

Food Stealing by Young Norway Rats (*Rattus norvegicus*)

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Six experiments were undertaken to explore factors affecting young rats' (*Rattus norvegicus*) frequencies of stealing food from conspecifics when identical food is available in surplus. It was found that (a) rats would walk across a bed of pellets to steal the particular pellet a peer was eating, (b) frequency of stealing within a pair did not decrease over days, (c) rats stole unfamiliar foods more frequently than familiar foods, (d) younger rats stole from older rats more frequently than older rats stole from younger ones, (e) hungry rats stole more frequently than replete rats, and (f) rats that had stolen a pellet of unfamiliar food from an anesthetized conspecific subsequently exhibited an enhanced preference for that food. Results suggest that food stealing is a mode of active seeking of information about what foods to eat.

When two food-deprived laboratory rats (*Rattus norvegicus*) are offered a single indivisible piece of food, one rat will pick up the morsel with either its forepaws or teeth, sit on its haunches, and begin to eat. The feeding rat will soon be approached by its partner, who often either attempts to take or succeeds in taking the piece of food from the feeding individual (Wishaw & Tomie, 1987). Such stealing of food by one animal from another is referred to in the biological literature as *kleptoparasitism* and has been described in numerous avian species (Brockmann & Barnard, 1979). Here, in accord with the tradition in psychology, we refer to appropriating of a food item by one rat from another as *food stealing* or *food snatching* (Wishaw & Tomie, 1987).

Field reports suggest that wild Norway rats, like their domestic conspecifics, engage in food stealing (Barnett, 1956; Barnett & Spencer, 1951; Galef, 1980). For example, Barnett and Spencer set out cabbage leaves near the entrance of a wild rat burrow and observed the behavior of colony members after a cabbage leaf had been carried into the burrow:

A great deal of noise and running about follow[ed]; on several occasions one rat . . . seized a fragment of cabbage and r[an] from place to place among the nest sites; wherever such a rat settled to feed on the cabbage other rats . . . evidently attempted to take it for themselves. (Barnett & Spencer, 1951, p. 235)

Both the organization and physiological substrate of the motor patterns, the "wrenching" and "dodging," involved in interactions between a feeding rat and one attempting to snatch food have been examined by Wishaw and his colleagues (Wishaw, 1988; Wishaw, DuBois, & Field, 1998; Wishaw & Gorny, 1994; Wishaw &

Tomie, 1987, 1988). Our interest in food stealing by rats is quite different.

When only a single piece of food is available, as in the studies carried out by Wishaw and his collaborators, it is not surprising that food-deprived rats contest the only piece of food available. However, food stealing occurs even when there is no need to compete for food. As can readily be observed by sitting quietly near an enclosure containing a group of young rats (and as demonstrated formally in Experiment 1 of the present series), hungry rats regularly attempt to secure the particular piece of food a conspecific is eating, even when an abundance of identical food objects is available. The motivation for and function of food stealing occurring in the presence of food surplus is not obvious and is the focus of the present inquiry. By exploring factors affecting the frequency of occurrence of apparently unnecessary food stealing and examining the consequences of such behavior, we hoped to achieve some understanding of this enigmatic though readily observed aspect of the feeding behavior of rats.

Experiment 1

Experiment 1 was undertaken to provide a compelling demonstration of the perseverance of food snatching by rats even in environments where competition for food is clearly unnecessary. To this end, we placed pairs of food-deprived rats in an enclosure the floor of which was covered with a layer of food pellets. It was and is amusing to watch a young rat run across the surface of dozens of identical food pellets to contest the particular pellet a peer is trying to eat.

Method

Subjects. Eight pairs of 5- to 6-week-old female Long-Evans rats (*Rattus norvegicus*) obtained from Charles River Canada (St. Constant, Quebec) and housed in a temperature- and humidity-controlled colony room illuminated for 12 hr/day (with light onset at 7 a.m.) served as subjects. To permit individual identification, we marked the tail of each rat with colored ink.

During the week preceding the start of the experiment, we housed rats in groups of 4 in standard shoe-box cages with lids constructed of stainless-steel rods. The lids were V-shaped at one end to facilitate rats' access to a water bottle and pelleted food placed in the V-shaped portion of the lid.

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Rats fed ad libitum on Purina Rodent Laboratory Chow 5001 (Ralston-Purina, Woodstock, Ontario, Canada), gnawing on pellets held in the lid of the cage as well as on occasional pieces of chow that fell through the bars of the lid to the cage floor.

Apparatus. Testing took place in a 5-gallon (19-L) glass aquarium, measuring 25 × 50 × 30 cm, the floor of which was covered to a depth of 1.5 to 2.0 cm with pellets of Purina Rodent Laboratory Chow 5001. A television camera suspended above the aquarium and connected to a videotape recorder permitted later review of test sessions.

Procedure. In the late afternoon of the day before a group of 4 rats were scheduled to be tested, we removed all food from their cage. Testing took place in the early afternoon of the following day.

To begin a test session, we randomly selected 2 rats from a cage and placed them in the aquarium. We then waited until 1 of the pair picked up a food pellet and started to eat. For the next 10 min, we recorded the number of times that rats either attempted to steal or succeeded in stealing a pellet that its pairmate was holding.

We defined a *successful instance* of food stealing as one in which a pellet was wrested from the rat holding it and an *unsuccessful instance* of food stealing as one in which a rat made physical contact with the pellet that another rat was holding but failed to gain possession of it.

Results and Discussion

The results of Experiment 1 are presented in Figure 1, which shows the mean number of times rats were both successful and unsuccessful in wresting a pellet from a pairmate during 10-min periods of observation. As can be seen in Figure 1, rats regularly attempted to steal pellets from one another, even when they had to cross a bed of identical pellets to reach the one they then attempted to steal. Clearly, competition for limited food was not necessary to motivate food stealing.

Experiment 2

It is possible that the food stealing we observed during a single interaction between a pair of hungry rats in the presence of a surplus of food occurs only the first time a pair of rats is placed in a novel situation or the first time they are food deprived. We undertook Experiment 2 to determine whether food stealing occurs repeatedly in pairs of rats provided with an excess of food.

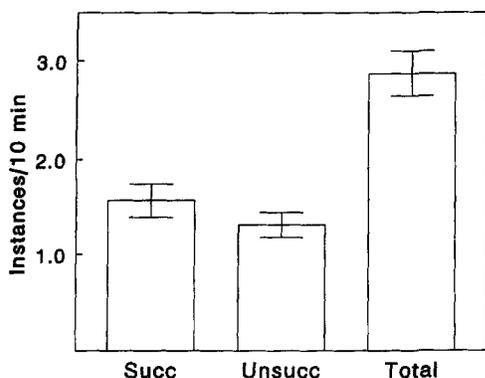


Figure 1. Mean total number (Total) and both successful (Succ) and unsuccessful (Unsucc) instances of food stealing during a 10-min test. Error bars = ± 1 SEM.

Method

Subjects. Twenty 4- to 5-week-old female Long-Evans rats, housed in groups of 4, served as subjects.

Apparatus. The apparatus was identical to that used in Experiment 1 except that we (a) covered the floor of the aquarium with wood-chip bedding, rather than with food pellets, and (b) scattered 10 pellets of Purina Rodent Laboratory Chow 5001 on the surface of the bedding.

Procedure. The procedure was identical to that of Experiment 1 except that all rats were kept on a 16 hr/day schedule of food deprivation for 5 days, and all were tested on 5 consecutive days in the apparatus.

Results and Discussion

The main results of Experiment 2 are presented in Figure 2, which shows the frequency with which pairs of rats engaged in successful and unsuccessful food-snatching on each of the 5 days of the experiment. As is clear from examination of Figure 2, food snatching did not decrease in frequency across 5 days of observation.

Although there appears to be a trend in the data toward an increase in the frequency of food snatching over days, the slope of the line relating day of testing to total number of snatches did not differ significantly from zero, $F(1, 3) = 3.66$, *ns*, and the change in total number of snatches exhibited by pairs from the 1st test day to the last was not statistically reliable, binomial test $q(N = 7) = 3$, *ns*. Indeed, three pairs of rats showed no change in frequency of stealing from the 1st to the last day of observation.

Experiment 3

In Experiment 3 we determined the effect of food novelty on the frequency of food snatching.

Method

Subjects. Forty-eight 4- to 5-week-old female Long-Evans rats, housed in groups of 4, served as subjects that we randomly assigned to preexposure and control conditions.

Apparatus. The apparatus was identical to that used in Experiment 2, except that we scattered 10 pellets of a casein- and cornstarch-based nutritionally adequate diet (Normal Protein Test Diet or Diet NPT; Catalogue No. TD 170590, Harlan-Teklad, Madison, WI), rather than 10 pellets of Purina chow on the surface of the bedding.

Procedure. The procedure was identical to that of Experiment 2, except that we kept all rats on a 16 hr/day schedule of food deprivation for 2 days before starting the experiment. On each of those 2 days, for 8 hr, we fed the 12 pairs of rats we had assigned to the control condition pellets of Purina chow (their normal maintenance diet) and the 12 pairs of rats assigned to the preexposure condition pellets of Diet NPT, the same type of pellets that we then offered to all rats during the 10-min test of food snatching.

Data analysis. Because of heterogeneity of variance, we used a non-parametric statistical test.

Results and Discussion

The main results of Experiment 3 are presented in Figure 3, which shows the number of instances of successful and unsuccessful food snatching shown by pairs of rats either fed or not fed pellets of Diet NPT for 2 days before testing. As can be seen in Figure 3, pairs assigned to the preexposure condition that had previous experience of Diet NPT were significantly less likely to

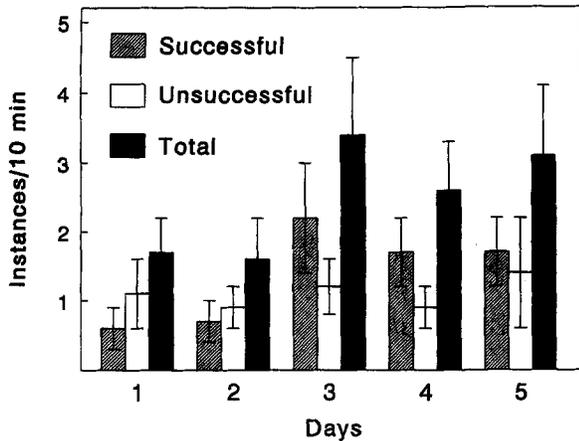


Figure 2. Mean total number and both successful and unsuccessful instances of food stealing during five 10-min tests. Error bars = ± 1 SEM.

engage in snatching behavior than were rats assigned to the control condition that were unfamiliar with Diet NPT before testing (Fisher's exact test, $p = .04$).

Experiment 4

In Experiment 4, we explored effects of rats' age on the frequency of both successful and unsuccessful food stealing.

Method

Subjects. Thirty-one 4- to 5-week-old and twenty-seven 7- to 8-week-old female Long-Evans rats served as subjects.

Apparatus. The apparatus was identical to that used in Experiment 2.

Procedure. To begin the experiment, we randomly assigned rats that were unfamiliar to one another to pairs whose members varied in age. Both members of each of the 10 pairs of rats assigned to the young group (group YY) were 4 to 5 weeks old; both members of each of the 8 pairs of rats assigned to the old group (group OO) were 7 to 8 weeks old; and 1 member of each of the 11 pairs assigned to the young-old group (group YO) was 4 to 5 weeks old and the other was 7 to 8 weeks of age.

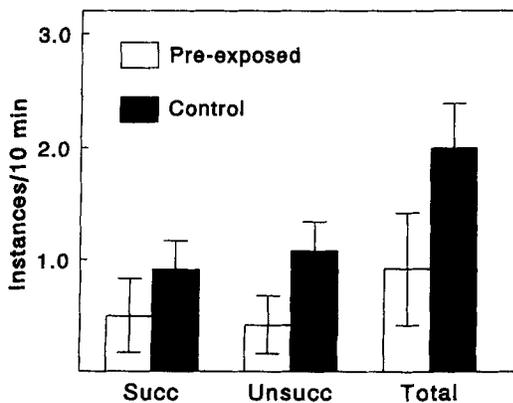


Figure 3. Mean total number (Total) and both successful (Succ) and unsuccessful (Unsucc) instances of food stealing by rats assigned to pre-exposed and control groups in Experiment 3. Error bars = ± 1 SEM.

We observed rats in Experiment 4 as we had observed them in Experiments 1 and 3.

Results and Discussion

The main results of Experiment 4 are presented in Figures 4A and 4B that show, respectively, the mean number of successful and unsuccessful instances of food snatching directed by members of groups YY, OO, and YO toward their partners; and for rats in group YO, the food snatching directed by young rats toward old and by old rats toward young.

As can be seen in Figure 4A, the total number of successful and unsuccessful instances of food stealing by members of the three groups did not differ significantly, $F(2, 26) = 1.16, ns$. However, this similarity in rates of food stealing by rats of different ages concealed some interesting differences. First, there was a significant difference across groups in individuals' probabilities of success in stealing food; in 7 of 10 pairs of rats in group YY, success in food stealing was more frequent than was failure, whereas in both groups OO and YO, failure was more frequent than was success (group OO: 6 of 8 pairs; group YO: 8 of 10 cases): $\chi^2(2, N = 28) = 6.20, p < .05$. Second, as can be seen in Figure 4B, within group YO, younger rats were more likely than were their older partners to both attempt to, paired t test, $t(10) = 4.34, p < .002$, and succeed in, $t(10) = 2.84, p < .02$, stealing pellets from their pairmates. In sum, younger rats stole food from older rats more frequently than older rats stole from younger rats.

Experiment 5

Experiment 5 was undertaken to examine effects of food deprivation on frequency of food stealing by young rats.

Method

Subjects. Thirty-six 4-week-old female Long-Evans rats purchased from Charles River Canada served as subjects.

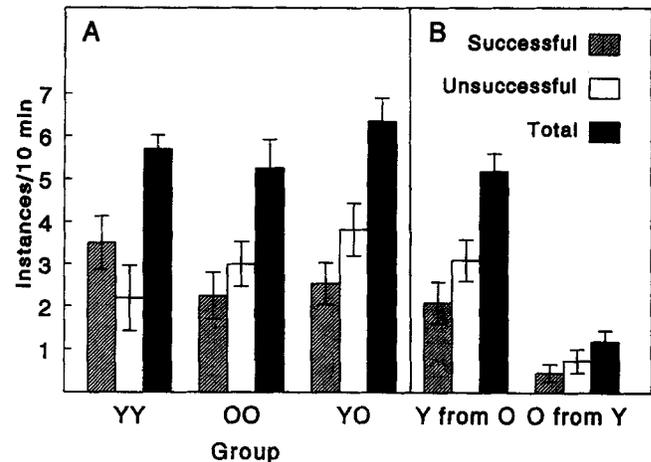


Figure 4. Mean total number and instances of successful and unsuccessful instances of food stealing during a 10-min test by rats in Experiment 4. A: Results for rats assigned to Groups YY (young-young), OO (old-old), and YO (young-old). B: Results for young rats stealing from old (Y from O) and old rats stealing from young (O from Y) in group YO. Error bars = ± 1 SEM.

Apparatus. The apparatus was identical to that used in Experiment 2.

Procedure. The procedure was the same as that used in Experiment 2, except that we varied the deprivation state of rats. We deprived pairs of rats assigned to the 16-hr condition of all food for 16 hr before we tested them. We did not food deprive rats assigned to the 0-hr condition before testing, and pairs we assigned to the 0–16-hr condition consisted of 1 rat food deprived for 16 hr and 1 nondeprived rat.

Results and Discussion

The main results of Experiment 5 are presented in Figure 5, which shows the mean number of successful and unsuccessful instances of food stealing exhibited by rats assigned to the three groups. As is evident from inspection of Figure 5, group assignment had a significant effect on the total frequency of attempted and successful food stealing, analysis of variance, $F(2, 33) = 4.78$, $p < .02$; rats assigned to the 16-hr condition were more likely to engage in food stealing than were rats assigned to the 0-hr condition (Tukey–Kramer Multiple Comparisons test, $q = 3.59$, $p < .05$), whereas rats in the 0–16-hr group did not differ from either of the other two groups in the frequency with which they stole food.

Within each pair of rats in the 0–16-h group, the food-deprived rat attempted to and succeeded in acquiring food more frequently than did the nondeprived rat 10 times out of 11, binomial test $q(N = 10) = 0$, $p < .01$; the 2 rats in one pair engaged equally often in food stealing.

Clearly, the deprivation state of rats affected the frequency with which they attempted to steal food even when, as was the case in the present experiment, it was not necessary to steal food in order to eat.

Experiment 6

Although the results of the five experiments described above provide some insight into stimulus situations that modify frequency of food stealing by rats, the results provide little clue as to the reason rats steal food from conspecifics even if it is not necessary to do so in order to eat. The findings that young rats are more likely to attempt to take food from their elders than vice

versa and that young rats are more likely to snatch unfamiliar food than familiar food from their peers suggest that food stealing may involve acquisition of information about foods. If so, food stealing would be one of a number of behavioral processes that rats have been shown to use in acquiring information from conspecifics about what foods to eat (for a review, see Galef, 1996).

In the present experiment, we used techniques developed in our laboratory to examine the impact of socially acquired information on food choices of young Norway rats (Galef, 1988, 1996; Galef & Wigmore, 1983) to compare the impact on young rats' later preferences for a food of simply eating that food and of stealing the same food from a conspecific and then eating it.

Method

Subjects. Forty-two 4- to 5-week-old, experimentally naive female Long-Evans rats obtained from Charles River Canada served as subjects. An additional thirty 7- to 8-week-old rats that had participated in earlier experiments in this series served here either as anesthetized "food providers" ($n = 18$) or anesthetized "stimuli" ($n = 12$).

Apparatus. Rats interacted with a food provider or stimulus rat or fed alone in the same 5-gallon (19-L) aquarium used in Experiments 1 to 5. However, in this experiment, we placed only a single pellet in the aquarium with each rat.

For 2 days before and 1 day after we placed rats in the aquarium, we housed them individually in stainless-steel hanging cages ($21 \times 24 \times 27$ cm) with grid floors. While housed in a hanging cage before the start of the experiment, each rat ate powdered Purina chow from a semicircular, stainless-steel food cup (10-cm diameter \times 5-cm deep) filled to only half its depth to prevent spillage.

Diets. In the present experiment, we used pelleted and powdered forms of both Rodent Bacon Lover Treats (Diet RBLT; Catalogue No. F3917, BioServ, Frenchtown, NJ) and Diet NPT. We whittled each pellet of both diets to a rounded point so that it could be firmly lodged in the mouth of an anesthetized rat and we weighed each pellet.

In a pilot test, 6 young rats that had eaten only powdered Purina Rodent Laboratory Chow 5001 throughout life and that were presented with weighed samples of powdered Diets NPT and RBLT for 22 hr ate roughly equal amounts of each (mean \pm 1 SEM), intake of Diet RBLT as a percentage of total intake = $52.7 \pm 1.5\%$.

Procedure. To begin the experiment, we placed all 42 rats on a 23-hr/day schedule of food deprivation; they ate powdered Purina Rodent Laboratory Chow 5001 for 1 hr/day for 2 successive days. On the 3rd day of scheduled feeding, just before rats were scheduled to be fed, we anesthetized the 18 food-provider and 12 stimulus rats by intraperitoneal injection with sodium pentobarbitol (25 mg/kg).

We then assigned each of the 42 rats to one of six groups that differed only in the conditions under which they ate on the 3rd day of the experiment. We placed each rat individually in a 5-gallon (19-L) aquarium for 1 hr with one of the following: provider groups—an anesthetized food provider with a single, shaped, weighed pellet of either Diet RBLT or Diet NPT wedged in its mouth (9 food providers with each diet); stimulus groups—a single, shaped, weighed pellet of either Diet RBLT or Diet NPT placed 20 cm away from an anesthetized stimulus rat (6 stimulus rats with each diet); or control groups—a single, shaped, weighed pellet of either Diet RBLT or Diet NPT (6 rats were presented with a pellet of each diet).

At the end of the 1-hr period of feeding in the aquarium, we returned each rat to the hanging cage where it had been housed for the preceding 2 days and offered it, for 22 hr, a choice between weighed samples of powdered Diets NPT and RBLT.

We determined the amount each rat ate during the 1 hr that it was in the aquarium as well as the amount of each diet each rat ate during the subsequent 22-hr choice test in its home cage. Then, we calculated (a) the percentage of each rat's total intake during the 22-hr choice test that was

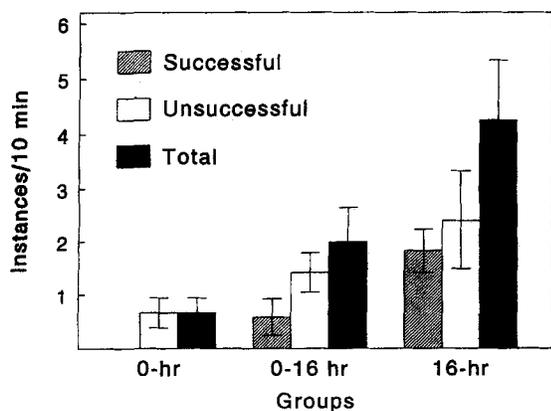


Figure 5. Mean total number and instances of successful and unsuccessful food stealing by pairs of rats in Experiment 5 that were food deprived for varying numbers of hours before testing. Error bars = \pm 1 SEM.

Diet RBLT and (b) the percentage of each rat's total intake during the 22-hr test that was the diet that rat had eaten during the 1 hr it was in the 5-gallon (19-L) aquarium.

Results and Discussion

We discarded data from 3 rats that ate less than 3.0 g during the 22-hr choice test. Each of the other 39 rats in the experiment ate 15.0 g or more ($M = 18.5 + 0.4$ g) during the test period.

The results of Experiment 6 are presented in Figures 6A and 6B, which show, respectively, the mean amount of food rats assigned to the six groups ate during the hour that they were in the 5-gallon (19-L) aquarium and the mean percentage of each group's total intake during the 22-hr choice test that was Diet RBLT.

As can be seen in Figure 6A, there was no main effect either of diet, $F(1, 36) = 1.87$, *ns*, or of group, $F(2, 36) = 0.24$, *ns*, on the amount that rats ate during the hour that they spent in the aquarium.

As can be seen in Figure 6B, group assignment had a significant effect on food preferences of rats during the 22-hr choice test. Those rats that had snatched a pellet from the mouth of an anesthetized food provider exhibited an enhanced preference for the food that they had snatched, Student's *t* test, $t(15) = 2.68$, $p < .02$, whereas those rats that had eaten a pellet either alone or in the presence of an anesthetized stimulus rat did not exhibit such a preference (both *ts*, *ns*).

Comparison of the percentage of rats' total intake during the 22-hr choice test that was concordant with the food that they ate in the aquarium during the hour preceding the start of the choice test revealed a significant effect of group assignment on concordance, $F(2, 38) = 4.40$, $p < .02$. Rats that had snatched food from the mouth of an anesthetized food provider ate a significantly greater percentage of that food during the choice test than did rats assigned to either of the other two conditions (Tukey's least significant difference test, both *ps* $< .05$).

It may seem counterintuitive for rats to have shown an enhanced preference for the flavor of a food snatched from the mouth of an unconscious conspecific. On the contrary, it might be expected that rats would avoid foods that appeared to have been eaten by unconscious animals. However, the results of a number of studies carried out both in our laboratory and elsewhere have shown that sick or unconscious rats that have eaten a food are as effective in causing conspecifics to prefer that food as are healthy rats (e.g., Galef, McQuoid, & Whiskin, 1990; Grover et al., 1988). The present results are thus consistent with results of previous experiments demonstrating that Norway rats developed enhanced preferences for, not aversions to, foods eaten by sick or unconscious conspecifics.

General Discussion

The results of the present series of experiments indicate that food snatching by Norway rats provides those engaging in the behavior with information as to what foods to eat. First, and most important, as shown in Experiment 6, young rats showed increased preference for an unfamiliar food stolen from the mouth of an anesthetized conspecific and eaten, but not for the same food eaten either in the presence of an anesthetized conspecific or while alone.

Second, if rats use food stealing to acquire information about potential foods, one might expect more frequent food snatching by rats eating an unfamiliar food and, therefore, in need of information as to its safety than by rats eating a familiar food (Barnett, 1958; Kalat & Rozin, 1973). As shown in Experiment 3, rats snatched unfamiliar food from conspecifics more frequently than familiar food.

Last, in formal models of the action of natural selection on social learning, it is generally assumed that social learning should more often involve acquisition of information by young individuals from their elders than the converse (e.g., Boyd & Richerson,

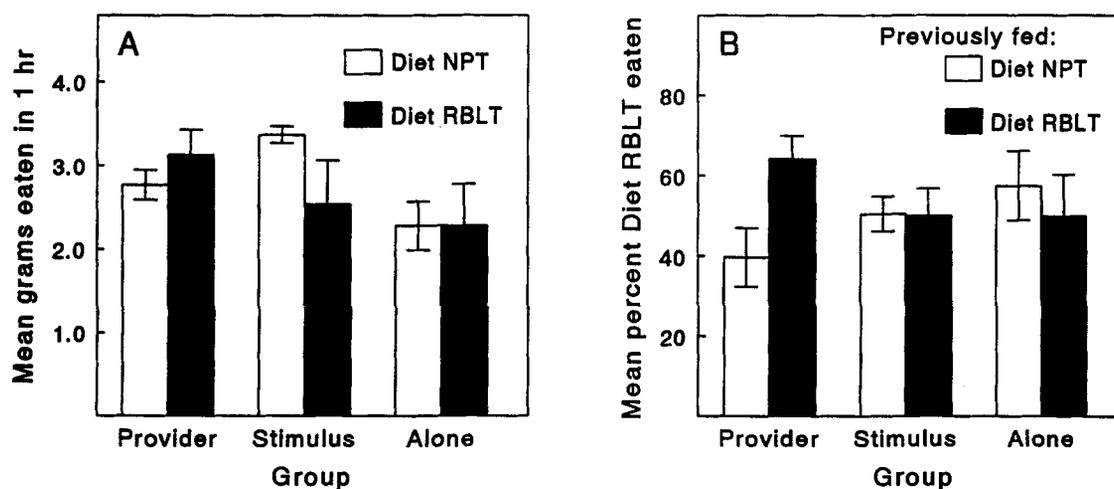


Figure 6. A: Mean grams of pelleted food eaten during 1 hr by rats assigned to the six groups in Experiment 6. B: Mean amount of Rodent Bacon Lover Treats diet (Diet RBLT) eaten by the six groups in Experiment 6 as a percentage of total intake during a 22-hr choice test. Diet NPT = Normal Protein Test diet; error bars = ± 1 SEM.

1985; Cavalli-Sforza & Feldman, 1981; Dugatkin & Godin, 1993; Findlay, Hansell & Lumsden, 1989). Frequent reports in the literature of young animals stealing food from parents or other adults (e.g., Fragaszy, Feuerstein, & Mitra, 1997; King, 1994) are consistent with such a view.

The finding in Experiment 4 that juvenile rats, like the young of many other mammalian species, steal food from their elders more frequently than adult rats steal from juveniles is consistent with the hypothesis that food stealing can function as a mechanism for social learning about food.

Previous publications from our laboratory have described a range of social learning processes, acting throughout life to affect the food choices of Norway rats (see Galef, 1996, for a review). Results of the present series of studies suggest that stealing food is yet another way in which rats learn what to eat by interacting with conspecifics. Our findings are thus consistent with Brockmann and Barnard's (1979) hypothesis that kleptoparasitism by birds furnishes not only food but also information of use to those that take food from others.

The food stealing described here differs from previously described behavioral mechanisms for social learning about foods in that it involves easily observed information seeking by social learners. It will be interesting to see whether factors such as degree of relatedness or reproductive state influence the rate at which such observable information seeking occurs.

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