Contrasting effects of group housing and isolation on subsequent open field exploration in laboratory rats[1]

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Female laboratory rats housed in isolation for two weeks were less active in an open field than animals group-housed (three or eight per cage) for the same duration, but these differences were not statistically significant. In a second experiment, female laboratory rats isolated for 24 weeks were significantly less active than animals housed in groups of three, five, or eight for the same period. No significant differences were found when the second experiment was replicated using male rats.

In recent years, many experiments have been carried out on the contrasting effects of group-housing and isolation on behavior and physiology in rodents. Besides providing evidence concerning the possible role of social factors in population control (Christian & Davis, 1964; Thiessen, 1964), this area of research has stimulated interest from workers more concerned with experimental psychology (e.g., Essman, 1966, 1968; Moyer & Korn, 1965). The latter approach is characterized by investigations which sacrifice simulation of the natural environment for a greater degree of experimental control, and by theoretical discussions which consider the mechanisms involved in the response of the dependent variables to differences in the social environment (e.g., Welch, 1964). Exploration of a novel area, in the form of an open field, is one of the behavioral variables investigated in several of these experiments. The present paper reports three further experiments concerning the contrasting effects of group-housing and isolation on subsequent open field behavior.

The literature on this subject has been described in a review article (Archer, in press), and will only be outlined briefly at present. Previous studies have reported conflicting results: Stern et al (1960), Thiessen et al (1962), Thiessen (1963), and Moyer & Korn (1965) all showed that group-housing leads to an increase in open field activity compared with isolation. The reverse was found by Essman (1966) and Weltman et al (1966). The present experiments vary two parameters which might be important in accounting for these conflicting results—the duration of housing and the sex of the animals—and in addition investigate the possible effects of different group numbers. In Experiment 1, female rats were housed in different numbers for two weeks, in Experiment 2, females were housed for 24 weeks under the different conditions, and in Experiment 3, males were used and the duration was again 24 weeks.

METHODS

Experiment 1

Forty-four female Wistar rats were isolated for six weeks in cages measuring 20 x 12 x 6½ in. from the age of four weeks. They were then assigned to one of three experimental conditions: 13 rats were simply placed in clean cages identical to the ones in which they had been housed previously, 15 were placed in similar cages in groups of three, and the remaining 16 were grouped in eights. At the end of two weeks, each rat was observed for 10 min in an open field (4 x 4 ft), under standard laboratory illumination and in the absence of white noise, and the number of squares that each one entered was recorded.

Experiment 2

Fifty-eight female Wistar rats, aged four weeks, were assigned to one of four experimental conditions: 15 rats were isolated, 12 were grouped in threes, 15 were grouped in fives, and the remaining 16 were housed in eights. For each group or isolate, the cage size was 12 x 6½ x 20 in. After 24 weeks in the differential housing conditions, each rat was observed in an open field, as in the first experiment.

Experiment 3

Forty-five male Wistar rats, aged four weeks, were assigned to one of the following conditions: 16 were housed in groups of eight, 10 in groups of five, 9 in groups of three, and 10 were isolated. Each group and each isolate was housed in a cage measuring 12 x 6½ x 20 in. After 24 weeks, the rats were each observed for 10 min in an open field as before.

RESULTS

Table 1 shows the means and standard deviations of the open field scores for the various conditions of the three experiments.

In all three experiments, the different groups within each condition involving group-housing were compared to determine whether the open field scores were statistically homogeneous for a given condition. In the case of Experiments 1 and 2, the scores were not statistically homogeneous and therefore nonparametric tests were used to assess these results.

In Experiment 1, the Kruskal-Wallis one-way analysis of variance (Siegel, 1956) revealed no significant differences between the three conditions ($H = 2.30$, $n_1 = 13$, $n_2 = 15$, $n_3 = 16$; $p > 0.1$); neither did the Mann-Whitney U test (Siegel, 1956) reveal any significant differences between the isolated and the grouped rats ($z = 1.39$, $N = 13$, $N = 31$; $p = 0.165$).

In Experiment 2, the Kruskal-Wallis one-way analysis of variance revealed a significant overall difference between the four groups ($H = 15.08$; $n_1 = 14$, $n_2 = 12$, $n_3 = 15$, $n_4 = 8$; $p < 0.005$). The open field scores of the socially isolated rats were significantly smaller than those of the group-housed animals ($z = 2.235$; $N_1 = 14$, $N_2 = 35$; $p = 0.025$-0.026). There were also significant differences between the three conditions involving group-housing ($H = 10.98$; $n_1 = 12$, $n_2 = 15$, $n_3 = 8$; $p < 0.005$).

In Experiment 3, there were no significant differences between the conditions with regard to variance ($B = 1.105$; $df = 3$, $p > 0.1$) and means ($F = 2.42$; $f_1 = 3$, $f_2 = 40$; $p > 0.05$). The isolated rats showed higher open field scores than the grouped rats, but these differences were not statistically significant ($t = 1.58$; $df = 42$, $p > 0.1$).

DISCUSSION

In Experiment 1, where the female rats were differentially housed for only two weeks, the activity scores of the isolates were smaller than those of the grouped animals, although this

Table 1
Open Field Scores of Rats Housed in Different Numbers for 2 or 24 Weeks

		Group Size 1	3	5	8
Experiment 1: females, 2 weeks differential housing.	$\bar{x}$	109.4	124.1		125.4
	s	50.4	46.7		22.2
	N	13	15		16
Experiment 2: females, 24 weeks differential housing.	$\bar{x}$	47.0	78.4	55.8	116.0
	s	35.7	24.7	38.5	35.3
	N	15	12	15	8*
Experiment 3: males, 24 weeks differential housing.	$\bar{x}$	61.2	57.7	30.0	45.8
	s	33.1	21.7	21.3	33.4
	N	10	9	10	16

** Two rats from one of the groups of eight died during the course of the experiment: therefore this group was omitted from the results.*

difference was not statistically significant. In the second experiment, where the female rats were differentially housed for 24 weeks, the activity scores of the isolates were significantly smaller than those of the grouped rats. These results can be explained on the basis of a hypothesis elaborated elsewhere (Archer, in press), that open field activity depends on the effects of the previous housing conditions, and the contrast between these conditions and the environment of the open field. The isolated rats from Experiment 2 experienced low stimulus conditions for a longer period than those from Experiment 1; consequently the change in stimulation involved in placing them in an open field is more likely to elicit fear-responses characterized by "freezing" than in the case of rats isolated for a shorter period of time or ones which have been group-housed for the same period of time.

In the second experiment, the open field scores of the rats from different sized groups also differed significantly, but these differences showed no consistent trend in relation to the group numbers.

In Experiment 2, the open field scores of the isolated female rats were significantly less than those of the grouped animals, whereas in Experiment 3, the open field scores of the isolated and grouped male rats were not significantly different. These results are probably related to differences in the social behavior of male and female rats, perhaps to differences in their aggressive behavior. However, the latter suggestion is only tentative, and will not be elaborated further, as it is discussed more fully elsewhere (Archer, in press).

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NOTES

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Initial test suppression for the forward-conditioned group who received PCS exposures was intermediate between the latter two. However, near complete recovery in performance occurred by the third test trial. Although this apparent relative recovery was not revealed in a significant Groups by Trials interaction for Day 1, the overall F for the groups effect was highly reliable ($F = 22.00$, $df = 2/21$, $p < .001$). Moreover, a comparison between the overall suppression data for Day 1 between the US-only and forward-conditioned PCS group was reliable ($p < .01$), as was the difference between the two forward-conditioned groups ($p < .02$).

The mean Day-1 SR for the four forward-conditioned Ss who received PCS exposures in holding cages was .14 while for the other four who did not get the PCS treatment it was only .02 ($p < .10$).

Mean total running times on the last retraining trial before testing in the alley were not different between groups ($F < 1$). Mean running times during CS presentation, collapsed over the first three trials of Test Day 1, were 10.18 sec for the forward-conditioned PCS group, 4.65 sec for the forward-conditioned group, and 2.20 sec for controls. This variation in group means was not quite reliable ($F = 2.79$, $p < .10$).

DISCUSSION

These data generally supported the more recent finding that PCS exposures can offset manifestation of CER learning. That somewhat greater suppression was observed for the PCS forward-conditioned group over that reported by Anderson et al (1968) probably is due to the considerably more intense US and the two additional conditioning trials that were given in the present investigation.

One trend in the data seems worth comment. The results suggested that the effectiveness of PCS exposures can, in part, be dependent upon the place of PCS presentation. For example, while PCS exposure in the holding cages partially offset test suppression, it was not near as effective as when this preconditioning treatment occurred in the test situation. Moreover, when the forward conditioned Ss who got PCS in the operant box were tested outside the latter situation (i.e., the alleyway), they evinced somewhat more evidence of fear learning than similarly treated, nonPCS Ss. While these latter findings are inconclusive due to marginal reliability values, they nevertheless seem to strengthen the suggestion that the place of preconditioning treatment may be important for demonstration of the PCS effect.

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NOTE

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