The dose delivered to the thyroids of babies under 1 year old was evaluated according to the following equation derived from Eq. 17, p. 867 of reference *3*, where $\bar{E}_{\beta}$ has been substituted by $\bar{E}_{eff}$; this takes into account the contribution of both beta and gamma radiations:

$$D_{(\infty)} = (73.8 \cdot \bar{E}_{eff} \cdot A \cdot U \cdot T_{eff})/M$$

where $D_{(\infty)}$ = total absorbed dose to the thyroid for complete removal of I^{131}; $\bar{E}_{eff}$ = effective energy per disintegration, 0.230 Mev (*4–6*); A = total intake in microcuries; U = uptake in gland as a fraction of A, 50 percent (*5*); T_{eff} = effective half life of I^{131} in the gland, assumed to be equal to physical half life, 8.05 days (*5*); and M = mass of the gland in grams.

Because of the uncertainty about the mass of babies' thyroids (*5, 7–9*) a graph for calculating the delivered dose as a function of both the amount of iodine-131 ingested and the thyroid's weight, is included (Fig. 3). However, according to Italian literature (*8*) a value of a thyroid mass of 2 g seems to be acceptable.

In Table 1 the doses calculated under this assumption are recorded for some cities where the data collected were sufficient to ensure statistical reliability (*10*).

ARRIGO A. CIGNA
FRANCO G. GIORCELLI
Laboratorio per lo Studio della Radioattività Ambientale, Comitato Nazionale per l'Energia Nucleare, S. Maria di Galeria, Rome, Italy

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Mice Reared with Rats: Modification of Behavior by Early Experience with Another Species

Abstract. *Mice in group 1 (controls) spent all their lives with other mice. Mice in group 2 had experience only with male and female rats after weaning; group 3 mice had no experience with peers—each litter was reduced to one pup, which was reared in isolation after weaning; group 4 mice were fostered to a lactating rat mother at approximately 3 days of age and thereafter lived only with rats. In adulthood group 4 mice were the least active and group 3 the most; mice in groups 2 and 4 preferred to spend time in a chamber adjacent to a rat, those from groups 1 and 3 in a chamber containing another mouse; when mice were paired off within experimental groups and given the opportunity to fight each other, the percentage of pairs in which fights occurred for groups 1, 2, 3, and 4 were, respectively, 44, 27, 100, and 0.*

Prior research has shown that the behavior of the mother rat toward her young between birth and weaning significantly modifies the offspring's subsequent emotional behavior and body weight (*1*). Other experiments have shown that postweaning social interactions with other organisms of the same species affect subsequent behavior (*2*). These are instances of intraspecies social interactions. One logical extension of these studies is to investigate interspecies social interactions in which the species involved are similar enough to be able to live together and interact with each other, yet are different enough in their behavioral patterns ("culture") so that one species can be influenced by the other. Such an experiment would help determine the degree of generality of the findings concerning the effects of early social interactions. This report presents the results of such an interspecies experiment with the rat and mouse, in which it is shown that the behavior pattern of mice reared with rats is markedly different from the behavior of mice reared with siblings or in isolation (*3*).

For group 1 (controls), approximately a week before expected parturition, female mice of the C57BL/10 strain were placed singly in metal maternity cages (22.5 by 22.5 by 37.5 cm) that had solid floors covered with shavings. The second day after a litter was born, it was reduced to four males and two females. The litter was weaned at 21 days and placed in stainless-steel cages (19 by 20.5 by 27.5 cm), two males and one female to a cage.

For group 2, the procedure before weaning was identical to that of group 1. When weaned at 21 days, the male mice were placed, singly, in steel cages each of which contained a male and a female Purdue-Wistar rat that had just been weaned. In this group, therefore, experiences before weaning were with the mouse mother and peers and after weaning were solely with rat peers.

For group 3, approximately 3 days after the birth of a mouse litter (range, 3 to 4 days) the litter was reduced to one male pup. These pups were weaned at 21 days and placed singly in steel cages. The social experiences of each animal in this group were thus limited to interactions with its mother between birth and weaning.

For group 4, when mice were approximately 3 days of age (range, 2 to 5 days), two males from the same litter were fostered to a Purdue-Wistar rat that had given birth to her own litter at the same time or after the mouse litter was born. The rat litter was reduced to two male and two female pups. The same metal maternity cages were used as for the mouse litters. In the event that both fostered pups in any one litter died, and if there were still available male mice from the same litter 5 days of age or younger, one or two more male mice were fostered to that rat mother.

In five litters both mice lived through weaning; (one of the ten died before testing); in 25 other litters one mouse lived. (In the subsequent tests these two subgroups did not differ in any of the behavioral variables and were combined in the analysis.) In most cases litters were weaned when they were 21 days old. In a few instances, where the mice were older than the rats, it was necessary to postpone weaning a litter until the rat pups were 20 days of age. At weaning a male mouse and a male and female rat were placed together in a steel cage. The social experiences of most of these mice, then, were with rat mothers and rat peers until weaning and entirely with rat peers after weaning.

The mice remained in their respective

living quarters except when removed for testing. Only male mice were tested.

Starting at 50 days of age each mouse was tested for 3 minutes a day for four consecutive days in the open field. The field was a box, 80 cm square, painted white with black lines subdividing the floor into 64 squares. The total number of the 10-cm squares entered and the number of boluses defecated were recorded.

A test of social preference was administered between 10 and 14 days after the termination of the open-field test. The unit, built of plywood, was in the shape of a T. The narrow stem of the T (10 by 10 cm) served as a starting box. Each arm of the T (25 by 26 cm) had a section walled off by a double layer of wire mesh. A male mouse was placed behind one wire-mesh wall and a male rat behind the other. The double layer of mesh prevented physical contact between the experimental mouse and the two stimulus animals. The experimental mouse was placed in the starting box to initiate a trial and left in the unit for 10 minutes. Total time spent in the rat chamber, the mouse chamber, and the neutral chamber (the starting box), respectively, was recorded. (All four feet had to be in a particular chamber in order for the time to be so recorded.) The mouse was tested on four consecutive days, the rat and the stimulus mouse being alternated daily between the right and the left chambers.

Aggression was tested between 21 and 68 days after the end of the social-preference testing. The fighting boxes were mouse boxes with two chambers, each of which measured 27.5 by 18 by 15.5 cm, with a removable partition separating the chambers. Mice from the same experimental group were paired so that they were as close to the same age as possible, and the two mice of a pair were placed in the separate chambers of a fighting box (*4*). They remained in complete isolation for 4 days. On each of the next 6 days the partition was removed, and the mice were allowed to interact for 5 minutes. If no fight began before the end of the 5 minutes, the mice were separated and the partition was replaced. When a fight did begin, the mice were separated after 5 seconds and the partition was replaced (*5*).

Table 1. Summary statistics for the behavioral tests. Numbers in parentheses refer to the *N* tested except for the aggression test, where they refer to the number of pairs tested.

Group No.	Rearing mother	Peers		Open-field test*		Social-preference test† (%)	Aggression test‡ (%)
		In infancy	After weaning	Squares entered (mean)	Boluses (mean)		
4	Rat	Rat	Rat	141.08 (34)	1.10 (34)	97 (33)	0 (12)
2	Mouse	Mouse	Rat	176.11 (33)	1.63 (33)	86 (29)	27 (11)
1	Mouse	Mouse	Mouse	192.49 (34)	2.06 (34)	27 (33)	44 (16)
3	Mouse	None	None	241.29 (12)	1.48 (12)	17 (12)	100 (6)

* Mean number of squares entered and mean number of boluses defecated daily. † Percentage of animals that spent more time in the chamber containing the stimulus rat than in the one containing the stimulus mouse. ‡ Percentage of pairs of mice that fought at least once during the 6 days of testing.

The results of all the tests are summarized in Table 1. Analysis of variance of the number of squares entered in the open field showed a highly significant difference beyond the .01 level ($F = 13.94$; $df = 3, 109$). Subsequent t tests established that group 4 was significantly less active than all other groups and group 3 was significantly more active than the other groups; groups 1 and 2 did not differ from each other. No significant differences were found among the groups on the bolus measure ($F = 2.08$; $df = 3, 109$).

The social-preference test was scored by computing the percentage of animals which spent more time (measured to the nearest second) in the rat chamber than in the mouse chamber. The chi-square test evaluating these percentages yielded a value of 52.49 ($df = 3$; $p < .01$). Further comparisons showed that groups 2 and 4 did not differ, nor did groups 1 and 3; but these two subgroups were significantly different from each other.

Aggression was quantified by determining the percentage of pairs of mice in which one or more fights occurred during the six test days. These data were evaluated by the Fisher exact-probability test. Group 4 was significantly less aggressive than groups 1 and 3 ($p < .01$) and less so than group 2 to a degree that approached significance ($p < .09$). Groups 2 and 1 did not differ from each other ($p < .18$), but both were significantly less aggressive than group 3 (p values less than .01 and .02, respectively).

The results clearly establish that social interactions with rats both before and after weaning significantly modify the mouse's behavioral patterns, including the behavior of fighting, which is presumed to be adaptive to the mouse (*6*). In a similar fashion the absence of social interactions with peers of the same species also resulted in behavioral changes. These changes were opposite to those induced by interactions with rats. Though methodological differences preclude any direct comparison, the aggressive behavior of group 3 is more consistent with the findings of Kahn (*7*) than with King's data (*5*). It is also important to note that social experiences at different stages in ontogeny do not have the same effects upon the various adult behaviors studied.

VICTOR H. DENENBERG*
GERALD A. HUDGENS
M. X. ZARROW
Departments of Psychology and Biological Sciences, Purdue University, Lafayette, Indiana

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4. When tested for aggression, the mean ages of the mice in groups 1 to 4 were, respectively, 104.4 days, 100.7 days, 98.8 days, and 99.5 days. Analysis of variance showed that group 1 animals were significantly older than the mice in the other three groups, which did not differ from each other. Since our older mice are somewhat less likely to fight than younger ones, the percentage of fights in group 1 (44) may be somewhat low because of this age bias. Even if this percentage were adjusted to allow for the possible bias, the increase would not be sufficient to change the interpretation of the findings.
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* Present address: Subdepartment of Animal Behaviour, University of Cambridge, England.

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