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Passage of time reduces effects of familiarity on social learning: functional implications

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Abstract. Previous experiments have shown that, after a rat *Rattus norvegicus* has eaten a food for several days, it is resistant to social induction of a preference for that food. The present experiments demonstrate that this inhibiting effect of individual experience of a food on social induction of preference for that food is transitory. Seven days after rats had last eaten a food, they exhibited socially induced preferences for that food as strong as the socially induced preferences exhibited by rats that had never eaten the food. These laboratory results suggest that the combined effects of personal and social exposure to foods should result in free-living rats exhibiting particularly pronounced socially induced preferences both for totally unfamiliar foods conspecifics are eating and for foods others are eating that a focal individual has not eaten recently.

Results of numerous experiments completed both in our laboratory and elsewhere show that after naive rats (observers) interact with recently fed conspecifics (demonstrators) the observers exhibit a substantial enhancement of their preferences for whatever foods their respective demonstrators ate (Galef & Wigmore 1983; Posadas-Andrews & Roper 1983; Heyes & Durlach 1990; Winocur 1990; Galef & Whiskin 1992).

Recently, our laboratory has been looking for constraints on such social induction of food preferences in rats (Galef 1993) with the expectation that any boundary conditions on social induction of food preference we discovered could be used to generate and test hypotheses about the functions that socially induced food preferences might serve in natural circumstances. For example, Galef (1993, experiment 2) found that, although naive observer rats exhibited strong preferences for foods their respective demonstrators ate, observer rats that had eaten the food that their demonstrators ate for several days immediately before interacting with them did not subsequently prefer the foods that their respective demonstrators had eaten. This result, as well as others reported in Galef (1993), was interpreted as consistent with the hypothesis that social induction of food preference acts primarily to expand the feeding repertoires of members of rat colonies, motivating colony members to ingest totally unfamiliar foods that their fellows are eating, rather than to continue eating familiar foods.

Of course, the duration of effects of ingestion of a food on subsequent development of a socially induced preference for that food will play an important role in determining how the combined effects of personal experience of various foods and social interaction with others will affect food selection. If familiarity with a food results in permanent inhibition of social induction of preference for that food, then social interaction would, as Galef (1993) suggested, be most effective in motivating rats to add totally unfamiliar foods to their respective dietary repertoires. If, on the other hand, the inhibitory effects of exposure to a food on subsequent development of a socially induced preference for that food were relatively transitory, then social interaction could act to motivate each rat to seek and ingest foods others were eating that it had not itself eaten recently. In the latter case, the combination of individual feeding experience and social interaction could motivate members of rat colonies to seek and ingest both intermittently available foods that others had discovered were again available, and totally unfamiliar foods that others had learned to eat.

In the pair of experiments described here, we examine the effects of a delay between ingestion of a food and interaction with a demonstrator that had eaten that food on the observer's socially induced preferences for that food.

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EXPERIMENT 1

Experiment 1 was undertaken: (1) to replicate Galef's (1993) demonstration that feeding an observer rat a food immediately before it interacts with a demonstrator rat that has eaten that food substantially disrupts social induction of a preference for the food in question and (2) to examine the effects of introducing a delay between an observer's ingestion of a food and subsequent interaction with a demonstrator that had eaten that food on the observer's socially induced preference for that food.

Methods

Subjects

Ninety-six, 42-day-old, female Long-Evans rats born in the vivarium of the McMaster University Psychology Department (Hamilton, Ontario) to breeding stock acquired from Charles River Canada (St Constant, Quebec) served as observers. An additional 96, 49- to 56-day-old rats from the same source, which had served as observers in previous experiments, served as demonstrators in the present experiment.

Foods

We made two diets by adding either 1·0 g of bulk ground cinnamon (Diet Cin) or 2·0 g of Hershey's Pure Cocoa (Diet Coc) to 100 g of powdered Purina Rodent Laboratory Chow No. 5001 (powdered chow).

Apparatus

Demonstrators and observers were housed in separate rooms in individual wire-mesh, hanging cages that measured 18 × 34 × 19 cm. Food was presented to both observers and demonstrators in 10-cm diameter, semicircular, stainless steel dishes, 4 cm deep.

Procedure

To begin the experiment, we randomly assigned each observer to one of six control or six experimental groups ($N=8$ per group) that varied: (1) in the diets that we fed both to observers and to demonstrators with whom observers interacted and (2) in the time that passed between when we fed observers and when we allowed observers to interact with their respective demonstrators.

Treatment of subjects assigned to experimental and control groups differed in only one respect. For the 3 days before observers interacted with their respective demonstrators (see step 1 below), we fed observers assigned to control groups unflavoured, powdered rat chow and observers assigned to experimental groups food of the same flavour (either Cin or Coc) as the food that we fed to their respective demonstrators.

To simplify exposition of the procedure, we first describe in detail treatment of subjects experiencing no delay between when they finished eating a diet and when they interacted with their respective demonstrators (subjects assigned to the 0-delay condition). Immediately thereafter we describe modifications in that procedure that allowed us to introduce delays of either 1 day (1-day delay condition) or 7 days (7-day delay condition) between the end of the period of pre-feeding of observers and their interaction with demonstrators.

The procedure that we used with the 32 observers and 32 demonstrators assigned to the 0-delay condition was carried out in three steps.

Step 1. To begin the experiment, we provided two groups of eight observer rats (those assigned to experimental groups) with ad libitum access to either Diet Cin or Diet Coc for 3 consecutive days and 16 observer rats (those assigned to control groups) with ad libitum access to unflavoured powdered Purina Rodent Laboratory Chow No. 5001 for 3 consecutive days. At the same time, we placed 32 demonstrator rats, housed in a room separate from the observers, on a 23 h/day food-deprivation schedule and fed them powdered chow for 1 h/day for 2 consecutive days. Following a third 23-h period of food deprivation we fed 16 of the demonstrators Diet Cin and the remaining 16 Diet Coc for 1 h.

Step 2. At the end of the third 1-h period of demonstrator feeding, we removed the food cup from the cage of each observer, introduced a single demonstrator into each observer's cage and then allowed each demonstrator–observer pair to interact freely for 30 min.

We allowed all eight observers that were fed Diet Cin for 3 days to interact for 30 min with demonstrators that were fed Diet Cin; all eight observers that were fed Diet Coc for 3 days interacted for 30 min with demonstrators that were fed Diet Coc. Eight of the 16 observers that were fed unflavoured, powdered chow for 3 days interacted for 30 min with demonstrators that were fed Diet Cin, and the remaining eight observers interacted with demonstrators that were fed Diet Coc.

Step 3. At the end of the 30-min interaction period, we removed demonstrators from the cages of observers and then offered each observer a choice for 22 h between two weighed food cups, one containing Diet Cin and the other containing Diet Coc. When the 22-h test period had concluded, we determined the amount of Diet Cin and Diet Coc eaten by each observer and calculated the percentage of each observer's total food intake during the test period that was the diet that its demonstrator had eaten.

1- and 7-day delay conditions. We treated the 32 observers and 32 demonstrators assigned to the 1- and 7-day delay conditions exactly as we treated the 32 observers and 32 demonstrators assigned to the 0-delay condition except that: (1) we introduced delays of 1 and 7 days, respectively, between the end of step 1 and the start of step 2 and (2) we delayed the start of scheduled feeding of demonstrators assigned to the 1- and 7-day delay conditions so that they finished their 1-h meal of either Diet Cin or Diet Coc just before we initiated step 2 of the procedure. During the period between the end of step 1 and the start of step 2, we fed all observers their standard maintenance diet (pellets of Purina Rodent Laboratory Chow No. 5001) so that they, like observers assigned to the 0-delay condition, were not food-deprived when they interacted with demonstrators.

Results and Discussion

Delays between when observers in experimental groups were fed and when they interacted with demonstrators significantly affected the tendency of observers to eat the same diet that their respective demonstrators had eaten (Kruskal–Wallis one-way ANOVA, $H=16\cdot60$, $P<0\cdot001$; Fig. 1).

A post hoc linear-trend analysis revealed a significant relationship across experimental groups between the duration of the delay between

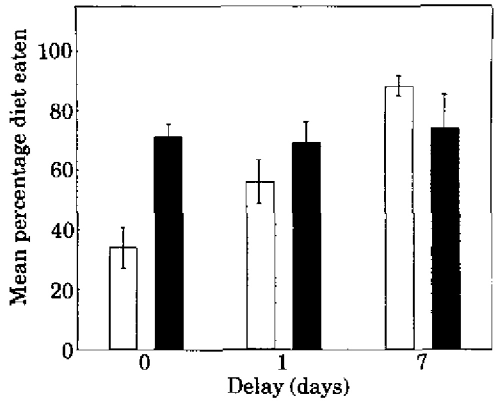

Figure 1. Mean (±SE) percentage of food intake by experimental (□) and control (■) observers during testing that was the same food that their respective demonstrators had eaten.

the pre-feeding of observers and their interaction with their respective demonstrators and the magnitude of observers' preferences for the diet that their respective demonstrators had eaten ($r^2=0\cdot44$, $P<0\cdot001$). The greater the delay between ingestion of a food and interaction with a demonstrator that had eaten that food the less the impact of individual experience on socially induced preference for that food.

Furthermore, we found that observers in the 0-delay condition assigned to experimental groups were significantly less likely to eat the same diet that their demonstrators had eaten than were observers assigned to control groups (Mann–Whitney *U*-test, $U=33$, $P<0\cdot001$). In contrast, neither observers assigned to experimental groups in the 1-day delay condition nor observers assigned to experimental groups in the 7-day delay condition were less likely to eat the diet eaten by their respective demonstrators than were observers assigned to their respective control groups (Mann–Whitney *U*-tests, both *U*s>91, both NS).

In summary, (1) we replicated Galef's (1993) finding of a profound effect of exposure to food on observers' subsequent response to demonstrators, when observers and demonstrators interacted immediately after the observers had eaten, and (2) we found significant attenuation of this effect if observers interacted with demonstrators either 1 or 7 days after eating a diet. Effects of diet novelty on the response of observers to demonstrators' diet were of short rather than of long duration.

EXPERIMENT 2

Galef (1993) found that, when offered a choice between two foods (Diets A and B), observer rats that had eaten either Diet A or Diet B and had then interacted with a demonstrator rat that had eaten both Diet A and Diet B exhibited a marked preference for the food that their respective demonstrators had eaten that they had not eaten: observer rats that had eaten Diet A preferred Diet B, while observer rats that had eaten Diet B preferred Diet A. In the present experiment, we: (1) repeated this demonstration of a difference in the magnitude of social enhancement of preferences for familiar and unfamiliar foods and (2) examined the effects of introducing either a 1- or a 7-day delay between when an observer rat ate a food and when it interacted with a conspecific demonstrator on this differential in social induction of preference for familiar and unfamiliar foods.

Methods

Subjects

Forty-eight, 42-day-old, female Long-Evans rats from the McMaster University Psychology Department vivarium served as observers. An equal number of 49- to 56-day-old female Long-Evans rats that had served as observers in other experiments served as demonstrators.

Foods

We used three different diets in the present experiment: Diet Cin and Diet Coc (which we had used in experiment 1) and Diet Cin/Coc, made by adding both 2·0 g of Hershey's Pure Cocoa and 1·0 g of bulk ground cinnamon to 100 g of powdered Purina Rodent Laboratory Chow No. 5001.

Apparatus

The apparatus used in experiment 2 was the same as that used in experiment 1.

Procedure

The procedure used in experiment 2 was identical to that used in experiment 1 except that in the present experiment: (1) we fed 24 observers Diet Cin and 24 observers Diet Coc ad libitum for 3 days before they interacted with their respective demonstrators and (2) we fed all 48 demonstrators Diet Cin/Coc for 1 h immediately before they interacted with their respective observers.

Sixteen of the observers (eight fed Diet Cin and eight fed Diet Coc) experienced no delay between the end of their 3-day period of ad libitum feeding and the beginning of their 30-min period of interaction with their respective demonstrators, while the remainder of the observers waited either 1 day or 7 days after they had finished their 3-day period of ad libitum feeding before interacting with their respective demonstrators.

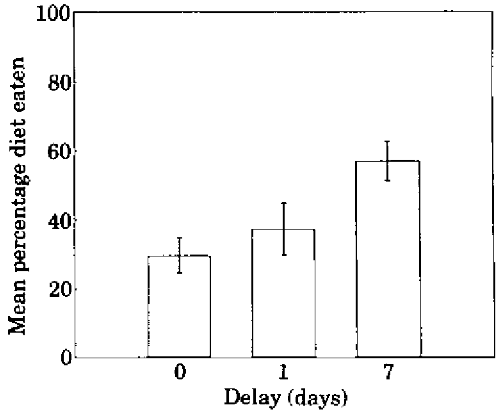

Figure 2. Mean (± SE) percentage of the food intake by observers during testing that was the same food they had eaten during 3 days of pre-exposure.

Results and Discussion

The delay between when observers ate Diet Cin or Diet Coc and when they interacted with demonstrators fed Diet Cin/Coc had a significant effect on the diet preferences of observers during testing (Kruskal–Wallis one-way ANOVA, H=8·07, P<0·02; Fig. 2). During testing, those observers that had interacted with demonstrators immediately after eating Diet Cin or Diet Coc (0-delay group) exhibited a significant avoidance of the diet that they had previously eaten (Wilcoxon test, T=18, P<0·005), while subjects in both 1- and 7-day delay groups failed to exhibit a significant effect of the diet that they had previously eaten on their food choices during testing (Wilcoxon tests, both Hs>34, both NS).

A post hoc linear-trend analysis revealed a significant relationship between the duration of the delay between the pre-feeding of observers and their interaction with their respective demonstrators and the magnitude of observers' preferences for the diets to which they were pre-exposed ($r^2=0{\cdot}19$, $P<0{\cdot}002$). Once again, the magnitude of the effect of individual experience of a food on socially induced preference for that food waned as the interval between individual experience and social learning increased.

These data both replicate the finding of Galef (1993) that pre-feeding observers a diet blocks subsequent social induction of a preference for that diet and indicate that such effects of diet exposure on social learning of diet preference are of relatively brief duration.

GENERAL DISCUSSION

The results of each of the two experiments described above demonstrate: (1) that during the 24-h period after a rat has eaten a food, it is resistant to social induction of a preference for that food and (2) that the inhibition of social enhancement of preference for a food induced by eating that food is relatively short lived.

The present finding of a transitory effect of pre-exposure to a diet on subsequent social induction of a preference for that diet contrasts markedly with previously described consequences of pre-exposure to a diet on subsequent learning of an aversion to that diet. For example, although Kraemer & Roberts (1984) found that allowing 21 days to pass after they exposed rats to a novel saccharin solution for 3 days somewhat diminished the disruptive effect of saccharin pre-exposure on conditioning of aversions to saccharin, disruption of aversion learning was still very much in evidence. Similarly, Best & Gemberling (1977) have reported that a 20-min pre-exposure to casein hydrolysate solution reduced the strength of conditioned aversions learned to that flavour 1 week later, and Kalat & Rozin (1973) have described substantial decrements in acquisition of aversions to casein hydrolysate by rats 3 weeks after the rats were exposed to casein hydrolysate for 20 min.

Given the evidence currently available, it seems reasonable to propose that personal experience of ingestion of a flavour has longer lasting effects on taste-aversion learning than on social learning of flavour preference. As a consequence of this difference in duration of effects of stimulus pre-exposure, taste-aversion learning will be focused on totally unfamiliar foods (Rozin & Kalat 1971), while social induction of flavour preference will be focused on foods that individual rats have not eaten in the last day or two as well as on completely novel foods. The data are thus consistent with the view that social learning of flavour preference allows rats to locate intermittently available foods that others of their colony have started to exploit as well as reduce potential costs of adding totally unfamiliar foods to an established dietary repertoire.

There are two obvious ways in which exposure to a diet might influence expression of subsequent social learning of a preference for that diet: first, as previous experiments have clearly shown, eating a diet for one or more days can produce avoidance of further ingestion of that diet during the succeeding 24 h (Galef & Durlach 1993). We would attribute to this effect the finding in experiment 1 that subjects assigned to the 0-delay experimental condition tended to avoid (rather than prefer) the diet to which they had been pre-exposed and which their respective demonstrators had eaten. Second, there is evidence consistent with the view that exposing an observer rat to a diet for several days interferes directly with subsequent social learning of a preference for that diet. Observer rats that first ate a target food for 3 days and then interacted with demonstrators fed the same food did not exhibit a significant enhancement of their preferences for that food relative to observers that ate the same food but did not interact with demonstrators that had eaten it (Galef & Durlach 1993, experiment 3). However, this result, which is consistent with the view that pre-exposure to a diet directly diminishes subsequent social learning of a preference for that diet, was found unexpectedly in a post hoc analysis. We have not yet completed experiments designed specifically to explore the direct effects of pre-exposure to a diet on subsequent social learning of diet preference.

Regardless of the particular behavioural processes involved in pre-exposure-induced interference with social induction of food preference, it is clear that for 1 or 2 days following subsistence on a particular food, rats are resistant to developing a socially induced preference for that food. One week after eating a food, effects of ingestion of that food on social enhancement of preference for it have dissipated. Such transitory effects of personal experience with a food on subsequent social learning of a preference for it are consistent with the hypotheses that the interaction of individual experience and social learning plays an important role not only in facilitating introduction of totally unfamiliar foods into rats' dietary repertoires, but also in motivating rats to seek out and ingest those foods that they have not eaten recently that other members of their colony are eating.

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