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Maternal rations affect the food preferences of weanling rats: II.

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Rat pups found a garlic-laced food to be less preferred than unadulterated Purina Lab Chow. A tolerance for the nonpreferred rations was established, however, by the exposure of developing rat pups to maternal females fed a garlic-tainted food.

Exposure of developing animals to food often results in a marked preference for the substance so presented. This effect has been demonstrated in birds (Rabinowitch, 1968), reptiles (Burghardt & Hess, 1966), insects (Thorpe & Jones, cited in Klopfer, 1962), and mammals (Drickamer, 1972). Furthermore, Bronstein, Levine, and Marcus (1975), Capretta and Rawls (1974), and Galef and Henderson (1972) all have shown that domesticated Norway rats are susceptible to such manipulations during the preweaning period. These authors have demonstrated that pups reared by distinctively fed females prefer the rations of their maternal caretaker when tested at weaning.

The main purpose of the current work was simply to employ a food additive not previously used in an attempt to determine whether food preferences due to preweaning experiences are robust and can be shown for a wider range of foods than had been reported previously. A commercially available garlic flavoring was used since the work of Capretta and Rawls (1974) and Cornwell (1975) suggests that exposure to garlic might alter the behavior of rodents.

The first study examined the feeding behavior of naive rats presented with a choice between unaltered Purina Lab Chow (powder) and that stock diet following the addition of one of several concentrations of garlic.

EXPERIMENT I

Method

Subjects. The animals in both studies were Sprague-Dawley derived albino rats born and raised in our laboratory. This colony of rats had been fed almost exclusively on Purina Lab Chow for 3 years prior to the exposure of any animals to garlic. Two separate colony rooms were maintained, and the administration of garlic-laced food (during both the rearing and testing of animals) occurred in one of these areas only. Garlic never entered the Purina room directly, and neither was the odor of garlic detectable there. Hence, none of the females bearing pups for these studies had ever contacted garlic prior to parturition. Both colony areas were heated to approximately 22.5°C, and were illuminated 18 h/day (0800 to 0200).

Thirty female rats were used in the first experiment. These subjects were 26 to 31 days old at the start of the procedure, and had been kept on ad-lib Purina Lab Chow and water since weaning (Day 21). In calculating subjects' ages, the day of birth was always designated Day 0.

Apparatus and procedure. The animals were divided into five groups of six animals each. For 4 consecutive days these rats were housed individually in wire-mesh cages (18 x 34 x 21 cm), with two foodcups (Wahmann, Model LC-306) and ad-lib water available. These food troughs were situated with their centers 12 cm apart, and the positions of the cups were alternated every 12 h. All animals received one cup of untainted Purina Lab Chow (meal) along with a second container which held that stock diet to which some weight of McCormick garlic powder had been added. The five groups received .1%, .5%, 1.0%, 1.5%, and 2.0% garlic mixtures, respectively. In each study, food consumption was determined by the daily weighing of the cups on a balance sensitive to .1 g.

The index of food preference used throughout this paper is the percentage of intake occurring at the Purina-filled trough—i.e., (weight of Purina/weight of both foods eaten) X 100. Also, only two-tailed statistical tests are reported, with the reliability criterion set at .05 unless otherwise noted.

Results

Figure 1 depicts the two-food preferences of juvenile rats that were naive to garlic prior to testing. Animals given a choice between any of the four most concentrated garlic mixtures and unaltered Purina took almost none of the garlic-laced food; each of these groups ate in a nonrandom manner ($Zs \geq 2.02$, $p < .05$ for all). Those rats offered .1% garlic chose their foods randomly ($Z = .12$, $p = .90$). Thus, naive weanlings find garlic powder in concentrations of .5% or more less preferable than untainted Purina.

The garlic powder used in the current work seems different from the liquid garlic additive employed by Capretta and Rawls (1974). The flavoring used by those authors was a preferred substance and became increasingly preferred as the rats received more experience

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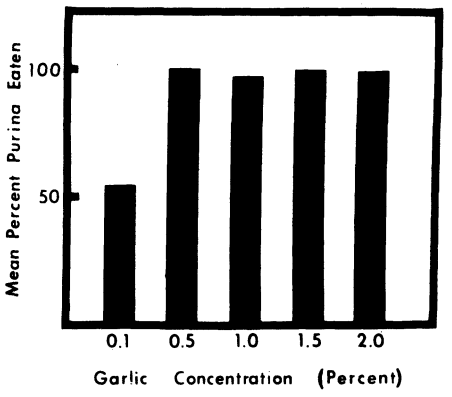

Figure 1. Food preferences of rats in Experiment I.

in the testing situation. Conversely, McCormick's garlic powder is a tastant to which naive rats show an aversion.

The second experiment was undertaken to determine whether weanling rats would tolerate the unpalatable garlic powder due to exposure of their dams to this flavoring.

EXPERIMENT II

Method

Subjects. Eight maternal females and their litters served as subjects. These dams were both donors of pups and foster mothers. Births occurred in plastic delivery cages (Carworth) with a 5-cm layer of Sanicel and newsprint serving as nesting material. Between 24- and 72-h postpartum, the litters were culled to eight pups, the dams were divided into two feeding groups, and the neonates shifted from their natural mothers to the care of a foster dam. Four of the females were then continued on the Purina diet, while the remaining four were fed only a 3.0% garlic mixture. Crossfostering was carried out semi-randomly with the following restrictions: (a) Half of each foster litter was composed of pups whose natural mothers were to be fed the ration other than that of the foster mother. (b) No female received any of her own pups. (c) Half of each litter was composed of male pups.

Following crossfostering, the dams and their foster young were housed in two-thirds of a Wahmann cage (Model 75/SC) equipped with a Plexiglas underliner to prevent the loss of pups. Shredded newsprint was also provided. The remaining one-third of the cage, separated from the nesting area by an opaque Plexiglas barrier, served as the feeding compartment for the dam. Within this feeding chamber, the females were fed for two 3-h periods daily (morning and afternoon). No solid food was introduced into the litter compartment by the experimenter; the pups were maintained solely by their foster dams until the start of testing. Water was always available in both sections of these rearing cages.

Apparatus and procedure. Testing consisted of two phases, lasting a total of 8 days, and beginning on the 18th day after crossfostering. Six weanlings per litter were chosen for testing (the smaller pups were not used), and these were provided a choice between unaltered Purina and a .5% garlic mixture on all tests. The initial phase of testing consisted of three 1-h trials (one per day) which occurred in circular, Plexiglas arenas (24 cm in diam and 7.2 cm deep). Bronstein, et al. (1975) provide a more detailed description of this apparatus; on the 2 days prior to testing, each litter was placed en masse in one of the arenas for 2 h/day. The two foodcups were in place but empty during these habituation trials, each of which occurred during the dams' morning feeding.

The three 1-h preference tests were each preceded by 3 h of maternal deprivation, during which each pup was housed individually in a wire-mesh cage with water available ad lib. No water was provided during testing, however; and the relative positions of the test diets were alternated at the midpoint of each trial. The pups were returned to their dams immediately following the first two trials; after the final 1-h test, the animals were placed in their holding cages for 3 h of food deprivation, but with water again available. The second phase of testing began when the rats were removed from their holding cages and placed into the wire-mesh testing cages described in Experiment I for 5 consecutive days. Food intake was monitored daily, and the positions of the test diets were switched every 12 h.

Results and Discussion

One of the garlic-fed females died during the first day of testing. Her pups' eating behavior, which was similar to that of the other garlic litters, was analyzed for only the first 1-h trial. In addition, approximately two subjects had to be eliminated from the analysis daily due to their spillage of food.

During the first phase of testing, there were no differences between the garlic-reared animals and those pups whose dams ate only Purina Lab Chow. As seen in the left panel of Figure 2, this null result was obtained during every day of testing in Phase 1. Also, there was no reliable difference between groups when a preference score was calculated for the composite of the first 3 days of testing. A reliable effect due to the maternal treatments did emerge in Phase 2, however. The garlic-reared pups showed a significantly smaller aversion to garlic on Days 4, 5, 7, and 8 than that exhibited by the Purina-reared weanlings ($p < .05$ for all). Furthermore, as seen in the right panel of Figure 2, there was a reliable difference between groups when the composite preferences for Phase 2 were analyzed [$t(39) = 3.07$, $p < .01$].

The results of the second testing phase support earlier findings showing that the diet of a lactating rat may determine the food preferences of pups that were provided care by such distinctively fed dams. The present work demonstrated this phenomenon with a flavoring, McCormick's garlic powder, which had not been

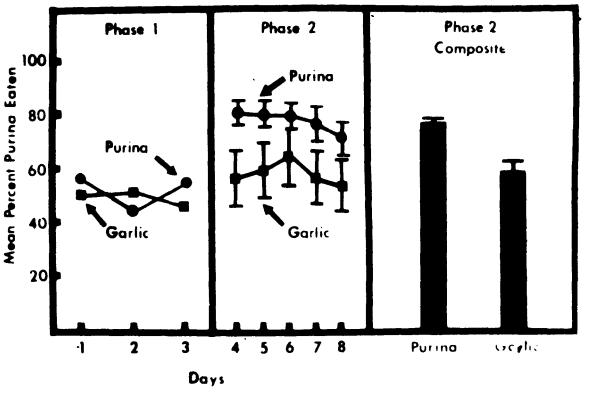

Figure 2. The mean percentage Purina consumed in the various testing phases of Experiment II. The vertical bars in the center and right-hand panels indicate one standard error about each mean.

employed in this context previously. Finally, we have shown in another report (Bronstein & Crockett, in press) that the current findings are replicable.

The present data are consistent with the theme that food-getting behaviors of several rodent species are somewhat open to modification due to experiences with foods occurring during periods of immaturity.

REFERENCES

BRONSTEIN, P. M., & CROCKETT, D. P. Exposure to the odor of food determines the eating preferences of rat pups. *Behavioral Biology*, in press.

BRONSTEIN, P. M., LEVINE, M. J., & MARCUS, M. A rat's first bite: The nongenetic, cross-generational transfer of information. *Journal of Comparative and Physiological Psychology*, 1975, **89**, 295-298.

BURGHARDT, G. M., & HESS, E H. Food imprinting in the snapping turtle, *Chelydra serpentina*. *Science*, 1966, **151**, 108-109.

CAPRETTA, P. J., & RAWLS, L. H., III. Establishment of a flavor preference in rats: Importance of nursing and weaning experience. *Journal of Comparative and Physiological Psychology*, 1974, **86**, 670-673.

CORNWELL, C. A. Golden hamster pups adapt to complex rearing odors. *Behavioral Biology*, 1975, **14**, 175-188.

DRICKAMER, L. C. Experience and selection behavior in the food habits of *Peromyscus:* Use of olfaction. *Behaviour*, 1972, **41**, 269-287.

GALEF, B. G., JR., & HENDERSON, P. W. Mother's milk: A determinant of the feeding preferences of weaning rat pups. *Journal of Comparative and Physiological Psychology*, 1972, **78**, 213-219.

KLOPFER, P. H. *Behavioral aspects of ecology*. Englewood Cliffs: Prentice-Hall, 1962.

RABINOVITCH, V. E. The role of experience in the development of food preferences in gull chicks. *Animal Behaviour*, 1968, **16**, 732-733.

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