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BRIEF REPORT
Food-Aversion Conditioning in Japanese Monkeys (*Macaca fuscata*): A Dissociation of Feeding in Two Separate Situations

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Monkeys were trained in a Skinner box to press keys for soybeans or regular diet pellets on a concurrent fixed-ratio schedule ("key-press session"). Having established a stable response, the monkeys were given "home cage sessions" in which they experienced soybean–poison (100 mg/kg of lithium chloride) pairings in the home cages. They eventually stopped eating soybeans in the home cages, but continued to work for and eat soybeans in the key-press sessions occurring between home cage sessions. Furthermore, avoidance of food in the home cage was specific to soybeans because the monkeys continued to eat diet pellets in this context. The monkeys showed a clear dissociation of feeding in two separate situations following food–poison pairings in one of the situations. These results suggest that, at least in monkeys, exteroceptive contexts have an important role in food-aversion conditioning.

Feeding behavior consists of a chain of component responses. Recent studies revealed that food-aversion conditioning can suppress not only the consummatory response to the target food but also some preceding components of the feeding behavior. For example, in the predatory situation, aversion established for the flesh of a dead prey suppressed the attack upon the living prey in coyotes and wolves. On the contrary,

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laboratory rats and ferrets never stopped killing prey to which they have been aversively conditioned (Garcia, Rusiniak, & Brett, 1977). These results with coyotes, wolves, rats, and ferrets suggest species-specific differences in the degree to which food aversions learned in one situation will generalize to a new situation or to a different response.

A few experiments using rats as subjects have studied the effects of flavor aversion learning on lever-pressing for food. In contrast to the results obtained when predatory behavior was measured, rats have been found to display suppression of operant responding for a target fluid, or in the presence of an odorant, which had been paired with illness in a situation separate from the operant chamber (Best, Best, & Ahlers, 1971; Lorden, Kenfield, & Braun, 1970). Therefore, when the arbitrarily defined response of lever-pressing was measured, the context within which a distinctive flavor had been paired with poison was not a major factor for rats in food-aversion conditioning. In contrast, the present experiment shows that contextual cues can be very important in food-aversion conditioning in monkeys: Pairing a specific food with a poison in the home cage had little effect on key-pressing for the same food or on consuming the same food in an operant situation.

The subjects were three male Japanese monkeys (*Macaca fuscata*), M351, M352, and M367, weighing 10.4, 8.5, and 9.7 kg, respectively, at the start of the experiment. They were housed individually in their home cages with free access to water. Food was available only in the experimental sessions. The behavior of each monkey was monitored and recorded with a video cassette recorder throughout the experiment.

During the preliminary training, each monkey was trained in a Skinner box to press keys for food rewards on a concurrent fixed-ratio 10/fixed-ratio 10 (FR 10/FR 10) schedule ("key-press session"). The front panel of the Skinner box contained two response keys and food dishes. At the start of each daily session, the right response key was transilluminated by red, and the left key by green. Ten responses on the right key delivered a soybean (0.34 g), and ten responses on the left delivered a diet pellet (3.15 g). The monkeys had been fed diet pellets for a long time, whereas they had never taken soybeans before this experiment. Each key darkened and became inoperative after 40 reinforcements. A session ended when 40 rewards had been delivered to each side or when 120 min had elapsed, whichever came first. Stimulus scheduling and response recording were performed with a minicomputer (PDP8F). Key-pressing on a concurrent FR 10/FR 10 schedule was considered stable when no upward or downward trend was observed in the session time for three consecutive sessions. The monkeys then entered the conditioning phase. During the preliminary training, each monkey experienced 12 (M351), 16 (M352), and 11 (M367) sessions, respectively, in which he always obtained and consumed 40 soybeans and 40 diet pellets.

On Day 1 of the conditioning phase, a soybean–saline injection treatment was initiated. During a 30-min period monkeys were presented 40 soybeans in the home cage for the first time and then were moved into an injection cage where an ip injection of physiological saline (9.4 ml/kg body wt) was administered. The monkeys remained in the injection cage for 3 hr and were returned to the home cage. On Days 2 and 3, they were placed in the Skinner box for key-press sessions. On Day 4 and every third day thereafter, each monkey received a soybean–poison pairing treatment ("home cage session"). This treatment was identical to the soybean–saline injection treatment except that monkeys were injected ip with lithium chloride (9.4 ml/kg of a 0.25 *M* solution: 100 mg/kg) instead of saline. The dose of lithium was based on a study with green monkeys (Johnson, Beaton, & Hall, 1975), in which 63.6 mg/kg of LiCl was used as a high dose, and on a preliminary experiment in our laboratory which revealed that a Japanese monkey showed marked food aversion at a dose of 100 mg/kg. After the LiCl injection, all monkeys showed a symptom of illness: lying on the floor, rocking the upper part of the body, putting a hand over the eyes, or yawning. These behaviors lasted 2 to 3 hr. In particular, M367 vomitted within 50–120 min in three of the four home cage sessions. Each monkey was subjected to at least four home cage sessions, with key-press sessions on the intervening days.

Figure 1 shows the soybean consumption for each monkey. The percentage was obtained by dividing the amount of soybeans consumed by the maximum amount of soybeans available (40 soybeans weighed 13.7 g). In the first home cage session on Day 4, all monkeys ate 40 soybeans within 1 min. This indicated that the saline injection treatment on Day 1 had no effect on subsequent soybean consumption. As poisoning was repeated, monkeys hesitated to take up the beans and spilled some pieces without swallowing them during home cage sessions. In the final home cage session, they refused to take soybeans from the food tray, suggesting that the monkeys had learned to avoid the target food. On the contrary, all monkeys continued to press the key for soybeans as well as for diet pellets in key-press sessions during the conditioning phase. Furthermore, they consumed all of the soybeans with a few exceptions (monkeys spilled some pieces of soybeans, which produced a small decrease in consumption; M352 obtained 34 soybeans on Day 12, and M367 obtained 29 on Day 5 within 120 min). These results indicate that soybean–poison pairings have little effect on the consumption of soybeans in the Skinner box. Best et al. (1971) and Holman (1975) reported that rats showed decreased consumption of the target fluid in the Skinner box after the fluid had been paired with illness in another situation. In contrast to their results, monkeys in this experiment continued to work for and eat the food which was aversively conditioned at the same time in the different situation.

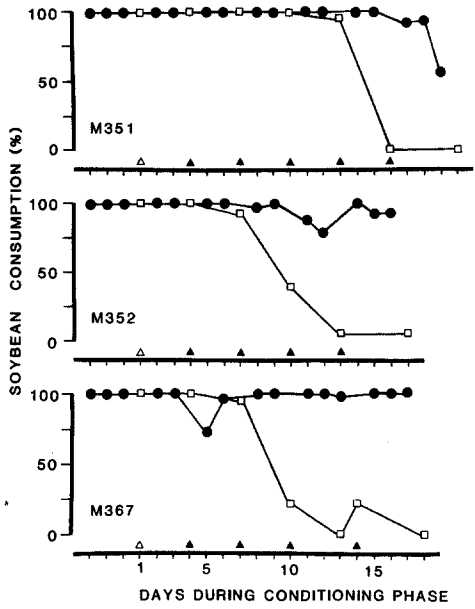

FIG. 1. Soybean consumption for each monkey during the preliminary training (the last three sessions) and the conditioning phase. ●, Key-press session; □, home cage session; △, saline injection; ▲, LiCl injection. Each monkey eventually stopped eating soybeans in home cage sessions, but continued to work for and eat soybeans in key-press sessions.

Table 1 shows the rates of key-pressing (respones/minute) in the last three sessions during the preliminary training and in the three sessions after the last soybean–poison pairing during the conditioning phase. In these sessions, monkeys rarely showed changeovers. A termination of the reinforcement, which was accomplished by 40 reward presentations, always occurred first on the left side for diet pellets. So that, the response rates for soybeans are calculated separately: in the concurrent situation (in which both keys were operative) and in the single schedule situation (in which only the right key for soybeans was operative). No systematic changes were observed in the rates of key-pressing for soybeans in the three monkeys. Even on this measure, the soybean–poison pairings in the home cage had little effect on key-pressing in the Skinner box.

An additional test was performed on the last home cage session day. The test, which was conducted in place of the poisoning, was begun 1 hr after the presentation of soybeans in the home cage: each monkey received 40 diet pellets in the home cage and, immediately after eating them, received another 40 soybeans. All of the diet pellets were eaten within 10 min, but none of the soybeans were taken from the food tray. This suggests that the soybean aversion was not due to a general intake suppression produced by the association of poisoning with the home cage, because the monkeys ate diet pellets in the same home cage.

TABLE 1
Rates of Key-Pressing (Responses/Minute) for Diet Pellets (DIET), for Soybeans in the Concurrent Situation (SOY CONC), and for Soybeans in the Single Schedule Situation (SOY SINGLE)

	M351			M352			M367		
	DIET	SOY CONC	SOY SINGLE	DIET	SOY CONC	SOY SINGLE	DIET	SOY CONC	SOY SINGLE
The last three sessions during the preliminary training	20.0	.0	21.1	25.0	.0	14.8	12.9	.0	20.0
	23.5	.6	22.9	26.7	.0	19.0	14.3	.0	25.0
	21.1	.0	22.2	23.5	.3	21.0	14.8	.0	25.0
The three sessions after the last soybean–poison pairing	17.4	.0	16.7	26.7	.0	20.0	10.0	.0	23.5
	15.4	.0	13.8	26.7	.0	17.4	10.3	.0	33.3
	13.3	.0	15.3	33.3	.0	25.0	10.8	.0	26.7

The monkeys showed a clear dissociation of feeding in two separate situations following food–poison pairings in one of the situations. This result was not expected from the viewpoint that food-aversion learning generalizes readily to a new situation (Garcia, Kovner, & Green, 1970). Recent studies with rats demonstrated that exteroceptive contexts have an important role in food-aversion conditioning and extinction (Archer, Sjödén, Nilsson, & Carter, 1979, 1980; Archer & Sjödén, 1980). In the present experiment, monkeys had a considerable amount of experience with soybeans in the Skinner box during the preliminary training, and similar "extinction" sessions (key-press sessions) between the soybean–poison pairings. Perhaps such an arrangement made it easier for the monkeys to discriminate the difference in exteroceptive contexts. It remains unclear as to whether other species would behave similarly if they were trained under a similar procedure. In any case, this experiment showed that a food aversion learned in the home cage did not generalize to an operant situation, suggesting at least in monkeys, that exteroceptive contexts can have an important role in food-aversion learning.

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