

Passive avoidance learning in rats, mice, gerbils, and hamsters*

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The acquisition of a passive avoidance response to electric shock was studied in hooded and albino rats, albino mice, gerbils, and hamsters. Rats acquired this response more rapidly than any of the other species. There were no differences in rate of acquisition between the two strains of rats or among the other three species. These results indicate that species-specific defense reactions may interact with the particular behavioral task in which the organism is studied.

In the learning of active shock avoidance tasks, the rat is required to perform some instrumental response such as barrier jumping or leverpressing in the presence of a warning stimulus (CS). Although the unconditioned response (UR) to shock also involves some movement-related activity, it is apparent that the acquisition of the appropriate response to the CS is a difficult task for the rat. This is especially so when the required response is not one which would normally be made by the animal in its natural setting, e.g., leverpressing (Meyer, Cho, & Wesemann, 1960).

Within this context, Bolles (1970) has recently argued that responses which are part of an animal's repertoire of innate defensive reactions should be acquired more rapidly than those which are not a major component of its defensive behavior. Thus, running, which occurs in aversive situations such as those involving footshock, is more readily acquired as an avoidance response than are either rearing or turning (Bolles, 1969).

Although the URs to aversive stimuli such as shock are typically jumping and running, those stimuli (viz, CSs) associated with aversiveness tend to elicit an immobility response usually described as either "crouching" or "freezing." Since such responses are incompatible with behavior required in the active avoidance situation, avoidance learning in the rat generally proceeds rather slowly (Meyer et al, 1960). On the other hand, guinea pigs and hamsters (Pearl, 1963), as well as gerbils (Walters, Pearl, & Rogers, 1963), have been found to acquire an active shock avoidance response such as leverpressing with much greater facility than does the rat, although footshock elicits much of the same behavior in all of these species (Pearl, 1963).

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Recently, Brener & Goesling (1969) have demonstrated that it is much more difficult for the rat to learn an avoidance response requiring activity (active avoidance) than it is for it to acquire an immobility reaction (passive avoidance) in response to a warning stimulus such as a light or tone. In other words, it appears that among the rat's species-specific defensive reactions involving both immobility and flight, the rat seems more "prepared" (Seligman, 1970) to make a "freezing" response than it is to make some response involving mobility. On the basis of these notions of species-specific defense reactions, or preparedness, and the comparative evidence in active avoidance conditioning (e.g., Pearl, 1963; Walters et al, 1963), it might be predicted that in a passive shock avoidance situation, where immobility is the to-be-learned response, rats would acquire this response more rapidly than other related species.

Accordingly, in the present study, the acquisition of a passive avoidance response was studied in hooded and albino rats, white mice, gerbils, and hamsters.

SUBJECTS

The following animals were studied: Seven hooded rats obtained from Blue Spruce Animal Farms; eight Holtzman albino rats; six Swiss Charles River descendent mice obtained from Canadian Breeding Laboratories; seven Mongolian gerbils (*Meriones unguiculatus*) from our own laboratory colony; and seven Golden Syrian hamsters from Canadian Breeding Laboratories. All animals were experimentally naive males between the ages of 90 and 120 days and were maintained in individual cages on ad lib food and water. The colony room housing the animals was on a 12-h light-dark cycle, and all testing was done during the dark portion of this cycle.

APPARATUS

A two-compartment box constructed of Plexiglas and separated by a guillotine door served as the

passive avoidance test unit. The startbox was 6 x 7 x 6 in. (i.d.) with a Plexiglas floor. The inside of the startbox, including the appropriate side of the guillotine door, was painted flat white. Attached to the startbox was a shock chamber of the same dimensions as the startbox. The shock chamber was 1 in. lower than the startbox so that the animal had to step down to enter the chamber. This half of the box was painted a flat black, and the floor consisted of 1/4-in.-diam stainless steel rods. The top of the entire box was clear Plexiglas to enable the E to observe the animals. The guillotine door was raised manually by the E.

Electric shock was derived from a Model E1064GS Grason-Stadler shock generator and scrambler. Shock was automatically delivered to the animal upon lowering of the guillotine door after the animal had made the criterion response of placing all four feet inside the shock chamber. Each shock was of 2-mA intensity and lasted for 3 sec. All testing was done inside a sound-attenuated room, and the only source of illumination was a 7½-W bulb suspended 5 in. over the center of the apparatus. Recording of avoidance latencies on a Cramer running-time meter was started with the raising of the guillotine door and terminated with its lowering.

PROCEDURE

All animals were handled daily for 2 weeks preceding the beginning of testing. Animals were assigned randomly to a testing order; once testing began, animals were run in the same order on all succeeding days in order to equate as nearly as possible for the interval between test days. Testing was done on consecutive days until any given animal reached criterion of acquisition.

All animals were placed individually into the startbox of the apparatus so that they faced the rear wall. Fifteen seconds later, the guillotine door was lifted, starting the running-time meter. As soon as the animal placed all four feet into the shock chamber, the guillotine door was lowered and shock was automatically delivered through the grid floor of the chamber. The animal remained in the shock chamber for a period of 15 sec following the termination of shock. It was then removed from the apparatus and immediately returned to its home cage. Each animal was run in this fashion on the initial test day. Approximately 24 h later the animals were again tested in the manner described above, except that if any given animal did not enter the shock chamber within 10 min it was removed from the startbox and returned to its home cage. Animals entering the shock

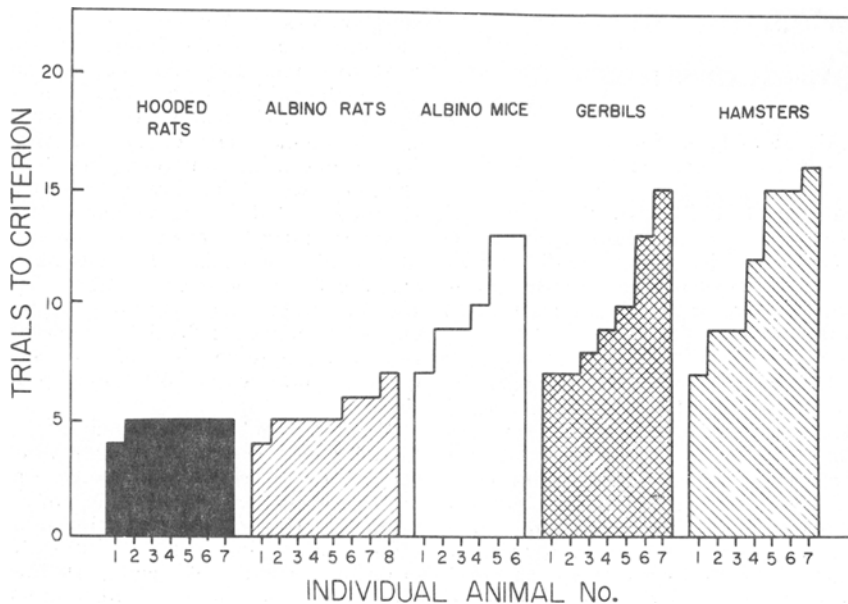


Fig. 1. Total number of trials required to reach criterion in the passive avoidance task. Total trials include the three criterion trials required of all animals, and each histogram represents the performance of individual animals in any given group.

compartment received shock as before. All animals were given a single trial each day until they reached a predetermined criterion of acquisition of the passive avoidance response: three consecutive test trials on which no entrances were made into the shock compartment. The total number of trials to reach criterion as well as the latency for each trial were recorded for each animal.

RESULTS

No differences were found among groups of animals on first trial latencies (i.e., the time required for the initial entrance into the shock chamber; $H = 3.41$, $p > .30$, $df = 4$). This indicates that all groups were similar in their tendency to enter the shock chamber before they had experienced shock. The latency ranges, in seconds, for each group of animals were: hooded rats, 2-11; albino rats, 1-25; mice, 8-24; gerbils, 1-11; and hamsters, 6-27.

The results of primary interest, the performance of the groups during passive avoidance testing, are presented in Fig. 1, which shows the total number of trials required by each species to reach the acquisition criterion (including the three criterion

trials). Both hooded and albino rats required far fewer trials to reach criterion than did any of the other species tested. In fact, only one rat showed overlap with animals from the other three groups. There were no differences between hooded and albino rats or among any of the other three species tested. Thus, the only differences found were between rats as a group and mice, gerbils, and hamsters as a group. This general pattern of results was confirmed statistically by a Kruskal-Wallis one-way analysis of variance ($H = 24.73$, $p < .001$, $df = 4$). Individual between-group tests were made using Mann-Whitney U tests for all possible group comparisons. These are not reported here since the degree of overlap in the raw data shown in Fig. 1 clearly indicates the lack of statistically significant differences among the groups in question.

DISCUSSION

The results of this study clearly show that both hooded and albino rats acquired a passive avoidance response more quickly than did mice, gerbils, or hamsters. This finding is just the opposite of reports of acquisition in active avoidance tasks (e.g., Meyer

et al, 1960; Pearl, 1963; and Walters et al, 1963), where rats have typically demonstrated poor avoidance learning. Thus, in studies of avoidance learning it is important to distinguish not only between an active and passive type of avoidance behavior (Mowrer, 1960), but also to be aware of a potential interaction between the nature of the task involved and the species of animal being studied. In this context, it is important to note that in our study all four species showed the same general reaction to the painful electric shock—jumping, squealing, urination, and defecation. However, in the testing situation itself, where immobility was the criterion response, rats displayed a strong tendency to remain immobile in the presence of “warning” cues (viz, environmental cues associated with shock in the avoidance apparatus). This reaction to stimuli associated with aversiveness appears to facilitate “learning” in particular tasks such as the acquisition of passive avoidance. Yet, it would be gratuitous to assume that on the basis of these data some basic “mechanism of learning” differed in the species tested. A more probable explanation is that, relative to our other species, immobility is a dominant species-specific defense reaction of laboratory rats to acquired aversive stimuli.

REFERENCES

- BOLLES, R. C. Avoidance and escape learning: Simultaneous acquisition of different responses. *Journal of Comparative & Physiological Psychology*, 1969, 68, 355-358.
- BOLLES, R. C. Species-specific defense reactions and avoidance learning. *Psychological Review*, 1970, 77, 32-48.
- BRENER, J., & GOESLING, W. J. Avoidance conditioning of activity and immobility in rats. *Journal of Comparative & Physiological Psychology*, 1970, 70, 276-280.
- MEYER, D. R., CHO, C., & WESEMANN, X. X. On problems of conditioned discriminated lever-press avoidance responses. *Psychological Review*, 1960, 67, 224-228.
- MOWRER, O. H. *Learning theory and behavior*. New York: Wiley, 1960.
- PEARL, J. Avoidance learning in rodents: A comparative study. *Psychological Reports*, 1963, 12, 139-145.
- SELIGMAN, M. E. P. On the generality of the laws of learning. *Psychological Review*, 1970, 77, 406-418.
- WALTERS, G. C., PEARL, J., & ROGERS, J. V. The gerbil as a subject in behavioral research. *Psychological Reports*, 1963, 12, 315-318.