Shock-elicited behaviors in paired gerbils*

ROBERT BOICE and ANTONETTE PICKERING

University of Missouri, Columbia, Mo. 65201

Pairs of shocked gerbils showed agonistic behaviors in encounters that were terminated when one animal showed a clearly submissive response. Intense aggression diminished, encounter durations decreased, and males won encounters increasingly more than females over days as a reliable dominance hierarchy was established.

If two organisms which have been coexisting peacefully receive painful shocks, they immediately exhibit characteristic patterns of aggression toward each other [Skinner, 1972, P. 27].

Skinner's use of "elicited aggression" as proof of the evolutionary adaptiveness of operant research incorporates three erroneous beliefs commonly found in the literature. One is that there is a characteristic pattern of shock-elicited behaviors in paired organisms. Another is that the behaviors are simply aggressive. The third erroneous belief is that the evolutionary significance of the behaviors is unrelated to genetic variables, including domestication.

"Characteristic patterns" of agonism apparently do not include reliably fixed sequences of behaviors in rodents (Barnett, 1963), but the variety of agonistic postures (Grant & Mackintosh, 1963; Reynierse, 1971a) is far greater than the sparring posture often used as sole criterion (Ulrich, 1966). Further objectification of such "aggression" to automatic recording of biting in a nonsocial context (Azrin, Rubin, & Hutchinson, 1968) only amplifies the problem of arbitrary limitation of definition. That is, once biting is arbitrarily equated with "aggression," then questions of validity of that measure diminish in the face of more systematic research. In paired squirrels, for example, footshock produces a variety of agonistic behaviors, including sparring, some of which are eventually replaced with threat postures (Turner, Boice, & Powers, in press).

King (1966) was one of the first to question the use of the label "aggressive" in these studies. He suggested that sparring is one element in a constellation of agonistic behaviors, including escape, threat, freezing, defensive postures, and dominance. Indeed, if some usual constraints are loosened in this context, dominance/submissiveness behaviors are most salient (Logan & Boice, 1969). In a more conventional situation, flight is prevented and defensive behaviors may be critical (Reynierse, 1971b).

The refusal of researchers in this area to openly recognize genetic variables is perhaps a tribute to the

Skinnerian influence stimulating the studies; Ulrich (1966) simply dismisses genetically determined tendencies to fight as complications solved by use of docile white rats. The variable of domestication concerns the docility and aggressiveness of animals typically used in psychological research, yet many psychologists remain naive regarding this variable (Boice, 1972, 1973). Thus, for example, Ashe & McCain (1972) are surprised that gerbil behavior cannot be extrapolated from hooded rat behavior. They seem to fail to recognize that gerbils are only semidomesticated relative to the domestication of laboratory rats. Dunstone, Cannon, Chickson, & Burns (1972) are surprised that gerbils actually bite in a shock-induced context and suppose the gerbil to be a unique rodent. What is relatively unique about gerbils as laboratory Ss is that tendencies to bite have not been removed by domestication. The quite ununique Norway rat bites with vigor if not domesticated (Logan & Boice, 1969) or even if in company with wild rats (Boice, 1972).

The present study is an attempt to deal with these problems in an animal increasingly affected by them, the gerbil. Particular attention is directed to the variety and system of agonistic behaviors as they effect dominance and submission in paired, shocked gerbils.

METHOD

Subjects

The gerbils (*Meriones unguiculatus*), all from different litters, were obtained from Tumblebrook Farms, Brant Lake, N.Y. at 7 weeks of age. Upon arrival, they were individually housed in plastic-bottomed cages with San-I-Cell bedding and free access to water and Purina Lab Chow and sunflower seeds.

The Ss were five males and five females, 40 weeks old.

Apparatus

The shock chamber was clear Plexiglas of 31 x 18 x 26 cm and was divided into two equal compartments by a vertical, sliding, Plexiglas partition which was manually operated. The floor consisted of stainless steel grids, 3 mm in diam, spaced 6 mm center to center. During the shock condition, the grids were charged in series with neon bulbs with 1.5 mA at 34 V dc; the animals could not escape shock while standing on any two grids.

Procedure

Ss, identified by washable markings on their tails, were taken from their home cages in plastic containers and transferred to the shock chamber for testing. Two Es each placed a gerbil into the appropriate side of the chamber at approximately the same time. Each S was paired with every other S each day for 10 consecutive days; thus each gerbil had nine encounters per day. There were three pair types: male-male, female-female, and male-female, with the total number of encounters per day 10, 10, and 25, respectively. Sequencing of trials within a daily session was random except for the constraint against successive encounters for any S. Placement of Ss in compartment sides was counterbalanced.

The onset of each encounter of trial was signaled by lowering the partition through the grids. If no criterion submissive response was displayed by either S within 5 sec, shock was delivered until either one S showed a submissive posture or until

*This paper was presented at the Midwestern Psychological Association Meetings, Cleveland, 1972. Reprints: R. Boice, Department of Psychology, 209 McAlester Hall, University of Missouri, Columbia, Mo. 65201.

Fig. 1. Mean durations of daily encounters shown in the solid lines for male-male, female-female, and all pair types combined. Broken lines indicate standard deviations.

30 sec of shock elapsed, whichever came first.

All descriptions of behaviors were recorded on audio tape. Observations were categorized into 5-sec blocks, which pertained to behaviors in the initial (pre-encounter), the door-down, the shock-elicited, and the dominance phases of the trial. Judgments concerning submissiveness and termination of trials were made only upon agreement of both Es. Trials lasting the full 30 sec resulted in a rating of tie for that encounter. Criteria of submission were similar to those used in research with other rodents (e.g., Turner, Boice, & Powers, in press). Essentially, submission was defined as a clear instance of body aversion or head aversion with averted gaze.

Thirty-eight other classes of behavior were recorded, including sparring, eye closure, defecation, biting, and threat, using conventions from Grant & Mackintosh (1963), Barnett (1963),

Eisenberg (1963), and Reynierse (1971a). Seven of these are presented and briefly described anon.

RESULTS

Male-male bouts were of longest, female-female bouts of shortest, and male-female bouts of intermediate duration (Fig. 1). Two additional trends are evident in these data; especially if male-male pairings are excluded: Duration of encounters and variance of that duration generally decreased over days. In female-female pairs, Days 5-10 were characterized by an absence of ties and terminations. This occurred in male-male pairs only on Days 6, 7, and 10, in male-female pairings on Days 6, 7, 8, and 10.

A win/lose ratio was calculated for each animal to provide daily rank-orders (Table 1). Reliable hierarchies began to emerge by Days 2 and 3 ($\rho = .83$, $p < .01$; Siegel, 1956). They continued to be significant on Days 4 and 5 ($\rho = .64$, $p < .05$), Days 6 and 7 ($\rho = .99$, $p < .01$), and Days 9 and 10 ($\rho = .65$, $p < .05$). Rankings on Days 8 and 9 were not significantly reliable ($\rho = .48$, $p > .05$).

Over days, male gerbils increased their total number of wins (Fig. 2). The relatively low correlations for Days 4 and 5 in Table 1 reflect the shift of females toward the bottom of the hierarchy. The most abrupt shift of ranks in Table 1, came with a foot injury to Male 2 on Day 8. By Day 9, he had dropped from first rank to ninth rank.

A brief account of some of S 2's encounters on Days 8 and 9 provides some description of events common to winners and losers. Prior to his injury in Day 8, his behaviors were similar to those of previous days: Assumption of threat posture elicited quick withdrawals with head or body aversion in Females 8 and 9 and the addition of quick movement to the opposite side of the chamber by Female 7. After the injury, he submitted to all opponents except Females 9 and 10, bracing himself against the wall of the chamber in an apparent attempt to maintain an upright stance. On Day 9, S 2 showed quick submissive postures of head and eye aversion to all male opponents, but not until after shock onset. There was no apparent tendency of any of the Ss to show clear threats or aversion prior to shock onset, as had been

Table 1
Dominance Ranks Over Days Based on Won/Lost Ratios

S Number*	Days									
	1	2	3	4	5	6	7	8	9	10
1 ♂	7	1	1	1	6.5	4	4	2.5	1	2
5 ♂	8	4	5	2	2	1.5	2	2.5	3	3
2 ♂	3.5	3	3	3	1	1.5	1	1	9	8
4 ♂	5	9	7	4	5	5	5	5	4	4
3 ♂	9	10	9.5	6	4	3	3	4	2	1
7 ♀	2	2	2	7	3	6.5	7	7	6.5	8
6 ♀	3.5	8	5	5	6.5	6.5	6	6	5	10
8 ♀	1	7	8	9	8	8	8	8	8	5
10 ♀	10	6	9.5	10	10	10	10	10	6.5	8
9 ♀	6	5	5	8	9	9	9	9	10	6

*Ordered by overall rank

observed with packrats in an analogous situation (Logan & Boice, 1969). Foot stamping, most common in males, was present during Days 3-10 during the initial period. Head bobbing, also somewhat specific to males, was observed on Days 2-4 and 7-10 during the initial period.

There were more ties in the male-male pairs (15) than in female-female pairs (6); surprisingly, the highest total of tied encounters came in male-female pairs (20).

The correlation between overall rank and a mean of daily body weights was not significant ($\rho = -.44$, $p > .10$ for a two-tailed test). The negative correlation reflects the lower mean body weight of the males (88.1 g) compared to the females (96.4 g).

In general, there was a decrease in aggressive behaviors and a stability of dominance and submissive behaviors over days (Table 2). Wrestling accompanied by biting did not appear until Day 3, but the totals of this and the separated aspects, wrestling or biting, of aggression were less on Days 6-10 than on Days 1-5. The more intermediate behavior of sparring usually preceded actual aggression and this too declined over days.

Threat postures, which might be assumed to be a logical substitute for aggression in the dominant animal, were defined here as looking toward the other animal with a fixed gaze, with back arched, and an upright stance (sometimes accompanied by tail flagging; Eisenberg, 1963). Threats did not, however, show a systematic increase over days. Nor did the two fundamental submissive postures of head and body aversion.

Analysis of behavior categories by time segments suggested that: (1) pair type differences exist with regard to the behaviors present and to the degree they are represented within and across trials: (2) more aggressive behaviors tend to follow nonaggressive behaviors, while dominance or submission follow the aggressive behaviors; and (3) more intense components appear later in trials. These findings resemble those with gerbils in a nonshock situation (Reynierse, 1971a).

DISCUSSION

There were three clear results in this study: (1) A reliable dominance hierarchy emerged over test days. (2) males won increasingly over females, with males holding Ranks 1-5 and females Ranks 6-10 in the overall hierarchy, and (3) aggressive behaviors such as biting and wrestling diminished over days as

Fig. 2. Total number of wins for males vs females over days.

the durations of encounters generally decreased.

The experimental establishment of dominance hierarchies in gerbils is not new (Boice, Hughes, & Cobb, 1969), but the use of a shock-elicited paradigm to effect it is. The finding of a dominance hierarchy as in wild ground squirrels (Turner, Boice & Powers, in press) is also extended to gerbils. In both studies with shock, intense aggression diminished as the hierarchy was maintained. But both studies seem subject to the criticism that the results can be explained away as nothing more than learning escape and avoidance contingencies. This criticism seems to ignore the possibility that dominance hierarchies are learned in nature. And it fails to account for the fact of individual recognition shown by differential responding (i.e., dominance or submission) consistent with particular opponents.

There is also agreement in this and the study with squirrels that females fare poorly in such encounters. The significance of this finding awaits further research, since the role of females in laboratory dominance hierarchies has been largely neglected. Field studies of primates (DeVore, 1965) suggest that the role of females in dominance hierarchies is surprisingly complex, or perhaps that the proper study of dominance hierarchies might exclude females.

More significant to the general area of research on shock-elicited agonistic behaviors is the demonstration that this is a dynamic social situation in which no one behavior, including sparring, can be designated representative. Indeed, careful observation of this situation suggested that aggression is not even the salient aspect. Sparring, for example, appears in photographic analysis to include much jumping to avoid shock. It might be necessary to include the label "defensive" with those behaviors previously called "aggressive" if further credence is given to the observation by Reynierse (1971b) that "systematic observation of the postures of shocked laboratory rats indicates that their behavior is probably a blend of aggression and submission [p. 106]."

Table 2
Total Frequency of Selected Behaviors Over Days

Behavior	Days									
	1	2	3	4	5	6	7	8	9	10
Biting	4	2	0	1	0	0	2	2	0	0
Wrestling	6	33	14	30	24	4	0	10	0	8
Wrestling and Biting	0	0	30	34	14	4	2	2	8	0
Sparring	106	80	42	24	26	22	6	18	40	12
Threat	40	52	36	43	34	47	39	40	31	34
Avert Head	30	11	16	23	13	14	8	11	22	18
Avert Body	7	32	22	30	29	33	32	40	34	25

REFERENCES

- Ashe, V. M., & McCain, G. Comparison of one-way and shuttle-avoidance performance of gerbils and rats. *Journal of Comparative & Physiological Psychology*, 1972, 80, 293-296.
- Azrin, N. H., Rubin, H. B., & Hutchinson, R. R. Biting attack by rats in response to aversive shock. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 633-639.
- Baenninger, L. P. The reliability of dominance in rats. *Animal Behaviour*, 1966, 14, 367-371.
- Barnett, S. A. *The rat*. Chicago: Aldine, 1963.
- Boice, R. Some behavioral tests of domestication in Norway rats. *Behaviour*, 1972, 42, 198-231.
- Boice, R. Domestication. *Psychological Bulletin*, 1973, in press.
- Boice, R., Hughes, D., & Cobb, C. J. Social dominance in gerbils and hamsters. *Psychonomic Science*, 1969, 16, 127-128.
- DeVore, I. (Ed.) *Primate behavior: Field studies of monkeys and apes*. New York: Holt, Rineheart & Winston, 1965.
- Dunstone, J. J., Cannon, J. T., Chickson, J. T., & Burns, W. K. Persistence and vigor of shock-induced aggression in gerbils. *Psychonomic Science*, 1972, 28, 272-274.
- Eisenberg, J. F. The behavior of heteromyid rodents. *University of California Publications in Zoology*, 1963, 69, 1-100.
- Grant, F. C., & Mackintosh, J. H. A comparison of the social postures of some common laboratory rodents. *Behaviour*, 1963, 21, 246-259.
- King, J. A. Recent findings in the experimental analysis of aggression. *American Zoologist*, 1966, 6, 628.
- Logan, F. A., & Boice, R. Aggressive behaviors of paired rodents in an avoidance context. *Behaviour*, 1969, 34, 161-183.
- Reynierse, J. H. Agonistic behavior in Mongolian gerbils. *Zeitschrift für Tierpsychologie*, 1971a, 29, 175-179.
- Reynierse, J. H. Submissive postures during shock-elicited aggression. *Animal Behaviour*, 1971b, 19, 102-107.
- Siegel, S. *Nonparametric statistics for the behavioral sciences*. New York: McGraw-Hill, 1956.
- Skinner, B. F. *Beyond freedom and dignity*. New York: Baentam, 1972.
- Turner, J. L., Boice, R., & Powers, P. C. Behavioral components of shock-elicited aggression in ground squirrels (*Citellus tridecemlineatus*). *Animal Learning & Behavior*, in press.
- Ulrich, R. Pain as a cause of aggression. *American Zoologist*, 1966, 6, 643-662.

(Received for publication June 18, 1973.)