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TARGET NOVELTY ELICITS AND DIRECTS SHOCK-ASSOCIATED AGGRESSION IN WILD RATS[1]

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Inescapable electric shock was delivered to freely moving wild rats in the presence of familiar and novel inanimate targets. It was found that: (*a*) In response to shock, wild rats rarely attacked a familiar target but would readily attack a novel one. (*b*) Amount of escape-directed behavior in response to shock decreased as the result of introducing a novel target into the shock situation. (*c*) In a choice situation, both proportion of attacks directed toward a novel target, as compared with a familiar one, and number of attacks directed toward the novel target decreased with increased exposure to the novel target.

Azrin, Hutchinson, and Sallery (1964) have described a procedure by which domesticated rats can be induced to bite an inanimate target in response to unavoidable shock. Rats in this Azrin et al. (1964) study were restrained ½ in. from a target object and received intense electric shock (5 ma.) to the tail. The shock resulted in biting of the target on almost every trial. Unfortunately, this procedure, which permits objective recording of the number and duration of bites, is of somewhat limited usefulness in the investigation of conditions eliciting aggressive behavior. Because of the confinement necessary to produce biting, the rats are severely limited in their response repertoire and the experimenter is limited in his choice of independent variables.

Wild rats are inherently far more aggressive in a variety of situations than their domesticated conspecifics (Barnett, 1958, 1963; Galef, in press; Karli, 1956; Richter, 1949; Stone, 1932). Preliminary investigation revealed that a single footshock of 1.3-ma. intensity and 1.0-sec. duration delivered to a freely moving wild rat could elicit as many as 19 discrete biting episodes directed toward an inanimate object in the 60 sec. following shock presentation, while domesticated rats (both albino and hooded) did not attack inanimate objects under identical conditions. The apparent readiness of freely moving wild rats to attack targets in response to the application of moderate footshocks permits the simultaneous study of both aggressive and nonaggressive responses to painful stimulation in a variety of stimulus situations.

Recent work (Galef, in press) has shown that stimulus novelty plays an important role in the elicitation of the naturally occurring aggressive behavior of wild rats directed toward human handlers, mice, and conspecifics. Experiment 1 demonstrates both the aggression of wild rats toward inanimate objects in response to shock and importance of stimulus novelty in eliciting and directing this pain-associated aggression.

Experiment 1

Method

Subjects. The subjects were 11 male, experimentally naive, adult, fourth-generation, laboratory-bred wild rats. Data from one rat were discarded because it climbed onto one of the target stimuli and received no shock.

Apparatus. Four large shock boxes (12 × 15 × 24 in.) were constructed using black opaque Plexiglas for three walls and transparent Plexiglas for the front wall. The top of each box was closed with a plate of transparent Plexiglas in which two holes were drilled 2 in. from the back wall and 2 in. from the nearest side wall to permit lowering

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TABLE 1

Mean Number of Attacks Directed toward Familiar (T_F) and Novel (T_N) Targets during Preshock and Shock Periods on Days 13 and 14 of Experiment 1

Condition	Experimental group		Control group	
	13	14	13	14
Target T_F				
Preshock	0.0	0.0	0.0	0.0
Shock	0.83	0.83	0.78	0.70
Target T_N				
Preshock		0.03		
Shock		7.0		

of stimuli into the enclosure. Access to each box was via a 3 × 3 in. guillotine door mounted on one wall. A water bottle and Norwich NS feeder containing powdered Purina rat chow were mounted on the wall opposite the guillotine door. The grid floor was constructed of stainless-steel rods of 3/16-in. diam., 5/16 in. apart, and shocks were administered via a Grason-Stadler Model E1064GS shock source and scrambler controlled by relay equipment.

Targets were 1¼-in.-diam. hardwood balls mounted on aluminum poles ⅜ in. in diameter and 24 in. long. The targets were painted either black or white, and one target of each color was mounted to the lid of each shock box by means of clamps. The targets could be lowered into the cage by the experimenter through the holes in the lid of the enclosure.

Procedure. Individual rats were placed in each shock box and 2 days later one of the targets, referred to below as the "familiar target" (T_F), was lowered to within 4 in. of the grid floor. The color of T_F was counterbalanced across the six wild rats used. Subjects were then left undisturbed for 11 days to become accustomed to the shock box and T_F. On Day 13 each rat received five shocks of 1.0-sec. duration and 1.3-ma. intensity at intervals of 60 sec. On Day 14, the other target, referred to below as the "novel target" (T_N), was lowered to the same level as T_F. The experimenter waited 5 min. following introduction of T_N and presented five shocks as on Day 13. The number of attacks delivered by each rat to each target and the number of escape attempts (leaps toward the lid of the enclosure or attempts to hide in the food cup) were recorded by the experimenter.

The duration of biting attacks and the number of discriminable bites comprising an attack episode varied considerably. A separate attack was recorded whenever the rat disengaged from and then returned to bite a target.

A group of four rats was used to control for the effects of previous experience of shock and of moving a stimulus object 5 min. prior to shock presentation. These control rats were treated in an identical fashion to the six experimental animals described above for the first 13 days of the experiment. On Day 14 T_F was raised and lowered, a 5-min. delay imposed, and five shocks given as on Day 13.

Results

The main results of Experiment 1 are presented in Table 1. On Day 14, when T_N was introduced into the enclosures of experimental rats, these animals showed a marked increase in shock-associated aggression over the base-line level of aggression shown on Day 13, when only T_F was present. All six experimental rats attacked more frequently on Day 14 than on Day 13. All additional aggression observed on Day 14 was directed toward T_N, aggression toward T_F remaining unchanged between the 2 days of the experiment. Observation of the number of shock trials on which experimental rats attacked T_F and T_N showed a similar pattern. On Day 14 all six experimental rats showed an increase in the number of shock trials on which they exhibited aggression toward T_N. Two of these six animals attacked T_F on more shock trials and two on fewer shock trials on Day 14 than on Day 13.

As can also be seen in Table 1, aggressive behavior was almost exclusively confined to the shock periods. All six experimental animals showed an increase in frequency of aggression during the 5-min. shock period on Day 14 as compared with the 5-min. preshock period.

Control rats showed a slight decrease in number of attacks between Days 13 and 14, indicating that the increased aggression shown by experimental rats on Day 14 was caused by the introduction of the novel stimulus rather than by target movement or previous experience of shock.

The number of escape attempts exhibited by experimental rats in response to shock decreased markedly between Days 13 and 14, all six animals showing more escape attempts on Day 13 ($\bar{X}$ = 9.3) than on Day 14 ($\bar{X}$ = 1.3). Two of the control rats showed an increase and two a decrease in number of escape attempts between Days 13 and 14. No escape attempts were made by any control animal during the 5-min. preshock period on either day.

Experiment 2

It was hypothesized that if stimulus novelty is important in eliciting and directing aggression there should be a decrease in both the total number and proportion of aggressive responses directed toward a novel target as the subject becomes more familiar with it.

Method

Subjects. The subjects were seven female and eight male experimentally naive, adult, fourth-generation, laboratory-bred wild rats. Data from one female and two male rats were discarded because the female climbed onto one of the targets and escaped shock and the two males showed no aggressive behavior in response to shock during the entire experiment.

Procedure. The apparatus and method were similar to those of Experiment 1. Each rat was placed in a shock box and 2 days later one of the targets (T_F) was introduced into it. On Days 13, 14, and 15 of the experiment each animal received five shocks (1.3 ma., 1.0 sec., 1/min) in the presence of both T_F and T_N.

For one group of rats, the T_N familiarization group (two females and three males), T_N was introduced into each rat's cage 5 min. prior to shock initiation on Day 13 and left there throughout Days 13, 14, and 15. For the second group of rats, the T_N nonfamiliarization group (three females and four males), T_N was introduced into each rat's cage 5 min. prior to shock initiation on each day and removed 1 min. following presentation of the last shock on that day. Thus, both groups were exposed to T_F throughout Days 2–15 of the experiment. The T_N familiarization group was exposed to T_N throughout Days 13, 14, and 15 and the T_N nonfamiliarization group was exposed to T_N for only 10 min/day on Days 13, 14, and 15.

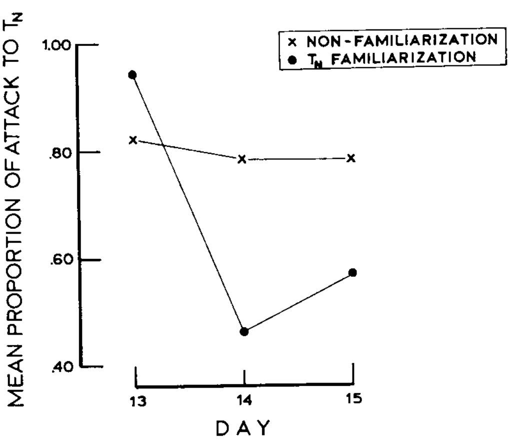

FIG. 1. Mean proportion of attacks delivered to the novel target (T_N) on Days 13, 14, and 15.

TABLE 2
MEAN NUMBER OF ATTACKS TO T_N ON DAYS 13, 14, AND 15 OF EXPERIMENT 2

Group	Day 13	Day 14	Day 15
Familiarization	11.2 (1.0)	2.8 (.75)	3.4 (1.1)
Nonfamiliarization	11.1 (1.1)	6.9 (.65)	4.7 (1.2)

Note.—Numbers in parentheses are standard errors of the means.

Results

The main results of Experiment 2 are presented in Figure 1 and Table 2. As seen in Figure 1, there was a marked decrease in the proportion of attacks directed toward T_N by the T_N familiarization group, while the proportion of attacks directed toward T_N by the T_N nonfamiliarization group remained constant. Two-tailed Mann-Whitney U tests performed on the proportion of attacks directed toward T_N by the T_N familiarization rats on Days 13 and 14 ($U = 2, p = .032$) and Days 13 and 15 ($U = 0, p = .008$) were significant. There was no significant difference in proportion of attacks directed to T_N by the T_N familiarization group on Days 14 and 15 ($U = 10, p = .790$).

Table 2 presents data describing the mean number of attacks delivered to T_N by the familiarization and nonfamiliarization groups on the 3 days of the experiment. While both groups showed a significant reduction in number of attacks to T_N on Day 14 compared with Day 13, the reduction in aggression shown by the familiarization group was significantly greater than that shown by the nonfamiliarization group. There was no significant decrease in aggression to T_N for either group between Days 14 and 15.

A χ^2 analysis of the correlation between the number of attacks directed toward T_N and T_F by all 12 rats on Day 13 indicated that rats showing a greater than average number of attacks toward T_N tended to show a significantly greater than average number of attacks toward T_F, and that animals showing a smaller than average number of attacks toward T_N showed a smaller than average number of attacks toward T_F ($\chi^2 = 5.33$, $df = 1$, $p < .05$).

Comparison of rats' behavior during the 5-min. preshock and 5-min. shock periods demonstrated the importance of painful stimulation in eliciting the behavior observed. A total of seven attacks were recorded during the preshock period for nonfamiliarization rats during the last 3 days of the experiment. In the succeeding shock trials these same animals attacked a total of 213 times. All seven rats showed a greater number of attacks during the shock period than during the preshock period on all 3 days.

The distribution of latencies from shock onset to each attack to T_N and T_F were very similar. Mean latency to attack T_N was 19.5 sec. ($\sigma = 17.7$) and to attack T_F 19.3 sec. ($\sigma = 16.9$). The mean absolute value of the difference between observed frequencies of attack latencies to T_N and T_F defined on 10-sec. intervals was .02, the maximum being .05 and the minimum 0.

General Discussion

First, it is clear that electric footshock presented to freely moving wild rats increases the frequency of occurrence of aggressive behavior directed toward inanimate objects. In both Experiments 1 and 2 there is a marked increase in aggression in the 5-min. shock period when compared with the 5-min. preshock period. Second, as can be seen in Experiment 1, stimulus novelty serves, as does shock, to increase the frequency of aggressive behavior. In the first experiment, introducing a novel target into the shock situation resulted in an 8.5-fold increase in aggression. That this increase was due to exposure to shock on Day 13 is unlikely in view of the results of the control group in Experiment 1 and the finding in Experiment 2 that there was a significant decrease in the amount of aggressive behavior displayed by the nonfamiliarization group toward T_N on Day 14 compared with Day 13. Third, stimulus novelty not only elicits aggression in response to shock, it also directs it. In both Experiments 1 and 2, all animals consistantly directed more attacks toward the novel than familiar target when both were available. The fact that attack-latency distribution is similar for the two targets and that a significant correlation exists between the number of attacks directed toward T_N and T_F by individual rats suggests that the observed distribution of attacks to T_F and T_N results from the directing of a single underlying attack pattern rather than two different attack mechanisms, one for familiar and the other for novel targets.

Azrin, Hutchinson, and Hake (1967) have reported that electric shock increases the frequency of both escape and attack behaviors. In examining the interaction between escape and attack, these investigators found that when escape was possible, the escape response became prepotent over the attack response in that escape eliminated attack behavior. Similarly, Hediger (1964) has observed that escape is the primary response of a wide variety of species to external threat, attack occurring only when an individual is unable to escape. In Experiment 1 in which the majority of rats were unable to escape shock, both escape-directed and attack behavior increased in frequency of occurrence as a result of shock presentation. The relative frequency of occurrence of escape and attack in this experiment depended on the particular stimulus situation in which shock was applied. When stimulus conditions suitable for eliciting attack were absent, escape-directed activity was frequent, and attack behavior rare. Conversely, when a novel, and hence attack-eliciting, stimulus was present, escape-directed activity was relatively rare, and attack behavior frequent. Thus, in a situation in which the opportunity to escape is absent, the frequency of attack and escape-directed behavior was determined by the presence or absence of stimuli appropriate for attack, the presence of attack-eliciting stimuli tending to reduce escape-directed activity.

The above observations suggest that aversive stimulation increases the frequency of both attack and escape directed behaviors, the behavior occurring most frequently depending on the stimulus conditions and response contingencies in the presence of which aversive stimulation is applied.

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