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Acquisition of leverpress shock avoidance in juvenile Norway rats and spiny mice

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This study tests the generality of the hypothesis that superior avoidance learning by certain rodent species is related to heightened activity and stimulus sensitivity levels in those species. Norway rats and spiny mice were compared using a discrete-trial leverpress avoidance procedure. Gender and age (30 and 60 days old) were additional between-subjects factors in the design. Despite previous reports indicating that spiny mice were significantly more active and exploratory than Norway rats, the comparison on avoidance showed them to be seriously inferior to rats. The species difference was discussed in terms of species-specific defense reactions.

Species-specific exploratory tendencies, activity levels, and stimulus sensitivity levels have been offered as explanations for species differences in avoidance learning in rodents. For example, attempts have been made to use differences in activity and arousal level to explain comparative differences between species representing varying degrees of domestication. Powell, Curley, and Palm (1978) hypothesized that gerbils would perform signaled free-operant leverpress avoidance better than domesticated Norway rats. This prediction was based on the idea that the less domesticated gerbils would be more active and more easily aroused, therefore producing more responses in the operant situation. Previous research had suggested that gerbils explore more, compared with domesticated rats, when placed inside a T-maze (Carey & Fischer, 1973). However, the results indicated that the superior avoidance performance of gerbils was not due to greater activity and more frequent operant responding, but to the superior ability of gerbils to use the signal as a predictor of shock.

Ashe and McCain (1972) reported a similar study, again comparing gerbils and domesticated rats, but in two types of avoidance situations designed, hypothetically, to identify possible species-specific defense reactions (SSDRs) in the two species. These two situations were (1) one-way avoidance in which subjects leave a shock compartment and enter a safe compartment on each trial and (2) shuttle avoidance in which shock and safe compartments alternate forcing subjects to leave the current shock compartment and enter a previous shock compartment. Gerbils showed superior performance in the shuttle situation, but inferior performance in the one-way situation. Gerbils also responded more quickly to the onset of the warning signal. Taken together, these findings do support the contention that there is a relationship between the superior avoidance performance of gerbils in comparative studies and their higher levels of activity and sensitivity to stimuli.

The study reported here was designed to provide a further test of the assumption that the more active and exploratory of two species of rodents would perform operant avoidance responses more readily and more efficiently. Domesticated Norway rats were compared with spiny mice on a discrete-trials leverpress avoidance procedure. Spiny mice were chosen for their high levels of activity and exploratory behavior in laboratory test environments (Makin & Deni, 1981) and for their precocial sensory and motor development, relative to rats, during the early preweaning period.

METHOD

Subjects

A group of 32 Norway rats (*Rattus norvegicus*) and a group of 32 spiny mice (*Acomys cahirinus*) were used as subjects. Each group consisted of 16 males (8 30-day-olds, 8 60-day-olds) and 16 females (8 30-day-olds, 8 60-day-olds). The animals were derived from breeding colonies maintained at Rider College. They were housed individually from 21 to 25 days of age and fed Purina 5012 chow and water.

Apparatus

The avoidance test chamber used consisted of a standard rodent operant chamber with certain modifications. The ceiling panel was lowered to within 15 cm of the grid floor. A 10-cm-long omnidirectional response lever was mounted near the center of the ceiling panel and projected straight down into the animal environment. The amount of space inside the chamber was further reduced by the addition of a Plexiglas wall 10 cm inside the metal front plate of the chamber. The result was a smooth-surfaced cubicle. These modifications were designed to make lever contact more likely. The warning stimulus consisted of a Sonalert signal generator emitting a 2.8-kHz tone. Both the Sonalert and a white-noise speaker were mounted on the metal front panel of the chamber. Electronic programming equipment was located in an adjacent room. The chamber was enclosed in a sound-attenuating chest. Scrambled ac shock (1.5 mA) was delivered to the grid floor of the chamber.

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Table 1
Means and Standard Deviations for Avoidance Responses per Session Over 10 Test Sessions

	Norway Rats		Spiny Mice	
Group	Mean	SD	Mean	SD
30-Day Males	10.4	5.8	.8	.5
30-Day Females	10.1	10.2	1.2	2.1
60-Day Males	14.9	2.4	1.0	1.0
60-Day Females	10.5	7.2	1.8	2.5

Note–Maximum per session = 30.

Procedure

Depending on group designation, subjects were tested beginning on Day 30 or Day 60 for 10 days during the next 15 days. Each daily test session consisted of 30 trials in the leverpress avoidance chamber. Each trial consisted of a 15-sec waiting period followed by a 5-sec warning signal. If a response occurred during the waiting period, it was ignored. If it occurred during the warning signal, it was counted as an avoidance response and the waiting period started again to begin the next trial. If no response occurred during the signal, a maximum of 10 sec of shock occurred. If a response occurred during shock, it immediately terminated shock and started the waiting period before the next trial.

RESULTS AND DISCUSSION

The data analyzed were the average number of avoidances per session over the 10 sessions of testing. A three-way between-subjects analysis of variance was used to test for group differences. The analysis factors included species (Norway rats, spiny mice), gender (male, female), and age (30 days, 60 days at start of testing). The only significant source of variance in the analysis was the species factor. Significantly more avoidances were performed by Norway rats than by spiny mice [$F(1,56) = 66.2$, $p < .05$]. Overall, the mean number of avoidances equaled 11.5 (SD = 6.9) for Norway rats and 1.2 (SD = 1.7) for spiny mice. Summary data for the eight factor combinations are shown in Table 1.

Spiny mice clearly did not avoid shock in this test situation. Several factors may have accounted for this finding. The location of the manipulandum (protruding downward from the ceiling to within 5 cm of the grid floor) may have fit the SSDR of rats but not of spiny mice. Observation of subjects during testing revealed that rats often moved upward, rearing on hind legs, when shocked and came into contact with the lever using forepaws, head, and ventral body surfaces to operate it. This reaction resembled "climbing" (a logical SSDR for the rat). Spiny mice were observed to orient downward when shocked, lying on the bars with paws often out of contact with the grid. Practically no leverpresses were recorded for these animals, even though activity and exploration measures indicate that they are significantly more active than Norway rats (Makin & Deni, 1981). Additional data on spiny mouse learned behavior, although not from a comparative study, indicates that the animals are highly resistant to extinction on appetitive operant contingencies (Deni, 1977) and aversive Pavlovian contingencies (Etscorn, Note 1), further supporting the observation that the species is highly active in laboratory test environments. The study of unconditioned responses in spiny mice exposed to aversive events needs to be undertaken systematically in order to explain the present data. Nevertheless, these data do caution against the general explanation of species differences in avoidance performance in rodents in terms of activity or stimulus sensitivity differences.

REFERENCE NOTE

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