. A. Shock values presented in an increasing order; each point is the median of five determinations. B. Shock intensities presented in a decreasing order; each point is the median of five determinations. C. Shock intensities presented in an increasing order but subjects previously not exposed to escape conditioning.

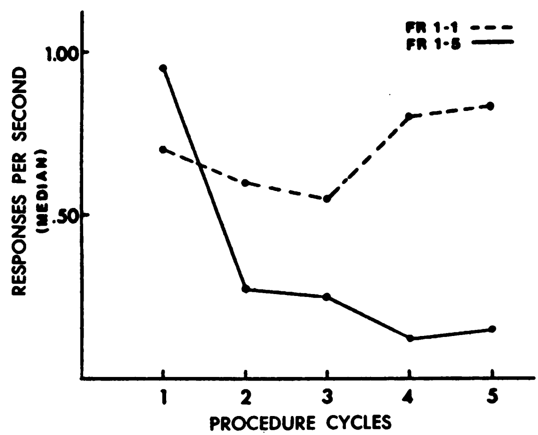

Fig. 2. Median rate of escape behavior in successive cycles of the procedure. Each point is the mean for four subjects. The escape requirement was kept constant for FR 1-1 subjects and increased for FR 1-5 subjects in successive procedure cycles.

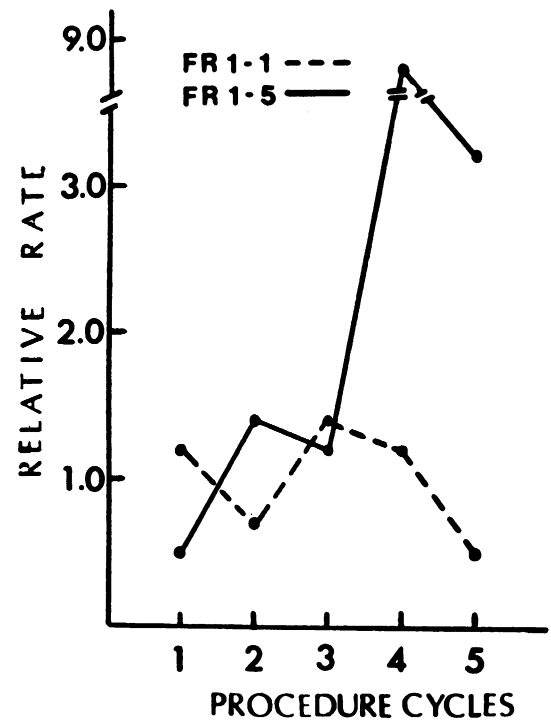

Fig. 3. Relative rate of responding during inescapable shock (see text) in successive cycles of the procedure. Each point is the mean for four subjects.

DISCUSSION

A history of escape conditioning facilitates responding during short inescapable shock. Subjects without escape conditioning made very few lever presses during No-Escape. The facilitation effect of escape conditioning suggests that responding during inescapable shock is superstitious escape behavior. Escape conditioning may facilitate No-Escape responding by increasing the probability that subjects will press the lever during shock. The probability that inescapable shock is terminated after a lever-press response is thereby also increased, and No-Escape responses are often fortuitously reinforced.

In subjects with a history of escape conditioning, higher rates of responding during inescapable shock are observed at higher shock intensities, and a change in the intensity of shock results in a corresponding change in the rate of No-Escape responding on the first day of the new shock value. These results are similar to reported effects of shock intensity on escape behavior. Numerous studies have shown that escape behavior increases with higher shock intensities (Boren, Sidman, and Herrnstein, 1959; Dinsmoor and Winograd, 1958; Stavely, 1966; Trapold and Fowler, 1960; and Winograd, 1965). And, Dinsmoor and Winograd (1958) showed that a change in shock intensity produces an immediate corresponding change in the strength of escape behavior.

A slight decline in No-Escape responses at high shock intensities was observed for subject R-157. Figure 1B shows that for R-157 the response rate was lower at 250 v than at 200 v. This decline in behavior is similar to reported declines in escape responding observed at high shock values (Trapold and Fowler, 1960; Winograd, 1965).

The near-zero level of responding of subjects never conditioned to escape shock shows that the direct relationship observed between lever pressing during inescapable shock and shock intensity is not merely an increase in "random" activity at high shock values. Higher rates of No-Escape responding at higher shock intensities appear to depend on a history that increases the probability of fortuitous reinforcement of lever pressing during inescapable shock.

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