Passive avoidance and strain differences associated with differences in emotionality: A test of Mowrer's theory

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In two separate experiments fearful (C3H/HeJ) and non fearful (C58/J) strains of mice were trained in a lid opening response for either food or water. In line with predictions made on the basis of Mowrer's theory, it was found that C3H mice gave significantly fewer punished responses under relevant food deprivation and under relevant water deprivation.

According to Mowrer (1960) the fear component of the total reaction to a negative reinforcer (punishment) may become classically conditioned to contemporaneous response-correlated stimuli of the punished act. Therefore, when the act is later begun, initial response-correlated stimulation may elicit fear, a complex intervening emotion. If the fear generated is sufficiently great, it inhibits further response and thus motivates passive avoidance. If Mowrer's theory is powerful, strain differences in fearfulness should cause differences in passive avoidance. Furthermore, the type of negative reinforcer should make no difference, given that it is made sufficiently sudden, intense and unexpected to generate enough of the emotion of fear. The present experiments were designed to test these deductions.

In a previous report (Carran, Yeudall, & Royce, 1964) skin resistance was used as an index of fear induced throughout a 2-min. interval by moderate foot shock. It was shown that C3H/HeJ mice remained fearful throughout the interval whereas C58/J mice quickly lost fear. The same strains are used in the present experiments to obtain differences in fear but the negative reinforcement is an air puff. It is predicted that C3H/HeJ mice will show greater passive avoidance.

EXPERIMENT 1

Subjects

A total of 39 mice of strains C58/J (20) and C3H/HeJ (19) were used. Only 15 mice of each strain survived until testing. Ss were males 40-45 days old on Day 1 of the experiment.

Apparatus

This included a 4-in.^{3} box and an adjoining 35-in alleyway, 1 in. wide and 1.5 in. high. Manual insertion of a clear plastic strip through a slot in the ceiling blocked entrance to an alleyway consisting of a 34-in. runway leading to a 1-in.^{2} wire food bin, .75 in. high and containing lab chow. A shelf adjoining the end of the alleyway and level with the top of the food bin supported a .8 x .1 x 2.5 in. clear plastic strip, the end of which could be inserted to cover the food.

The apparatus included a system delivering a 2-sec. air puff of desired intensity via tubing of .13 in. inside diameter opening .3 in. below the ceiling at the end of the alleyway. Air pressures below 207 cm Hg were controlled by an LP valve with gauge and were further reduced via an 804 Hohe-Phoenix pressure regulator. A mercury manometer was used to measure pressures below 207 cm Hg. The system was activated when a mouse nudged the food bin cover back .25 in. This closed a contact activating a timer delivering a 2-sec. pulse to a solenoid valve.

Procedure

The design was a complete factorial with five levels of air puff intensity (3.0, 7.3, 16.8, 41.0, and 207 cm Hg), two strains (C3H/HeJ and C58/J) and three Ss per cell. On Day 1 an S was begun on 16-hr. food deprivation and on Day 2 the deprived S was placed in the box. The barrier to the alleyway was removed after 1 min. The time for S to approach within 1 in. of the food bin and the time thereafter until S had uncovered .25 in. of the food bin by nudging the cover was recorded. Eight hours later S was removed and placed in its home cage on deprivation. This cycle was repeated for a total of 17 days except that on the last day S was given 15 min. of passive avoidance training beginning with the first air puff received. The lid was replaced immediately after an air puff by E_1, and E_2 recorded the number of air puffs each mouse received.

Results

Total time to open the food bin was approximately equal for the two strains over the last two training

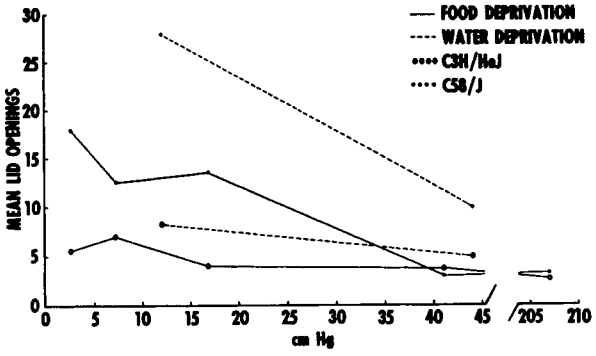

Fig. 1. Lid opening responses made during a 15-min. period as a function of strain and intensity of air puff received as punishment.

trials. On the average C58/J mice were 2.3 sec. faster than C3H/HeJ mice in approaching the food bin but were 3.9 sec. slower in opening it. The results for passive avoidance training are shown as the solid-line curves of Fig. 1. As predicted, the C3H/HeJ mice received significantly fewer air puffs (for fewer lid openings) than the C58/J mice ($F = 6.90$, $df = 1/20$, $p < .05$).

EXPERIMENT 2

Possibly the differences obtained in Experiment 1 could have been specific to the effects of food deprivation rather than strain differences in fearfulness. Therefore it was decided to switch to water deprivation in a second experiment.

Subjects and Apparatus

Eighteen C58/J and 18 C3H/HeJ males, 50 days old on Day 1 of the experiment, serves as Ss. The apparatus was identical to that used earlier except that food pellets were always available on the floor of the box and aluminum foil cups holding 2.75 ml of water were substituted for food in the food bin.

Procedure

The design was a 2 by 2 complete factorial with two levels of air puff intensity (12 and 44 cm Hg) and two strains (C3H/HeJ and C58/J). On Day 1 Ss were placed in the apparatus where they were maintained ad lib on water in the bin and pellets on the floor. On Day 52 they were returned to their home cages for their first 24-hr. water deprivation period. The procedure thenceforth was identical to that followed in Experiment 1 except for the following changes: (a) Ss were always on ad lib food but were given 24-hr. water deprivations alternated with 24-hr. ad lib water periods that began with the reinforcement for the lid nuzzling response; (b) only six training trials were given; (c) the mice remained in the apparatus only 20 min.; and (d) only the last training trial was timed.

Results

C58/J mice were on the average 6.5 sec. faster in their approach to within 1 in. of the bin and took 1 sec. less time to uncover the water. The results for passive avoidance training are shown as the dash-line curves of Fig. 1. As predicted, the C3H mice received significantly fewer air puffs (for fewer lid openings) than the C58 mice ($F = 24.6$, $df = 1/32$, $p < .005$). There was also a significant interaction of strain and air puff intensity ($F = 8.4$, $df = 1/32$, $p < .01$).

Discussion

Possibly differences in genetic factors having nothing to do with emotion are responsible for the obtained strain differences in passive avoidance. It may be, for example, that the two strains are differently motivated by both hunger and thirst. Or it may be that the strain differences found at the lowest intensities of air puff were caused by differences in the emotion of anger (Mowrer, 1960) instead of differences in fear. On the other hand, a Pavlovian might interpret the results as differences in external inhibition across two strains of mice. However, in view of the fact that strain differences in passive avoidance were correctly predicted in each of the present studies, the results are interpreted as marginal support for Mowrer's analysis of passive avoidance motivation.

References

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