The effect of epinephrine on extinction of an avoidance response¹

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The effect of three dose levels of epinephrine upon extinction of an avoidance response was studied. It was hypothesized that a low dosage would prolong extinction because of increased sympathetic arousal and that this effect would be masked in the high dose group because of motor impairment. No significant effect of the hormone on trials to reach the extinction criterion was found but the high dose group showed significantly greater running times on the first five extinction trials.

Conflicting evidence has been found with regard to the effect of adrenal medullary hormones in avoidance learning. Moyer & Bunnell (1959) found no effect of demedullation on the acquisition of an avoidance response in a runway, whereas Levine & Solliday (1962) found a deficit in avoidance learning if the animals were tested in a shuttle box using a training procedure and shock level that maximized the likelihood of the response being learned. Exogenous epinephrine has been reported to have no effect on avoidance acquisition (Moyer & Bunnell, 1958) and to facilitate acquisition (Latane & Schachter, 1962) at low dosage. Higher doses impaired acquisition because of resulting motor disabilities.

Extinction of an avoidance response has not been used as a measure of epinephrine effects although there are at least two possible reasons to expect that the hormone would affect this sort of behavior. If the maintenance of avoidance behavior results from fear elicited by the CS (Mowrer, 1960) then increasing sympathetic activity with epinephrine should prolong extinction provided the dose does not produce motor impairment.

In addition the injection of epinephrine has been reported to stimulate the secretion of ACTH but as Long's (1956) review indicates this effect is found only if indirect measures of ACTH activity such as adrenal ascorbic acid depletion and eosinopenia are used. Steroidogenesis per se is apparently not affected. If ACTH secretion is stimulated by exogenous epinephrine one would expect extinction to be prolonged since Miller & Ogawa (1962) have shown that ACTH does prolong extinction even in adrenalectomized animals.

The experiment to be reported investigates the effect of three dose levels of epinephrine upon extinction of an avoidance response.

Method

The Ss were 40 (20 male and 20 female) hooded rats of the Long-Evans strain aged 90-120 days.

The apparatus was an avoidance runway (Brookshire, Littman, & Stewart, 1961), the essential features of which were, a startbox, a 3 ft. runway and a goal box each

separated by a guillotine door. Raising the guillotine doors activated the CS (eight 6-volt light bulbs in the startbox) and a decade interval timer which delivered a 1.5 ma (root mean square) shock to the grid floor 2.0 sec. later, if the animal had not reached the goal box (made an avoidance response) and opened the circuit by breaking a photo-cell beam across the entrance to this box. Running times were recorded by means of an electric timer connected to the same circuit.

During acquisition each S was given 5 trials per day until it had reached a criterion of 8 avoidance responses on 10 consecutive trials. If an S failed to reach criterion by 15 days it was discarded. Ss were tested in groups of five on a rotating basis resulting in an intertrial interval of approximately 3 min.

The 40 Ss who reached criterion were assigned to one of four extinction groups: C (placebo of 0.5 cc peanut oil), E-1 (.01mg/100gm) of epinephrine, E-2 (.10mg/100gm), E-3 (.30mg/100gm). All injections were peanut oil suspensions of epinephrine USP and were given subcutaneously in the nape of the neck 45 min. before testing. During extinction Ss were tested in the same manner as during acquisition except the shock was never presented. If an S did not leave the startbox after 10 sec. the guillotine doors were lowered and the trial was ended. The criterion of extinction was 5 consecutive failures to enter the goal box within 5 sec. (across days).

Results and Discussion

The mean number of trials required for each group of rats to reach the criterion of extinction is presented in Table 1. Analysis of variance performed upon this data revealed no significant effect due to epinephrine ($F = .43$, $df = 3/32$, $p > .05$), sex ($F = .12$, $df = 1/32$, $p > .05$) or the interaction between variables ($F = .08$, $df = 3/32$, $p > .05$).

Table 2 shows the mean running time for each group of Ss on the first 5 extinction trials. Analysis of variance on this measure revealed a significant drug effect ($F = 3.82$, $df = 3/32$, $p < .025$) but revealed no significant effects due to sex ($F = .08$, $df = 1/32$, $p > .05$) or the interaction between the variables ($F = .98$, $df = 3/32$, $p > .05$).

Comparison of individual groups revealed a significant difference between Group C and Group E-3 ($t = 2.72$,

Table 1. Mean Number of Trials to the Criterion of Extinction

Group	Males	Females	Mean
C	19.60	28.80	24.20
E-1	23.40	20.60	22.00
E-2	27.00	18.60	22.80
E-3	12.20	21.20	16.70

Table 2. Mean Running Time in Seconds

Group	Males	Females	Mean
C	3.43	2.18	2.80
E-1	4.22	3.55	3.88
E-2	3.28	2.86	3.07
E-3	4.71	6.33	5.52

df=18, $p < .01$) and between Group E-2 and E-3 ($t = 2.40$, df=18, $p < .025$). In both cases the mean running time of the Ss in Group E-3 was greater than the mean running time of the Ss in the other group. Marked motor disturbances were observed in all males and in 3 of the 5 females of Group E-3 following epinephrine injections.

The results clearly indicate that extinction of the avoidance response was not affected by epinephrine although the high dose did produce some motor impairment as revealed by running times and observation of the Ss. While exogenous epinephrine may lead to increased indications of fright in stress situations (Singer, 1963) it is clear that it does not affect the probability of an avoidance response which has been associated with termination of fear arousing stimuli. The lack of effect upon extinction is, however, consistent with the finding of Kamin, Briner, & Black (1963) that diminished fear of the CS cannot be used to explain the extinction of the instrumental response in avoidance situations.

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Notes

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