Effects of inescapable shock upon subsequent one-way avoidance learning in two strains of rats*

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Holtzman and Sasco rats given unsignaled shock exposure acquired a subsequent one-way avoidance response more readily than nonpreshocked rats of the same strains. In addition, the more active Holtzman rats required fewer trials to reach the avoidance criterion and were more resistant to extinction than Sasco rats. Movement ratings taken during intershock intervals in pretraining were found to be good predictors of subsequent avoidance performance. Results were taken to indicate that response repertoire changes during prior shock exposure influence subsequent one-way avoidance learning.

Although it is well established that prior shock exposure (PSE) will augment the rate of acquiring a subsequent one-way avoidance response (Baum, 1969; DeToledo & Black, 1967), few data are available concerning the effects of PSE on response repertoire changes and on subsequent avoidance learning in different strains of rats. It has, however, been reported (cf. Weiss, Kriekhaus, & Conte, 1968) that within a strain of rats, the amount of movement exhibited during PSE was directly related to the number of avoidance responses made in a subsequent avoidance task. Specifically, these investigators report that relatively unemotional rats, i.e., those rats in which activity was not greatly suppressed by PSE, acquired an avoidance response more readily than did rats who were relatively high in emotionality.

The present study sought to determine whether PSE would have differential effects upon response repertoire changes and on subsequent avoidance learning in two strains of rats. It was predicted that (1) PSE would facilitate subsequent avoidance learning in both strains, (2) rats in the more active strain would reach the avoidance criterion earlier than rats in the relatively inactive strain, and (3) within each strain, rats exhibiting a

greater degree of movement during PSE would acquire the avoidance response more readily than rats which were relatively immobile during PSE.

SUBJECTS

The Ss were 16 experimentally naive male Sasco rats and 16 experimentally naive male Holtzman rats whose ad lib weights were between 260 and 310 g. The Sasco rat, although originally a hybrid of the Holtzman and Sprague-Dawley strains, has been found to be less active in an open field following shock exposure than the Holtzman rat (Reynierse, 1970). Ss were individually housed in standard wire cages and permitted ad lib food and water for the duration of the experiment.

APPARATUS

A modified one-way Miller box, whose interior dimensions were 50.0 x 11.5 x 12.5 cm, was used for avoidance training. The shock compartment, painted white, had a grid floor made of 0.31-cm brass rods spaced 1.27 cm apart. The safe compartment had a plywood floor and was painted medium gray. The two compartments were separated by a guillotine door which rested 1.27 cm above a 5.0-cm hurdle.

The shock compartment contained a 6-W light situated 11.0 cm above the grid floor on the wall adjacent to the safe compartment. A speaker, wired to a tone generator, was centered 20.5 cm above the Plexiglas lid of the shock compartment. CS onset, the simultaneous illumination of the light and the sounding of a 9-dB tone, could be achieved by depressing a microswitch via the lifting of the guillotine gate or by wiring the CS to

an interval timer.

PROCEDURE

Pretraining

The Ss were placed in the shock side of the conditioning apparatus for a 6-min period, during which half of the Sasco and Holtzman rats were given 10 unsignaled 2-sec shock presentations at 30-sec intervals. The remaining Ss were not shocked and thus spent an uneventful 6-min period in the shock compartment. Following each shock presentation, activity was recorded using a 7-sec time sampling procedure; hence, four activity measures were taken during each intershock interval. For the nonshock Ss, activity was likewise recorded using a 7-sec time sampling procedure. Four readings were taken during each 32-sec interval, the amount of time equal to that of the intershock interval plus the duration of the shock in the preshock groups. Movement was rated on a 4-point scale: 3 points for walking, running, jumping, or prying at the gate; 2 points for grooming or rearing with head and/or whiskers moving; 1 point for sitting, lying, or crouching with head and/or whiskers moving; and 0 points for sitting, lying, crouching, or rearing without head or whisker movement. Following the preshock procedure, Ss were placed in a plastic holding cage for a 3-min period.

Avoidance Learning

Following the rest interval, Ss were trained in an avoidance task until a criterion of 9 out of 10 consecutive avoidance responses was attained. The avoidance conditioning procedure consisted of S being placed in the shock compartment facing away from the guillotine gate. Fifteen seconds after the placement of S in the shock compartment, the guillotine gate was raised and the CS (light and tone) presented. If S crossed into the safe compartment within 5 sec, the gate was lowered and the CS terminated. If an avoidance response was not made within 5 sec, the CS was terminated and a 1-mA shock presented until an escape response was made, after which the gate was lowered. S remained in the safe compartment for 10 sec, after which the CS was again presented. Thus, the entire intertrial interval was 30 sec long.

Response Prevention

Immediately after S attained the avoidance criterion, response prevention was begun. Ss were placed in the shock compartment for a 6-min period, during which the CS was presented on 10 occasions at intervals of 30 sec. The gate was not raised, however, thereby preventing S from crossing into the safe compartment. During response prevention, the UCS was not presented.

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Table 1
Repertoire of Intershock Behavior (Percentage of Total) as a Function of Rat Strain and Prior Treatment

Response Category	Group			
	Sasco Preshock	Sasco No Preshock	Holtzman Preshock	Holtzman No Preshock
Walking, running, jumping	0.31	7.30	2.55	9.58
Grooming	1.25	10.47	0.93	10.77
Rearing (head or whiskers moving)	31.15	39.68	35.96	41.61
Gate prying	0.62	0.00	0.31	0.00
Sitting (head or whiskers moving)	15.88	35.87	19.55	35.02
Crouching (no head or whisker movement)	38.00	6.35	29.90	2.99
Rearing (no head or whisker movement)	12.77	0.31	11.04	0.00
Mean weighted movement rating	34.12	62.75	41.25	69.25

Extinction

Thirty seconds after the last response-prevention trial, the gate was raised and the CS presented. If S did not cross into the safe compartment within 5 sec, the gate was lowered and the CS terminated. If S crossed into the safe compartment, the gate was lowered, the CS terminated, and S immediately placed in the shock compartment. The intertrial interval was 30 sec in duration.

RESULTS

Table 1 shows the repertoire of inter shock behavior during PSE as a function of rat strain and pretraining procedure. Over blocks of trials, activity (walking, grooming, and rearing or sitting with whiskers moving) for preshocked Ss decreased, while immobility response (e.g., crouching, lying, or rearing without head or whisker movement) increased in frequency. For nonshock Ss, activity held constant over blocks of trials. The analysis of variance on the weighted movement ratings indicated that preshocked Ss were less active than nonpreshocked Ss ($F = 279.47$, $df = 1,28$, $p < .001$) and Holtzman rats were more active than Sasco rats ($F = 18.46$, $df = 1,28$, $p < .001$).

Table 2 shows the mean trials to the avoidance acquisition criterion and the mean number of crossings in extinction for each of the groups. The analysis of variance on trials to criterion and on number of crossings in extinction indicated that preshocked Ss reached criterion earlier than nonpreshocked Ss ($F = 9.46$, $df = 1,28$, $p < .01$) and Holtzman rats reached criterion earlier and were more resistant to extinction than were Sasco rats ($F = 10.33$, $df = 1,28$, $p < .01$, and $F = 8.79$, $df = 1,28$, $p < .01$, respectively). In addition, activity during preshock was found to be a good predictor of subsequent avoidance performance. Specifically, the correlation between preshock activity and trials to the avoidance criterion was found to be $-.72$ for preshocked Sasco rats and $-.62$ for preshocked Holtzman rats.

DISCUSSION

Consistent with earlier reports (e.g.,

Blanchard & Blanchard, 1969; Bolles & Moot, 1970), the present study indicated that exposure to shock produced increased crouching and tended to reduce the frequency of occurrence of active responses such as walking, rearing, and grooming. In addition, the degree of immobility, as reported by Reynierse (1969), was greater in Sasco than in Holtzman rats.

Taken together, the findings that (1) the greater immobility following PSE in Sasco rats was accompanied by poorer avoidance performance compared to Holtzman rats and (2) preshock activity was a good predictor of subsequent avoidance performance regardless of rat strain, suggest that response repertoire changes during PSE may be an important determinant of subsequent avoidance performance. Specifically, avoidance learning is believed to involve two phases: (1) the classical conditioning of fear to the CS and/or apparatus cues and (2) escape from the CS via an instrumental response. Accordingly, the facilitative effects of the preshock experience have been posited to be a function of fear being conditioned to the CS and/or apparatus cues during PSE, thereby making the subsequent avoidance task simply one of learning the correct instrumental response (Anisman, 1971; Baum, 1969). Concomitant with

the establishment of the conditioned fear response, however, an unconditioned crouching response, which eventually comes under stimulus control, is also established (Blanchard & Blanchard, 1969). Since it is necessary for the crouching response to be suppressed before an active instrumental response can be acquired (Blanchard & Blanchard, 1969; Bolles, 1970), it follows that the more prepotent crouching was in S's hierarchy of responses, the greater would be the number of trials required for such a response to be suppressed and for the active running response to become dominant. As such, it would be expected that if crouching were relatively more prepotent in Sasco than in Holtzman rats, more trials would be required for the Sasco rats to acquire the instrumental response. Similarly, less active Ss in both strains would also be slower in learning the avoidance response, compared to more active Ss.

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Table 2
Mean Trials to the Avoidance Criterion and Mean Number of Crossings in Extinction as a Function of Rat Strain and Prior Treatment

Group	Mean Trials to the Avoidance Criterion	Mean Number of Cross- ings in Extinction
Sasco Preshock	4.87	2.12
Sasco No Preshock	7.12	0.25
Holtzman Preshock	1.50	6.25
Holtzman No Preshock	4.75	3.87