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Differences in the decision to attack between grasshopper mice and hamsters: Effects of novel, noxious, and aversive stimuli

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The decision to attack may operate differently in various species. Certain situations may inhibit an attack in one species more readily than in another. This study examined the inhibitory effects of novel, noxious, and aversive stimuli on the predatory attack responses of grasshopper mice and hamsters. A novel test situation suppressed the attack of hamsters more readily than that of grasshopper mice. Noxious stimuli associated with a stinkbug inhibited a hamster's attack but not a grasshopper mouse's. Preexposure to crickets mitigated the inhibitory effects of toxicosis on the attack behavior in grasshopper mice but not in hamsters. Possible reasons for these differences between species are discussed.

Many rodent species prey upon insects for food (Landry, 1970). The ferocity of the attack response may vary among these species. Certain situations may inhibit the attack in one species more readily than in another. For example, the decision to attack may be more resistant to potential inhibitory situations in grasshopper mice (*Onychomys leucogaster*) than in hamsters (*Mesocricetus auratus*), because grasshopper mice depend on their attack response for food more than do hamsters. Grasshopper mice feed almost exclusively on arthropods (Flake, 1973), whereas hamsters eat primarily plants, with some arthropods (Polsky, 1977). Novelty of the test situation, the added presence of noxious stimuli, or a developed aversion toward prey are all situations that could inhibit an attack response. This study examined the effects of these three situations on the decision of grasshopper mice and hamsters to attack.

GENERAL METHOD

All hamsters and grasshopper mice were lab reared, all were at least 70 days of age, and none had any prior experience capturing or eating insects. For 2 weeks before the tests and during the tests, the subjects were housed individually in 18 × 28 × 23 cm plastic cages with Selsite bedding. They had unlimited access to rat chow and water. Observations were made in a darkened room with only a 40-W red light 40 cm above the floor of the cage or aquarium as a light source. Each animal had 5 min to attack.

EXPERIMENT 1

Novelty of a test situation is most likely to affect the attack of inexperienced subjects, but increased hunger can often overcome a rodent's initial inhibition to attack (Polsky, 1975, 1979). If an animal is sensitive to the novelty of a test situation, a change that causes an increase in the overall novelty of the situation may reverse the mitigating effects of hunger and once again inhibit the attack. These ideas about the inhibitory effects of novelty were examined here.

Method

In all, 29 hamsters and 29 grasshopper mice served as subjects for three tests. In the first test, 8 hamsters and 8 grasshopper mice were divided equally into two subgroups. Each animal in one subgroup received a house cricket (*Acheta domesticus*) in its home cage 1 h after food and water were removed. Two hours later, the animal was placed in a 40-liter aquarium and was allowed 1 h to become familiar with the chamber. The animal received a second cricket, but this time in a novel environment (the aquarium). Each animal in the other subgroup was presented with two crickets in reverse order, that is, one in the aquarium and then one in the home cage.

In a second test, 7 hamsters and 7 grasshopper mice were deprived of food and water for 24 h and each was then presented with a cricket in a 40-liter aquarium.

In a third test, 14 hamsters and 14 grasshopper mice were presented with almond-coated crickets. Half of each group ($n = 7$) were presented with crickets in their home cages and half in aquariums. Each subject had been deprived of food and water for 24 h beforehand. The dorsal sufaces of the crickets were brushed three times with almond extract (Safeway), which is palatable to both hamsters and grasshopper mice (Langley & Knapp, 1982, 1984).

Results and Discussion

The novel environment inhibited the attack of inexperienced hamsters but not that of grasshopper mice. In the first test, the sequence of testing (home cage or aquarium first) produced no apparent effect, so the responses of both subgroups were pooled. All 8 hamsters killed the crickets in their home cages, but only 2 of 8 did so in the aquariums, a significant difference (Fisher exact test, $p < .01$). All 8 grasshopper mice killed crickets in both environments. A significantly greater proportion of inexperienced grasshopper mice than hamsters killed the

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crickets in the novel environment of an aquarium (Fisher exact test, $p < .05$).

Starvation seemed to overcome the inhibitory effects of a novel environment in hamsters. In the second test, 5 of 7 starved hamsters killed crickets when tested in an aquarium; only 2 of 8 nonstarved hamsters had killed crickets in the previous test, a significant difference (Fisher exact test, $p < .05$). Starvation had no measurable effect on the grasshopper mouse's attack: in both the first (nonstarved) and second (starved) tests, all mice killed crickets.

The added presence of a strong odor reversed the effects of increased hunger, so that the novelty of the test situation once again suppressed the attack of the hamsters but not that of the grasshopper mice. Six of the 7 hamsters attacked almond-coated crickets in the home cage, but 0 of 7 did so in a novel aquarium, a significant difference (Fisher exact test, $p < .01$). All 7 grasshopper mice killed the almond-coated crickets, whether in the home cage or aquarium. A significantly greater proportion of starved grasshopper mice than hamsters killed the almond-coated crickets in a novel environment (Fisher exact test, $p < .05$).

In summary, the novelty of the test situation inhibited the attack of hamsters more than that of grasshopper mice.

EXPERIMENT 2

This experiment measured the effects of noxious stimuli on the inhibition of an attack response. A stinkbug has a noxious taste and produces a noxious pungent odor when disturbed (Waterhouse, Forss, & Hackman, 1961).

Method

Another 10 hamsters and 10 grasshopper mice served as subjects. All subjects were deprived of food and water for 24 h before the experiment. The stinkbugs (*Euschitus sp.*) presented as prey were adults and were approximately 10 mm long. A stinkbug was presented on the 1st and 3rd days and a house cricket was presented on the 5th day. The house cricket served to measure the subjects' responses to another insect. All tests were conducted in the subjects' home cages.

Results and Discussion

All 10 grasshopper mice immediately killed and ate the stinkbugs on both occasions. The median latency of attack for the first and second presentations were 27 sec and 32 sec, respectively. In contrast, only 4 of the 10 hamsters killed stinkbugs the first time. Their median latency of attack was 121 sec. None of the hamsters attacked the stinkbugs during the second test. A significantly greater proportion of grasshopper mice than hamsters killed stinkbugs during the first test (Fisher exact test, $p < .05$). All 10 grasshopper mice and all 10 hamsters killed and ate the house crickets presented on the 5th day.

The majority of hamsters perceived the stinkbugs as so noxious that they stopped their attacks the first time, and the rest did so by the second test. These same stimuli did not inhibit attack or feeding in grasshopper mice. Although hamsters and grasshopper mice showed different attack responses toward stinkbugs, both rodents killed and ate another, less noxious, insect, the house cricket.

EXPERIMENT 3

In Experiment 2, certain situations affected the hamster's decision to attack but not the grasshopper mouse's. The reverse occurred in Experiment 3. The strength of a conditioned taste aversion is strongly influenced by the novelty of the flavor paired with illness (Robbins, 1979). Previous capture and consumption of prey may reduce the inhibitory effects that a conditioned taste aversion has on a rodent's attack response. This experiment measured the effect of preexposure on the inhibitory effects produced by toxicosis when uncoated and almond-coated crickets were presented in a novel environment.

Method

Another 15 hamsters served as subjects. Tests occurred in a novel aquarium outside of the home cage. Before receiving injections, 7 hamsters received three safe preexposures to uncoated crickets on separate days. These subjects were deprived of food and water for 24 h before the first presentation and for 22 h before the other presentations. They ate and drank in their home cages for 2 h after each test presentation. On the 4th day, each received a 0.3-M LiCl injection (2% of body weight) intraperitoneally. For the next 2 days, each received an uncoated cricket without an accompanying injection. Eight other hamsters were treated similarly but were given no preexposures to uncoated crickets; however, they received the LiCl injection after their first cricket.

Because inexperienced hamsters will not attack an almond-coated cricket in an aquarium even when starved (Experiment 1), no group of hamsters was tested without preexposure to almond-coated crickets. In a second test, 7 other hamsters were preexposed to almond-coated crickets. To increase the likelihood that these hamsters would attack almond-coated crickets in a novel aquarium, they were first presented with three uncoated crickets and then with three almond-coated crickets over a 6-day period. On the 7th day, after they captured and consumed a fourth almond-coated cricket, they received a LiCl injection. On the 1st, 2nd, 7th, and 14th days after the injection, they were again presented with almond-coated crickets, but without an accompanying injection, and their responses were recorded.

Grasshopper mice were treated similarly in both tests with the following exceptions in the second test: 7 mice received three safe preexposures to almond-coated crickets and 7 received no preexposures before the injection.

Results and Discussion

Toxicosis inhibited the attack of hamsters for 1 day, with or without preëxposure to the prey. Without safe preexposures, 5 of 8 hamsters killed uncoated crickets and received LiCl injections. The day after the injection, none of these 5 hamsters killed a cricket. By the 2nd day after the injection, 4 of the 5 resumed killing. With safe preexposures, all 7 hamsters killed and ate uncoated crickets on the day of the injection, but on the day after, only 2 of 7 animals attacked, a significant difference (Fisher exact test, $p < .05$). By the second day following injection, all 7 resumed killing. Safe preexposures did not diminish the inhibitory effects of toxicosis in hamsters.

Toxicosis did not inhibit the attack of grasshopper mice on uncoated crickets. All 7 grasshopper mice killed uncoated crickets the first 2 days after an injection, with or without safe preexposures. The effect of preexposure could not be measured here.

In the second test, safe preexposures to almond-coated crickets also did not diminish the inhibitory effects of toxicosis in hamsters. On the day of the injection, all 7 hamsters killed and ate the almond-coated crickets within 5 min. No hamster attacked an almond-coated cricket the 1st day after, 1 attacked the 2nd day after, and only 4 did so on the 7th and 14th days after. The differences between the proportion of hamsters that attacked on the day of the injection and those that attacked on the first 2 days after were significant (Fisher exact test, $p < .05$ in both cases), but they were not significant for the 7th and 14th days after (Fisher exact test, $p > .05$). Four hamsters never did resume killing after the injection.

In grasshopper mice, preexposure to almond-coated crickets diminished the inhibitory effects of toxicosis. All 7 mice in both groups, preexposed and not preexposed to almond-coated crickets, killed and ate coated crickets on the day of the injection. Six of the 7 preexposed mice killed the 1st day after, whereas only 1 of 7 that were not preexposed did so, a significant difference (Fisher exact test, $p < .05$). All 7 mice that were not preexposed resumed killing on the 2nd day after the injection. Toxicosis inhibited the attack of non-preexposed grasshopper mice for 1 day but did not stop the attack of preexposed mice at all.

GENERAL DISCUSSION

The decision to attack operates differently in hamsters and grasshopper mice. More contingent factors seem to affect the decision to attack in hamsters than in grasshopper mice. Perception of novel, noxious, or aversive stimuli associated with potential prey are more likely to inhibit a hamster's attack than that of a grasshopper mouse. The grasshopper mouse's attack appears to be more canalized than the hamster's; that is, it appears less likely to be inhibited. Such a canalized attack response may contribute to the grasshopper mouse's image as a ferocious predator.

One reason the grasshopper mouse's decision to attack is canalized may be that the selective pressures associated with the way in which the mice hunt prey favors such a pattern. Grasshopper mice range over large areas to search for a wide variety of prey (Bailey & Sperry, 1929; Blair, 1953; Flake, 1973; Horner, Taylor, & Padykula, 1964), they often feed extensively on prey that have noxious defenses (Eisner & Meinwald, 1966; Horner et al., 1964), and their success in capturing certain nocturnal insect prey depends on the speed of their attack (Langley, 1981). Another reason that the attack is canalized may be that grasshopper mice have a particularly aggressive temperament (Scudder, Karczmar, & Lockett, 1967), a tendency that might affect their predatory behavior. There are no comparative data on these aspects of hunting behavior and aggressive temperament in hamsters or other rodents. Further comparisons of the predatory behaviors of grasshopper mice and hamsters may reveal other differences.

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