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SOME SOCIAL EFFECTS ON EATING AND DRINKING IN DEER MICE PEROMYSCUS MANICULATUS BAIRDII AND P. M. GRACILIS

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY
JAMES JUSTIN COOPER
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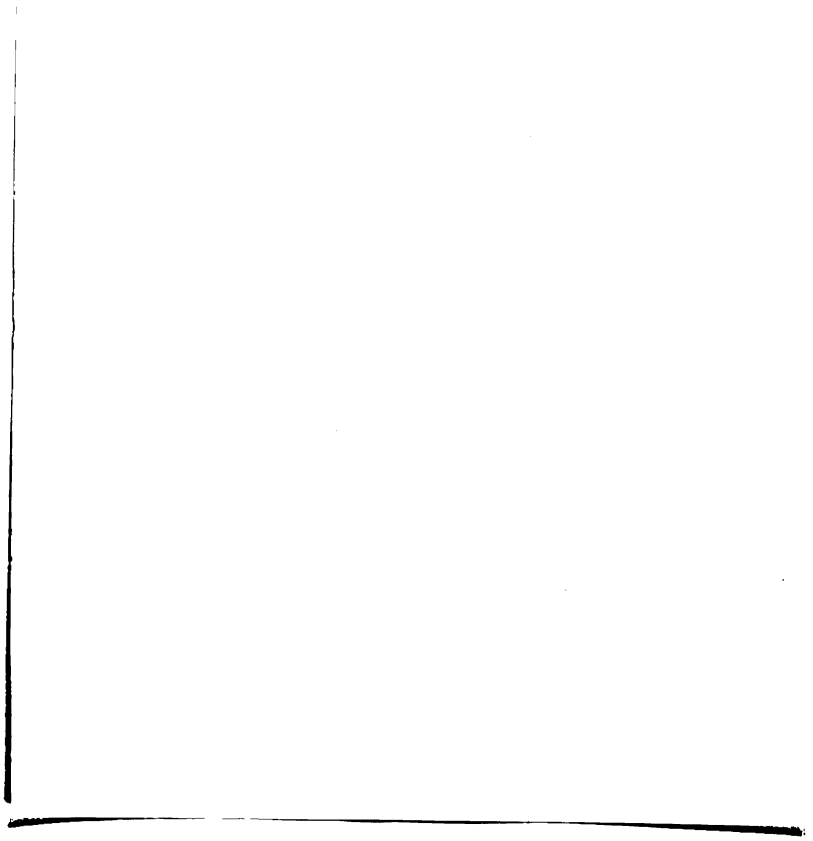

ABSTRACT

SOME SOCIAL EFFECTS ON
EATING AND DRINKING IN DEERMICE
PEROMYSCUS MANICULATUS BAIRDII AND
P. M. GRACILIS

By

James Justin Cooper

Many experiments have shown that social facilitation of eating occurs in dogs, chickens, and albino rats. These animals eat more food when fed in groups than when fed as isolated individuals. Whereas, most food and sucrose preference experiments have been conducted on individual subjects, some investigators have used groups of subjects. In view of the evidence for social facilitation of eating, it seems risky to generalize from these group preference studies to the behavior of isolated individuals.

Experiment I was done to see if social facilitation occured under conditions like those used in sucrose preference studies. Forty-eight pairs of deermice were given ad libitum water, 8% sucrose solution, and food. Half of the time the members of each pair were housed together in one cage, half of the time they were housed apart in individual cages.

The results indicated that given water, P. m. gracilis drank more when housed apart than when housed together in pairs, and both subspecies ate more when housed apart than when housed together. Given 8% sucrose solution, both subspecies drank more when housed apart than when housed

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together, although the social conditions did not reliably affect eating. Whether water or 8% sucrose solution was given, both subspecies consumed more calories when housed apart than when housed together. Thus social interference, the opposite of social facilitation occured.

Two mechanisms might have produced the social interference: (a) an increase in arousal caused by the presence of other animals, leading to the enhancement of the most probable response, and to a decrement in all other responses (Zajonc, 1965), and (b) social huddling, leading to reduced heat losses, reduced energy needs, and thus, reduces caloric consumption (Allee, 1938). Experiment II was an attempt to determine which of these mechanisms caused the social interference by making drinking the most probable response. Twelve pairs of deermice from Experiment I were tested as before, except they received water or 8% sucrose solution for only 1 hour per day, following 23 hours of water deprivation. Food was still available ad libitum.

The results showed that even when drinking was the most probable response, social interference of drinking occured. The social huddling explanation of the social interference of caloric consumption is better able to account for this data than the arousal explanation.

Aside from social interference, it was noted that P. m. bairdii consumed more calories per gram-body-weight and drank less water than P. m. gracilis when housed individually; P. m. gracilis showed social interference of water drinking, but P. m. bairdii did not. P. m. bairdii drank less 8% sucrose solution than P. m. gracilis, but ate more food given 8% sucrose solution, and obtained a higher proportion of their calories from this food. It is possible that some of these differences between the subspecies were produced by the difference in mean age

between the P. m. gracilis and P. m. bairdii.

In addition, mice housed in small cages consumed more calories given 8% sucrose solution than given water. When mixed pairs, consisting of one P. m. gracilis and one P. m. bairdii were housed together, their intakes did not differ from intakes predicted using the data of homogeneous pairs.

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By

James Justin Cooper

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Social facilitation is one of the most widely demonstrated phenomina of social psychology. Scott (1968), following Crawford (1939), defined social facilitation as "any increment of performance resulting from interaction between two or more individuals (p. 57)" and social interference as "any decrement of performance resulting from social interaction (p. 57)." If, for example, two mice ate more food when they were housed together, in one cage, than when they were housed apart, in two cages, social facilitation of eating is said to have occured, but if the mice ate more food when housed apart than when housed together, social interference of eating is said to have occured. Social facilitation of eating has been demonstrated in chickens (Tolman, 1964 and 1965; Tolman & Wilson, 1965), dogs (Ross & Ross, 1949a and 1949b; James, 1953; James & Cannon, 1955; James & Gilbert, 1955; James, 1960), and in albino rats (Harlow, 1932).

The large amount of evidence for social facilitation of eating in laboratory animals leads one to question some of the methods which have been used to test food preferences in the past. Whereas, in most food preference studies the subjects are housed and tested in individual cages, some sucrose preference studies have been conducted on animals housed in groups with sucrose solutions available ad libitum (Jacobs & Scott, 1957; Carpenter, 1958).

Similarly, in his food preference research, Young (1944), 1945, 1946, 1947) carried out a series of experiments in which rats were housed in

groups in cafeteria cages. In the first of these studies, Young listed the advantages of this procedure and included the statement that "The average intake - intake per rat per day - can be obtained by dividing the total intake for the group by the number of rats in the cage (Young, 1944, p. 372)." He went on to say that the major disadvantage of this procedure is the loss of individual differences in intake in the group results. Levine (1968) has shown that this loss of individual differecnes in intake can lead to misinterpretation of results in sucrose preference studies. Furthermore, the social facilitation literature suggests that a second major disadvantage exists: It is unsafe to assume that the average per subject daily intake is the same for group-housed and individually-housed subjects. Social facilitation may cause subjects housed in groups to consume more food, sucrose solution, water, or other substances than individually-housed subjects.

Not all studies, however, have demonstrated social facilitation of eating. Shelley (1965) found that albino rats housed in groups ate less and gained less weight under ad libitum food and water conditions than rats housed individually. Thus he found social interference of eating, not social facilitation.

This descrepancy can be accounted for using a theory of social facilitation suggested by Zajonc (1965 and 1968). The basic assumption of the theory is that the presence of individuals of the same species causes an increase in non-spacific drive or arousal. Recently, Latane' & Cappell (1972) have demonstrated that in rats, heart rate increases in the presence of other rats, supporting this assumption. This increase in arousal causes the enhancement of the dominant or most probable response in the situation, and a decrement in all nondominant responses.

All of the above mentioned studies which demonstrated social facilitation of eating used feeding schedules or food deprivation schedules. It seems likely that at feeding time, the dominant response of an animal on a feeding schedule is eating. If a second animal is present in the feeding situation, one would, therefore, expect social facilitation of eating to occur. On the other hand, eating may never be the most probable response for an animal receiving food ad libitum, as Shelley's rats were (Shelley, 1965). The dominant response for such animals might be moving around in their cages, for example, and the enhancement of this response caused by the presence of a second animal, should, according to Zajonc's theory, result in a decrement in all other responses including eating.

Based on data collected by Vetulani (1931) and Retzlaff (Personal communication; both cited by Allee, 1938), Allee postulated another mechanism which might produce social effects on eating behavior in some circumstances. Retzlaff showed that given abundant food under high temperature conditions (85° F.), young albino mice gained weight more rapidly when isolated than when housed in groups. This result tends to support Shelley's (1965) similar finding with young rats. However, under lower temperatures (61° F.) Retzlaff obtained the opposite result. He found, as Vetulani had found earlier, that isolated mice grew more slowly than group-housed mice.

According to Allee (1938), the mice housed together grow more rapidly under cool conditions, because they were able to huddle to keep warm. Huddling animals have a lower body-surface-area to weight ratio than they would have if they were not huddling. Because heat loss is proportional to body-surface-area, the huddling animals lose heat

more slowly than they would otherwise. Hence, by huddling, the group-housed mice conserved energy for growth which the isolated mice used to maintain their body temperatures.

In support of this analysis, it has been demonstrated that the minimum rate of metabolism (rate of oxygen consumption) of four house mice huddled together was only 2.2 times as great as that of a single mouse, implying that less food per mouse was being oxidized by the huddling mice than by the lone mouse (Pearson, 1947). Thus animals allowed to huddle should need to consume fewer calories to maintain their body temperature than those prevented from huddling. This energy savings might manifest itself as a faster rate of growth, or as a decrease in food consumption.

Thus Zajonc and Allee proposed two different mechanisms which may produce social effects on consumatory behavior: (a) arousal caused by the presence of conspecifics, and (b) energy conservation produced by huddling when groups of animals are housed together. Either or both of these mechanisms could have been at work in the previously cited food and sucrose preference studies, and not generaliziable to isolated subjects. Hence, the first experiment was done for two reasons: (a) to see if social facilitation of social interference effects occured in the eating and drinking behavior of deermice (Peromyscus maniculatus bairdii and P. m. gracilis) in conditions comparable to those used in sucrose preference studies done in our laboratory and elsewhere, and (b) to see if the mechanisms postualted by Zajonc and Allee could explain such effects, if any were found.

EXPERIMENT I

To make the present study similar to previously done sucrose preference studies, food, water, and 8% sucrose solution were given to the deermice ad libitum, as food was given to the animals in Shelley's (1965) study and in the studies reported by Allee (1938). Specifically, the question asked was: Do pairs of mice housed together drink and eat more or less than the same pair of mice housed individually?

The mice were tested with water (0%) and 8% sucrose solution (8%) to see if social effects differed for these two liquids. Collier and Bolles (1968) conceptualized the typical one-bottle sucrose preference experiment as a situation in which the subjects select a diet from two components, food and sucrose solution. Their results showed that rats in one-bottle sucrose preference studies tend to consume a fixed number of calories per day, and to get a fixed proportion of these calories from the sucrose solution. Thus differences caused by changed in caloric intake might be expected to appear in 8% intake, while such differences should not appear in 0% intake.

Most studies of social facilitation have used only one species of animal, but Ross & Ross (1949a) showed that social facilitation of eating was greater for one breed of dogs than for another. Two subspecies of deermice were used in the present study to see if similar social effects on eating and drinking occured for the two subspecies. Mixed pairs, made up of one subject from each subspecies, were also tested to

determine whether or not social effects for mixed pairs differed from those for homogeneous pairs.

METHOD

Subjects

The subjects were 96 male deermice bred in the Michigan State University Zoology Department Colony; half of the mice were Peromyscus maniculatus bairdii and half were P. m. gracilis. A sizable body of psychological research has been done using members of the genus Peromyscus as subjects; see King (1968) for a summary of this work. At the beginning of the experiment, the mean ages of the mice were 315 and 576 days, with standard deviations of 58 and 414 days, and ranges of 120 - 410 and 126 - 1439 days for bairdii and gracilis respectively.

Prior to the experiment, the mice were housed in groups of from two to six animals in the small plastic rodent cages described below, with the subspecies segregated. Both before and during testing, the subjects were exposed to a 12 hours light - 12 hours dark schedule. They were maintained on Purina Mouse Chow and tap water and had had no previous experience with sucrose solutions. Four mice died during the course of the experiment. All data from the pairs to which these mice belonged was discarded and replacement pairs were tested.

Apparatus

The mice were tested in the same room in which the mouse colony was housed. Temperatures in the room generally varied about 5 or 6° F. over each 24 hour period. The mean daily maximum temperature during the experiment was 72° F., the mean daily minimum temperature was 66° F.

Maximum and minimum temperatures ranged from 79 to 67° F. and 73 to 64° F. respectively.

Half of the mice were tested in large cages and half in small cages, 14 X 12 X 6.5 in. and 11 X 7 X 5 in. respectively. Both types of cages were made of clear plastic and were equipped with tops made from stainless steal rods. These cage-tops were designed so that food could be placed in a trough extending across the width of the cage. In all conditions, food was spread out along the bottom of the trough, between the drinking tubes, to preclude competition for food. The cage bottoms were covered with a layer of wood-chips during testing; no additional nesting material was given.

Solutions were presented to the mice in 50 ml. Pyrex graduated cylinders (bottles) graduated in ml. The bottles were fitted with number-three one-hole rubber stoppers into which Girton stainless steel drinking tubes had been inserted. The bottles were placed on the cages so that the drinking tubes protruded into the cages between the rods of the cage tops. Under all conditions, two bottles were placed on each cage with their drinking tubes about 4 in. apart. Care was taken to insure that the tube placements were as similar as possible in the large and small cages.

A Mettler P-6 electronic balance was used to weigh the mice and their food, and assorted large beakers and bottles were used to mix and store the fluids given to the mice.

Design

The major independent variables of the experiment were:

1. Species combination: The 96 mice were randomly paired so that 16 paris consisted of two bairdii (BB), 16 pairs of one bairdii and one

gracilis (BG), and 16 pairs of two gracilis (GG). These three types of pairs constituted the levels of the species combination variables.

2. Social condition: Each pair was tested for 24 days, divided into four six-day periods. During two of these periods, the pair was housed apart, with one of its members in each of two cages (A). During the other two periods, the pair was housed together in one cage (T). The social conditions were presented in two different orders; hald of the pairs received the sequence ATAT and half TATA. The third and fourth six-day periods provided a replication of the first and second periods.

3. Cage size: Half of the pairs in each species combination were tested in small cages and half in large cages. The cage size variable was included to control for the possibility that the amount of cage-size space per animal might effect the dependent variables under study. If, for example, only small cages were used, the cage-space did have an effect on drinking, one might erroneously conclude that social condition was producing the effect, since in the together condition, cage-space per animal would be half as great as in the apart condition. Using large and small cages controlled for this possible confounding, since if cage-space per animal produced a significant social condition effect, it should also produce a significant cage size effect or Cage Size X Social Condition interaction, because the large cages contained more than double the amount of space contained in the small cages.

4. Solution: Within each six-day social condition perdio, the mice were given tap water (0%) for the first three days and 8% sucrose solution (8%) for the last three days. Table 1 shows the basic design.

Procedure

The mice were run in four squads, each of which contained four pairs from each species combination. The pairs of mice were randomly assigned to Squad X Cage Size X Order of Social Condition cells so that each cell contained one pair of each species combination.

The four squads were started on 5 February, 1 March, 26 March, and 23 April 1969. The replacement pairs were run as soon as possible after it became apparent that a replacement would be required.

On the first day for each squad, the mice were weighed and placed in the proper cages. A weighed amount of Purina Mouse Chow was placed in each cage-top. Cages containing one mouse were supplied with 7 pellets of chow, those containing two mice with 14 pellets. Bottles containing 0% were placed on the cages, and the amount of fluid given was read to the nearest .2 ml. and recorded. Fresh bottles were supplied daily and the amount left in the old bottles was recorded.

The mice received three days of 0% alternating with three days of 8% for 24 days. At the end of each three-day period, the food left in each cage-top was weighed and fresh food given. At the end of each six-day period, the mice were placed in clean cages and changed from one social condition to the other. At the end of the 24 days of testing, the mice were given a final weighing, and a new squad was started.

The 8% solutions were mixed by dissolving 160 gm. of commercial sugar in enough tap water to make two liters of solution; thus the 8% refers to weight of solute per unit volume of solution. Fresh solutions were mixed about every other day, and both 0% and 8% solutions were stored under refrigeration prior to use.

Table 1. The design of Experiment I.

Cage Size	Social Condition and Solution			
	Apart 0%	Together 0%	Apart 8%	Together 8%
		Bairdii-Bairdii Pairs		
Small Cage	Pair 1 . . . Pair 8	Pair 1 . . . Pair 8	Pair 1 . . . Pair 8	Pair 1 . . . Pair 8
Large Cage	Pair 9 . . . Pair 16	Pair 9 . . . Pair 16	Pair 9 . . . Pair 16	Pair 9 . . . Pair 16
		Bairdii-Gracilis Pairs		
Small Cage	Pair 17 . . . Pair 24	Pair 17 . . . Pair 24	Pair 17 . . . Pair 24	Pair 17 . . . Pair 24
Large Cage	Pair 25 . . . Pair 32	Pair 25 . . . Pair 32	Pair 25 . . . Pair 32	Pair 25 . . . Pair 32
		Gracilis-Gracilis Pairs		
Small Cage	Pair 33 . . . Pair 40	Pair 33 . . . Pair 40	Pair 33 . . . Pair 40	Pair 33 . . . Pair 40
Large Cage	Pair 41 . . . Pair 48	Pair 41 . . . Pair 48	Pair 41 . . . Pair 48	Pair 41 . . . Pair 48

RESULTS

Informal Observations

The mice were generally inactive while the lights were on in the laboratory. Typically they curled up in a corner of their cage; when in the T condition, both mice usually shared the same corner. Observations made during the 12 hour dark period, using red lights, showed that the mice were very active in the dark and spent most of the time running around their cages in stereotyped patterns; relatively little time was spent eating and drinking.

Some pairs fought when they were first placed in the T condition. The fighting seldom lasted more than 24 hours, and most fights ended after a few minutes. Bairdii seemed more inclined to fight than gracilis, and often won fights with gracilis, although they were usually outweighed.

Fluid Intake Results

The individual fluid and food intakes for the two members of each pair in the A condition were summed to obtain total intakes for the pair. These intakes were analyzed with the corresponding intakes for each pair in the T condition.

The mean daily 0% intakes for the six groups of pairs under the four within-pair treatments are shown in Table 2, and the corresponding 8% intakes are shown in Table 3. Comparing these tables shows that all groups drank more 8% than 0% in each condition. A complete analysis of

Table 2. 0% intake and food intake given 0%: Experiment I

Social Condition	Species Combination X Cage Size Group					
	BB Small	BB Large	BG Small	BG Large	GG Small	GG Large
	0% Intake in ml./day					
Apart	11.4	10.4	11.8	12.8	13.0	14.5
Together	11.8	10.0	10.6	12.5	10.9	12.4
	Food Intake given 0% in gm./3 days					
Apart	30.0	26.6	24.8	28.0	23.8	27.6
Together	27.1	24.2	21.9	24.4	21.0	24.7

Table 3. 8% intake and food intake given 8%: Experiment I

Social Condition	Species Combination X Cage Size Group					
	BB Small	BB Large	BG Small	BG Large	GG Small	GG Large
	8% Intake in ml./day					
Apart	34.9	27.9	45.6	37.3	47.8	48.9
Together	32.9	22.9	41.7	33.8	42.4	42.1
	Food Intake given 8% in gm./3 days					
Apart	23.4	20.4	16.2	18.9	15.1	16.4
Together	21.5	20.4	26.3	18.0	13.8	15.9

variance (AOV) was performed on the daily 0% and 8% intakes. The solution, social condition, Solution X Social Condition, species combination, Solution X Species Combination, Social Condition X Species Combination, Solution X Cage Size, pairs within groups, Solution X Pairs, and replications effects were significant, $p < .05$ (see Table 1A in Appendix A). Solution was by far the biggest effect, accounting for 67% of the variance. Since there was no doubt that the mice drank more 8% than 0%, and since so many other variables interacted with the solution variables, separate AOVs were drawn on 0% and 8% intakes. To simplify the calculation of these AOVs, means averaged over replications and days were used in this analysis.

In the 0% AOV the Social Condition X Species Combination interaction was significant (see Table 2A in Appendix A). Tests of the simple main effects (Kirk, 1968) of social condition for the levels of species combination showed that BG and GG pairs drank more 0% in the A condition than in the T condition, $F(1,42)=8.7$ for BG, $F(1,42)=70.6$ for GG, $p < .01$, while BB pairs showed no social effect. Of the 48 pairs tested, all but 13 drank less in the T condition than in the A condition; 8 of the 13 were BB pairs and 5 were BG pairs.

Tests of simple main effects of species combination at the two levels of social condition indicated that differences between the species combinations occured for the A intakes, $F(2,84)=6.6$, $p < .01$. Tukey's honestly significant difference (HSD) test (Kirk, 1968) revealed that in the A condition the BB pairs drank less 0% than the GG pairs, $q(3,84)=5.1$, $p < .01$, and that the BG pairs did not differ significantly from the BB or GG pairs.

The 8% AOV showed that the mice drank more 8% in A than in T (see Table 3A in Appendix A). Forty-two of the 48 pairs showed this social interference effect. The six nonconformist pairs were evenly divided among the species combinations.

The species combination effect was also significant for 8% intakes, and Tukey's HSD test indicated that the BB pairs drank less 8% than the GG pairs, $q(3,42)=6.8$, $p < .01$, and the BG pairs, $q(3,42)=4.3$, $p < .05$, but the latter two groups did not differ significantly.

The Solution X Cage Size interaction, which was significant in the complete fluid intake AOV, was apparently caused by the large difference between 8% intakes for the large cage and small cage groups, as compared with a small difference in the opposite direction for 0% intake. However, this difference in 8% intake for the cage size groups did not prove significant in the AOV done on 8% intakes (see Table 3A in Appendix A).

The significant pairs within groups and Solution X Pairs effects in the complete AOV suggest that some pairs in each group drank more than others, and that these inter-pair differences were larger for 8% intake than for 0% intake. The replications effect was significant because of the small amount of variability between days within replications.

Food Intake Results

The mean three-day food intakes for each group in each treatment, given 0% and given 8% are shown in Tables 2 and 3 respectively. A complete AOV done on the food intake data under both 0% and 8% conditions (see Table 4A in Appendix A) indicated that the solution, social condition, Solution X Social Condition, species combination, Solution

X Species Combination, pairs within groups, and Solution X Pairs effects were significant, $p < .05$. Again, there was no doubt that the mice ate more food under the 0% condition than under the 8% condition, so separate AOVs were calculated for food intakes given 0% and food intakes given 8%. These AOVs were done on the mean three-day food intakes for each pair in the T and A conditions averaged over replications.

The food intake given 0% of AOV indicated that the mice ate more food in the A condition than in the T condition (see Table 5A in Appendix A). No other effects were significant. Again, a large majority of the pairs (42) exhibited social interference to some degree. Of the six pairs which did not show interference, three were BB pairs, and three were BG pairs.

The food intake given 8% AOV also had only one significant effect, but it was species combination, not social condition (see Table 6A in Appendix A). Tukey's HSD test showed that BB pairs ate more given 8% than GG pairs, $q(3,42)=5.2$, $p < .01$, and that BG pairs did not differ on the average from either BB or GG pairs. Although the social interference effect was not significant, 30 pairs ate more in A than in T.

The significant pairs within groups effect, which accounted for 38% of the variance in the complete food AOV, suggests that differences in food intake between pairs within groups were quite large.

Caloric Intake Results

Each pair's mean caloric intake per three days was calculated for each within pair treatment. Each gm. of sucrose was counted as 3.85 calories, and each gm. of food as 4.47 calories. The resulting group means are shown in Table 4. An AOV done on the caloric intake data

indicated that the Solution X Social Condition and Solution X Cage Size interactions were significant (see Table 7A in Appendix A), and tests of simple main effects were carried out.

These tests indicated that caloric intake was higher in the A condition than in the T condition whether the mice received 0% or 8%, $F(1,84)=48.4$ for 0%, $F(1,84)=15.8$ for 8%, $p < .01$. Given 8%, 34 of the 48 pairs consumed more calories in A than in T; five BB pairs, five BG paris, and four GG pairs did not show this effect. The corresponding figures for 0% have already been given in the food intake results, since in this case, the only source of calories was the food.

Tests for simple main effects also showed that the mice consumed more calories given 8% than when given 0% only in the T condition, $F(1,84)=14.3$, $p < .01$. In the A condition, the mice consumed as many calories given 0% as given 8%.

Tests of the simple main effects of solution at the levels of cage size revealed that mice housed in small cages consumed more calories when given 8% than when given 0%, $F(1,42)=19.8$, $p < .01$, however, solution differences in caloric intake for mice housed in large cages were not significant. Moreover, differences in caloric intake between groups housed in large and small cages were not significant.

Relating the caloric intake results to the fluid and food results shows that in the A condition, the mice behaved as Collier and Bolles (1968) might have predicted: they maintained a constant caloric intake whether or not sucrose was present. Pairs housed in large cages also maintained a constant caloric intake in the T condition with or without 8%, however, pairs housed in small cages in T consumed more calories when 8% sucrose was available than when it was not. Of the 24 pairs in the

Table 4. Caloric intake and proportion of calories from food.

Social Condition	Species Combination X Cage Size Group					
	BB Small	BB Large	BG Small	BG Large	GG Small	GG Large
	Caloric Intake given 0% in cal./3 days					
Apart	129	119	111	125	106	123
Together	121	108	98	114	94	111
	Caloric Intake given 8% in cal./3 days					
Apart	137	117	115	119	112	119
Together	126	112	111	112	101	116
	Proportion of Calories from Food given 8%					
Apart	.764	.772	.621	.702	.602	.617
Together	.759	.806	.642	.709	.607	.658

small cage group, 19 pairs showed this effect.

When 0% was given, a mean social interference effect of 11.4 calories per three days was detected, a 9.6% decrease from A to T. When 8% was given, the corresponding effect was only 6.5 calories, a 5.4% decrease. Mean food intake given 8% decreased 2.5 calories (4.1%), but mean calories from 8% decreased by 4.0 calories, a 10.7% reduction. Therefore, the social interference of caloric intake in the 8% condition was due mostly to social interference of 8% drinking. This suggests that the average proportion of the total calories obtained from food, given 8%, was greater in the T condition than in the A condition.

Table 4 shows the proportion of total calories obtained from food in the A and T conditions for each group, given 8%. An AOV performed on these proportions (see Table 8A in Appendix A) indicated that both social condition and species combination effected the proportion of calories obtained from food, however, the effect due to social condition was a small one; it accounted for only one percent of the varaince in the proportions, and only 29 of the 48 pairs demonstrated it.

Tukey's HSD test revealed that the BB pairs obtained a higher proportion of their calories from food than either the BG pairs, $q(3,42)=3.9$, $p < .05$, or GG pairs, $q(3,42)=5.7$, $p < .01$, while no significant difference occured between the Bg and GG mean proportions. This was to be expected, in ivew of the species combination differences in 8% drinking and eating given 8%, discussed previously.

However, it was not expected that the total caloric intakes for the three species combinations would be essentially equal, since the mean body weights for pairs in the three combinations varied considerably; 41.7, 47.5, and 56.9 gm. for BB, BG, and GG pairs, respectively. An AOV on caloric intake per gm. body weight indicated that differences between the species combinations existed for this variable, $F(2,42)=30.2$, $p < .01$, and Tukey's HSD test revealed that BB pairs consumed more calories per gm. body weight (2.9 calories/gm./3 days) than BG pairs (2.4 cal./gm./3 days), $q(3,42)=4.2$, $p < .05$, which in turn consumed more than GG pairs (1.9 cal./gm./3 days), $q(3,42)=3.5$, $p < .05$.

BG Results

If social effects were different for BG pairs, consisting of individuals from both subspecies, than for GG or BB pairs, one would expect the mean intakes for BG pairs in the T condition to differ from the

mean intakes for all other pairs in T. Scheffe's test (Kirk, 1968) was used to test this contrast for 0% intake, 8% intake, food intake given 0%, food intake given 8%, and total calories given 8%. None of the differences between mean BG intake and mean homogenous pairs intake in T proved significant. Hence, the effect of putting one member of each subspecies together in one cage was substantially the same as the effect of putting two members of the same subspecies together in one cage, as far as eating and drinking were concerned.

Predicting T Intakes from A Intakes

Three models of the relationship between intakes in the T and A conditions were examined for 0%, 8%, food given 0%, food given 8%, and total calories given 8% intakes. The models were:

1. The purely additibe model: $T_i = A_i + e_i$, where T_i and A_i are the T and A intakes of the i^{th} pair, and e_i is the error term. This model is called additive since it assumes that the sum of the A intakes for the members of each pair is approximately equal to the T intake for the pair.

2. The additive model with a constant non-additive term: $T_i = A_i + K + e_i$, where K is a constant such that the expected value of the error term is zero.

3. The unrestricted regression model: $T_i = C A_i + K + e_i$, where C and K are the usual regression coefficients, chosen to minimize the sum of the squared error terms.

As might be expected from the results presented previously, the purely additive model accounted for a much lower proportion of the variance in T than either of the other two models, except for food intake given 8% (see Table 5). The purely additive model seemed almost as

satisfactory as the other models for predicting this intake. For all five intakes, the additive model with a constant non-additive term accounted for only slightly less of the variance in T than the unrestricted regression model.

Table 5. Variance in T intake accounted for by three models.

Model	Type of Intake				
	0%	8%	Food Given 0%	Food Given 8%	Calories Given 8%
	Proportion of Variance Accounted for				
$T_i = A_i + e_i$	.52	.70	.44	.89	.73
$T_i = A_i + K + e_i$	.68	.85	.70	.90	.82
$T_i = C A_i + K + e_i$	.72	.88	.70	.90	.83

EXPERIMENT II

Experiment I indicated that in the ad libitum situation frequently employed in sucrose preference studies, social interference seemed to be operating. Zajonc's (1965) theory states that the dominant response in any situation should be socially facilitated, and nondominant responses should undergo social interference. Thus if eating and drinking were nondominant in the situation used in Experiment I, which casual observations indicated to be the case, then this theory could account for the social interference.

Furthermore, Allee's (1938) huddling for energy conservation mechanism could also have produced the observed interference in eating given 0% and in 8% drinking, since the mice were observed huddling during the 12 hour light period when in the T condition. Experiment II was performed to discover whether or not drinking 0% and 8% would be socially facilitated when drinking was made the dominant response by means of a deprivation schedule. Under these conditions, Zajonc's theory would predict social facilitation of 0% and 8% drinking. On the other hand, the energy conservation through huddling explanation would lead one to predict social interference with 8% drinking and eating and no effect on 0% drinking.

METHOD

The subjects used in Experiment II were the 12 pairs of deermice tested in small cages in squads two and three of the first experiment. In Experiment II, they were tested in the same pairs in which they were run in Experiment I. The apparatus used was the same as that used in the previous experiment except no large cages were used. The design of the present experiment was the same as that of the earlier experiment except that cage size was not a factor, and only four pairs of each species combination were run.

Each pair received the same order of presentation of social conditions it had received in Experiment I, and the procedure was the same as that used before except that 0% and 8% were available to the mice only for the last hour of each 24 hour day; this hour began at approximately 9:00 A.M. Food was again available ad libitum; food deprivation was not attempted since deermice adapt poorly to food deprivation schedules.

The mice were run in two squads; the pairs from squad two of the Experiment I were started on 25 March 1969, and the pairs from squad three were started on 22 April 1969.

RESULTS

Observation of the mice during the hour when fluid was available indicated that they generally spent about five minutes drinking, immediately after the bottles were placed on the cages. The rest of the hour was spent eating, grooming, or sleeping, with some additional drinking. A strong tendency to eat after the initial drinking bout was noticed. There was no doubt that drinking was the dominant response during the first five minutes of the hour.

As Table 6 shows, social interference, not social facilitation of drinking occured, although much less fluid, especially 8%, was drunk here than in Experiment I. An AOV performed on the complete fluid data (see Table 9A in Appendix A) indicated that the solution and social condition effects were significant. However, only six of the 12 pairs drank more 0% in A than in T, and 9 pairs drank more 8% in A than in T. Thus the social interference here was less convincing than that found in the first experiment. On the other hand, no evidence for social facilitation of drinking was found. The solution effect indicated, of course, that more 8% was drunk than 0%.

The pairs within species combination effect was also significant, indicating differences between pairs in the species combination groups. The significant replication effect seemed to be due to an increase in fluid intake from the first to the second replication, probably caused by adjustment to the deprivation schedule.

Table 6. 0%, 8%, and food intakes: Experiment II

Social Condition	Solution X Species Combination Group					
	0% BB	0% BG	0% GG	8% BB	8% BG	8% GG
	Fluid Intake in ml./day					
Apart	6.1	5.8	6.4	6.9	6.5	7.5
Together	6.1	5.2	6.2	6.8	6.2	6.8
	Food Intake in gm./3 days					
Apart	25.1	20.6	23.4	22.8	18.5	29.8
Together	20.8	18.0	20.5	21.3	17.2	17.8

Mean three-day food intakes for the species combinations in each treatment are also shown in Table 6. In conjunction with Tables 2 and 3 they indicate that less food was eaten in Experiment II than in Experiment I, given 0%. An AOV performed on the food data revealed that, just as in the first experiment, the mice ate more when given 0% than when given 8%, and more in the A condition than in the T condition (see Table 10A in Appendix A). Ten pairs ate more in A than in T when given 0%, and 11 pairs ate more in A than in T when given 8%. Again, differences between pairs within species combinations occured.

BG pairs consumed less food and fluid than BB or GG pairs in Experiment II, although these differences were not significant. This effect can be attributed to sampling error, since a similar effect occured in Experiment I for these same pairs.

An AOV done on caloric intake per three days showed that the pairs consumed more calories in A (100 cal./3 days) than in T (89 cal./3 days), $F(1,9)=13.8$, p .01. Eleven of 12 pairs showed this effect when given 8%, and , as mentioned in the food results, 10 of the pairs showed the effect when given 0%. As in the previous experiment, there were no significant differences between mean caloric intakes for the species combinations. An AOV carried out on three day caloric intakes per gm. body weight showed that differences between species combinations existed for this variable, $F(2,9)=8.3$, p .01. Tukey's HSD test revealed that BB pairs consumed more calories per gm. body weight (2.9 cal./gm/3 days) than GG pairs (2.0 cal./gm./3 days), $q(3,9)=5.45$, p .01, or BG pairs (2.2 cal./gm./3 days), $q(3,9)=4.4$, p .05; the BG and GG pairs did not differ significantly.

Another AOV indicated that the species combinations differed in the proportion of calories obtained from food when 8% was given, $F(2,9)=4.7$, p .05. Tukey's HSD test showed that BB pairs got a higher proportion of their calories from food (.94) than GG pairs (.93), $q(3,9)=4.4$, p .05, but this difference seems ngeligible. Of course, the proportion of total calories from food, given 8%, was much higher here than in Experiment I, because of the restricted 8% intake in this study.

DISCUSSION

The major findings of Experiment I and II were (a) the observation of social interference (not social facilitation) of eating and drinking, and (b) the observation of differences in 0%, 8%, and food consumption for the three species combinations.

Social Interference

Social interference was observed in Experiment I for 8% drinking, eating given 0%, total caloric intake given 0% and given 8%, and for 0% drinking in BG and GG pairs. Only for food intake given 8% was the interference effect nonsignificant, and the purely additive model sufficient to account for the T intakes of the pairs. These interference effects cannot be attributed to variations in the amount of cage space per animal, since differences between groups housed in large and small cages were not statistically reliable. Moreover, in Experiment II, social interference was found for 8% drinking, eating given 0%, eating given 8%, and total caloric consumption given 0% and given 8%.

Zajonc's (1965) idea that the dominant response in any situation will be socially facilitated, while all other responses will show a social decrement, can account for the social interference in Experiment I, if one assumes that eating and drinking were not dominant responses, and therefore, showed a decrement when the dominant response was socially facilitated. But it is difficult for this theory to explain why drinking in Experiment II did not show social facilitation; there, drinking was certainly the dominant response for the first few minutes after the

bottles were placed on the cages.

It is also hard for this theory to account for the lack of social interference in eating, when 8% was given in Experiment I. Here, eating was most likely less dominant when 8% was given than when 0% was given, since less food was eaten given 8% than given 0%. Yet eating given 0% showed social interference and eating given 8% did not. The absence of social interference for 0% drinking in BB pairs presents a similar problem for Zajonc's theory.

On the other hand, Allee's (1938) heat conservation mechanism can explain the occurance of social interference in 8% drinking and food consumption in both experiments. In both experiments, the subjects were observed huddling during the light-on period of the day when in the T condition. By this means, they could have reduced the amount of food required to maintain stable body weights.

Similar effects have been noted in Peromyscus by other investigators; Kind (1968) stated that social huddling is one thermoregulatory mechanism employed by this genus. Furthermore, in an experiment with Peromyscus leucopus noveboracensis, Howard (1951) demonstrated the importance of this mechanism for winter survival. The mice were housed alone or in groups of two, three, or four and exposed to low temperatures with limited food supplies. Those housed in groups of four survived lonter than those housed alone or in smaller groups. According to Howard, this result was due to reduced heat losses produced by huddling. Howard (1951) also reported winter observations of aggregations of from a few, up to a dozen Peromyscus maniculatus bairdii and P. leucopus under natural conditions. He attributed these aggregations to the needs to conserve food and to survive low temperatures.

Social huddling, rather than ad libitum feeding might be one reason Shelley (1965) found social interference of eating in young rats. His group-housed subjects could huddle, but his isolated subjects could not. In constrast, studies which found social facilitation of eating not only used feeding schedules, as noted before; they prevented huddling for all subjects (see Harlow, 1932, for example) or allowed huddling for all subjects (see Ross & Ross, 1949a, for example), regardless of whether the subjects were fed singly or in groups. Thus huddling could not have been a factor in these studies.

To test the hypothesis that huddling could account for the social interference of caloric intake found in the present experiments and in Shelley's (1965) study, the present study could be repeated under high temperature conditions, as in Retzlaff's study (cited by Allee, 1938). Because the high temperature would minimize the advantage in heat conservation which subjects in T have compared to subjects in A, differences in caloric intake should be minimized under these conditions. By the same reasoning, lowering the temperatures should increase social interference with caloric consumption to the extent that huddling produces this effect.

One result that the huddling hypothesis does not explain is the social interference of 0% drinking found for Bg and GG pairs in the first experiment; 0% drinking does not contirbute to caloric intake, why when, should it decrease when huddling is possible? Perhaps reduced eating leads to reduced drinking. The fact that for GG pairs the amount of social interference of 0% drinking in Experiment I correlated .61 with the amount of social interference of eating, given 0%, supports this idea. Moreover, Bartoshuk (1971) cited a number of rat studies which

indicated that water deprivation produced reduced food intake and vice versa. It might be that P. m. gracilis drink less when they eat less, while P. m. bairdii do not.

One might ask how other variables manipulated in this study might have influenced the huddling behavior of the subjects. In this regard, the following variables should be examined: (a) cage size, (b) subspecies, (c) solution, and (d) pair age.

It seems that a smaller cage might increase the probability of huddling by reducing the opportunity for other competing activity. If this were the case, one would expect to find greater social inhibition of caloric intake for small-cage subjects than for large-cage subjects, assuming that huddling produced such inhibition. However, no significant cage size main effect or Cage Size X Social Condition interaction was found for caloric intake, so no support for tne above reasoning can be found.

Similarly, one might expect that the larger mice in the experiments would show greater savings in caloric intake than the smaller mice, when the A and T conditions were compared. This follows from the facts that the surface area reduction for two huddling mice, as compared with the same mice not huddling, is proportionate to the total surface area of the mice, and heat loss is proportionate to surface area. Again, no support was found for this idea, since the larger gracilis showed no more social inhibition of caloric intake than the smaller bairdii. In addition, within groups, weight of the pair usually correlated negatively with the amount of social inhibition. For BB, BG, and GG the correlations of weight with the magnitude of inhibition of caloric intake were -.12, -.26, and -.17 for 8%, and -.46, .10, and -.41 for 0%.

On the other hand, it makes no intuitive sense to assume that the mice would vary their huddling behavior when given 8% instead of water to drink. Thus it is not surprising to find that social inhibition of caloric intake occured for both solutions. But it is surprising to find that in the T condition the subjects consumed more calories given 8% than given 0%. If huddling is to account for this effect, one must assume that the mice huddled less when given 8% than when given 0%. It is even less reasonable to attribute this effect to a liking for suger solution, since in the A condition no similar increase in caloric intake when given 8% was detected. Further research is required to clarify this issue.

Finally, age did not seem to have a clear-cut effect on huddling. As stated earlier, the species combinations did not differ in the amount of social inhibition of caloric intake observed, although the gracilis were older on the average than the bairdii. Within pair types, age did appear related to the amount of social inhibition of caloric intake observed. For BB pairs, caloric-intake social inhibition was negatively correlated with pair age given 0% (-.30) and 8% (-.34), but for GG pairs, age correlated positively (.37 and .62 for 0% and 8%) with these variables. Thus the younger bairdii and the older gracilis pairs showed more social inhibition than the older bairdii and the younger gracilis pairs. This suggests that younger bairdii and older gracilis pairs may have huddled more frequently than other pairs. The results for BG pairs are difficult to interpret, since when given 8%, age and inhibition correlated as with the BB pairs (-.46), while when given 0% their pair ages correlated like those of the GG pairs with social inhibition of caloric consumption (.31).

It is obvious from the above analysis that some effects which the huddling explanation of social inhibition of caloric consumption might lead one to expect were not detected, while other effects were detected which are not easily understood in terms of huddling. In addition, huddling alone cannot account for the observed social facilitation of caloric intake for a few pairs of deermice, or for the greater sensitivity of 8% intake to social condition changes contrasted with that of food intake given 8%. Thus it is probable that factors other than huddling, such as those discussed by Zajonc were also influencing caloric consumption in these studies.

Species Combination Differences

In Experiment I, differences among the species combinations were found for 0% and 8% drinking, and for eating when 8% was available. For 0% drinking, mean intakes for the species combinations did not differ significantly in the T condition. For the A condition, and for 8% drinking, BB pairs drank less than GG pairs and BG pairs fell in between.

On the other hand, BB pairs ate more food given 8% than GG pairs with BG pairs again in the middle. Collier and Bolles' (1968) idea of treating sucrose preference experiments as diet selection experiments seems useful in summarizing these 8% eating and drinking results: P. m. bairdii selected a diet with more food and less sucrose than did P. m. gracilis. This result tends to support Drickamer's (1972) finding that P. m. bairdii were conservative in sampling unfamiliar foods, when given a choice between new and old foods.

Species combination differences were also found for caloric intake per gm. body weight in both experiments; BB pairs consumed more calories per gm. body weight than GG pairs with BG pairs again in between.

Although these differences between P. m. bairdii and P. m. gracilis were observed, they were almost all differences in the amount of some behavior exhibited by both subspecies. The sole exception was the social interference of 0% drinking which occured for BG and GG pairs but not for BB pairs. It seems reasonable to assume that the gracilis showed this effect in mixed and homogeneous pairs, but the bairdii did not.

Finally, the behavior of the BG pairs can be more economically accounted for in terms of a sort of average of the behaviors of the BB and GG pairs. Mixing the subspecies did not seem to add any new dimensions to the variables studied here.

Limitations of the Results

These experiments have demonstrated that social interference effects occur for eating and drinking in deermice in an experimental situation often used for sucrose preference testing. The magnitude of the interference effects does not seem large enough to preclude group preference testing using these subjects and a similar procedure under similar temperature conditions. However, caution should be exercised in drawing conclusions from such group data about the behavior of isolated animals, and vice versa.

No specific mechanism or mechanisms have been shown to account for the social interference effects that were observed. Social huddling may be one factor that is envolved. These experiments present only a crude picture of the social effects occuring in the test situation. For instance, no information about the behavior of the individual animals in the together condition was obtained, and such information is certainly a necessary prerequisite for understanding what was going on.

APPENDICES

APPENDIX A: ANALYSES OF VARIANCE

Table 1A. Complete fluid intake analysis of variance: Experiment I.

Source	df	MS	F
Solution (A)	1	199920.09	448.8**
Social Condition (B)	1	2077.17	67.0**
A X B	1	877.63	41.0**
Species Combination (C)	2	7509.62	22.5**
A X C	2	4740.49	10.6**
B X C	2	149.56	4.82*
A X B X C	2	7.03	1
Cage Size (D)	1	1705.04	2.5
A X D	1	2505.44	5.6*
B X D	1	26.92	1
C X D	2	881.69	1.3
A X B X D	1	32.91	1.5
A X C X D	2	453.88	1.0
B X C X D	2	40.99	1.3
A X B X C X D	2	5.00	1
Pairs within C X D (E)	42	667.47	18.3**
A X E	42	445.49	12.2**
B X E	42	31.02	1
A X B X E	42	21.39	1
Replications within A X B X E	192	36.43	3.4**
Days within Replications	768	10.59	
Total	1151		

** $p < .01$

* $p < .05$

Table 2A. 0% analysis of variance: Experiment I.

Source	df	MS	F
Social Condition (A)	1	21.28	42.8**
Species Combination (B)	2	26.71	2.8
A X B	2	9.07	18.3**
Cage Size (C)	1	6.10	1
A X C	1	.03	1
B X C	2	21.61	2.3
A X B X C	2	1.39	2.8
Pairs within B X C	42	9.57	
A X Pairs	42	.50	
Total	95		

** p . .01

Table 3A. 8% analysis of variance: Experiment I.

Source	df	MS	F
Social Condition (A)	1	455.88	51.2**
Species Combination (B)	2	2061.96	12.0**
A X B	2	14.56	1.6
Cage Size (C)	1	660.45	3.8
A X C	1	7.82	1
B X C	2	220.54	1.3
A X B X C	2	6.41	1
Pairs within B X C	42	172.52	
A X Pairs	42	8.90	
Total	95		

** p .01

Table 4A. Complete food intake analysis of variance: Experiment I.

Source	df	MS	F
Solution (A)	1	5150.21	530.9**
Social Condition (B)	1	263.51	30.8**
A X B	1	76.59	10.9**
Species Combination (C)	2	609.89	4.2*
A X C	2	110.36	11.4**
B X C	2	1.13	1
A X B X C	2	2.91	1
Cage Size (D)	1	106.58	1
A X D	1	18.77	1.9
B X D	1	1.77	1
C X D	2	276.51	1.9
A X B X D	1	2.36	1
B X C X D	2	2.21	1
A X C X D	2	13.49	1.4
A X B X C X D	2	8.07	1.1
Pairs within C X D (E)	42	143.41	22.5**
A X E	42	9.70	1.5*
B X E	42	8.54	1.3
A X B X E	42	7.00	1.1
Replications within A X B X E	192	6.36	
Total	383		

** $p < .01$

* $p < .05$

Table 5A. Food given 0% analysis of variance: Experiment I.

Source	df	MS	F
Social Condition (A)	1	156.06	36.0**
Species Combination (B)	2	50.42	1.3
A X B	2	1.26	1
Cage Size (C)	1	53.70	1.4
A X C	1	.01	1
B X C	2	101.56	2.6
A X B X C	2	.46	1
Pairs within B X C	42	38.81	
A X Pairs	42	4.34	
Total	95		

** p .01

Table 6A. Food given 8% analysis of variance: Experiment I.

Source	df	MS	F
Social Condition (A)	1	7.40	3.1
Species Combination (B)	2	283.51	7.2**
A X B	2	.95	1
Cage Size (C)	1	16.13	1
A X C	1	6.03	2.5
B X C	2	50.16	1.3
A X B X C	2	6.24	2.6
Pairs within B X C	42	39.55	
A X Pairs	42	2.40	
Total	95		

** p .01

Table 7A. Caloric intake analysis of variance: Experiment I.

Source	df	MS	F
Solution (A)	1	449.60	7.6**
Social Condition (B)	1	3848.09	44.5**
A X B	1	286.90	6.8*
Species Combination (C)	2	2130.17	1.3
A X C	2	7.67	1
B X C	2	7.16	1
A X B X C	2	28.83	1
Cage Size (D)	1	363.49	1
A X D	1	743.06	12.6**
B X D	1	31.46	1
C X D	2	3639.57	2.2
A X B X D	1	39.11	1
A X C X D	2	74.11	1.2
B X C X D	2	25.82	1
A X B X C X D	2	72.44	1.7
Pairs within C X D (E)	42	1648.71	
A X E	42	59.20	
B X E	42	86.50	
A X B X E	42	42.22	
Total	191		

** p .01

* p .05

Table 8A. Proportion of total calories from food given 8% analysis of variance: Experiment I.

Source	df	MS	F
Social Conditions (A)	1	.006952	9.6**
Species Combination (B)	2	.200573	15.7**
A X B	2	.000245	1
Cage Size (C)	1	.048875	3.8
A X C	1	.002465	3.4
B X C	2	.005190	1
A X B X C	2	.001766	2.4
Pairs within B X C	42	.012753	
A X Pairs	42	.000723	
Total	95		

** p .01

Table 9A. Fluid intake analysis of variance: Experiment II.

Source	df	MS	F
Solution (A)	1	44.97	32.3**
Social Condition (B)	1	7.03	6.8*
A X B	1	.39	1
Species Combination (C)	2	15.79	1.3
A X C	2	.15	1
B X C	2	1.32	1.3
A X B X C	2	.65	1
Pairs within C (D)	9	12.15	9.6**
A X D	9	1.39	1.1
B X D	9	1.04	1
A X B X D	9	1.01	1
Replications within A X B X D	48	1.27	2.0**
Days within Replications	192	.63	
Total	287		

** p .01

* p .05

Table 10A. Food intake analysis of variance: Experiment II.

Source	df	MS	F
Solution (A)	1	79.21	22.1**
Social Condition (B)	1	140.65	13.4**
A X B	1	16.17	2.5
Species Combination (C)	2	124.61	1.6
A X C	2	11.84	3.2
B X C	2	1.74	1
A X B X C	2	1.83	1
Pairs within C (D)	9	78.47	10.4**
A X D	9	3.58	1
B X D	9	10.47	1.4
A X B X D	9	6.58	1
Replications within A X B X D	48	7.52	
Total	95		

** p .01

APPENDIX B: PILOT EXPERIMENTS

APPENDIX B: PILOT EXPERIMENTS

A pilot study was done to investigate the possibility of social facilitation of drinking in Peromyscus maniculatus (deermice). Two subspecies, P. m. bairdii and P. m. gracilis were used. The six subjects were paired off so that one pair consisted of two bairdii (BB), one of two gracilis (GG), and one of a gracilis and a bairdii (BG). The subjects were tested in three different housing conditions: (a) apart in small cages (AS), (b) together in large cages (TL), and (c) together in large cages with a hardware-cloth barrier down the middle of the cage to separate the mice (Barrier). In the together conditions, only the two members of a pair were housed in one cage, not all six mice. In each housing condition, the mice were first given water for three days, than given an 8% sucrose solution for three days. Food was available ad libitum in all conditions.

In a second study, three other pairs of mice, one pair of each species combination, were tested in the same three housing conditions. They were given 8% sucrose solution in two other conditions as well: (a) apart in large cages (AL), and (b) together in small cages (TS).

In both studies, intakes in the apart conditions were summed and compared with intakes in the together conditions for each pair of mice. Mean intakes for the different species combinations in the AS, TL, and Barrier conditions are presented in Table 1B for the mice in both pilot studies.

Comparing 8% sucrose intakes for the apart and together conditions makes it clear that interference of drinking occured in the together condition. It is not clear whether this was due to the presence of two

Table 1B. Liquid intakes for six pairs in three housing conditions: Pilot studies.

Housing Condition	Species Combination		
	BB	BG	GG
	8% Sucrose Solution in ml./day		
Together Large Cage	13.6	30.4	43.6
Apart Small Cage	18.4	38.8	49.0
Together Large with Barrier	16.4	39.6	57.6
	Water in ml./day		
Together Large Cage	8.6	12.6	12.0
Apart Small Cage	8.6	8.6	12.8
Together Large with Barrier	9.0	12.0	14.4

mice in the same cage, or to the difference in cage size, however. The Barrier condition produced facilitation of 8% sucrose drinking for GG pairs but not for BB or BG pairs. An analysis of variance done on the TL and AS conditions for the 8% intakes showed that the effects of housing conditions were significant, $F(1,3)=16.8$, $p < .05$, as were the effects of species combination, $F(2,3)=18.5$, $p < .05$. The interaction of these factors was not significant. This indicated that the housing condition effect was the same for each species combination.

Water intake was effected much less by the changes in housing conditions. No consistent facilitation or interference effect can be found. An analysis of variance done on the TL and AS data showed that the housing condition effect was significant, $F(1,3)=10.6$, $p < .05$, but

so was the Housing Condition X Species Combination interaction, $F(2,3)=20.4$, $p < .05$. Furthermore, the interaction accounted for 18% of the total variance, while the housing effect accounted for only 5%. It can be seen from Table 1B that the BG pairs were causing the large interaction by drinking more in TL than in AS. Possibly this effect was linked to the large amount of fighting observed when the BG pairs were first put together in the same cage.

Table 2B gives the mean 8% intakes for each pair of mice in the second study for four housing conditions. It is evident that all three pairs drank less in the TL condition than in the AL condition. Similarly, both the BB and BG pairs drank less in the TS condition than in the AS condition. Only the GG pair drank more in the TS condition than in the AS condition. Hence a social interference effect was obtained in five of six possible comparisons.

Moreover, comparing the means of the TL and AL conditions to those of the TS and AS conditions indicates that the mice drank less in large cages than in small cages in four out of six cases when the social condition did not change. Thus it seems likely that the interferince effect in the Table 1B data was due to changes in both cage size and social condition.

The data in Table 1B show a large difference in mean 8% sucrose intake between the BB and GG pairs; their water intakes can be seen to be much more closely clustered. Species combination accounted for about 80% of the variance for the 8% data, and only about 36% of the variance for the water data. In both cases, pairs within species combinations was the next most important source of variance, accounting for 7% and 27% of the variance for 8% sucrose and water respectively. Thus there

Table 2B. 8% intakes for three pairs in four housing conditions: Pilot studies.

Housing Condition	Species Combination		
	BB	BG	GG
Together in Large Cage	12.4	28.0	50.8
Apart Large Cage	16.6	41.8	56.6
Together Small Cage	16.6	36.8	61.4
Apart Small Cage	20.2	38.8	53.8

Note. - The above intakes are in ml./day.

appears to be an intersubspecific difference in drinking behavior for these mice, as well as differences between particular pairs.

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