SHOCK-INDUCED THREAT AND BITING BY THE TURTLE¹

DAVID FRASER AND IRWIN M. SPIGEL

UNIVERSITY OF TORONTO

Shock-induced biting and threat by the male painted turtle (*Chrysemys picta marginata*) were studied in three experiments. When restrained facing each other, the turtles threatened and bit other turtles in response to electric shock. Shock alone caused turtles to threaten an unshocked turtle; the movements of a shocked turtle were sufficient to cause an unshocked but restrained turtle to threaten. When the turtles were free to move, they avoided an encounter when shocked, even reversing a strong position preference in order to do so.

In a variety of species, electric shock results in behavior that has been called pain-aggression (Azrin, Hutchinson, and Sallery, 1964), pain-elicited fighting (Payne, Anderson, and Murcurio, 1970), shock-induced aggression (Ulrich, Wolfe, and Dulaney, 1969) shock-induced fighting (Dreyer and Church, 1970; Ulrich, Wolfe, and Azrin (1964), and reflexive fighting (Blanchard and Blanchard, 1968). The first two experiments reported here explored analogous behavior in Central Painted Turtles (*Chrysemys picta marginata*).

Azrin, Hutchinson, and McLaughlin (1965) have shown that, for squirrel monkeys, the opportunity for aggression can act as an operant reinforcer during aversive stimulation. In the third experiment of this paper, turtles were allowed to approach or avoid an encounter with another turtle immediately after receiving electric shock.

EXPERIMENT 1

The first experiment was designed to demonstrate that biting and threat can be induced by electric shock in turtles.

METHOD

Subjects

Eight Central Painted Turtles, 4 to 6 yr of age as estimated from carapace length, were housed in a group in a Wahmann tank with areas for both swimming and basking. The turtles were screened before use, and several were rejected because they either withdrew their heads on being picked up, or failed to

threaten a second turtle held so that the nares of the two touched.

Apparatus

The experimental chamber was a 12 by 8 by 12.75 in. (30 by 20 by 27 cm) box with two metal sides, a metal bottom, and white curtains over each end. The chamber was illuminated by two overhead 15-w bulbs separated from the animals by the chamber's milk-glass top. The box was placed in a darkened room from which the experimenter could watch the turtles through a one-way vision window.

Shocks were delivered to the turtles via alligator clip electrodes attached to the tail and one leg of each subject. A Lafayette shock generator was controlled by two Hunter decade interval timers.

Procedure

The turtles, paired randomly, were removed from the home tank and held briefly in warm water to wet the skin uniformly. Each was then taped to the end of an upright brick. The alligator clips were attached, and the animals were placed in the test chamber facing one another. They were spaced sufficiently apart so that either animal could avoid being bitten by the other by withdrawing under the carapace. For most pairs, this meant that the front edges of the carapace were separated by

¹This research was financed in part by a grant from the National Research Council of Canada. We are grateful to Mr. S. A. Barnett and Mr. P. E. Cowan for their helpful comments on the manuscript. Reprints may be obtained from Irwin M. Spigel, Department of Psychology, University of Toronto, Toronto 5, Canada.

about 2 in. (5 cm). When in position on the bricks, the animals could move their heads and legs freely, but the legs could touch nothing. The turtles were unable, therefore, to change the position or orientation of their bodies.

The animals were allowed a 5-min period in which to habituate to the situation. The overhead light was then turned on and both turtles of each pair received a 1-sec, 1.0-mA shock at 29-sec intervals until 30 shocks had been delivered. During the intervals an observer recorded the behavior of the animals on a pen recorder.

RESULTS

During the first few seconds after a shock, the turtles generally extended their heads and waved their legs. Two activities commonly seen were threat and biting. In threat, one turtle faced the other, holding the jaws widely opened, often hissing loudly. In biting, the turtle darted its head forward and snapped its jaws closed on some part of the other animal's body. If the bite missed, the jaws snapped shut with an audible click; if the jaws gripped the other turtle, the attacker often withdrew its head under its carapace holding the grip for several seconds.

Fig. 1. The number of shocks followed by biting or threat during each second of the inter-shock interval.

Of the 240 shocks delivered, (eight turtles, 30 shocks each), 193 were followed by the turtle's threatening, or biting, or both. Combining the number of instances of threat and

biting, Fig. 1 shows that aggressive behavior was common during the first few seconds after the onset of shock. The behavior was, however, quite variable. Some turtles generally threatened or bit only once after each shock; this tended to be done immediately after the shock was delivered. Others showed additional threatening and biting later in the inter-shock interval. The cause of these later bouts was not always apparent, but some of them were probably occasioned by movement of the other turtle.

EXPERIMENT 2

In this experiment, behavior was studied while both animals were shocked, when only one of the pair was shocked, and when neither animal was shocked.

METHOD

Subjects

Twelve naive turtles, paired randomly, were used. The apparatus and the preparation of the animals was the same as in Exp. 1.

Procedure

After a 5-min habituation period, subjects were given four blocks of eight trials with each block separated by a 5-min interval with the light turned off. The four blocks corresponded to the four possible conditions: neither animal shocked, the left-hand animal shocked, the right-hand animal shocked, and both animals shocked.

Shocks were of 1-sec duration, 1.0-mA ac separated by 20-sec intervals. During each post-shock period, an observer scored whether the animal had threatened without biting (scored as threat), or had simply bitten or had both threatened and bitten (which was scored as biting).

Each of the six pairs of turtles was given three such daily sessions. In each session the condition in which neither animal was shocked was applied first in order to establish a baseline. The remaining three conditions were ordered according to the principle of two Latin squares counter-balanced for order effects; *i.e.*, each condition occurred in each position of the order for each pair, and following each other condition an equal number of times.

RESULTS

On each day, a turtle was observed under four conditions: *both*, when both turtles were shocked; *neither*, when neither turtle was shocked; *alone* when the first turtle was shocked but the partner was not; and *other*, when only the partner was shocked. The number of trials resulting in (a) biting, and (b) threat-without-biting were combined across days for the 12 animals in the four conditions, and these figures appear as percentages in Fig. 2.

Fig. 2. The percentage of trials that resulted in threat or biting in each of four conditions: *Both* shocked, the animal shocked *Alone*, only the *Other* animal shocked, and *Neither* animal shocked.

Analysis of variance of recorded scores indicated significant differences across conditions for both threat and biting ($F = 6.18$, $df = 3/44$; $F = 17.83$, $df = 3/44$, respectively). More biting was observed under the *both* condition than under any other condition, and the *alone* condition resulted in more biting than the *neither* condition. All three shock conditions resulted in more threat than did the *neither* condition, and the *both* condition gave rise to more threat than did the *other* condition.

In brief, then, threat was elicited by (i) shock alone, (ii) the movements of a partner responding to shock, (iii) these two factors in combination, and the combination was the most effective. Biting was elicited by shock alone, and by shock in combination with the moving partner. If both animals were shocked, biting was more common than threat; the reverse was true if only one animal was shocked.

EXPERIMENT 3

In the above experiments, shock elicited threat and biting when the turtles were restrained so that they could not turn away from each other. Pilot work suggested that turtles avoided encounters when shocked if they were not so restrained.

Earlier observations by Spigel and Ellis (1965) and pilot work for the present experiment showed that after a turtle had entered one arm of a Y-maze several times, it rarely turned in the other direction even after forced trials. If the preferred arm was blocked, the turtle generally climbed over the obstruction or pushed against it, rarely turning in the other direction. In this experiment, unrestrained turtles were allowed to approach or to avoid another turtle when shocked, but they were required to overcome an established tendency to turn in one direction in order to approach or to avoid consistently.

Subjects

Eight turtles were selected from those that displayed the most threat and biting in Exp. 2.

Apparatus

The shock-producing and scheduling apparatus of the previous experiments was used. A topless, 6 in. (15 cm) deep, grey, wooden Y-maze served as the test box. The start-box was 6 in. (15 cm) square and was separated by a removable partition from the choice point, which led to two 9 by 6 in. (23 by 15 cm) arms at right angles to one another. A 100-w overhead bulb illuminated the chamber.

Procedure

Turtles, paired randomly, were removed from the home tank, dipped in warm water, and the alligator clips attached to the tail and one hind leg.

The target animal was taped to the floor in one arm of the Y-maze so that the test animal could pass through the choice point into the unoccupied arm of the maze without touching the target turtle, but in such a way that when the test turtle was at the choice point the two animals faced each other with a separation of 2 to 3.25 in. (5 to 8 cm).

In each session the test animal was given two forced-choice trials to each side of the maze. Then the target animal was placed in one arm

of the maze, and the test animal was given 10 free-choice trials. The target animal was removed, and the test animal was given two more forced-choice trials to each side of the maze. Then the target animal was placed in the other arm, and 10 more free-choice trials were given.

For each trial, the test animal was left in the start box with the partition in place for 10 sec. The partition was then removed, and a 1-sec 1.0 mA ac shock was delivered to both animals. The target turtle generally moved its head and legs in response to the shock, and the test animal almost invariably moved forward into one arm of the maze. It was left in the arm for 10 sec before being returned to the start box. If the test turtle did not cross the entrance to either arm of the maze within 10 sec of shock onset, additional shocks were given to both animals at 10-sec intervals until it did.

The forced-choice trials differed from the free-choice trials only in that the entrance to one arm of the maze was blocked, and the target animal was not in the maze.

During each trial an observer recorded which arm the test animal entered, and whether either animal displayed threat or biting.

Each turtle served once as test animal and once as target animal on successive days.

RESULTS

Figure 3 shows individual results for the eight test turtles. Seven of the eight consistently entered the unoccupied arm during the first block of 10 free-choice trials. Of these eight turtles, only T5 threatened the target turtle. Although T2 entered the occupied arm six times, it did not threaten or bite the target turtle; rather, it climbed over its carapace.

Six of the eight test turtles continued to avoid the occupied arm during the second block of 10 free-choice trials. In so doing, these animals had to overcome the side-preference they had apparently developed during the first block. On the first free-choice trial after the change these six turtles typically turned, at first, in the usual direction, but when they were faced by the target turtle they stopped, backed up, or performed an awkward-looking sidestep and entered the unoccupied arm. This sort of behavior was never seen in pilot exper-

Fig. 3. The total number of avoidances (out of 10 made by each of the eight turtles during the first and second blocks of 10 trials.

iments when an inanimate object obstructed the preferred arm. T3 was the one turtle that consistently avoided the occupied arm during the first block of trials, but failed to do so during the second block. This animal did not threaten at all during its successful avoidances, but threatened on five occasions when it approached the target turtle. It did not, however, bite the target turtle; rather, it climbed over its carapace.

On average the unrestrained test turtles threatened on only 0.6% of the trials, while the restrained target turtles threatened on 38% of the trials, (Mann-Whitney $U_{8,8} = 14$, $p < 0.05$).

DISCUSSION

Under the conditions of the first experiment, shock elicited threat and biting when two turtles were restrained facing each other, a short distance apart. But when two animals are shocked simultaneously there may be at least two factors influencing their behavior: (i) the shock itself, and (ii) the proximity of another turtle moving or threatening in response to shock. Experiment 2 attempted to separate these factors. It showed that shock alone elicits threat and biting directed toward an unshocked partner, and that the movements of the shocked partner are sufficient to elicit threat and biting from an unshocked animal. It is also interesting that biting was more common than threat when both animals were shocked, but the reverse was true when only one was shocked.

Much of the literature on shock-induced aggression falls into two categories. In some studies, two animals are shocked and their behavior with respect to each other is recorded. Ulrich and Azrin (1962) found that when two laboratory rats were shocked together, they performed certain actions including the boxing posture. Various authors have called this behavior aggression. Other studies have observed the behavior of shocked animals towards inanimate objects. Shock-elicited biting of such targets has been demonstrated for laboratory rats (Azrin, Ruban, and Hutchinson, 1968), wild rats (Galef, 1970), and squirrel monkeys (Azrin *et al.*, 1965). This behavior, too, has sometimes been called aggression.

Dreyer and Church (1970) studied the first type of shock-elicited behavior with laboratory rats and concluded that the opportunity for aggression during noncontingent shock was acting as a reinforcer for their animals. Azrin *et al.* (1965) studied the second type of aggression with squirrel monkeys and drew a similar conclusion. But in the present study, shocked turtles appeared to avoid the opportunity to threaten and bite another turtle after shock was delivered to both animals. The conditions of the experiment were very limited, (one shock intensity, one type of apparatus), but suggest caution in cross-species generalizations.

REFERENCES

- Azrin, N. H., Hutchinson, R. R., and McLaughlin, R. The opportunity for aggression as an operant reinforcer during aversive stimulation. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 171-180.
- Azrin, N. H., Hutchinson, R. R., and Sallery, R. D. Pain-aggression toward inanimate objects. *Journal of the Experimental Analysis of Behavior*, 1964, 7, 223-228.
- Azrin, N. H., Rubin, H. B., and Hutchinson, R. R. Biting attack by rats in response to aversive shock. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 633-639.
- Blanchard, R. J. and Blanchard, D. C. Limbic lesions and reflexive fighting. *Journal of Comparative and Physiological Psychology*, 1968, 66, 603-605.
- Dreyer, P. I. and Church, R. M. Reinforcement of shock-induced fighting. *Psychonomic Science*, 1970, 18, 147-148.
- Galef, B. G., Jr. Target novelty elicits and directs shock-associated aggression in wild rats. *Journal of Comparative and Physiological Psychology*, 1970, 71, 87-91.
- Payne, R., Anderson, D. C., and Murcurio, J. Pre-shock-produced alterations in pain-elicited fighting. *Journal of Comparative and Physiological Psychology*, 1970, 71, 258-266.
- Spigel, I. M. and Ellis, K. R. An emergent albedo preference in turtle. *Perceptual and Motor Skills*, 1965, 21, 113-114.
- Ulrich, R. E. and Azrin, N. H. Reflexive fighting in response to aversive stimulation. *Journal of Experimental Analysis of Behavior*, 1962, 5, 511-520.
- Ulrich, R. E., Wolff, P. C., and Azrin, N. H. Shock as an elicitor of intra- and inter-species fighting behavior. *Animal Behavior*, 1964, 12, 14-15.
- Ulrich, R., Wolfe, M., and Dulaney, S. Punishment of shock-induced aggression. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 1009-1015.

Received: 8 September 1971.
(Final Acceptance: 27 May 1971.)