Environmental factors influencing the affiliative behavior of male and female rats (*Rattus norvegicus*)

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Three experiments were conducted to investigate the influence of rearing and housing manipulations on the affiliative behavior of male and female rats. Animals were tested in same-sex pairs in an open field for time spent in contact and for socially facilitated activity. The results revealed a sex difference in both the degree and the form of affiliative behavior of rats. In general, males were more affiliative and more responsive to a second animal. Males engaged in more rough-and-tumble play, whereas females spent more time in social grooming. Housing conditions of adult animals and rearing conditions were found to influence the degree to which males engaged in male-like affiliative behaviors and females engaged in female-like affiliative behaviors. Social behavior appears to be a function of the interaction between the affiliative repertoire of the animals involved, the nature of the social stimulus, and the features of the environment.

Although it is well known that rats establish complex societies and are unquestionably social animals (e.g., Lore & Flannelly, 1977), little is known about the basic features of the social behavior in these animals. That rats are socially organized implies that they should exhibit a degree of social/approach or affiliative behavior necessary for cooperative functioning within a colony. Latané (1974) has found that pairs of male rats observed in a novel environment show a species-specific attraction to conspecifics that results in predominantly "friendly" behavior. Such findings confirm earlier observations made by Barnett (1958), Grant (1963), and Seward (1945), that rats show social/approach tendencies that do not necessarily result in aggression or mating. It is this social/approach and contact or affiliative behavior, seen as a subclass of social behavior, with which this paper is concerned. Affiliative behavior is meant to refer to the behavior that occurs as a result of an animal's social attraction to conspecifics.

Recently, we (Meaney & Stewart, Note 2) have reported that there are sex differences in the affiliative behavior of rats. When tested for social interactions in an open field, pairs of male animals were observed to engage in chase and rough-and-tumble play behavior to a greater extent than were pairs of female animals, while females were observed to engage in social grooming behavior more frequently than were males. Moreover, males interacted more

frequently than did females. It is worth noting that these sex differences in social behavior are not unlike those reported in primates, e.g., rhesus monkeys (Goy, 1970) and baboons (Owens, 1975). In this paper, we report on the influence of environmental factors on the patterns of social interactions of male and female rats and on the frequency with which they occur.

EXPERIMENT 1

One question that arises from the finding of a sex difference in the affiliative behavior of rats is whether the affiliative behavior of male and female rats would be differentially influenced by a manipulation previously shown to affect the degree to which male rats will affiliate. Latané, Nesbitt, Eckman, and Rodin (1972) found that adult males subjected to periods of social deprivation (socially isolated housing) spent more time in contact than did animals not so deprived (socially housed animals). Thus, in "normally" reared male rats, periods of social isolation appear to produce an increase in the tendency to affiliate with conspecifics.

The results of Meaney and Stewart (Note 2) suggest that because male rats are more responsive to same-sex conspecifics, they would be more affected by social deprivation. Experiment 1 was designed to examine the degree to which social deprivation might influence the affiliative behavior of male and female rats. It was expected that, in comparison to socially housed animals, animals housed in social isolation would show a greater tendency to affiliate with same-sex conspecifics. It was also predicted that these differences would be greater in male animals. Of further

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interest was the manner in which the patterns of affiliative behavior of male and female rats might be influenced by social deprivation.

In Experiment 1, pairs of male rats and pairs of female rats were tested in two different test situations. The first was an open-field test of gregariousness used by Latané (1969). In this test, the amount of time spent in contact between pairs of animals is recorded. The second was a social-facilitation test in which socially facilitated activity in an open field was examined. This test is assumed to indicate the degree to which the behavior of one animal was influenced by that of another. Video tapes of the test situation were made and were subsequently scored for the following behaviors: rough-and-tumble play, chase, sniffing, social grooming, passive contact, and no interaction.

Method

Subjects

The subjects were 24 male and 24 female hooded rats (Long-Evans strain) obtained from the Canadian Breeding Farms and Laboratories, La Prairie, Québec. On arrival, half of the animals, 12 males and 12 females, were housed individually in standard wire-mesh cages. The remaining animals were housed, by sex, in double-width wire-mesh cages in groups of 4. The animals were not handled again until testing, 20 days later. The animals had free access to food and water throughout the experiment. At the time of testing, the animals were approximately 90 days old.

Apparatus

The tests were conducted in a 60 × 60 cm open field, the floor of which was marked off into 16 equal squares. A 12-dB noise, produced from a Grason-Stadler (Model 901B) noise generator, served to mask extraneous noises throughout the testing sessions. A manually operated cumulative clock was used to record the amount of time in contact. The camera of a Sony video tape recorder (VTR) system was mounted about 75 cm above the open field. Lighting was provided by a series of 15-W light bulbs hung around the perimeter of the open field at a height of about 60 cm.

Procedure

Test of gregariousness. The four groups (housing by sex) of 12 rats were assigned to six pairs within each group. All pairs were tested over a 2-day period in a random order. The animals were transported to the laboratory in separate containers, and then the two animals of the pair were placed, one at a time, in opposite ends of the open field. They were allowed to move about freely for a period of 10 min. During this period, the experimenter recorded the amount of time the animals spent in physical contact (tail contact was not considered as physical contact) in each of the 10 time blocks of 55 sec each. The last 5 sec of each minute were used for recording purposes.

Social-facilitation test. As in the previous test, the animals were assigned to same-sex and same-housing-condition pairs. Two test sessions were conducted; for each session, the pairs were composed of different animals. The composition of the pairs was also different from that in the test of gregariousness. Again, the animals were transported to the laboratory in separate containers. Testing was done over a 2-day period.

During the first testing session, one animal was designated as the target animal and the other as the stimulus animal. The target animal was placed in a designated start spot in the open field. During the next 5 min, the number of square crossings made by the target animal was recorded in five 55-sec time blocks. The

location of the animal's right front paw was used to determine in which square the animal was positioned. After 5 min, the stimulus animal was placed into the open field in the corner farthest from where the target animal was located at that particular moment. The number of square crossings made by the target animal was recorded for the next 5 min in 55-sec time blocks. That period prior to the introduction of the stimulus animal was referred to as the "alone" condition, while the period following the introduction of the stimulus animal was referred to as the "paired" condition.

For the second session, one member of each pair was a target animal from the previous session and the other was a stimulus animal. For this second session, the roles were reversed. The tests were conducted in an identical manner to the first session.

Behavioral analysis. The video tapes made during the testing sessions were scored using a time-sampling procedure in which the interactions of the animals were scored once every 3 sec. The behavioral categories constructed were both mutually exclusive and exhaustive. The categories were defined as follows: *Chase*—the active pursuit of a moving animal by another animal. *Sniffing*—any sniffing directed at another animal. *Passive contact*—instances when the animals were in physical contact, but were either motionless or directing their behavior toward something other than the other animal. *Rough-and-tumble play*—instances in which one animal was crawling over, under, and pushing along another animal. *Social grooming*—the grooming of one animal by another. *No interaction*—instances when the animals were not in physical contact.

Results and Discussion

Test of Gregariousness

The time-spent-in-contact scores for each time block were analyzed using a three-way analysis of variance (Winer, 1962) for Sex by Housing Condition by Time Block. An examination of the results revealed that the main effect of sex [$F(1,20) = 21.54, p < .0001$] and housing [$F(1,20) = 20.09, p < .0001$] were significant. The mean time spent in contact over time blocks for each of the four groups can be seen in Figure 1. The Sex by Housing interaction [$F(1,20) = 9.70, p < .01$] was also significant. A Tukey post hoc analysis (Myers, 1972)

Figure 1. Time spent in contact over time for isolation-housed male (■) and female pairs (●) and socially housed male (□) and female pairs (○).

revealed that males housed in isolation spent more time in contact than did any of the three other groups. Both females housed in isolation and socially housed males spent more time in contact than did socially housed females.

Social-Facilitation Test

The square-crossing scores for each time block were analyzed using a four-way analysis of variance for Sex by Housing by Alone/Paired Condition by Time Block. The results revealed that there was a significant effect of sex [$F(1,44) = 5.04, p = .03$]. From Figure 2, it can be seen that the females were generally more active than were the males only in the alone condition; thus, there was also a significant Sex by Alone/Paired Condition interaction [$F(1,44) = 12.59, p < .001$].

There was also a significant main effect of housing condition [$F(1,44) = 7.75, p = .008$]. This appeared to be due to the greater overall activity of the isolation-housed animals, especially in the paired condition; this is reflected in the significant Housing by Alone/Paired Condition interaction [$F(1,44) = 14.34, p < .001$].

The alone/paired condition main effect was also significant [$F(1,44) = 63.46, p < .0001$]. As can be seen in Figure 2, the animals were more active in the paired condition than in the alone condition. There was also a significant main effect of time block [$F(4,176) = 30.46, p < .0001$]. This effect was due to a general decrease in activity over the five time blocks in both the alone and the paired conditions.

Of primary interest was the significant Sex by Housing by Alone/Paired Condition interaction [$F(1,44) = 6.22, p = .02$]. A Scheffé post hoc test (Myers, 1972) revealed that this effect was due to a greater increase in activity from the alone to the paired condition among the isolation-housed males than among any of the three other groups. Also, males in general showed a greater increase in activity in the paired condition than did the females.

Behavioral Analysis

For this analysis, the behavioral categories were divided into two categories—those involving interactions (interaction class) and those that did not (no-interaction class). The number of times a particular behavioral category was scored within an observational session was calculated for each pair of animals. For the behavioral categories within the interaction class, scores were expressed as a percentage of the total scores for all the behavioral categories within that class. This was done to avoid the possibility that a large sex difference might simply reflect a difference in the total amount of time spent interacting. The results of the behavioral analysis are presented in Table 1. The statistical analysis of the

Figure 2. Mean number of squares crossed for isolation (Isol) housed and socially (Soc) housed male and female target animals in the alone and paired conditions of the social-facilitation test.

data across all four groups was done using a Kruskal-Wallis H test (Siegel, 1956) for each of the behavioral categories. A post hoc analysis, comparing groups within each of the behavioral categories, was done using Mann-Whitney U tests (Siegel). All tests were conducted at the two-tailed level of $p < .05$. The first U value given refers to the analysis of the data from the test of gregariousness ($n_1 = 6, n_2 = 6$), and the second to the data from the social-facilitation test ($n_1 = 12, n_2 = 12$).

The results indicated that (1) isolation-housed males engaged in more chase behavior than did socially housed males ($U = 8, p = .07$; $U = 23.5, p < .001$); (2) isolation-housed males engaged in more rough-and-tumble play behavior than did socially housed males ($U = 0, p < .001$; $U = 13, p = .002$); and (3) females housed in isolation engaged in more social grooming behavior than did socially housed females ($U = 10, p = .12$; $U = 9.5, p < .001$).

Considered as a whole, the results of Experiment 1 can be summarized as follows. Isolation housing served to increase the amount of time the animals spent interacting. This result is in accord with a similar finding by Latané et al. (1972). More importantly, male animals were influenced to a greater extent than were females. Isolation housing also affected the degree to which the ongoing behavior of one rat was influenced by the introduction of a same-sex conspecific. This effect of isolation housing was also greater

Table 1
Percentage of Total Interaction Class Score for Various Behavioral Categories for Each Group

Group	Behavioral Categories				
	Chase	Sniffing	Passive Contact	Play	Social Grooming
Test of Gregariousness					
Isolation-Housed Males	12.4	25.3	32.3	27.3	2.7
Isolation-Housed Females	7.7	37.5	39.3	8.3	7.1
Socially Housed Males	9.1	32.1	49.0	7.9	.1
Socially Housed Females	7.0	36.0	50.3	3.5	3.8
Social-Facilitation Test					
Isolation-Housed Males	11.2	31.3	34.4	22.1	2.8
Isolation-Housed Females	10.0	37.9	35.4	6.0	10.7
Socially Housed Males	6.0	36.6	46.0	9.4	2.0
Socially Housed Females	10.6	48.0	36.9	3.0	4.0

among male animals than among females. These findings support the contention that males are more responsive to same-sex conspecifics than are females.

Male rats housed in isolation engaged in more chase behavior and more play behavior than socially housed males, whereas the most pronounced effect of isolation housing on females was on the frequency of social grooming behavior. That is, as a result of isolation housing, males did not merely engage more often in all categories of affiliative behavior, but rather they engaged most often in those behaviors most specific to males (i.e., chase-and-play behavior). The same is true of females; isolation-induced affiliative tendencies enhanced the frequency of social grooming behavior between females. Isolation housing appears, then, to increase the social responsivity of the animals to the social stimulus, but does not change the relative importance of the different behaviors for the different sexes.

EXPERIMENT 2

Experiment 2 was concerned with the possible effects of social rearing experience on adult patterns of affiliative behavior. Recent studies have shown that sex differences exist in the play behavior of prepubescent rats; and, as expected, males have been found to engage in more rough-and-tumble play behavior than females (Olioff & Stewart, 1978; Poole & Fish, 1976; Meaney, Note 1). Moreover, among prepubescent rats, females have been found to engage in more social grooming behavior than males (Meaney, Note 1). That such sex differences exist in the affiliative behavior patterns of prepubescent animals as well as in adults suggests that early social experience may play a role in the determination of the adult patterns.

A further question addressed in Experiment 2 was whether abnormal social rearing might have a differential effect on the affiliative behavior of male and female rats. The work on early experience effects

by Levine (1974) and Rosenzweig and Bennett (1977) has suggested that the neural and hormonal development of male rats is influenced to a greater extent by early experience than is that of female rats. Becker (1971) reports results, that, although awkward to interpret in terms of main effects, suggest that the tendency to affiliate in male rats is affected to a greater extent by social rearing conditions than is that of female rats. Moreover, in Experiment 1 it was found that the effects of social deprivation on affiliative behavior were greater among male rats than among females.

The specific questions addressed in Experiment 2 were: (1) Do early social-rearing conditions differentially influence the degree to which animals will respond to same-sex conspecifics, both in terms of physical contact and in socially facilitated activity, and (2) do early social-rearing conditions differentially influence the nature of the affiliative behavior in which rats engage?

Method

Subjects

The subjects in this experiment were taken from 96 male and female hooded rats (Long-Evans strain) born in the Concordia University animal colony, the offspring of eight females obtained from the previously mentioned supplier. Upon arrival at the colony, the mothers were placed into maternity cages (41 × 25 × 18 cm) and given free access to food and water. All eight females subsequently gave birth to litters that ranged in size from 9 to 16 pups. All litters were born within a 36-h period. The day upon which the last litter was born was taken to be Day 1 of the experiment. From birth until weaning, the litters were left intact. Maintenance was done without handling the animals. All animals had free access to food and water throughout the experiment. Room temperature was maintained at about 22°C. The animal colony was on a 14-h to 10-h light-dark schedule (lights off at 11:00 p.m.).

On Day 22, 72 of the 96 animals were randomly assigned to one of three rearing conditions: same-sex pairs, heterosexual pairs, or social isolation. The mothers were removed and 24 animals, 12 males and 12 females, were assigned to each condition with the provision that all pairs be constituted of animals from different litters.

Isolation rearing. All animals reared in this condition were

housed individually in wooden cages (20 × 15 × 15 cm) with woodchips scattered on the floor. The cages had wire tops that contained an overhead feeder and a water bottle. No visual or physical contact with conspecifics was possible during the period of social isolation. The animals were not otherwise handled until testing began.

Same-sex rearing. Animals reared in this condition were housed in same-sex pairs in wire-mesh cages. On Day 75, the animals were separated and housed individually in cages of the same dimensions. The animals were not otherwise handled until testing began.

Heterosexual pairs. The animals in this condition were housed in the same manner as same-sex pairs, except that the cagemate was of the opposite sex. As a result of the pairings, all females in this condition gave birth to a litter. All pups were removed immediately after parturition. Animals were not otherwise disturbed until testing began.

Apparatus and Procedure

The apparatus and procedure were the same as that for Experiment 1. Testing was done over an 8-day period. The animals were between 90 and 100 days old at testing.

Results and Discussion

Test of Gregariousness

The time-spent-in-contact scores were analyzed using a three-way analysis of variance for Sex by Rearing Condition by Time Block. An examination of the results revealed that the main effect of sex [$F(1,30) = 8.94, p < .01$] and of time block [$F(9,18) = 3.78, p < .001$] were significant.

It can be seen from Table 2 that the males in all three rearing conditions spent more time in contact than did the females. Although the means would seem to indicate that isolation rearing led to an increase in the amount of time spent in contact in male animals, this effect can be accounted for by the extremely high scores of a few pairs and is therefore not statistically significant. Within the isolation-reared male group, the scores of two of the pairs were high, while those of the remaining four pairs were well within the range of the scores for male animals.

Social-Facilitation Test

The square-crossing scores for each time block were analyzed using a four-way analysis of variance for Sex by Rearing Condition by Alone/Paired Condition by Time Block. The results revealed that only the main effect of the alone/paired condition [$F(1,42) = 22.03, p < .0001$] and of time block [$F(4,168) = 8.51, p < .001$] were significant. While the Sex by Alone/Paired Condition interaction [$F(1,42) = 5.51, p = .02$] was significant, none of the interactions involving the rearing condition variable was significant.

As in the previous experiment, there was an overall sex difference in the degree to which the behavior of the animals was influenced by the introduction of a same-sex conspecific, males being influenced to a greater extent than females. There was, however, no significant effect of rearing condition. Thus, while the results support the findings of the previous ex-

Table 2
Mean Time-Spent-In-Contact Scores and Standard Deviations (SD) for Each Sex by Rearing Group

Group	Mean	SD
Males		
Isolation	28.0	16.3
Same-Sex Paired	21.1	4.2
Heterosexual Paired	17.9	9.9
Females		
Isolation	11.7	5.3
Same-Sex Paired	16.7	9.4
Heterosexual Paired	10.9	3.4

Note— $n = 6$ for each group.

periment, they offer no evidence that the affiliative tendencies reflected in the social-facilitation test were affected by differential social rearing.

Behavioral Analysis

The analysis of the behavioral data was conducted in the same manner as in Experiment 1. The results of this analysis are presented in Table 3. The results indicated that (1) males engaged in more rough-and-tumble play behavior than did females ($U = 35.5, n_1 = 18, p < .001; U = 91, n_1 = 36, n_2 = 36, p < .001$); (2) same-sex socially reared males engaged in more rough-and-tumble play behavior than did males reared in social isolation ($U = 4, n_1 = 6, n_2 = 6, p = .02; U = 5, n_1 = 12, n_2 = 12, p < .001$); (3) female animals engaged in more social grooming behavior than did males ($U = 38, n_1 = 18, n_2 = 18, p < .001; U = 26, n_1 = 36, n_2 = 36, p < .001$); and (4) same-sex socially reared females engaged in more social grooming behavior than did females reared in heterosexual pairs ($U = 5, n_1 = 6, n_2 = 6, p = .09; U = 13, n_1 = 12, n_2 = 12, p = .002$).

These results provide some evidence for an effect of early social rearing conditions on the adult social behavior of the rat. In both test situations, for example, male rats reared with a same-sex peer engaged in more play behavior than did male rats reared from 21 days of age until maturity in social isolation. Rat pups have been reported to spend a large amount of time engaging in play behavior during the period of 21 to 45 days of age (Baenninger, 1967). It seems that depriving male rats of this early social experience permanently alters their pattern of social behavior.

It should be noted that the effects of isolation rearing on play behavior in male rats were in the direction opposite to those of isolation housing in males reared under normal laboratory grouped, same-sex housing conditions (Experiment 1); the effect of the latter was to increase the frequency of occurrence of play behavior between pairs of male rats. This finding would seem to suggest that there is a

Table 3
Percentage of Total Interaction Class Score for Various Behavioral Categories for Each Group

Group	Behavioral Categories				
	Chase	Sniffing	Passive Contact	Play	Social Grooming
Test of Gregariousness					
Males					
Isolation	14.8	21.1	51.0	9.0	.0
Same-Sex Paired	8.9	16.5	55.0	15.8	3.1
Heterosexual Paired	5.5	20.4	56.4	15.2	1.1
Females					
Isolation	3.9	23.1	57.3	1.4	10.3
Same-Sex Paired	3.3	18.8	62.5	4.0	9.3
Heterosexual Paired	9.3	32.3	42.4	4.8	6.7
Social-Facilitation Test					
Males					
Isolation	9.4	33.4	46.7	10.0	.4
Same-Sex Paired	15.9	28.4	38.3	13.8	.6
Heterosexual Paired	8.1	22.7	46.1	16.8	1.1
Females					
Isolation	10.0	35.9	44.5	4.3	5.4
Same-Sex Paired	5.8	23.1	55.4	9.3	5.4
Heterosexual Paired	14.7	36.8	41.3	4.8	2.3

critical period for the development of normal socio-affective responses in the rat. In addition, it is interesting to note that females reared with same-sex peers engaged in more social grooming behavior than females reared with an opposite-sex peer. Again, it would appear that the kind of social interactions that females have during the period between 21 days and maturity are essential for the development of their pattern of affiliative behavior. As with the effects of differential housing, the results of differential early rearing were most pronounced on play behavior in male rats and on social grooming behavior in female rats.

EXPERIMENT 3

In the first two experiments, rats were observed to engage in a number of affiliative behaviors that appeared to be contact oriented and "friendly" in nature. No instances of direct fighting were observed in the two situations used in these experiments. This finding is similar to findings of Latané (1974) that led him to conclude that the social interactions between rats were, for the most part, nonaggressive. Although this conclusion is supported by other evidence in the literature (e.g., Lore & Flannelly, 1977), there are reports by Barnett (1958) and by Steinger (1950) that under certain circumstances rats engage in intense fighting.

One difference between the studies reporting amicable interactions and those reporting aggression is that of the test situation. The studies of Barnett involved placing a number of animals together in a large enclosed area and allowing them to establish a

colony. After they had become thoroughly familiar with their environment and with each other, new animals were introduced. It was toward these new animals that the aggression was directed. Little aggression occurred between the animals making up the original colony. Barnett attributed this aggression to the defense of territory by the established animals, and further stated that the amount of aggressive behavior would be inversely related to the degree of strangeness of the environment. In the experiments reported here, as well as in those of Latané, animals were placed into a strange test environment for a relatively short period of time.

An additional difference between the experiments of Latané (1974) and Lore and Flannelly (1977) and those of Barnett (1958) was that the latter used wild rats while the former used domestic strains. It has been suggested (Boice, 1973) that domestic strains do not show many of the aggressive behaviors observed in wild rats, e.g., threat posture and aggressive grooming. Thus, an alternative explanation to the aforementioned conflicting results might be found in the effects of domestication.

Experiment 3 was designed to determine to what extent the social interactions observed in the present set of experiments were situation dependent, and to test whether under some conditions domestic rats would exhibit aggressive postures observed in wild animals.

In this experiment, animals were placed in separate but adjoining compartments for approximately 20 h. The compartments were separated by a barrier which, when removed, left the animals together in a single environment, half of which had been occupied

by one animal and half by the other. Following the removal of the barrier, the social interactions between the animals were scored according to an expanded set of behavioral categories.

Method

Subjects

The subjects used in this experiment were the same as those used in Experiment 2. Thirty-two pairs of animals were tested—six pairs of same-sex socially reared males, six pairs of same-sex socially reared females, six pairs of males and five pairs of females reared in social isolation, and five pairs of males and four pairs of females reared in heterosexual pairs. All animals had been housed individually in standard wire-mesh cages since the completion of Experiment 2. Food and water were freely available throughout the experiment. At the time of testing, the animals were between 180 and 200 days old.

Apparatus

The apparatus used in this experiment was a wooden box measuring 61 × 46 × 31 cm. It was divided into two equal compartments by a wooden barrier. The top of the box was a sheet of Plexiglas perforated in several places so as to provide adequate air circulation. Each compartment contained an externally mounted feeder and water bottle. The floor of the box was covered with woodchips. Lighting was provided with a series of 15-W light bulbs hung about 50 cm above the test environment. The previously described noise mask was used throughout the experiment. The VTR camera was mounted 1 m above the test environment.

Procedure

The animals were transported to the laboratory in separate containers. One was placed into each compartment of the test environment with food and water available. Twenty hours later, testing began; the partition was removed and the animals were free to interact. The VTR system was turned on immediately after the partition was removed and video tapes were made of the social interactions between the animals during the next 30 min.

The video tapes were scored using a time sampling procedure in which the interactions of the animals were scored once every 5 sec. The behavioral categories included the affiliative behaviors described in Experiment 1 as well as categories for both aggressive and sexual behavior. The additional categories were defined as follows: *Anogenital sniffing*—sniffing directed at the anogenital region of the other animal. *Fighting*—instances in which the animals were engaged in direct fighting. *Dominant-submissive posture*—instances in which one animal was stably positioned over the other animal which was lying on its back. *Aggressive grooming*—instances in which one animal vigorously grooms another, while gripping the fur of that animal, usually

around the region of the neck, with its forepaws. *Boxing*—instances in which the two animals were standing upright facing one another and making pawing movements toward each other. *Kicking*—when one animal kicks at the other with its hindpaw. *Threat posture*—instances in which one animal arches its back, and, with all four limbs extended, directs its flank toward the other animal. *Mounting*—including the full mounting posture of approaching the other animal from the back, putting its forepaws on the back of the animal, executing pelvic thrusts, and finally grooming its own genitals.

Results and Discussion

For the purpose of analysis, the aggressive behavior categories were added together and treated as a single category. Mounting was not scored frequently enough to merit analysis. The analysis of the data was done in the same manner as in the previous experiments.

The findings, which are presented in Table 4, can be summarized as follows: (1) Males engaged in more rough-and-tumble play behavior than did females ($U = 55$, $n_1 = 15$, $n_2 = 17$, $p = .003$); (2) same-sex socially reared males tended to engage in more play behavior than did males reared in social isolation ($U = 8$, $n_1 = 6$, $n_2 = 6$, $p = .06$); (3) females engaged more frequently in passive contact than did males ($U = 80$, $n_1 = 15$, $n_2 = 17$, $p = .04$); (4) females engaged in more social grooming than did males ($U = 0$, $n_1 = 15$, $n_2 = 17$, $p < .001$); (5) same-sex socially reared females tended to engage in more social grooming behavior than did females reared with an opposite-sex peer ($U = 6.5$, $n_1 = 6$, $n_2 = 5$, $p = .07$); (6) males engaged in more chase behavior ($U = 82.5$, $n_1 = 15$, $n_2 = 17$, $p = .04$) and in more aggressive behavior ($U = 40.5$, $n_1 = 15$, $n_2 = 17$, $p < .001$) than did females; and (7) same-sex socially reared males engaged in more play behavior than did females socially reared with a same-sex peer ($U = 5$, $n_1 = 6$, $n_2 = 6$, $p = .02$).

Most notable were the sex differences in affiliative behavior. In the present experiment, males engaged in more play-and-chase behavior, while females

Table 4
Percentage of Total Interaction Class Score for Various Behavioral Categories for Each Group

Group	Behavioral Categories							
	Chase	Sniffing	Passive Contact	Play	Social Grooming	Threat Posture	Fight	Aggressive Grooming
Males								
Isolation	5.0	36.8	23.6	8.0	.0	8.3	6.8	2.7
Same-Sex	6.8	25.7	36.0	13.0	1.5	2.1	2.8	2.8
Heterosexual	5.0	20.1	29.1	11.6	5.1	1.8	2.2	5.6
Females								
Isolation	2.4	21.6	43.2	2.6	7.2	2.8	.6	1.8
Same-Sex	4.3	25.9	31.4	7.8	15.9	.1	.7	2.2
Heterosexual	.9	16.7	43.5	8.4	9.3	.0	.0	2.5

engaged more often in social grooming. Thus, despite the changes in the test environment, the sex differences in affiliative behavior were consistently observed.

The most obvious difference between the results of this experiment and those of the previous experiments was the occurrence of aggressive behavior. This finding would seem to indicate that the procedure was, to some extent, successful in introducing into the test situation the conditions for establishing territoriality.

The aggressive behavior observed in these results indicates that the social interactions of rats are not always "friendly" or playful in nature. Rather, they are influenced by certain features of the environment, such as territoriality. Despite the consistent presence of aggression between the male pairs at some point in the test period, the social interactions were more often scored as affiliative behavior than as aggressive behavior. Thus, although it is naive to assume that rats do not show interspecies aggression given the appropriate situational stimuli, even in such situations rats continue to engage in affiliative behavior (cf. Barnett, 1958).

Finally, as seen in Table 4, male animals were observed to engage in threat posturing and in aggressive grooming. Moreover, direct fighting occurred between all pairs of male animals. These findings would seem to suggest, that although thresholds for aggressive behaviors may be higher for domesticated strains of rats, the behavioral repertoire of these animals has not been altered by domestication.

GENERAL DISCUSSION

The sex differences consistently observed in the preceding experiments may be thought of as differences in the behavioral repertoires of the animals. Again, these are differences of degree rather than kind. These results indicate that a higher incidence of play and chase may be thought of as male-pattern affiliative behavior, whereas a higher incidence of social grooming is characteristic of a female pattern of affiliative behavior.

Manipulations of socioenvironmental factors (housing and rearing conditions) appear to differentially affect the social behavior of male and female rats: that is, the effects are sex dependent. These factors affect most the male-pattern affiliative behavior in males and the female-pattern affiliative behavior in females. This suggests that it is the social responsiveness of the animals rather than the behavioral repertoires that is influenced by these social factors. The increase in social responsiveness observed in isolation-housed animals (Experiment 1), for example, most affected play behavior in males and social grooming behavior in females. Similarly, differential social

rearing (Experiments 2 and 3) most affected play and chase behavior in males and social grooming behavior in females. The implication of these findings is that the frequency of occurrence of these behaviors is a function of the interaction between the social responsiveness and the behavioral repertoires of the animals involved.

The results of Experiment 3 suggest that, at least in males, situational factors also influence the nature of the social interactions between the animals. The effect of familiarity of territory was to increase the occurrence of aggression between male pairs. Presumably, the presence of a litter would have affected the nature of the social interactions between females (cf. Gandleman, 1972). Thus, the equation presented in the preceding paragraph should be expanded so as to include situational variables.

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