A COMPARISON OF ESCAPE AND AVOIDANCE CONDITIONING IN WILD AND DOMESTICATED RATS¹

ROBERT W. POWELL AND GRANT MORRIS

UNIVERSITY OF SOUTH FLORIDA

In the first of two experiments, three cotton rats (*Sigmodon hispidus*) and three albino rats were exposed to instrumental escape, unsignaled avoidance, and signaled avoidance, in that order. All subjects learned the escape procedure quickly, with the albino rats having generally shorter latencies, higher response rates, and requiring fewer sessions to reach the criterion. When the avoidance contingency was introduced, the cotton rats continued to respond almost entirely in the presence of the shock, whereas the albino rats responded in its absence, thus displaying effective avoidance behavior. Introduction of a pre-aversive stimulus did not improve the performance of the cotton rats. In the second experiment, five cotton rats and four albino rats were exposed to a free-operant (Sidman) avoidance procedure with a shock-shock interval of 3 sec and a response-shock interval of 20 sec. The cotton rats initiated responding at lower shock intensities than the albino rats, but their asymptotic avoidance responding was far less effective.

Few behavioral comparisons have been made between wild and domesticated animals which are closely related on the phylogenetic scale. The present investigation was undertaken for this purpose. The animals studied are not of the same family, but they do belong to the same order and suborder, and their relationship would appear to be close enough to permit meaningful behavioral comparisons.

EXPERIMENT I

Method

Three experimentally naive albino rats (*Rattus rattus*) of the Wistar strain, two male and one female, and three adult male cotton rats (*Sigmodon hispidus*), approximately six and three months old respectively at the start of the experiment, served as subjects. The albinos weighed 225 to 275 g and the cotton rats 150 to 200 g. The cotton rats were trapped in the field and brought into the laboratory approximately one month before the experiment. All animals were housed in individual cages and had free access to food and water throughout the experiment.

A Gerbrands rat test chamber and Grason-Stadler electromechanical circuits served as the apparatus. Electric shock was provided by a 110-v ac shock source which included 200,000 ohms in series with the output. The shock was scrambled to the grid floor of the test chamber. Data were recorded by electromechanical counters and a Gerbrands cumulative recorder.

The animals were successively exposed to three experimental contingencies: escape, unsignaled avoidance, and signaled avoidance. No shaping procedure of any type was used. The animals were merely placed in the experimental chamber, and after a 15-min period to allow for adaptation, the shock was turned on.

Under the escape contingency, each bar press turned the shock off for 18 sec. Responses during the shock-off period had no effect. The avoidance contingency differed in that responses during the shock-off period served to reset a timer, and thus postpone shock for 18 sec. During the unsignaled component, no cue as to shock imminence was given. During the signaled component, a bank of four 28-v dc bulbs came on 3.5 sec before the shock, and remained on until the animal responded. The lights were mounted behind a translucent panel approximately 2 in. above the bar.

Each animal was initially exposed to a shock level of 0.5 ma. This level was increased as necessary to establish and maintain effective

¹This work was supported in part by a grant from the University of South Florida Research Council. A report of this study was presented at the 1968 Eastern Psychological Association Convention, Washington, D.C. Reprints may be obtained from Robert W. Powell, Department of Behavioral Science, University of South Florida, Tampa, Florida 33620.

responding under the escape procedure. Effective responding was defined as a reduction in total time that the shock was on to less than 20% of the experimental session. After one day of effective responding under the escape schedule, the animals were shifted to the unsignaled avoidance contingency. This procedure was continued until a stable level of performance was achieved. Stability was defined as a range of 30 or fewer shock occurrences over five consecutive sessions. The shift to signaled avoidance was made when this criterion was met. Experimental sessions lasted 1 hr each day.

Results

All animals met the escape criterion; results for the session when this occurred are shown in Table 1.

The albino rats, as a group, performed somewhat better under this condition than did the cotton rats. They had generally shorter latencies, higher rates of response, and achieved the criterion in fewer sessions. One of the cotton rats (Sig. 1) was noticeably superior to the other two, performing as well as two of the albino rats.

When the avoidance contingency was introduced, a clear-cut difference between the groups developed in the first session and grew increasingly larger over time. The albino rats rapidly decreased the number of shocks to approximately 10 to 20% of the number they had received under the escape schedule. The cotton rats continued to receive almost as many shocks under the avoidance schedule as they had under the escape schedule. The change from unsignaled to signaled avoidance had little effect upon the avoidance of either group, with the exception of Sig. 2, which reduced the mean number of shocks by 15% under this condition. All of the animals ex-

cept Sig. 1 showed reduced responding under signaled as compared to unsignaled avoidance, with decreases ranging from 5% (Alb C) to 20% (Alb A). These data are shown in Fig. 1.

The cumulative records of the last session under unsignaled avoidance for all subject are shown in Fig. 2. All cotton rats displayed a consistent pattern of responding immediately upon onset of shock, but they made very few responses in its absence. The albino rats, on the other hand, responded in the absence of shock, and thus avoided a large percentage of the shocks.

EXPERIMENT II

Method

This experiment was performed to examine the possible contributions of several variables to the differences obtained in the first experiment. One intention was to examine the effect of initial exposure to an avoidance contingency upon responding, as compared to avoidance responding after initial exposure to an escape contingency. The subjects were five cotton rats and four albino rats. Two of the cotton rats had participated in the first experiment (Rats 2 and 3), while the remainder of the animals were experimentally naive. A free operant avoidance (Sidman, 1953) procedure was used. Under this procedure, a fixed time interval occurs between the presentation of brief electric shocks in the absence of a lever-press response (shock-shock interval), and each lever-press postpones the next shock for a fixed period of time (response-shock interval). In the present case, the shock-shock and response-shock intervals were 3 and 20 sec, respectively. The shock duration was 0.5 sec. Responses in the presence of shock did not terminate it. Experimental sessions were 1 hr each day.

Table 1
Performance for the Final Session Under the Escape Schedule for Each Animal

Subjects	Shock Intensity (ma)	No. of Shocks	% of Time Shock on	Total Sec Shock	Mean Latency (Sec)	Responses	No. of Sessions to Criterion
Sig 1	0.50	179	10.50	378	2.11	264	2
Sig 2	0.75	169	15.50	558	3.30	290	4
Sig 3	2.00	167	16.50	594	3.56	289	8
Alb A	1.00	178	11.00	396	2.22	497	3
Alb B	0.75	180	10.00	360	2.00	276	3
Alb C	0.75	192	4.00	144	0.75	386	2

Fig. 1. The number of shocks and responses for each animal under unsignaled and signaled avoidance.

Fig. 2. Cumulative records of the last session under unsignaled avoidance for each animal. The downward pips indicate shock onset.

All animals were first exposed to a shock intensity of 1.0 ma and this was increased in increments of 0.25 ma as required to initiate effective responding. Effective responding was defined as 100 or more responses in an experimental session. Shock intensity was then successively increased in increments of 0.25 ma as stable performance was achieved at a particular shock level. Stable performance was again defined as a range of 30 or fewer shock occurrences over five consecutive sessions. The shock intensity was similarly increased if the animal failed to meet this criterion after 15 sessions. An animal was exposed to successively higher shock intensities as long as it continued to reduce the mean number of shock occurrences by 10 or more from the number received at the preceding shock level.

Results

The number of shock occurrences over the last three sessions at each intensity is shown for all subjects in Fig. 3.

The cotton rats met the criterion for effective

responding at much lower intensities than did the albino rats. All cotton rats responded effectively at 1.0 ma whereas none of the albino rats met the criterion until 1.75 ma. Once responding was initiated, however, the albino rats quickly achieved more effective avoidance responding than did the cotton rats. With one exception (Sig. 4), all of the albino rats performed more effectively than did the cotton rats. A Mann-Whitney U Test of the most effective avoidance displayed by each of the subjects over five consecutive sessions yields $p = 0.032$ (two tailed), given that the two samples were drawn from the same population. Four of the five cotton rats displayed response patterns very similar to those seen for this group in Exp. I. They responded immediately to presentation of the shock, but made very few responses in its absence. Sidman (1966) pointed out that most animals pass through this phase before they achieve more effective shock avoidance. Only one cotton rat progressed beyond this stage over the range of shock intensities employed

Fig. 3. The number of shocks over the last three sessions at each shock intensity for each animal. The data for sessions when performance was below criterion are not presented here. These data are available in Table 2.

here. Thus, the number of shock occurrences for four of the cotton rats closely approximates the duration of the session divided by the response-shock interval plus the shock duration ($\frac{3600}{20 + 0.5} = 175.6$).

The number of sessions at each shock intensity, with asymptotic response rates and shock occurrences, is given for each subject in Table 2.

DISCUSSION

Both experiments showed rather marked differences between cotton rats and albino rats in instrumental avoidance responding. The cotton rats typically initiated responding at lower shock intensities, but with one exception, they did not achieve the level of avoidance effectiveness attained by the albino rats. Direct observation of the animals in the experimental chamber confirmed that the

cotton rats did display a much more intense reflexive response to the shock.

While the albino rats were somewhat superior in several measures under the simple escape contingency in Exp. I, the differences between groups were much smaller than those observed under either avoidance condition.

The albino rats consistently displayed higher response rates, but the major difference observed was that the cotton rats, with the exception of Sig. 4, made few responses except to shock presentation. The albino rats responded in the absence of the shock to postpone its onset.

The three naive cotton rats employed in Exp. II, and thus lacking an escape history, did perform somewhat better than those animals initially trained to escape. The differences were not great enough, however, to indicate that this variable played more than a minor role in the differences observed. Increases in shock intensity improved the per-

Table 2

The number of sessions and the mean number of responses and shocks over the final five sessions at each shock intensity.*

Subjects		Shock Intensity (ma)					
		1.00	1.25	1.50	1.75	2.00	2.25 2.50
Sig 2	Sessions	15	5	5	5	15	
	Responses	200	302	339	384	324	
	Shocks	324	213	193	172	165	
Sig 3	Sessions	11	7	5	6	7	
	Responses	160	164	209	265	227	
	Shocks	357	345	314	218	285	
Sig 4	Sessions	15	7	15			
	Responses	291	315	400			
	Shocks	77	51	52			
Sig 5	Sessions	15	6	7	5		
	Responses	216	254	291	326		
	Shocks	194	179	169	189		
Sig 7	Sessions	14	8	7			
	Responses	258	316	344			
	Shocks	212	169	173			
Alb D	Sessions	2	1	1	1	15	13
	Responses	2	0	0	3	545	489
	Shocks	1016	1028	1028	1010	35	34
Alb E	Sessions	1	1	1	15	14	7
	Responses	4	3	25	468	495	581
	Shocks	1004	1011	907	44	33	22
Alb F	Sessions	1	1	1	1	15	8
	Responses	0	7	0	17	408	334
	Shocks	1028	998	1028	960	38	18
Alb G	Sessions	1	1	2	15	12	9
	Responses	2	0	53	269	274	269
	Shocks	1020	1028	938	83	72	115

*Where data for fewer than five sessions are presented, the performance was below criterion.

formance of both groups, but did not significantly alter the pattern of responding of any of the cotton rats.

Based upon his behavioral studies of wild White-footed mice, Kavanau (1967) sounded a note of caution to experimenters. He stated:

"The existence of marked individual differences between mice selected at random from wild populations sounds the need for a cautious approach in the interpretation of results obtained with highly inbred domestic animals. The relatively uniform behavior of inbred strains represents only a small fragment of the total response spectrum for the species and probably has minimal significance for adaptation and evolution in the wild" [p. 1639].

Whether the differences found in the present experiment are due to differences in the species themselves, or whether they relate to the vastly different histories of the two groups of subjects, cannot now be stated. This question can be approached by breeding and raising wild specimens in the laboratory, and then making relevant behavioral comparisons with domesticated species. Another approach would be to secure wild specimens of *Rattus rattus* and compare the field-caught with

laboratory-reared specimens. Boice, Denny, and Evans (1967) recently compared wild and domesticated Norway rats in the acquisition of shuttle-box avoidance. They found no significant differences between groups, although the wild rats did begin to avoid earlier. These authors did not report data for individual subjects, so a more precise interspecies comparison cannot be made from their report.

Sigmodon hispidus, the species studied here, is a particularly vicious and intractable animal. While they did adapt somewhat to handling after several months, it was still necessary to wear a heavy glove for protection against biting.

REFERENCES

- Boice, R., Denny, M. R., and Evans, T. A comparison of albino and wild rats in shuttlebox avoidance. *Psychonomic Science*, 1967, 8, 271-272.
- Kavanau, L. Behavior of captive white-footed mice. *Science*, 1967, 155, 1623-1639.
- Sidman, M. Two temporal parameters of the maintenance of avoidance behavior by the white rat. *Journal of Comparative and Physiological Psychology*, 1953, 46, 253-261.
- Sidman, M. Avoidance behavior. In W. K. Honig (Ed.), *Operant behavior: areas of research and application*. New York: Appleton-Century-Crofts, 1966. Pp. 448-498.

Received 17 May 1967.