Influence of dominance on food transmission in rats

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Abstract This study is a replication of Awazu & Fujita (1998) which showed both the familiarity and
the dominance between demonstrators and observers influenced on the social food transmission in
rats, with some changes in the procedure. In the present study, observer rats were exposed to two
demonstrators successively that had just eaten powdered chow having different flavors unfamiliar to
observers, then subsequent preferences by the observers for these food items were tested in a choice
situation. We found the same influence of dominance again; the observers preferred the food
transmitted by the subordinate demonstrators to the food transmitted by the dominants. This effect
of dominance ought to be a robust tendency. But we found no influence of familiarity in this experiment.
The difference in the shape of the food between the previous and the present study may account for
this inconsistency.

Key words : rats, food preferences, food transmission, dominance, social learning.

Galef & Wigmore (1983) demonstrated observer rats that interacted with recently fed
rats (demonstrators) increased their relative intake of whatever food the demonstrators ate.
Galef and his colleagues have systematically investigated the condition under which this food
transmission takes place (see Galef, 1990, for a review). However, as they have held their
attention to mechanisms and functions of this learning, they have not been so interested in
influences of social relation on it.

Awazu & Fujita (1998) investigated this issue to show that social relation actually affected this
learning in rats. When observer rats successively interacted with two demonstrators that were fed
recently, the observers preferred the food transmitted by unfamiliar and subordinate
demonstrators.

This fact seems to be inconsistent with other studies on social learning. In general, social
learning is facilitated when observers and demonstrators are familiar to each other, and
when demonstrators are dominant to observers.

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(e. g. Nicol & Pope, 1994; see Mazur, 1994). Awazu & Fujita (1998) did not place the
dominance factor under strict control, because they originally planned to investigate only the
influence of familiarity between demonstrators and observers on this transmission. This could
have influenced the result by chance.

This study is a replication of Awazu & Fujita (1998) with some changes in the procedure
to confirm our previous findings. Major modifications were as follows; 1) in this study, we
measured the relative dominance between familiar demonstrators and observers before we
tested the food transmission. Consequently, we used the same numbers of observers that had
interacted with familiar dominant demonstrators and with familiar subordinate demonstrators. 2)
We used powdered laboratory chow as test food. This allowed us to weigh the consumption of the
food more accurately. 3) In the previous study, we had measured the dominance between
unfamiliar demonstrators and observers post-hoc after a considerable lag time since the
food transmission test. In the present study, we measured it on the day next to the food
transmission test.

**Method**

**Subjects**

Thirty-two male Sprague-Dawley rats (*Rattus norvegicus*) participated in this experiment. They were experimentally naive, and were 9 to 10 weeks old when the study started. There were no siblings in the subjects. We divided them into 16 pairs randomly, each of which was housed in a wire-mesh cage throughout the present study. Solid lab chow and water were freely available except when they were under food or water deprivation (see below).

After 10 days of paired housing, we habituated the subjects to eating powdered chow from food cups and to drinking water from water bottles in experimental cages for four or five days. They were alone in the experimental cages.

Then, we measured relative dominance in each pair with a water competition test (e.g., Drews & Dickey, 1977). After being deprived of water for 24 hrs, each pair was presented one water bottle for five minutes in the experimental cage. We measured the time duration during which each rat occupied the bottle after videotaping this test session. The rat that occupied it longer was defined as more dominant.

We divided the 16 pairs into two groups each containing 8 pairs. In one group, the dominant rats were marked on their tails with a black marker and participated in food transfer tests as demonstrators. While in the other group, the subordinates were marked and participated as demonstrators while the dominant rats were observers. Each observer met two demonstrators in this study, one was a familiar individual and the other was an unfamiliar individual. The familiar demonstrator was the observer’s cage mate, while the unfamiliar demonstrator was housed with another observer in the same group; for example, a dominant observer met a familiar subordinate demonstrator and an unfamiliar demonstrator that lost the water competition test to their cage mates.

**Food items**

We made six kinds of test food by combing powdered lab chow with six marketed flavorings. Two of them were made by combing powdered lab chow with 5% by weight cocoa powder or 3% cinnamon powder. The other four were made by sprinkling 2 ml almond essence, 3 ml vanilla essence, 2 ml rum flavoring or 6 ml brandy flavoring on the chow of 100 g. Three food pairs, cocoa and cinnamon, almond and vanilla, and rum and brandy, were prepared for the present experiment. These pairs were easily distinguishable to humans.

**Apparatus**

We used wire-mesh cages (38 × 24 × 18 cm) and food cups (5 cm deep and 7.5 cm in diameter), both made of stainless steel. We also used water bottles designed for rodents. These cages were the same as those used for housing subjects. Two cups were fixed on the floor of the cage at the front-end when food were presented.

**Procedure**

The experimental procedure for the food transmission test consisted of the five stages described below (see Awazu & Fujita 1998 for a diagram). 1) Each of the two demonstrators alone (a familiar and an unfamiliar demonstrator) was fed one of the pair of the novel-flavored food for 60 min. Water was freely available during this period. 2) The observer interacted with one of the two demonstrators (familiar or unfamiliar) for 15 min. 3) The observer interacted with the other demonstrator (unfamiliar or familiar) for 15 min. The order of interaction with two types of demonstrators and the food items each demonstrator had eaten were counterbalanced between subjects. 4) The observer was presented simultaneously the two flavored food items each demonstrator had eaten in the food cups for 60 min. Water was freely available during this period. We measured the weight of the food the subject ate. Because we used powdered chow as the experimental food, the subjects could not carry the food around, they actually ate the food from the cups. Very little food spilled. Before the food transmission test, both the observers and the demonstrators were deprived of food for 24 hours.

Then, after the food transmission test, both
the observer and the unfamiliar demonstrator were deprived of water for 24 hours in their home cages. On the next day, we measured dominance between them using the water competition test mentioned above.

We repeated the same procedure three times with the three pairs of test food. We used cocoa-cinnamon pair first, almond-vanilla pair second, and rum-brandy pair last. The second and the third tests were conducted within a few days after the water competition tests. The subjects were deprived of food for 24 hours before each food transmission test. For a given observer, the same familiar demonstrator was used three times, which was housed with the observer throughout the study. On the other hand, unfamiliar demonstrators were changed in each food transmission test. The unfamiliar demonstrators were chosen from the same group. In both the food transmission test and the water competition test, we put the demonstrators into the experimental cages the observers had been in.

Results

Matched t-tests showed that observers had no significant preference in each of the three food pairs. On the average, they ate 1.90g of cocoa-flavored food and 3.39g of cinnamon-flavored food ($t = -1.72, p > .1$, two-tailed), 4.03g of almond-flavored food and 4.25g of vanilla-flavored food ($t = -0.37, p > .1$, two-tailed), and 4.94g of rum-flavored food and 4.10g of brandy-flavored food ($t = 0.81, p > .1$, two-tailed).

A three-way ANOVA based on the amount of the food consumption (food pairs × familiarity with demonstrators × dominance of demonstrators) showed a significant main effect of food pairs ($F_{[2, 84]} = 6.97, p < .01$). Subjects significantly ate the cocoa-cinnamon pair less than the other two pairs (a Sheffe’s procedure, $p < .05$ to the almond-vanilla pair, and $p < .01$ to the rum-brandy pair). This may be because the cocoa-cinnamon pair was tested first.

![Figure 1](image1.png)

**Figure 1.** The amount of food consumption by the observer rats in grams. “Dominant” and “Subordinate” means the relative dominance of demonstrators to the observers. ** shows a statistical significance of $p < .01$ (a three-way ANOVA, see text for details).

![Figure 2](image2.png)

**Figure 2.** The amount of food consumption by the observer rats in grams. “Familiar” and “Unfamiliar” means the familiarity between the observers and the demonstrators. There is no significant difference (a three-way ANOVA, see text for details).
The ANOVA also showed a significant main effect of dominance of demonstrators (Figure 1, F[1, 84] = 10.39, p < .01) as our previous study. But the familiarity with demonstrators had no significant main effect (Figure 2, F[1, 84] = 2.79, p > .05) in the present study. No interaction was statistically significant.

**Discussion**

We found that the food transmission in rats occurred more strongly from subordinate demonstrators than from dominant demonstrators. This effect of dominance is consistent with our previous finding (Awazu & Fujita, 1998) and thus ought to be a robust tendency in the social transmission of food in rats. As we already discussed in the previous paper (Awazu & Fujita, 1998), the preference for the food transmitted by subordinates seems to be adaptive; the observers have presumably better chances to obtain food when they compete with the demonstrators for the food.

On the other hand, we have found no influence of familiarity in the present study. This is inconsistent with our earlier finding (Awazu & Fujita, 1998); the observers preferred the food transmitted by the unfamiliar demonstrators to the food transmitted by the familiar demonstrators in the previous study.

What made the difference between the results of our two studies? One plausible reason may be the difference in the shape of food; we used solid food in the first study and powdered food in the present study. The different shape of the food caused rats to change their eating behavior. Indeed, in our informal observation, rats carried the solid food to the other side of the experimental cage, while they ate the powdered food right in the food cup. Nakatsuyama & Makino (1999) reported that rats ate small pellets at the food site, while carried larger pieces of laboratory chow back to the nest box. They concluded that rats might have decided whether they would carry food to their nest or eat immediately where they had found it according to the time they would need to eat it up. Rats seemed to reduce a risk of predation. This behavioral tendency may account for the apparent inconsistency of the two studies of ours.

As we discussed in the previous paper (Awazu & Fujita, 1998), to prefer novel food transmitted by unfamiliar demonstrators may be more beneficial to observers for expanding feeding repertory. Because the novel food transmitted by the unfamiliar demonstrators are likely to be more abundant in the area unfamiliar to the observers than the area familiar to them, such preferences may well lead the observers to include novel food items into their diets. But there may be potential dangers if they spend too much time in eating in the unfamiliar area. Thus, the preference for the food transmitted by unfamiliar demonstrators is adaptive only when the transmitted food is transportable and allows the observers to carry it to safe refuge. This hypothesis assumes that rats have a general preference for the food transmitted by unfamiliar demonstrators at least when the transmitted food is transportable. We should examine this assumption in the future.

Although we did not investigate details of behavioral mechanism that directly caused observers to change the amount of transmitted food they ate, perhaps it is worthwhile to discuss it. In the previous study (Awazu & Fujita, 1998), we measured the duration during which observers sniffed at demonstrators' nose or mouth. This duration could be the time when the observers had opportunity to learn odor of food the demonstrators had just eaten. The result showed that the duration had no relation to the amount of the observers' later consumption of the transmitted food. Thus, the observer rats did not prefer the food because they explored the odor of the food longer. If so, what mechanism worked to change the amount of food consumption according to social relationships between the observers and the demonstrators? It seems plausible that the observers' food consumption is influenced by 'depth' of learning not by the duration of learning. The 'depth' of learning could vary in several reasons. For example, observers' motivation to interact with demonstrators may be changeable according to the social relationship between the observers and the demonstrators, or the interaction with dominants could be aversive so that observers
might dislike food transmitted by the dominant demonstrators.

References
Drews, D. R., & Dickey, C. L. 1977 Observational and competitive measures of dominance in rats. The Psychological Record, 2, 331-338.
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