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THE USE OF RATS AS DISCRIMINATIVE STIMULI[1]

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A free operant procedure was used to determine whether or not one rat could discriminate: (1) between the presence and absence of a second rat, and (2) between two other rats of the same species and sex. The subjects were four male Wistar rats. The discriminatory response was a bar press and food was used as reinforcement during training. Although there were wide individual differences in rate of learning, all subjects learned to make both discriminations.

A great deal of research has been done on the sensory processes of the rat and their use in making discriminations. Few studies have been concerned with the ability of the rat to discriminate among other rats. Miller and Dollard (1941) found that rats could respond to cues from other rats in learning to run a maze, but the salient stimulus here was the movement of the leader rat. Barnett (1963), observing a colony of rats, concluded that rats could differentiate members of their own colony from a foreign rat on the basis of olfactory stimulation. Barnett also observed the formation of a dominance hierarchy when mature male rats were brought together. He differentiated three groups of rats: one dominant, the other two submissive, which developed as a result of fighting among the rats when they were first introduced into the new colony. This suggests that rats are able to make discriminative responses to other rats. Church (1959) trained rats to use the fear response of another rat as a discriminative stimulus.

The present study sought to determine whether a rat could be trained to make a discriminatory bar-press response: (1) in the presence of another rat (S^D) but not in its absence (S^Δ), and (2) in the presence of one rat (S^D) but not in the presence of a second rat (S^Δ).

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METHOD

Subjects

Four three-month-old male white Wistar strain rats, bred in DePauw University Laboratory, served as subjects, and two others as stimuli.

Apparatus

A Model 801 Skinner Conditioning Cage (8½ by 11 in.) manufactured by Physiological Electronics, Inc. was used, with 45 mg food pellets as reinforcement.

Procedure

Overview. The design was divided into two phases. Phase 1 was concerned with whether or not the subjects could discriminate between a situation in which a second rat was present (S^D) from one in which it was absent (S^Δ). Phase 2 was designed to determine whether or not subjects could discriminate between two other rats of the same species and sex.

Phase 1 training. Four subjects were used. Before discrimination training began, each subject was placed on a one-week feeding rhythm permitting free access to food for 1 hr each day. The subject was then placed in an operant conditioning box for 1 hr daily and reinforced for each bar press until 75 responses occurred. Next, discrimination training was started using the presence of a stimulus rat as the S^D condition and its absence as the S^Δ. The subject was placed into the conditioning box and the stimulus rat (S^D) immediately added. The stimulus rat had no previous bar press training and was not food deprived. After two to four (randomly varied) reinforced

bar presses by the subject, the stimulus rat was removed for 30 sec. The subject received no reinforcement for responding during this S^{Δ} period. After 30 sec the stimulus rat was reintroduced into the box and the subject again reinforced on a continuous schedule for two to four responses during the S^{D} period. This sequence of a S^{D} period followed by a S^{Δ} period constituted one trial. Twenty trials were given each subject each day. Training was continued to a criterion of not more than 15 bar presses in a block of 10 successive S^{Δ} periods. To insure that the subject was responding to the discriminative stimulus rather than to the differential reinforcement during the S^{D} and S^{Δ} periods, the discrimination was tested the following day under extinction conditions.

Phase 1 test. Immediately before testing for discrimination, five additional training ("priming") trials were given to minimize the effect of spontaneous recovery in the S^{Δ} period. After these were completed, the subject was removed from the conditioning box for 1 min. It was then returned to the box and the number of bar presses recorded for 1 min. At the end of this period the stimulus rat was placed into the box for 1 min and the number of responses again recorded. This alternation was continued for three S^{Δ} and S^{D} periods. No responses were reinforced during the test period.

Phase 2 training. Three of the four subjects from phase 1 were used in phase 2 (subject #2 died). The procedure in the first part of phase 2 training was similar to that used in phase 1 discrimination training. The stimulus rat which was present in the S^{D} condition during phase 1 training was again used as the S^{D} rat in phase 2. However, instead of merely removing the stimulus rat during the S^{Δ} period, another rat of the same approximate age, sex, and species and from the same living cage was substituted for it. Thirty-second S^{D} and S^{Δ} periods were alternated, as in phase 2 discrimination training, until the subject reached a criterion of no more than 20 responses in a block of 10 S^{Δ} periods. At this point, two changes were made in the procedure: (1) the S^{D} and S^{Δ} periods were sequenced randomly rather than alternated, to insure that the rat was discriminating between the two stimulus rats rather than the alternation sequence; (2) the reinforcement schedule during the S^{D} period was gradually built up over several sessions to a 15:1 fixed ratio (FR) schedule in order to increase resistance to extinction during the test period. Each day's training included 20 S^{Δ} periods and approximately 20 S^{D} periods (depending upon the random sequence). When the subject had been on a 15:1 FR schedule for at least 10 S^{D} periods during a day's training, it was tested under extinction conditions the next day.

Phase 2 test period. First, the subject was given five training or "priming" trials. Then after a 1-min interval, during which it was removed from the box, it was returned and the S^{Δ} rat was immediately placed in the box. The S^{D} and S^{Δ} rats were alternately placed in the box for 1-min intervals and the number of responses recorded. This procedure was continued for three S^{Δ} and three S^{D} periods without reinforcement. The same S^{D} rat and S^{Δ} rat were used throughout the experiment.

RESULTS

Phase 1 discrimination training. The results in the phase 1 discrimination training period and test period are presented in Fig. 1 and

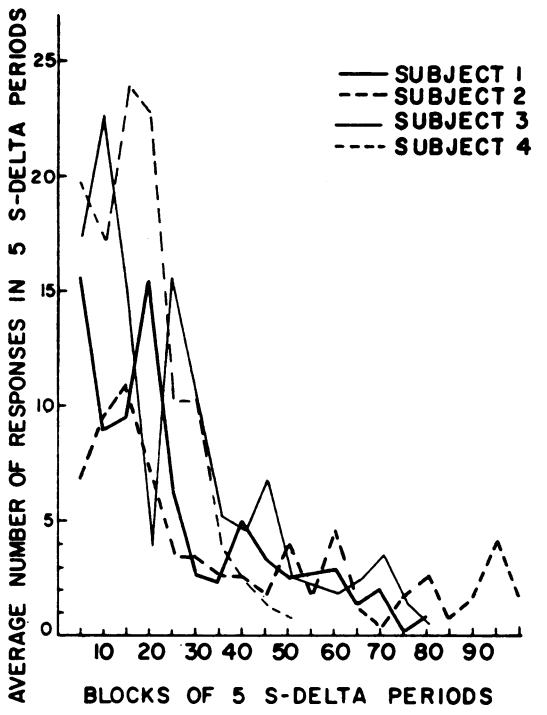

Fig. 1. Mean number of responses per 30-sec S^{Δ} period in blocks of five S^{Δ} periods during phase 1 discrimination training.

Table 1 respectively. These show that all four subjects made the discrimination between the stimulus rat being present (S^D) and absent (S^Δ). The ratio of the number of responses in the S^D period to the number in the S^Δ period range from 4 to 1 in subject #1 to 15 to 1 in subject #4 (Table 1).

Table 1

Total Number of Responses in Phase 1 Test Period

Subject	No. of Responses S^D period	S^Δ period
1	60	15
2	10	2
3	22	2
4	15	1
Total	107	20

Phase 2 discrimination training. The results of phase 2 are presented in Fig. 2 and in Table 2. The ratio of number of responses in the S^D period to the number in the S^Δ period range from 114 to 0 in subject #1 to 10 to 1 in subject #4. The average rate of responses in the S^D test period was 26.6 responses per min compared to an average response rate in the S^Δ period of 1.77.

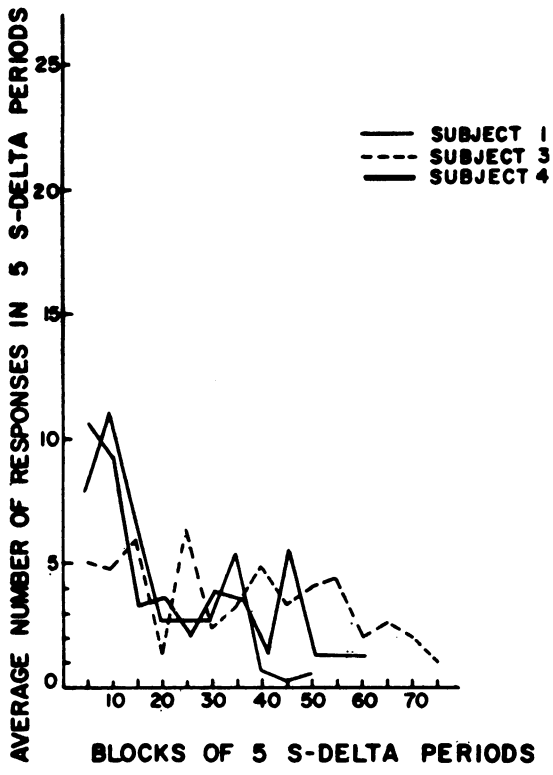

Fig. 2. Mean number of responses per 30-sec S^Δ period in blocks of five S^Δ periods during phase 2 discrimination training.

Table 2

Total Number of Responses in Phase 2 Test Period

Subject	No. of Responses S^D period	S^Δ period
1	114	0
3	45	8
4	81	8
Total	240	16

DISCUSSION

The present results support Barnett's observation that rats can learn to discriminate among other rats. Although the design does not permit direct investigation of the cues involved in making the discrimination, observations suggest that in discriminating between the presence and absence of another rat, visual stimuli appeared to play the major role. Little bodily contact was observed between the subject and the stimulus rat. The subject would hover near the bar and simply turn its head periodically, apparently to see if the stimulus rat was in the cage. A great deal more physical contact was observed between the rats in the second phase. This contact was usually initiated by the subject rather than by the stimulus rat and there was a great deal of sniffing behavior, usually of the stimulus rat's back, tail, or anal region. These observations suggest that olfactory stimuli were important cues in the discrimination between the two stimulus rats.

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