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Shock and defensive fighting in the rat

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A film analysis of fighting and nonfighting episodes in a shock-elicited fighting task indicated an almost total absence of behaviors typical of the attack pattern of dominant colony rats on intruders. The most frequent "fighting" response seen was striking, a forelimb movement oriented toward the opponent. However, forelimb movements identical except for the lack of such orientation occurred during nonfighting shock episodes. "Strikes" occurred primarily when shock was given to animals in a defensive boxing posture with forelimbs extended: Otherwise, nonoriented forelimb movements occurred. Similarly, "kicking" and nonfighting hindlimb movements were indistinguishable except for orientation. Bites and wounds made were similar to those of colony rats under conspecific attack and not to those made by attacking dominant colony males. These analyses support the notion that the shock-elicited fighting task consists primarily of a defensive behavior pattern combined with reflexive fore- and hindlimb jerks to electric footshock.

Recent comparisons of attack and defensive behaviors shown by albino rats in established colonies and in the "reflexive fighting" or "shock-elicited aggression" situation strongly suggest that the latter tasks provide an extremely poor measure of attack, and a mixed measure of defensive behavior (Blanchard & Blanchard, 1977; Blanchard, Blanchard, & Takahashi, in press). First, the behaviors and postures most typical of the "reflexive fighting" task are extremely similar to those shown by colony intruder rats under attack and are very dissimilar to the attack reactions of dominant colony males. Second, the limb movements usually interpreted as "striking" in this situation may partially represent unconditioned forelimb movements elicited by footshock.

In the present study, film analysis was used to clarify the circumstances in which such "striking" movements occur, in order to permit a more accurate assessment of the traditional view that such reactions represent an aggressive behavior elicited by shock.

METHOD

Subjects

The subjects were 16 naive male Wistar-derived albino rats, weighing 363-450 g, from the colony maintained by the University of Hawaii Department of Psychology. All subjects were singly housed for at least 3 weeks prior to the experimental procedure and were given free access to both food and water.

Apparatus

The apparatus was a 24.5 x 23.5 x 30 cm plywood chamber with a grid flooring. The front and top of the chamber were constructed of clear Plexiglas to permit observation and filming. A Grason-Stadler Model E-1064 shock source delivered scrambled shock to the grid floor. Behaviors were filmed with a Canon Autozoom 814 electronic 8-mm cinema camera, using Kodak Ektachrome 160 film, at a speed of 18 frames/sec. The films were examined using a Goko Model G-2002 film editor for frame-by-frame analysis.

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Procedure

The subjects were paired on the basis of body weight. Paired rats were allowed to explore the test chamber for 3 min before delivery of shock. Shocks were then administered every 15 sec (2 mA, .5-sec duration).

Beginning on the first trial after any animal bit, kicked, or struck the other rat, films were made of the period .5 sec before shock, during shock, and .5 sec after each shock. Filming and shock delivery continued until a minimum of five episodes of fighting (striking with the forepaws, kicking with the hindpaws, or biting the other animal) and five nonfighting episodes had been recorded. Observers also recorded any fighting that occurred during the nonfilmed intervals. A neon lamp placed beside the outer right wall of the chamber indicated the duration of shock. One animal in each pair was marked with Fuschan Basic dye 3 h prior to the experimental procedure, in order to permit separate analysis for the two animals in each pair.

All behaviors were summarized for the first five fighting and nonfighting episodes. These behaviors included boxing, freezing, locomotion, and orientation with vibrissae contact. Attack behaviors were also noted whenever they occurred. Behavioral definitions and descriptions may be found in previous reports (Blanchard & Blanchard, 1977).

RESULTS AND DISCUSSION

No striking, kicking, or biting was seen for any animal during the 3-min preshock exploration period. An average of 3.6 shocks (range = 2-8) were given before the first fighting instance occurred, and an average of 19.8 shocks (range = 11-30) were required to record five fighting and five nonfighting instances per pair.

Table 1 presents the dominant behaviors observed during fighting and nonfighting episodes. Attack behaviors (i.e., those typical of an attacking male rat) (Blanchard & Blanchard, 1977) were either absent

Table 1
Proportion of Time Spent in Each of the Major Behaviors During Five Fighting (F) and Five Nonfighting (NF) Episodes

	Preshock		Shock		Postshock	
Behavior	F	NF	F	NF	F	NF
Locomotion	3.25	3.75	55.34	74.46	29.23	77.21
Orientation	43.05	22.10	60.35	38.70	76.75	40.30
Box	41.25	13.75	28.27	8.17	40.87	14.71
Freeze	55.50	81.25	6.18	8.65	0.00	0.00

Note–Orientation refers to orientation with vibrissae contact, which is not mutually exclusive of the other behaviors. Also, other behaviors were occasionally observed. Column sums therefore do not add to 100%.

(piloerection and lateral attack) or extremely infrequent (cf. on top was observed for a total of 2.1 sec). The three behaviors of boxing, freezing, and locomotion accounted for about 90% of the preshock and shock sequences measured. However, boxing was higher [$t(14) = 3.22$, $p < .01$] during preshock sequences just before fighting episodes. Because of the possible importance of vibrissae contact in reflexive fighting (Blanchard, Takahashi, Fukunaga, & Blanchard, 1977), this behavior was also measured, although it was not a nonoverlapping category: Reliably more orientation with vibrissae contact was seen before fighting episodes than before nonfighting episodes [$t(14) = 2.36$, $p < .05$].

During the shock periods, fighting animals continued to spend reliably more time boxing and orienting with vibrissae contact [$t(14) = 2.89$, $p < .05$, and $t(14) = 5.05$, $p < .001$, respectively] than did the nonfighting pairs. These same measures were also reliably different during the .5-sec postshock period following fighting and nonfighting episodes [$t(14) = 3.94$, $p < .01$, and $t(14) = 6.37$, $p < .0001$, respectively].

These data suggest that animals in a boxing posture accompanied by mutual orientation and vibrissae contact are more likely to strike, bite, or kick when shock is given. They also add to a growing body of data that stresses the importance of sensory input from the vibrissae in shock-elicited boxing (Bugbee & Eichelman, 1972).

This view of the role of the immobile boxing posture as a reliable predictor of fighting conflicts with a previous study reporting that the upright posture cannot be considered a major variable leading to a fight (Knutson & Hynan, 1972). Since manipulated differences of singly shocked rats precludes the importance of sensory factors governing a fight, perhaps a more reasonable explanation would be to suggest that when two animals are shocked, the social interactions will elicit behaviors that are prepotent over prior effects of training. This is supported in a study in which single animals trained to avoid shock were subsequently paired in an avoidance context (Logan & Boice, 1969). Avoidance decrements following pairing occurred in situations requiring close proximity between the animals.

Table 2 shows the mean number of striking, kicking, and biting instances per pair of animals. No strikes, kicks, or bites were ever observed in the .5-sec periods preceeding shock. However, such fighting responses sometimes occurred during shock, and also in the period just after shock termination. This immediate postshock period accounted for 53.5% of all such fighting responses.

Striking was by far the most frequent "fighting" response, accounting for 85.4% of all fighting responses. Furthermore, 83.74% of all strikes occurred during periods of shock and the .5-sec period following its offset. Over 76% of all strikes occurred when the animals were in the boxing posture. Kicks and bites were relatively rare and accounted for only 11.29% and 3.23% of all fighting responses, respectively. There were no observed kicks or bites during the nonfilmed intertrial interval.

Table 2 also presents the mean number of forelimb and hindlimb movements that began with the onset of shock and terminated during the .5-sec postshock period. The "forelimb movements" category involved movements identical in definition (movement of 1 cm or more in .5 sec or or less) to those of the "strike" category, with the exception that strikes were oriented with reference to the opponent animal, while forelimb movements were not. During frame-by-frame analysis, these movements could not be distinguished from strikes except in terms of orientation to the other rat, an observation that is congruent with the suggestion that strikes are in part reflexive forelimb jerks to shock in "boxing" rats (Blanchard, Blanchard, & Takahashi, in press).

This suggestion receives considerable support from the finding that the proportion of the total number of forepaw movements (strikes plus other movements) during fighting periods to total number of forepaw movements during nonfighting periods is almost identical to the relative proportions of forelimb extensions during fighting and nonfighting periods.

Perhaps the most parsimonious explanation of these relationships is suggested by the observation that rats in a boxing posture, or otherwise oriented toward each other in a shock situation, often appear to be pushing at each other with the forepaws. Thus forepaw extension is more frequent when there is mutual orientation;

Table 2
Mean Number of Fighting Responses and Limb Movements per Pair During Five Fight and Nonfight Periods

Mean Frequency	Fight	Nonfight
Strike	12.88	*
Forelimb Movements	8.63	11.88
Strike plus Forelimb Movement	21.51	11.88
Forepaw extension	8.00	4.00
Kick	1.75	*
Hindlimb Movement	6.75	9.38
Kick plus Hindlimb Movement	8.50	9.38
Bite	.88	*

**Could not occur in nonfight.*

shock given during forepaw extension is more likely to produce movement of the unsupported forelimbs, while the mutual orientation that promoted this extension virtually insures that the forelimb movements will also be oriented toward the opponent animal, and thus described as strikes.

This analysis serves equally well for the "kicking" data. Since forepaw extension should not physically facilitate kicking, the major factor influencing the incidence of kicks as opposed to hindlimb movements lies in the orientation of the movement. In fact, the total number of kicks plus hindlimb movements during fighting trials was almost identical to the number of hindlimb movements alone seen on nonfighting trials. This suggests the interpretation that both sets of movements are reflexive reactions to shock, but that some proportion of such actions appear to be "aimed" at the opponent when they are made by animals closely facing each other in a "boxing" posture.

The final fighting response was biting. Bites were quite infrequent with less than 1 shock in 20 resulting in a bite for each rat. Every bite made was localized to the head or snout region of the opposing animal. Moreover, lesions resulting from these bites were small punctate wounds rather than larger tears in the skin. In both these respects (and also in terms of infrequency), these are similar to the bites and wounds made by attacked rats on their attackers (Blanchard & Blanchard, 1977) and are extremely unlike bites by attackers on colony intruders.

This suggestion that the behaviors in shock-elicited fighting situations are defensive rather than aggressive in nature is opposed by a study reporting high initial levels of "aggressive threat" behavior in unrestricted paired and isolated rats (Reynierse, 1971). Given the social nature of aggressive behaviors in colonies of laboratory and wild rats (Barnett, 1975; Blanchard & Blanchard, 1977), it is difficult to conceive of a higher occurrence of "threat" behaviors in singly shocked animals than in pairs that were separated tactually but not visually. The "aggressive threat" behavior described in this study may perhaps consist of a freezing or crouching posture that occurs at high levels during intershock periods in isolated rats.

These analyses therefore provide several points of support for the notion that reflexive "fighting" consists of elements of a defensive pattern (boxing and biting at the snout) along with other actions (striking, kicking) that may be more parsimoniously interpreted as reflexive reactions to shock.

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