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Effects of food deprivation and competition on mouse killing in the rat

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An initial experiment assessed mouse killing in the rat following different periods of recovery from a food deprivation schedule. Testing which immediately followed food deprivation resulted in a high mouse killing rate relative to rates observed after a 2-week recovery period and control conditions. A second experiment investigated the effects of intraspecies competition, independent of food deprivation, on mouse-killing behavior in the rat. In contrast to previous reports, no significant competition effects on interspecies aggression were found.

Interspecies aggression is frequently observed when a mouse is placed in a cage with a rat. Karli (1956) tested for the mouse-killing response in both feral and domesticated Norway rats. He found that approximately 70% and 12% of feral and domesticated rats, respectively, spontaneously killed mice. Galef (1970) reported that only about 4% of domesticated rats were spontaneous mouse killers.

Karli (1956) suggests that the response of a specific rat to a mouse is influenced by at least three general factors. These include: the past life history of the rat, the physical state of the organism, and the present ambient conditions. Heimstra (1965) and Heimstra and Newton (1961) believe that the difference in mouse-killing behavior between domesticated and feral rats is produced by past environmental conditions. They suggest that the difference is due to the feral rat's experience in a relatively more competitive environment. Heimstra and Newton (1961) have reported that prior competition for food increases mouse-killing behavior in domesticated rats. Heimstra (1965) has observed that domesticated rats which receive both food deprivation and competition experience kill significantly more mice than rats receiving either food deprivation or competition experience alone.

However, the exact roles played by food deprivation and competition in determining interspecies aggression remain to be delineated. Whalen and Fehr (1964) report that competition, per se, has no effect on mouse-killing behavior. Baenninger and Baenninger (1970) have found that the quantity and success of prior competitive sequences of intraspecies aggression have no relationship to interspecies aggression. Further, in one study (Heimstra & Newton, 1961) which reported competition effects, food deprivation may have been confounded with competition. The study employed food deprivation to provide an incentive for intraspecies competition in rats and tested for mouse killing immediately (24 h) following the food-deprivation, competition period.

Since food deprivation has been employed as an incentive for intraspecies competition in rats, it is necessary to determine if food deprivation alone effects mouse-killing behavior. Karli (1956) and Heimstra (1965) have concluded that food deprivation does not effect mouse killing in the rat. Other investigators (Paul, 1972; Paul, Miley, & Baenninger, 1971; Whalen & Fehr, 1964) report that food deprivation facilitates mouse-killing behavior. If food deprivation does increase mouse-killing behavior, food deprivation effects must be controlled in any study which uses food deprivation as an incentive for competition and attempts to determine the effects of competition on mouse-killing behavior. Experiment I examined the effects of immediate and prior food deprivation on mouse-killing behavior in the rat.

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EXPERIMENT I

Method

Subjects. Forty-eight adult male Sprague-Dawley albino rats, 80 days of age, were employed as subjects. Two-hundred and forty adult male albino mice obtained from Sprague-Dawley were used as target animals.

Rats were housed individually in stainless steel cages measuring 40 x 24 x 19 cm. Mice were housed in pairs in wire-top plastic cages which measured 28 x 18 x 12 cm.

Procedure. Rats were assigned randomly to one of three groups (Groups I, II, III) with the restriction that each group contain 16 subjects. After a 2-week habituation period, Group I was food deprived on a 23-h deprivation/1-h ad-lib feeding schedule for 14 consecutive days (Day 1-14). Groups II and III were fed ad lib. In the next 14-day period (Days 15-28), Group II was food deprived on a 23-h deprivation/1-h ad-lib feeding schedule. Groups I and III were fed ad lib. Thus, Group III (control group) was never food deprived.

On the 1st day (Day 29) after the second 2-week deprivation period, each rat was tested for the killing response in his home cage. During testing, a naive mouse was placed in the cage with each rat for 1 h each day for 5 consecutive days. If the rat killed, the mouse was removed, and testing was concluded for the day. Rats were fed ad lib during testing.

Table 1
Number of Animals Killing and Number of Total Kills for Each Experimental Group in Experiment I

Experimental Group	η	Animals Killing	Total Kills
I (Prior deprivation)	16	2	3
II (Immediate deprivation)	16	9	39
III (Control)	16	3	11

Results

The number of animals killing and the number of total kills out of the total possible (80) for each of the experimental groups are presented in Table 1. Analysis of these data indicated significant differences between the experimental groups in the number of animals killing ($\chi^2 = 6.14$, df = 2, $p < .05$). Inspection of Table 1 reveals that Group II, the immediate deprivation group, which underwent testing immediately following deprivation produced both the largest number of killers and the greatest number of total kills.

EXPERIMENT II

Data from Experiment I indicate that food deprivation which occurs immediately (24 h) before testing for mouse killing significantly increases the number of animals killing mice, while prior food deprivation followed by a recovery period does not effect mouse killing. Although Experiment II employs food deprivation as an incentive for intraspecies competition, the study was designed to investigate the effects of intraspecies competition, independent of food deprivation, on mouse-killing behavior in the rat.

Method

Subjects. Twenty-nine naive male Sprague-Dawley albino rats, 80 days old, were used as a subject pool. Two-hundred and forty-five adult male albino mice obtained from Sprague-Dawley were employed as target animals.

Rats were housed individually in stainless steel cages measuring 40 x 24 x 19 cm. Mice were housed in pairs in wire-top plastic cages which measured 28 x 18 x 12 cm.

Apparatus. A competition runway was constructed as follows. The runway was a chamber measuring 105 x 9 x 12 cm which was divided by three movable panels into four similar compartments each measuring approximately 20 x 8 x 11 cm. The panels between each compartment could be raised to allow an animal to move from one compartment to another. Each compartment was accessible from above through a hinged screen door. The two center compartments each contained a small screen wire tunnel which measured 8 x 5 x 5 cm and was attached to the wall containing the center movable panel. The size of this tunnel permitted the passage of only one animal at a time through the passageway when the middle panel was raised.

Procedure. Initially, all rats underwent a 14-day habituation period during which they were given Purina Rat Chow and water ad lib. On the 15th day, each subject began 5 days of baseline testing. Each day during the baseline test period, rats were presented individually with a mouse for a 1-h period. If a kill was observed during the 1-h test period, the latency to kill was recorded, the mouse was removed from the cage, and testing was concluded for the day. At the end of each 1-h test period, all surviving mice were returned to their home cages and were not exposed to further testing. During the baseline test period, all subjects were given chow and water ad lib. Any rat which killed during the baseline test period was labeled a "killer," and any subject failing to kill was designated a "nonkiller."

On the basis of the frequency of kill and latency to kill, 20 rats were selected from the subject pool. Of the 20 rats, six were "killers" and 14 were "nonkillers." Two matched groups (competition and control) were formed, each consisting of three "killers" and seven "nonkillers."

On the 20th day of experimentation, both groups were placed on a daily 23-h deprivation/1-h ad-lib feeding schedule. During this period, water was given ad lib. Beginning on the 21st day, both groups were trained individually in the competition runway for 10 trials/day over 10 consecutive training days. During the training period, each rat was trained to run from one end chamber of the competition runway to the opposite end chamber. During training trials, end chambers were alternately used as starting points, and animals received a P. J. Noyes rat pellet reward at the completion of each successful run.

Following the 10-day training period, control rats continued to run individually in the runway, 10 trials each day, for 18 consecutive days receiving rewards on the same schedule employed during the training period. The competition rats were run in pairs, each rat starting from the opposite end chamber, for 10 trials each day for 18 days. The competition animals were allowed to move toward the middle movable panel. When each rat entered the wire tunnel, and when each rat's nose was touching the middle movable panel, the panel was raised. During the 18 days of competition. each subject was run against each of the other nine competition animals during the first 9 days of the competition period and once during the second 9 days. P. J. Noyes pellets were provided as a reward for each animal as it entered the appropriate end chamber.

Following the 18-day competition period, all animals were given chow and water ad lib throughout the remaining days of the study. All subjects were allowed to recover from the 23-h deprivation schedule for 2 weeks. Following the recovery period, a procedure identical to the one employed during baseline testing was used to test for the killing response.

Results

Table 2 shows the number of baseline and post-treatment kills for the competition and control groups. In terms of the proportion of kills out of the number of opportunities to kill, the control group killed 16% of the time, and the competition group killed 14% during baseline testing. In the postcompetition testing period, the control group killed 44% of the time compared to the competition group's 12% rate. However, analysis of the data from the post-treatment test period indicated that the difference in the number of animals killing in the control and competition groups was not significant ($p > .05$).

Table 2
Number of Animals Killing and Number of Total Kills for Competition and Control Groups in Experiment II

	Testing Period			
	Baseline		Postcompetition	
Group	Animals Killing	Total Kills	Animals Killing	Total Kills
Competition	3	7	2	6
Control	3	8	5	22

DISCUSSION

In Experiment I, food deprivation immediately before testing increased the number of rats killing mice and the total number of mice killed. These data support other reports (Paul, 1972; Paul et al., 1971; Whalen & Fehr, 1964) that food deprivation increases interspecies aggression in the rat.

Analysis of the data in Experiment I also indicated that the recovery period or the latency between the end of the food-deprivation period and the onset of testing for mouse killing is important. In Experiment I, a 2-week recovery period was sufficient to allow the animals to recover from the effects of food deprivation. In contrast, Paul et al. (1971) have reported food-deprivation effects after a recovery period of 2 weeks. In the Paul et al. study, although killing rates after recovery were below those observed immediately following deprivation, they were above the mean killing rates observed during control conditions. Unfortunately, no statistical test of the difference was provided. Nevertheless, it is apparent that the exact relationships between food deprivation, length of recovery period, and the development of mouse-killing response remain to be fully delineated.

The results of Experiment II did not support the hypothesis that intraspecies competition facilitates interspecies aggression in the rat. The number of kills for animals receiving competition experience decreased from seven kills during baseline to six kills during post-treatment testing. The control (noncompetition) group, however, showed a nonsignificant trend toward an increase in the number of animals killing and in the total number of kills during the post-treatment testing. In contrast to eight baseline kills, the control animals killed 22 times during final testing.

Several studies (Heimstra, 1965; Heimstra & Newton, 1961) have suggested that competition experience facilitates mouse-killing behavior in rats. Heimstra and Newton (1961) reported that competition for food plays a major role in facilitating the killing response. However, Heimstra and Newton appear to have confounded food deprivation and competition effects. Heimstra and Newton (1961) began testing for mouse killing immediately following the competition/food-deprivation period. The data from Experiment I indicate that immediate food deprivation alone facilitates interspecies aggression in rats. In another study, Heimstra (1965) reported that animals which are both food deprived and exposed to intraspecies competition for food killed more mice than food-deprived rats or control animals. In contrast, Whalen and Fehr (1964) have found that rats experiencing both food deprivation and competition kill less than rats merely food deprived. Whalen and Fehr suggest that during competition, rats may acquire social habits which conflict with the effects of food deprivation. Further, Baenninger and Baenninger (1970) report that the quantity and success of prior competitive experiences of intraspecies aggression is not related to mouse-killing behavior. Thus, the present study, as well as others (Baenninger & Baenninger, 1970; Whalen & Fehr, 1964), suggests that intraspecies competition alone does not facilitate the development of mouse killing in the rat. The effect of a Food Deprivation by Competition interaction, which was not investigated in the present study, remains less clear.

The nonsignificant trend toward an increase in interspecies aggression in the control group in Experiment II was unexpected. A possible explanation of this increase is that the control's lack of social experiences during the experiment functioned in a manner similar to isolation on the rat's propensity to kill. Investigators (Ader & Freidman, 1964; Hahn, 1965; Moyer & Korn, 1965) have reported that isolation results in greater emotionality and facilitates mouse killing in the rat. Since the procedures employed for the competition and control groups were identical except for the competition experience received by the competition group, the interspecies competition may have generated social experiences for the competition group which inhibited the facilitation of killing behavior due to their general isolation. The control group was totally isolated throughout Experiment II and, subsequently, may have increased their killing behavior due to the isolation.

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