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Abstract

Parents commonly use rewards to encourage children to eat healthfully, but this practice remains controversial because rewards are suspected of undermining children's intrinsic motivation. A cluster-randomized trial examined children's acceptance of a disliked vegetable over 12 daily taste exposures. These exposures were paired with a tangible reward, a social reward, or no reward, and the findings were compared with the results from a no-treatment control condition. Liking and intake of the vegetable were assessed in a free-choice consumption task at preintervention, postintervention, 1 month after intervention, and 3 months after intervention. Liking increased more in the three intervention conditions than in the control condition, and there were no significant differences between the intervention conditions. These effects were maintained at follow-up. Children in both reward conditions increased consumption, and these effects were maintained for 3 months; however, the effects of exposure with no reward became nonsignificant by 3 months. These results indicate that external rewards do not necessarily produce negative effects and may be useful in promoting healthful eating.

Keywords

rewards, intrinsic motivation, eating, mere exposure, children

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A century of research has demonstrated the power of reinforcement (Thorndike, 1911). However, the use of rewards¹ for reinforcement has shown paradoxical effects. Both over-justification theory (Lepper, Greene, & Nisbett, 1973) and self-determination theory (Deci, Koestner, & Ryan, 1999) propose that extrinsic rewards undermine intrinsic motivation. Behavioral economists have identified a similar phenomenon, *motivational crowding out*, which was first described when it was found that paying people for blood donations undermined altruistic motivation (Titmuss, 1971).

In the food domain, some child-feeding experts counsel against offering rewards because of the potential for rewards to undermine liking. However, many parents use rewards to encourage children to eat healthfully (Campbell, Crawford, & Hesketh, 2007; Casey & Rozin, 1989). Are parents storing up trouble?

Behavioral research has produced conflicting results. Community-based studies have generally found that rewards increase acceptance. In the Kids Choice school-lunch program, giving tokens for trying fruits and vegetables increased intake (Hendy, Williams, & Camise, 2005). In the Food Dudes

intervention, which combined rewards with peer modeling, substantial increases in intake were seen, and these increases were maintained after rewards were withdrawn (Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). However, the opposite pattern of results has been obtained in laboratory studies: Decreases in liking from baseline levels were observed in preference tests after contingencies were no longer implemented in two classic studies (Birch, Birch, Marlin, & Kramer, 1982; Birch, Marlin, & Rotter, 1984), and similar results have been obtained in other research (Mikula, 1989; Newman & Taylor, 1992).

Three factors may explain these discrepancies. One is the intended outcome of the study. When intake is the outcome, the effects of rewards tend to be positive (Baer, Blount, Detrich, & Stokes, 1987; Hendy, 1999; Hendy et al., 2005; Stark, Collins, Osnes, & Stokes, 1986; Wardle, Cooke, et al., 2003).

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But when liking is the outcome, results are mixed (Birch et al., 1982, 1984; Hendy, 2002; Hendy et al., 2005; Mikula, 1989; Wardle, Herrera, Cooke, & Gibson, 2003). External reward may undermine hedonic evaluation more than it undermines behavior, and this relationship perhaps parallels differences between liking and wanting (Berridge, 1996).

The second potentially explanatory factor is the type of reward used. Increased consumption following the offer of a food reward (e.g., dessert) has been observed (Hendy, 1999). However, using food in both parts of the instrumental contingency can increase liking for the unhealthy reward food (Mikula, 1989), and this may be an undesirable side effect. Social rewards have been posited to have a less undermining effect than food rewards (Henderlong & Lepper, 2002), although, in the context of eating, tangible nonfood rewards (Birch et al., 1984; Hendy et al., 2005; Stark et al., 1986) and social rewards (Baer et al., 1987; Birch et al., 1984) have each produced positive and negative effects.

The third factor is the level of initial liking, which may be a moderator in the influence of rewards on acceptance. The meta-analysis of Deci et al. (1999), for example, focused on behaviors that were already liked, and laboratory studies have also tended to use palatable foods. In contrast, community studies usually target vegetables: children's least favorite food.

A further complication is that reward studies inevitably involve repeated exposure to the taste of the target food, and this *mere exposure* is an established technique for promoting food acceptance (Birch, 1987; Cooke, 2007; Wardle, Herrera, et al., 2003). This makes it important to distinguish the effects of rewards from the effects of exposure per se. More important for the rewards debate, mere exposure often involves a positive social context, which is created when an adult invites the child to taste a food and the child complies; social reward may therefore be an important ingredient in the child's acceptance of the food.

The present study had two aims. First, it was designed to investigate short-term effects (acquisition) and long-term effects (maintenance) of nonfood rewards on liking and on intake of a moderately disliked vegetable. Second, this study was intended to compare exposure without reward (mere exposure) with a no-exposure control condition. We expected exposure to increase liking and intake during the acquisition phase of the study. We expected rewards to increase intake during the acquisition phase and for these effects to persist in the maintenance phase, but we made no prediction concerning long-term effects on liking.

Method

Participants and design

Parents provided informed consent for 472 children out of a potential sample of 492, and 422 children (53% boys and 47% girls) completed the study. Of these children, 216 were in their reception year (kindergarten; ages 4–5 years) and 206 were in

Year 1 (ages 5–6 years). To ensure adequate representation of children from families of low socioeconomic status, we selected schools in which the proportions of pupils who were eligible for free school meals, who spoke English as a second language, and who came from minority ethnic backgrounds were above the national average (we do not have individual child data on these variables). Ethical approval was obtained from the University College London Research Ethics Committee.

Using a cluster-randomized design, we compared liking and intake in four conditions: exposure plus tangible nonfood rewards (ETR), exposure plus social reward (i.e., praise; EP), exposure alone (EA), and no-treatment control (C). In order to avoid children observing others in their class receiving differential treatment, we randomly assigned entire classes to each of the conditions. Power calculations for multilevel designs indicated that 16 classes in eight schools would give 90% power to detect a medium effect ($d = 0.50$, $p = .01$).

The study was scheduled in four waves, with one class randomly assigned to each condition per wave. Sessions took place on 15 days over a period of 3 weeks, with participants in the ETR, EP, and EA conditions scheduled for 12 exposure sessions. The number of subjects in the four conditions was as follows—ETR: $n = 99$; EP: $n = 106$; EA: $n = 105$; and C: $n = 112$. Outcomes were assessed preintervention, postintervention, 1 month after the study, and 3 months after the study. Acquisition data were collected at preintervention and postintervention, and maintenance data were collected during the follow-up visits. We assessed three outcomes for each subject: ad libitum consumption, rated liking, and ranked liking.

Procedure

Preintervention. On Days 1 and 2, each child in every condition was individually shown six vegetables (carrot, red pepper, sugar snap pea, cabbage, cucumber, and celery). The child was asked to taste a small piece (approximately 2.5 g) of each vegetable and rate how much he or she liked it using a faces scale. This scale consists of cartoons of three faces with expressions corresponding to “yummy,” “just OK,” and “yucky” (Birch, Zimmerman, & Hind, 1980). After the child had tasted and rated all of the vegetables, the experimenter asked the child to rank them from 1 (*most liked*) to 6 (*least liked*). Each child's target vegetable was his or her fourth ranked; this permitted us to observe positive or negative shifts in preference over the course of the study period. The child was then invited to eat as much of the vegetable as he or she wanted, with intake (in grams) assessed by weighing the dish before and after consumption using a digital scale.

Intervention period. Children in the intervention conditions were seen individually from Day 3 to Day 14 and offered a small piece of their target vegetable. Children in the ETR condition were told that if they tasted the vegetable, they could choose a sticker as a reward. Children in the EP condition were praised if they tasted the vegetable (e.g., “Brilliant, you're a

great taster”), and children in the EA condition were invited to taste the target vegetable but received minimal social interaction. Children in the control group did not receive taste exposure to the target vegetable during the intervention period.

Postintervention and 1- and 3-month follow-ups. Outcomes were assessed on Day 15 and at 1- and 3-month follow-up visits. The procedure was similar to that used in the preintervention assessment, but care was taken to ensure that children in the ETR condition understood that the sticker reward was no longer available. Children in all four conditions rated and ranked their liking of all six vegetables, and ad libitum consumption of their target vegetable was recorded.

Statistical analysis

Analyses were conducted using MLwiN 2.20 software (Rasbash, Charlton, Browne, Healy, & Cameron, 2009). Clustering by school was minimal; therefore, the final analyses adjusted only for clustering by class. Class and child were treated as random effects, and time was treated as a fixed effect. Intake data were positively skewed, so they were square-root transformed for analysis. Linear models were used for intake, and ordinal multinomial models were used for liking. Time was included with linear and quadratic terms and as a repeated measures indicator. Time and group were the primary independent variables, with age, gender, and target vegetable as covariates. Significant effects were decomposed with chi-square tests.²

Results

Sample and attrition

Intake data were analyzed using the full sample ($N = 422$). However, during the follow-ups, 37 children were absent from school and 13 declined to participate. Liking analyses were restricted to cases with complete data ($n = 344$). This was necessary because multinomial models cannot handle missing data. There were no significant group differences in the numbers of children included at each measurement time, nor significant group differences in gender, age, choice of target vegetable, or baseline intake or liking.

On the basis of evidence that 10 exposures are needed to alter preferences (Sullivan & Birch, 1990), we decided to repeat all analyses for a restricted subset of children who tasted their target vegetable on at least 10 days ($n = 365$ for intake; $n = 304$ for liking). Because there were no significant differences between the restricted and the full samples, results are reported for the full sample.

Compliance

Children in the three intervention groups agreed to taste their target vegetable in most sessions—EA: $M = 9.97$ sessions,

$SD = 2.87$; EP: $M = 10.45$ sessions, $SD = 1.94$; and ETR: $M = 11.34$ sessions, $SD = 1.45$. Because the number of taste exposures was negatively skewed, a Kruskal-Wallis test was used to examine group differences, $\chi^2(2, N = 310) = 25.67, p < .001$. Post hoc analyses showed higher compliance in the ETR condition than in the EP or EA conditions (both $ps < .05$), and compliance in the latter two conditions did not differ. The number of taste exposures was therefore included as a control variable in all analyses.

Liking

We assessed both rated and ranked liking, but children found both assessments easy, and the results were identical. Therefore, we present results based only on rated liking.

Overall effect. Over the study period, liking of the target vegetable increased ($z = 3.91, p < .001$). There was also a main effect of group, $\chi^2(3, N = 344) = 79.95, p < .001$, and a group-by-time interaction, $\chi^2(3, N = 344) = 18.33, p < .001$, with greater increases in the intervention groups than in the control group (see Fig. 1).

Acquisition phase. There was a significant group-by-time interaction during the acquisition phase, $\chi^2(3, N = 344) = 32.33, p < .001$, and a main effect of group, $\chi^2(3, N = 344) = 32.84, p < .001$. Between-group comparisons showed that liking increased more in the intervention groups than in the control group (see Table 1). There were no significant differences between intervention groups.

Maintenance phase. The main effect of group remained during the follow-up assessments, $\chi^2(3, N = 344) = 38.09, p < .001$, and this indicated that the effect of the intervention was persistent (see Table 1). There were no significant differences in maintenance between intervention groups (group-by-time interaction; $p = .58$).

Intake

Overall effect. Consumption of the target vegetable increased over the study period ($z = 7.685, p < .001$). There was also a main effect of group, $\chi^2(3, N = 422) = 28.04, p < .001$, and a group-by-time interaction, $\chi^2(3, N = 422) = 13.53, p < .05$, with greater increases in consumption in the intervention groups than in the control group (see Fig. 2).

Acquisition phase. There was a significant group-by-time interaction during the acquisition phase, $\chi^2(3, N = 422) = 33.59, p < .001$, and a main effect of group, $\chi^2(3, N = 422) = 23.46, p < .001$. All three intervention groups increased intake more than the control group did (all $ps < .05$). Consumption increased more in the ETR group than in the EP or the EA group, but the difference between the EP and the EA group was not significant (see Table 2).

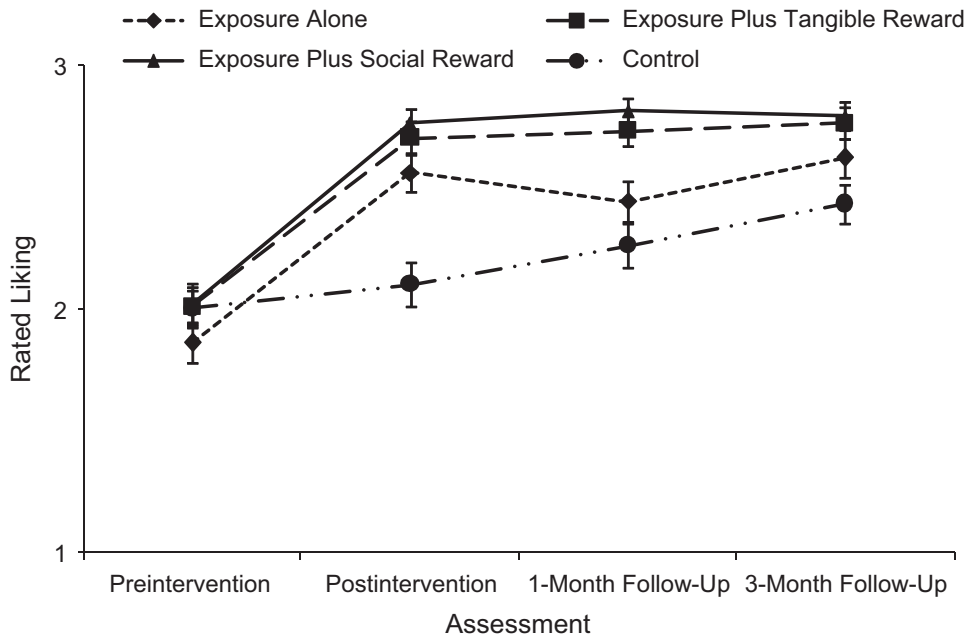


Fig. 1. Rated liking of the target vegetable across the duration of the study, as a function of condition: exposure plus tangible nonfood rewards, exposure plus social reward, exposure alone, and control. Ratings were made on a 3-point scale. Error bars represent standard errors of the mean.

Maintenance phase. In this phase, there was a significant group-by-time interaction, $\chi^2(3, N = 422) = 12.75, p = .001$, and a main effect of group, $\chi^2(3, N = 422) = 30.19, p < .001$. Intake remained higher in the ETR and the EP groups than in the control group, but this was not the case for the EA group. Results for the ETR and the EP groups were not significantly different (see Table 2).

Discussion

The results of this study confirmed that repeated taste exposure to an initially disliked food, either alone or when associated

with rewards, increased children’s acceptance of that food. However, the effect varied depending on whether the outcome was hedonic (liking) or behavioral (intake). Also, the effects of the three types of intervention differed depending on whether the outcome was measured during acquisition or maintenance. In the acquisition phase, the groups in all three intervention conditions achieved similar increases in liking, but effects on intake were larger in the ETR group than in the EA group. During the maintenance phase, when rewards were withdrawn, liking remained high in all the intervention groups, but effects on intake were maintained only in the ETR and the EP groups.

Table 1. Results of Chi-Square Tests Comparing Rated Liking of the Target Vegetable Between Conditions

Study phase and group comparison	df	N	χ^2	p	Odds ratio	95% CI
Acquisition						
EA vs. C	1	172	17.68	< .001	6.07	[2.62, 14.08]
ETR vs. C	1	174	18.74	< .001	6.61	[2.81, 15.54]
EP vs. C	1	174	22.40	< .001	8.59	[3.52, 20.96]
Maintenance						
EA vs. C	1	172	11.98	< .001	3.17	[1.65, 6.11]
ETR vs. C	1	174	24.40	< .001	4.98	[2.63, 9.41]
EP vs. C	1	174	28.47	< .001	6.73	[3.34, 13.54]

Note: Subjects were divided into four groups: exposure plus tangible nonfood rewards (ETR), exposure plus social reward (EP), exposure alone (EA), and control (C). Only significant comparisons are shown. CI = confidence interval.

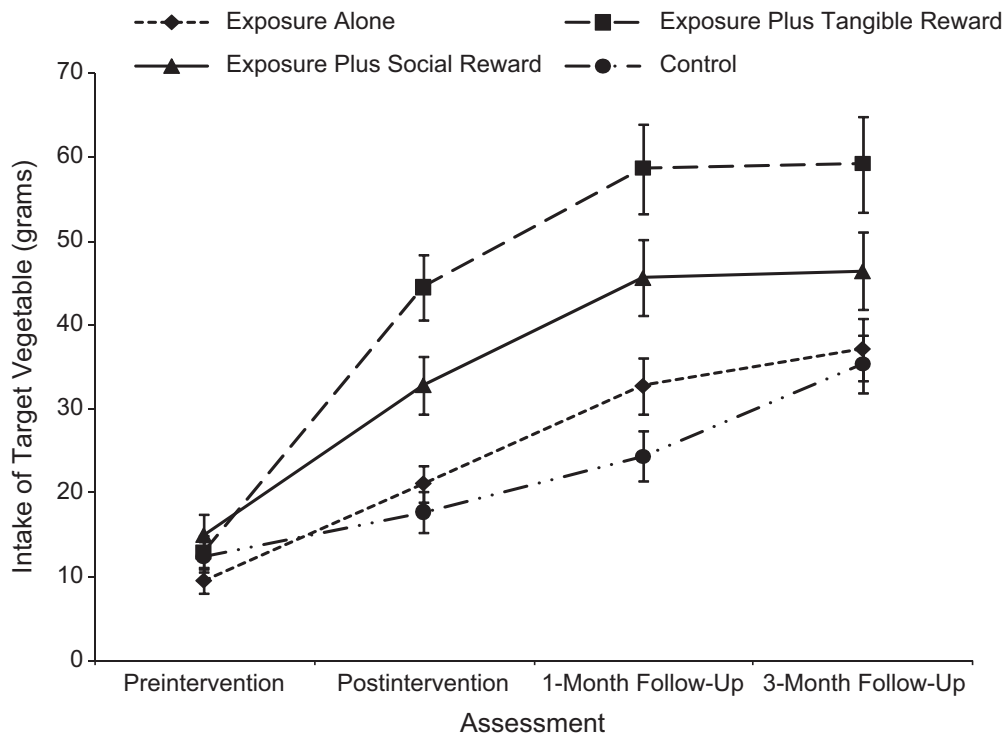


Fig. 2. Intake of the target vegetable across the duration of the study, as a function of condition: exposure plus tangible nonfood rewards, exposure plus social reward, exposure alone, and control. Error bars represent standard errors of the mean. The figure is based on raw data; statistical analyses were carried out on transformed data to allow for skewed distributions.

Research on food choice has equated liking with intrinsic motivation, and this has raised concern that rewards, even if beneficial in the short term, might have an undermining effect on liking in the long term. This concern is implied in

Table 2. Results of Chi-Square Tests Comparing Intake of the Target Vegetable Between Conditions

Study phase and group comparison	df	N	χ^2	p	d
Acquisition					
EA vs. C	1	196	11.08	< .001	0.26
ETR vs. C	1	196	23.31	< .001	0.93
EP vs. C	1	199	14.51	< .001	0.58
EA vs. ETR	1	194	7.31	< .05	0.72
EA vs. EP	1	197	0.31	> .58	—
ETR vs. EP	1	191	4.95	< .05	0.34
Maintenance					
EA vs. C	1	201	1.74	> .18	—
ETR vs. C	1	202	10.93	< .001	0.72
EP vs. C	1	196	6.66	< .05	0.42
EA vs. ETR	1	191	8.44	< .005	0.57
EA vs. EP	1	197	1.84	> .18	—
ETR vs. EP	1	191	2.51	> .11	—

Note: Subjects were divided into four groups: exposure plus tangible non-food rewards (ETR), exposure plus social reward (EP), exposure alone (EA), and control (C).

self-determination theory (Deci et al., 1999), and laboratory studies have tended to confirm this expectation (Birch et al., 1982, 1984). However, the present results gave no support for this; children who were given rewards alongside exposure achieved as much increase in liking as children who received exposure alone. The most likely explanation for differences between our findings and laboratory results is the initial level of liking. Declines in preference following a reward contingency have typically been observed with reasonably well-liked foods (Birch et al., 1982, 1984), precisely as self-determination theory would predict. However, the present study, along with most community studies, targeted vegetables, which are probably children's least favorite food. Intrinsic motivation (or liking) at baseline was therefore already low and did not decline further.

Only one previous study has tested social reward (praise) alone (Birch et al., 1984), and it found that praise without tangible reward decreased liking for the initially liked target food. However, the present study found social reward to be almost as beneficial as tangible rewards. Social reward might be particularly valuable in the home because it may help parents avoid being accused of unfairness in offering incentives to a fussy child but not to the child's siblings (Webber, Cooke, & Wardle, 2010).

One surprising finding of our study was that exposure alone had no sustained effect on intake, although liking increased as expected. This is the first study to try to distinguish between mere exposure and exposure with praise, and the results indicate that social reinforcement is necessary for

sustained behavior change. Alternatively, an absence of praise when a child complies with an eating request may be a negative experience. Liking and wanting are hypothesized to be independent determinants of consumption (Berridge, 1996), and it is possible that the reward paradigm is another way to dissociate them (Finlayson, King, & Blundell, 2007). This possibility is worth exploring in future research. But it is also possible that differences between liking and intake were an artifact of differential sensitivity of the two measures.

There were group differences in compliance with the taste exposures. Children in the tangible-reward (ETR) group achieved significantly more exposures on average than children in the EA group, although controlling for number of exposures did not change the results. However, when compliance is a problem (e.g., in the home), rewards might be a valuable ally.

This study had limitations. Although children in the control group did not receive the intervention, the repeated assessments gave them four de facto exposures, and both intake and liking increased. This has been observed before (Wardle, Herrera, et al., 2003), and it suggests that even limited exposure can increase acceptance. This situation therefore diluted the observed treatment effect. A school setting and unfamiliar researchers reduced ecological validity, so revisiting the issue with exposure delivered by parents in the home is necessary to assess real-life generalizability, although parents may require support to persist for 10 exposures.

This large study demonstrated that rewarding children for tasting an initially disliked food produced sustained increases in acceptance, with no negative effects on liking.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Notes

1. We define incentives as the offer of reward before performance of a behavior, whereas rewards refer to the consequences of carrying out the behavior. However, in the child-feeding literature, the terms are used interchangeably.
2. Data from the 1-month follow-up were included in analyses, but there were no differences between the 1-month data and the 3-month data. For ease of presentation, the entire maintenance phase is reported as one period.

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