RESEARCH
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Parent-Administered Exposure to Increase Children's Vegetable Acceptance: A Randomized Controlled Trial

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ABSTRACT

Background Repeated taste exposure, in combination with small rewards, has been shown to increase children's acceptance of disliked foods. However, previous studies have used direct contact with researchers or professionals for the implementation of the repeated exposure procedure. If mailed taste exposure instructions to parents produced comparable outcomes, this could be a cost-effective and easily disseminable strategy to promote healthier diets in children.

Objective Our randomized controlled study aimed to test the efficacy and acceptability of mailed materials giving instructions on taste exposure as a means of increasing acceptance of vegetables in preschool-aged children.

Design Participants were families of 3-year-old twins from the Gemini cohort who took part between March 2011 and April 2012. Families were randomized to a mailed intervention or a no treatment control condition. The intervention involved offering each child 14 daily tastes of a disliked (target) vegetable with a small reward (a sticker) if the child complied.

Main outcome measures Outcomes were the child's intake of the target vegetable (number of pieces) and parent reports of the child's liking at two baseline (T1 and T2) and one postintervention (T3) behavior assessment.

Results Record sheets with intake and liking data from T1, T2, and T3 were returned for 472 children, of which 442 were complete (94%). Over the intervention period (T2 to T3) intake and liking of the target vegetable increased significantly more in the intervention group than in the control group (intake: odds ratio 12.05, 95% CI 8.05 to 18.03, $P<0.001$; liking: odds ratio 12.34, CI 7.97 to 19.12, $P<0.001$). Acceptability of the procedure was very high among parents who completed the protocol.

Conclusions Mailed instructions for taste exposure were effective in increasing children's acceptance of an initially disliked vegetable. These results support the value of parent-administered exposure to increase children's vegetable acceptance, and suggest that it can be carried out without direct health professional contact.
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VEGETABLES ARE AMONG CHILDREN'S MOST disliked foods,[1,2] and vegetable intake consistently falls short of dietary guidelines.[3-5] Low consumption of fruits and vegetables is associated with a range of negative health outcomes.[3,6-8] Food patterns established in early childhood have been shown to track into adulthood[9-11]; therefore increasing children's vegetable intake should be a priority for public health.

Early childhood appears to be a sensitive period for development of food preferences.[12,13] Food neophobia, which is characterized by a rejection of novel foods, is associated with low consumption of fruits and vegetables[14,15] and limited dietary variety.[10,16,17] Patterns of food refusal commonly begin around age 2 years. Although rejection of foods such as vegetables is widespread among preschool children,[18-20] it is nonetheless a significant cause of anxiety to parents and a common reason for consulting health professionals. Family mealtimes with fussy children can become a source of stress that in turn can negatively affect children's eating behavior.[21]

Food preferences are developed through exposure to specific flavors. People become more familiar with foods the more they taste them, which in turn results in greater liking for these foods over time. This observation underpins a body of research into the effect of repeated exposure on children's food preferences, which has demonstrated that daily taste exposure can increase children's acceptance of unfamiliar or moderately disliked foods.[22-24]

Several recent studies have extended the repeated exposure protocol by introducing small rewards to encourage

children to taste an unfamiliar or disliked food. The first of these studies was conducted with 4- to 6-year-old children in a school setting.[25] Children in two reward conditions and in a mere exposure condition increased their acceptance of a vegetable, but after 3 months the effect was only maintained in the reward conditions. A second study built on these findings, investigating the use of the exposure plus rewards protocol in a home setting.[26] Families were visited by researchers and given training in the use of exposure with rewards. Two weeks of parent-administered repeated exposure in combination with a sticker reward was found to be effective in increasing children's vegetable acceptance, and parents were extremely positive about the program.[26] Similar results were reported in an Australian study of 4- to 6-year-olds that successfully demonstrated the effectiveness of using a sticker reward combined with a repeated exposure strategy administered by parents in the home.[27] These findings suggest the addition of small rewards for tasting as part of the exposure protocol have no adverse effect on outcomes and may help encourage pickier children to comply.[28]

It has been suggested that rewarding children for tasting a food could backfire, resulting in decreased preference and intake.[20,29-31] However, a recent review proposes that the effect of rewards might depend on the initial liking of the rewarded food.[28] Rewarding consumption of well-liked or palatable foods may result in decreased preference and intake,[30,32] whereas rewarding consumption of disliked foods, such as vegetables, may encourage tasting without any detrimental effects on preference.[26] The studies described above have demonstrated that repeated exposure in conjunction with small rewards can successfully increase children's vegetable acceptance. However, the contact with researchers or health professionals necessary to demonstrate the procedures is expensive and prohibitive of wider dissemination. The positive feedback received from parents participating in the home-based studies, together with the relative ease with which they managed to carry out the exposure-plus-reward procedure, suggested that simply mailing instruction materials to parents, without any researcher input, might hold promise as a cost-effective and easily disseminable intervention.

Therefore, the primary aim of our study was to evaluate the efficacy of a taste exposure-plus-reward intervention delivered through mailed materials and access to an online video. We predicted that parents in the intervention condition would successfully implement the exposure and reward protocol with their children, resulting in increased intake and liking of the target vegetable.

SUBJECTS AND METHODS

Study Design and Sample Size

Using a double pretest, randomized controlled design, we compared a protocol of parent-administered taste exposure sessions with a no-treatment control condition. Outcomes (intake and liking of the target vegetable) were assessed through parent-administered tests at baseline (T1), 14 days later immediately before the intervention period (T2), and 14 days after that, immediately following the intervention period (T3). This design permitted between-group analyses of the treatment effect (T3 controlling for T2), as well as within-group comparisons between the rest phase (T1 to T2) and the experiment phase (T2 to T3). This trial is registered as ISRCTN70302102 with Current Controlled Trials (www.controlled-trials.com).

Participants, Recruitment, and Study Group Allocation

Participants were families with 3- to 4-year-old children from the Gemini study, a cohort of 2,402 families with twins born during 2007 in England and Wales.[33] Currently active families (n=2,321) were sent information about a study to test a method of increasing children's acceptance of vegetables, and just under half (n=1,006; 43%) expressed interest in taking part. Randomization was at the level of the family stratified by twin zygosity (ie, monozygotic and dizygotic). Ethical approval was granted by the Joint University College London/University College London Hospitals Committee on the Ethics of Human Research.

All families were sent instructions for assessing intake and liking at T1, T2, and T3. Intervention families were also sent information on the exposure protocol (called the tasting game) in a sealed envelope that they were asked to open after they had completed T2. The entire Gemini cohort was sent the intervention materials after the end of the intervention period, to maintain consistency within the sample.

The vegetables used in the study were not provided by the researchers; instead, parents were asked to select a target vegetable themselves that neither twin liked. Parents were given some suggestions of vegetables that are easily available and edible without cooking (eg, carrot, cucumber, and celery), but could select others if these were not suitable. The same target vegetable was used for both twins in the three assessments (all study families) and throughout the experiment phase (intervention families only). Parents were asked to carry out all the study procedures with each child separately to minimize imitation or social facilitation within twin pairs.

Outcome datasheets were returned for 472 children (216 in the intervention group and 256 in the control group); these constituted the sample for analysis. Of the 770 nonparticipating families, 84 formally withdrew (17 said their children had no issues with eating vegetables, 38 had other priorities, and 29 gave no reason).

Intervention

The intervention pack contained an exposure instruction leaflet, progress charts, and stickers. The exposure instructions asked parents to offer the child a single very small piece of their target vegetable every day for 14 days, allowing the child to choose a sticker as a reward if they tried it. They were asked to do this separately with each child and outside mealtimes. The process was described to the child as playing the tasting game. Parents were asked to ensure the child understood that the sticker was a reward for tasting the target vegetable. They were encouraged to record if the daily taste session took place and if the child tried the vegetable on a progress chart. The instructions stressed the importance of repeated exposure, explained the techniques of exposure feeding, and emphasized the need for patience and persistence. Parents were also directed to a website with an online video featuring a researcher demonstrating the intervention procedure: how to offer the target vegetable to the child, what to do if the child accepted or refused the vegetable, and

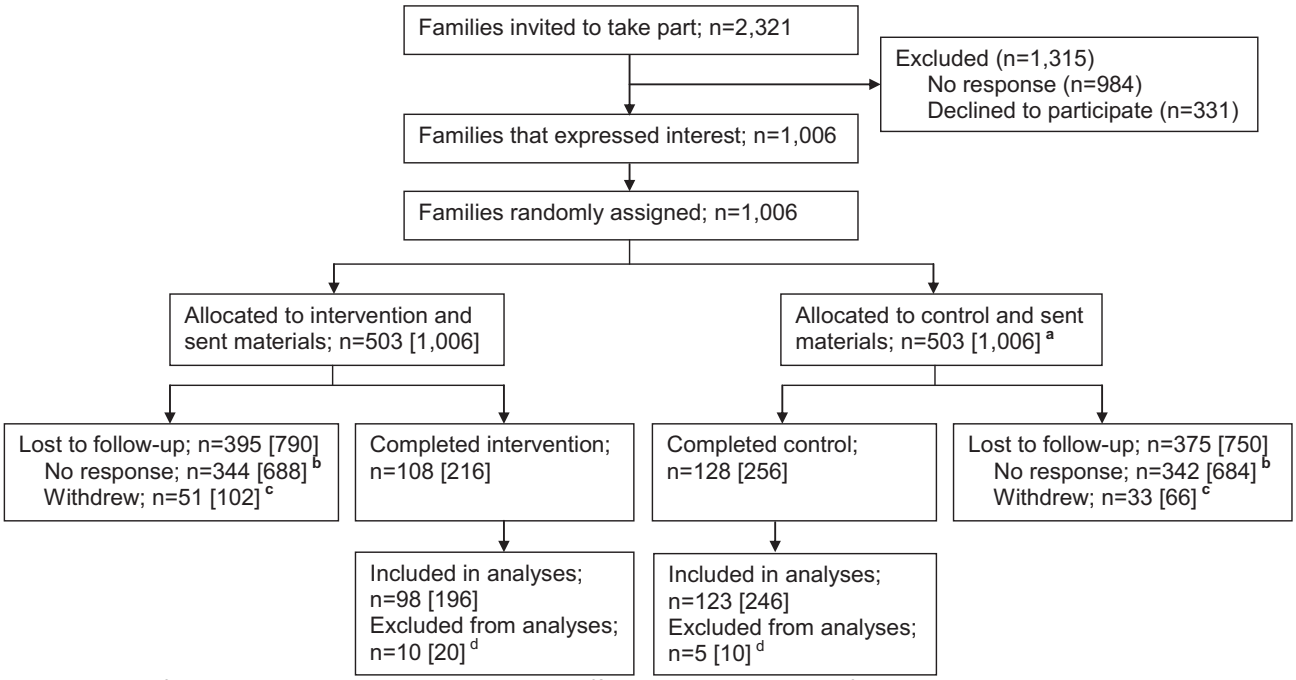

Figure 1. Flow of participants through the trial to test the efficacy and acceptability of mailed materials giving instructions on taste exposure as a means of increasing acceptance of vegetables in preschool-aged children. [a]Values shown are number of families [number of children]. [b]Did not return test sheets. [c]Withdrew due to the children having no issues with eating vegetables, other priorities, or failed to provide a reason. [d]Test sheets were completed incorrectly resulting in exclusion from the analyses.

how to record the outcome of the tasting session on the progress chart.

Families assigned to the control group were not sent the tasting game instructions during the study period and did not perform the daily taste exposures, but they were told they would receive information about a technique to help their child to like vegetables after they had completed the three tests and returned their datasheets. Control families were sent the intervention materials on completion of the study.

Outcome Measures

The primary outcomes, intake and liking, were assessed at three behavior test sessions (T1, T2, and T3), with each twin tested separately. The procedure for measuring intake was based on previous studies,[25,26] but the outcome measure was simplified to number of pieces instead of weight (in grams) to minimize the burden to parents of administering the tests at home. Parents were instructed to cut six approximately equal-sized pieces of the target vegetable (1.5 cm×1.5 cm approximately) and invite the child to eat as many as he or she liked. No reward was offered at the test sessions. If the child finished the pieces, parents cut more and continued until the child had eaten all they wanted. Parents were asked not to encourage their child to eat and to respond neutrally if they refused. They recorded the number of pieces (including half-pieces) of vegetable the child ate; this comprised the intake measure. Parents were also asked to estimate how much the child liked the target vegetable using a 9-point scale anchored with "dislikes a lot" and "likes a lot." This was scored one to nine for quantitative analyses. Parent ratings were used because of the children's young age. Parent rating of vegetable liking using this scale have been shown to correlate with unrelated observer ratings and intake (in grams) in young children.[34,35]

Parents in the intervention condition were sent a follow-up questionnaire in which they were asked to what extent they agreed with the following statements: "I think the tasting game worked to make my twins more willing to try vegetables," "I would play the tasting game with my children again in the future," and "I would recommend the tasting game to a friend," with response options of "strongly disagree," "disagree," "neither agree nor disagree," "agree," and "strongly agree." They were also asked how easy they found it to follow the information in the pack, and how easy they found it to complete the procedure ("very easy," "easy," "neither easy nor difficult," "difficult," or "very difficult"). In addition, they were asked whether they had viewed the online demonstration video and whether they found it helpful. Finally, parents were invited to give any comments on the program.

Statistical Analysis

Because the distributions of intake and liking were skewed, we grouped responses into three to optimize use of the variation in the data for the primary analyses. For intake, the three groups were: noneaters, low eaters (1 to 2 pieces), and eaters (3 or more pieces). For liking, the groups were: dislike (score 1 to 3), neither like or dislike (score 4 to 6), and like (score 7 to 9). We used ordinal regression to examine group differences in T3 intake (or liking) with T2 intake (or liking) as a covariate. The assumption of parallel lines was met for all ordinal regression analyses ($P>0.05$), and all models used complex samples to take account of the clustering of twins within families.

Table 1. Sample demographics, target vegetable distribution, and test intervals in intervention and control groups (N=442) in a study to test the efficacy and acceptability of mailed materials giving instructions on taste exposure as a means of increasing acceptance of vegetables in preschool-aged children

Variable	Intervention (n=196)		Control (n=246)	
	mean±standard deviation			
Maternal age (y)	38.0±4.8		37.3±4.8	
Test intervals (d)				
Between Time 1 and Time 2	17.8±6.7		17.0±5.8	
Between Time 2 and Time 3	18.7±9.4		17.1±9.2	
Maternal body mass index	24.2±4.2		24.0±4.0	
Child age (y)	3.9±0.3		3.8±0.3	
	n	%	*n*	%
Maternal education				
Below university level	96	49.0	120	48.8
University level or above	100	51.0	126	51.2
Child sex				
Male	100	51.0	123	50.0
Female	96	49.0	123	50.0
Target vegetable				
Red pepper	66	33.7	62	25.2
Celery	40	20.4	74	30.1
Cucumber	32	16.3	34	13.8
Carrot	22	11.2	28	11.4
Sugar snap peas	12	6.1	20	8.1
Cabbage	6	3.1	18	7.3
Other	18	9.2	10	4.1

The secondary analyses compared change in intake (or liking) utilizing the full range of scores between the rest phase (T1 to T2) and the experiment phase (T2 to T3) using repeated measures analyses of variance. When a significant time×group interaction was detected, paired-samples *t* tests were conducted separately for each group. Differences in change scores between groups were tested using independent-samples *t* tests. These were defined as secondary analyses because calculated change scores may be biased due to regression to the mean.[36]

Data analyses used IBM-SPSS Statistics for Windows software (version 20, 2011). Analyses were repeated randomly selecting one twin per family and results remained the same.

RESULTS

The flow of families participating throughout the trial is shown in Figure 1, and sample characteristics are summarized in Table 1. One hundred ninety-six intervention children and 246 control children were included in the analyses. There were no group differences in the intervals (days) between the three tests (see Table 1), but children in the intervention group had significantly lower intake and liking than the control group at T1 and T2 (see Table 2). This is an unexpected finding given that group allocation was randomized, but the differences were small and the majority of children in both the intervention and control groups were classified as disliking their target vegetable before the intervention.

Changes in intake and liking over the experiment phase (T2 to T3) are shown in Table 2. In the control group, the percentage of children who ate none of the target vegetable was relatively constant throughout the study period: T1 (41%), T2 (38%), and T3 (39%). In contrast, in the intervention group, the percentage of noneaters was constant from T1 (50%) to T2 (45%), but dropped to 9% after the intervention period (T3). Intervention participants had higher odds of eating more of the target vegetable (odds ratio 12.05, 95% CI 8.05 to 18.03; $P<0.001$) and liking the target vegetable more (odds ratio 12.34, 95% CI 7.97 to 19.12; $P<0.001$) over the intervention period.

Increases in intake across the two study phases using continuous data are shown in Figure 2. Overall, intake of the target vegetable increased during the rest phase ($P=0.01$), but there was no significant time×group interaction ($P=0.43$)

Table 2. Group differences in intake and liking at baseline (T1), immediately before the intervention (T2), and immediately following the intervention (T3) between intervention and control groups (N=442) in a study to test the efficacy and acceptability of mailed materials giving instructions on taste exposure as a means of increasing acceptance of vegetables in preschool-aged children

	Intervention		Control				
Variable	n	%	n	%	Odds ratio	95% CI	*P* value
Intake							
T1					0.67[a]	0.51-0.87	0.003
Noneaters	97	49.5	101	41.1			
Low eaters	60	30.6	72	29.3			
Eaters	39	19.9	73	29.7			
T2					0.69[a]	0.53-0.90	0.007
Noneaters	88	44.9	93	37.8			
Low eaters	60	30.6	68	27.6			
Eaters	48	24.5	85	34.6			
T3					12.05[b]	8.05-18.03	<0.001
Noneaters	18	9.2	96	39.0			
Low eaters	37	18.9	56	22.8			
Eaters	141	71.9	94	38.2			
Liking							
T1					0.62[a]	0.46-0.85	0.003
Dislike	136	69.4	147	59.8			
Neither like or dislike	37	18.9	48	19.5			
Like	23	11.7	51	20.7			
T2					0.69[a]	0.51-0.94	0.019
Dislike	120	61.2	134	54.5			
Neither like or dislike	47	24.0	51	20.7			
Like	29	14.8	61	24.8			
T3					12.34[b]	7.97-19.12	<0.001
Dislike	25	12.8	11	48.0			
Neither like or dislike	59	30.1	61	24.8			
Like	112	57.1	67	27.2			

[a]Ordinal regression analyses using complex samples taking into account clustering of twins in families.
[b]Ordinal regression analyses adjusted for T2 using complex samples taking into account clustering of twins in families.

indicating change in intake over the rest phase did not differ between groups. Comparisons of change in intake over the rest phase compared with the experiment phase revealed a significant time×group interaction ($P<0.001$). Change in intake did not differ significantly between the two phases for the control group (rest phase: mean change 0.60±3.90, experiment phase: mean change 0.61±4.35; paired $t=0.04$; $P=0.97$). In contrast, change in intake differed significantly between the two phases for the intervention group (rest phase: mean change 0.32±3.36, experiment phase: mean change 4.07±7.52; paired $t=6.03$; $P<0.001$).

Similar results were obtained for liking. An overall increase in liking of the target vegetable was observed during the rest phase ($P<0.01$), but there was no significant time×group interaction ($P=0.50$). A significant time×group interaction was found for rest phase liking change scores compared with experiment phase liking change scores ($P<0.001$). Changes in the control group's liking did not differ across the two phases (rest phase: mean change 0.27±1.89, experiment phase: mean change 0.31±1.36; paired $t=0.24$; $P=0.81$) but was large and highly significant for the intervention group (rest phase: mean change 0.39±1.61, experiment phase: mean change 2.81±2.50; paired $t=9.94$; $P<0.001$).

Exposure Protocol Compliance and Acceptability

Parents in the intervention group were encouraged to return progress charts recording daily tastings during the experiment phase. Among the 175 returned (89%), the mean number of exposure sessions was 13.8 (range=11 to 14), and

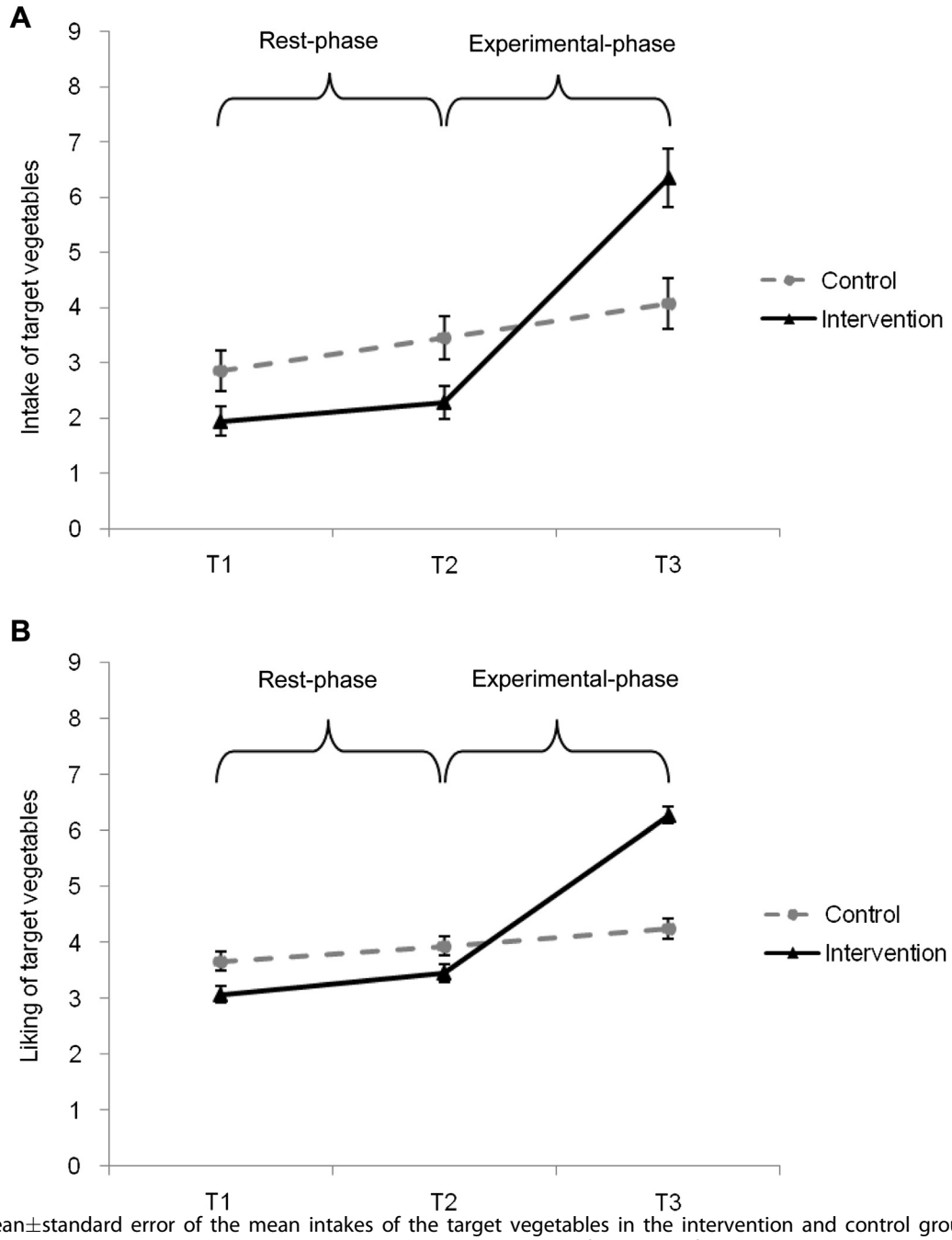

Figure 2. Mean±standard error of the mean intakes of the target vegetables in the intervention and control groups based on continuous data. Intake (or liking) change scores were calculated using the full range of scores. (A) During the rest phase, intake change scores did not differ between groups (intervention: mean change 0.32±3.36, control: mean change 0.60±3.90; $t=-0.80$; $P=0.43$). During the experiment phase the intervention group had significantly higher intake change scores (intervention: mean change 4.07±7.52, control: mean change 0.61±4.35; $t=6.06$; $P<0.001$) than the control group. (B) During the rest phase liking change scores did not differ between groups (intervention: mean change 0.39±1.61, control: mean change 0.27±1.89; $t=0.68$; $P=0.49$). During the experiment phase the intervention group had significantly higher liking change scores (intervention: mean change 2.81±2.50, control: mean change 0.31±1.36; $t=13.41$; $P<0.001$) than the control group.

children tasted their target vegetables a mean of 12.4 times (range=0 to 14). Children complied with the intervention by trying their target vegetable on an average of 90% (range=0% to 100%) of the exposure days during the experiment phase.

In a follow-up questionnaire (completed by 87 intervention families), the majority of parents (70 out of 87) agreed (or strongly agreed) the procedure made their twins more willing to try vegetables. Most (74 out of 87) agreed they would use it again, and 76 agreed they would recommend it to a friend. In addition, 82 of 87 parents agreed that the information was easy to understand, and 65 described completing the procedure as "easy" or "very easy." Only 15

parents reported having viewed the online video and all but one reported finding it helpful.

DISCUSSION

The results of our study demonstrate that a taste exposure program delivered by parents, without any health professional involvement, can increase acceptance of a disliked vegetable. Using simple mailed instructions, parents were able to carry out the specified 14 exposure sessions with the sticker reward, resulting in children increasing their liking and intake of the target vegetable. Qualitative feedback about the program was also extremely positive.

The number of children declining any of the target food at the pretest was slightly higher (>40%) in this sample compared with the sample tested by a researcher in a classroom (31%).[25] This may reflect the stranger effect, a common finding of lower compliance with instructions from parents than from an unfamiliar person.[37,38] However, refusal in the intervention group dropped to 10% after 12 rewarded tastings compared with little change in the control group. In terms of total consumption, the results were similar to those obtained with a researcher-delivered intervention.

Although the ecologic validity of the intervention is a positive feature, there were limitations to the design. Parents themselves carried out the taste tests and, therefore, strict experimental conditions could not be ensured, and parents were not blind to condition. This could have resulted in inflated parental liking ratings in the intervention group after the intervention period or deflated liking ratings in the control condition, although the similar patterns observed for intake suggest it was not just parental perception. The possibility of error or bias in parental reporting of vegetable intake should also be acknowledged. However, given the large intervention effects sizes, and the equal possibility for error in both control and intervention conditions, this is not likely to fully explain the findings. No long-term follow-up data were collected, although in a previous study the positive effects of exposure were maintained for at least 3 months.[26] There was self-selection into the study in that only 23% of parents who expressed interest and were randomized returned the outcome data record sheets. However, outcome data were returned by similar numbers in the control group who merely completed the three assessments (25%) as by those who were asked to follow the exposure protocol (21%). This suggests the burden of the three assessment sessions, rather than the intervention, was the major deterrent to completing the study.

It is not possible to assess the optimal number of vegetable exposures required to modify children's vegetable acceptance from the present findings. The 14 exposure sessions adopted by the present research were based on previous studies demonstrating 10 to 12 exposures to be sufficient for increasing acceptance and also to allow for missed exposure sessions and fit into the natural timing of 2 weeks. It is likely that the number of food exposures needed to achieve acceptance varies by child's age and may also vary between individual children and between target foods.[39] Although 14 exposures were sufficient to increase intake and liking in the majority of children in our study, it is possible that further exposures could have been valuable for some of the intervention children who failed to increase their acceptance over the study period. It is also possible that for many children, <14 exposures were necessary to modify their preferences. Further research is required to identify the optimal number of exposures needed to produce a sustained increase in children's food acceptance.

CONCLUSIONS AND IMPLICATIONS

Repeated taste exposure is an established technique that has been consistently shown to increase acceptance of a disliked food. Research suggests parents typically offer their children a disliked food between three and five times before giving up,[40,41] indicating that the message of repeated exposure is not reaching the wider public. In addition, recent studies have shown that by providing sticker rewards, parents can facilitate the multiple tastings essential for achieving acceptance. Our research extends these findings and demonstrates that parents can easily be taught to carry out exposure techniques using mailed materials with access to an online video. These simple, stand-alone materials enabled parents to successfully increase their child's acceptance of disliked vegetables. Wider dissemination of the program would be easy and relatively inexpensive to implement and has the potential to have a positive influence on children's acceptance of vegetables.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

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