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Increasing Children's Consumption of Fruit and Vegetables: Does the Type of Exposure Matter?

Chelsea Osborne

Catherine A. Forestell
William & Mary, caforestell@wm.edu

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Highlights

Increasing children's consumption of fruit and vegetables: Does the type of exposure matter?*Physiology & Behavior xxx (2012) xxx–xxx*

Chelsea L. Osborne, Catherine A. Forestell *

The College of William and Mary, Williamsburg, VA 23185, United States

► Children were exposed to food variety or to books about healthy eating. ► Exposure to food or books increased acceptance of fruit. ► Parental pressure to eat was negatively associated with increased fruit acceptance. ► Children who were exposed to books ate more of an infrequently consumed fruit. ► **Neither** food nor book exposure affected children's acceptance of familiar vegetables.



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Increasing children's consumption of fruit and vegetables: Does the type of exposure matter?

Chelsea L. Osborne, Catherine A. Forestell*

The College of William and Mary, Williamsburg, VA 23185, United States

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ABSTRACT

This study sought to determine how eight days of home exposure to information about healthful foods and eating behaviors in the form of children's books and a variety of fruit and vegetables interacted to affect 4- to 8-year-old children's ($N=59$) consumption of fruit and vegetables. Before and after the home exposure, children participated in a task in which their consumption of a variety of fruit and vegetables, which ranged in familiarity, was measured. Results indicated that exposure to food and books were both effective at increasing consumption of fruit, but not vegetables. Additionally, children who were exposed to books consumed more of an infrequently consumed fruit presented during the post-test, but only if they had not been exposed to food during the home exposure. Overall children's fruit consumption increased more if their mothers did not pressure them to eat and those who were less neophobic were more likely to try a novel fruit or vegetable during the post-test. These findings suggest that information and food variety can both be effective for increasing acceptance of fruit, and highlights the need for more research that investigates the efficacy of intervention strategies that promote vegetable consumption in young children.

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In order to maintain a healthful diet, adults should consume between 2.5 and 6.5 cups [1] or at least 5 portions of a variety of fruits and vegetables each day [2] to maintain a healthy diet. Diets that are rich in fruit and vegetables have been shown to reduce the risk of chronic disease and various cancers [3,4]. However, despite these health benefits, many adults fail to consume enough fruit and vegetables to meet daily dietary recommendations. Given that children, like adults have unhealthy eating patterns [5–7], it is not surprising approximately 32% of children and adolescents are overweight or obese [8]. Because consumption of fruit and vegetables helps to protect against obesity [9], it is of imminent importance to develop better strategies to increase children's willingness to consume these healthful foods.

As most parents and caregivers are aware, increasing children's consumption of fruit and vegetables can be challenging. Children are born with a genetic predisposition to prefer sweet and to avoid bitter foods such as green leafy vegetables [10,11]. It has been hypothesized that this predisposition evolved to attract children to energy-dense foods while discouraging consumption of toxins [13,14]. Although this may have enhanced survival in environments that were historically characterized by food scarcity, it is clearly maladaptive in our obesogenic environment.

Another barrier to healthy eating is neophobia, defined as a reluctance to try unfamiliar foods [15,16]. This hesitancy to eat unfamiliar

foods rises dramatically around two years of age and then decrease gradually [17,18]. Neophobia has been shown to predict food variety in children's diets, with neophobic children trying and liking fewer foods, and consuming fewer calories than their less neophobic peers [19–21]. According to Wardle et al. [5], neophobia accounts for 5.5% of the variance in children's fruit and vegetable consumption. High levels of neophobia tend to be associated with lower frequency of consumption of fruit and vegetables, but not sweet, fatty, or starchy foods [22]. In an attempt to promote children's fruit and vegetable intake, parents often resort to various controlling and coercive feeding strategies, such as providing rewards for eating disliked foods (e.g. "If you finish your vegetables, you can have dessert"). Although this approach may encourage children to eat an undesired food (thereby potentially combating neophobia), it ultimately reduces liking for the food [23]. Children's reduced liking of foods that they are pressured to eat, is thought occur through associations formed between the food and the negative emotions experienced during the eating episode [24,25].

A strategy that has been shown to be more effective for increasing children's liking of healthful foods is repeated exposure to these foods [26–28] as well as exposure to a variety of healthful foods [29]. However, from a practical perspective these strategies may have limited efficacy. That is, as parents become frustrated with their children's continued resistance to try new or disliked foods they may discontinue exposing them, thereby limiting the variety of foods the child experiences [30]. As a result, children's experience with healthful foods may be limited to visual exposure, and/or to information about their healthfulness (e.g., "You should eat this because it is good for you").

* Corresponding author at: Department of Psychology, College of William and Mary, P.O. Box 8795, Williamsburg, VA 23187-8795, United States. Tel.: +1 757 221 3892. E-mail address: caforestell@wm.edu (C.A. Forestell).

Although children gain information about healthy eating from a variety of sources at home and at school [e.g., 31] and acquire well-developed schemas about healthy eating [32], there is evidence suggesting that information, or visual exposure to foods alone may not be effective for increasing children's liking and consumption of healthful foods [e.g. 27,28]. There are several factors that may explain this. First, although children understand that nutritious food contributes to a healthy body, they are generally not concerned about their health [33] and second, children appear to believe that healthful foods are unpalatable [34].

However, more recent work suggests that toddlers who are repeatedly exposed to pictures of fruit and vegetables may learn to preferentially attend to these foods relative to other unexposed foods [35]. It appears that this enhanced interest in the appearance of the exposed foods eventually reduces their reluctance to taste them [36]. The present study sought to extend this work by determining whether exposure to pictures of healthful foods and information about healthy eating would affect children's consumption of fruit and vegetables to the same extent as exposure to a variety of healthful foods. Towards this aim, we tested children's willingness to consume a variety of fruits and vegetables before and after a home-exposure phase in which they were exposed to several different fruits and vegetables and/or children's books that depicted fruit and vegetables and discussed healthy eating in a repeated measures design. A secondary goal of the current study was to determine whether individual differences in mothers' feeding style and children's neophobia mediated changes in consumption of the foods from pre- to post-test.

Based on previous research that has shown that repeated exposure to foods and variety is effective for increasing children's acceptance of foods [e.g. 28,29], we hypothesized that exposure to a variety of foods would increase children's consumption of the test foods. Based on recent work by Houston-Price et al. [36], we additionally predicted that exposure to books that depicted healthful foods would increase children's acceptance of the foods. Finally we predicted that children whose mothers pressured them to eat healthful foods would increase their intake of the foods less than those with mothers who did not pressure their children to eat [24,25], and children with higher levels of neophobia would consume less food during the pre- and post-tests [22].

1. Methods

1.1. Participants

Fifty mothers and their 64 four- to eight-year-old children (mean age = 6.01 ± 0.17 years) were recruited through advertisements placed in local newspapers, flyers, and mass mailings throughout the region. Children with food allergies or those taking medication that suppressed their appetite were not eligible for participation.

1.2. Design

Each mother-child pair agreed to participate in a 10-day experimental study. Children were tested individually one day before (Day 1) and the day after (Day 10) an eight-day home exposure period. On both test days children were exposed to a free-eating task, which we called a "buffet". During this task they were offered a variety of fruit and vegetables and given the opportunity to eat as long as they wished. Each mother-child pair was randomly assigned to one of four experimental groups using a 2 × 2 between-subjects design according to a predetermined group list which was created with a random number generator. Groups differed according to whether they received books and/or food during and 8-day home exposure period. That is, for half of the participants, mothers were sent home with books to read to their children each day, and approximately half of the mothers within each of these groups received four fruits and four vegetables to feed to their children each

day. Thus the following four groups were created: Group F (food exposure only), Group B (book exposure only), Group F-B (food and book exposure), and Group C (the control group which received neither book nor food exposure). The College of William & Mary Protection of Human Subjects Committee approved all procedures. Informed consent was obtained from each mother and assent was obtained from each child over eight years of age.

1.3. Test stimuli

1.3.1. Buffet foods

On Day 1, children were presented with six foods during the buffet: apple, banana, orange, broccoli, baby carrots, and red pepper. These foods were chosen because they are commonly consumed uncooked in their natural form. The foods were held in individual clear rectangular plastic containers (approximately 13 cm × 7 cm × 7 cm) in two larger clear plastic bins with flip-up lids (approximately 38 cm × 13 cm × 10 cm), one for fruit and one for vegetables. All foods were presented raw, in bite-size portions, and filled the plastic containers halfway to three-fourths to the top. The position of the fruits and vegetables in each of the bins was randomized and the bin facing the child was counter-balanced. On Day 10, children were again presented with the original six foods. Additionally they were presented with two new fruits and two new vegetables, which their mothers reported were infrequently consumed on Day 1 during the food frequency interview (Table 2). The two fruits were chosen from kiwi, papaya, starfruit, or another tropical fruit (quince, or ugly fruit) and the vegetables were chosen from snap peas, baby corn or water chestnuts. For each child, we chose one fruit and vegetable that was completely novel (hereafter referred to as Day 10-Novel) to the child, whereas the other fruit and vegetable had been consumed before (Day 10-previously consumed, hereafter referred to as Day 10-PC). Thus, on Day 1 and 10, three fruits and three vegetables were presented. Additionally on Day 10 only, two relatively unfamiliar fruits and two relatively unfamiliar vegetables were presented alongside the familiar foods for a total of 10 foods.

1.3.2. Home exposure foods

Children took home four fruits and four vegetables that were each to be consumed on separate days between Days 2–8. For each child, foods were randomly chosen from the following: apple, banana, orange, blueberries, pineapple, papaya, baby carrots, broccoli, sweet pepper, cauliflower, celery, baby corn, and snap peas, with the limitation that two of the fruits and two of the vegetables were foods that had not been presented during the buffet. Apples, oranges, and bananas were sent home whole and uncut and the remaining foods were in bite-size pieces. Each food was sent home in pre-weighed, clear quart-size plastic, sealed freezer bag, with a label that indicated the date on which the contents of that particular bag should be fed. The order in which the foods were assigned was randomized according to a random number generator.

1.3.3. Home exposure books

Children in Groups B and F-B brought home two books; one of which focused on healthy eating habits (*Eat Healthy, Feel Great* [37]) and another which identified more than 70 colored drawings of fruit and vegetables, from the everyday apple to the jicama (*Eating the Alphabet* [38]).

1.4. Questionnaires and interviews

1.4.1. Child Food Frequency Interview

Mothers were asked to indicate whether their child ever tried each of the foods presented during the home exposure and the buffet, as well as a wide array of other fruit and vegetables, and if so, the frequency with which they consumed each of these foods per day, week, month, or year.

1.4.2. Food Neophobia Questionnaire

All mothers completed a 10-item scale that measured their own approach and avoidance of novel foods [17] in which they responded on a seven-point Likert scale from “extremely disagree” (1) to “extremely agree” (7). Pliner and Hobden [16] reported good internal consistency (Cronbach's alpha coefficient of 0.88) and satisfactory test-retest reliability for this test.

1.4.3. Mother's perceptions of their child's temperament and food neophobia

Mothers also completed a 25-item scale that measured aspects of their child's temperament [39]. Dimensions included emotionality, shyness, activity, sociability, neophobia, and negative reactivity to food. The last two subscales were of primary interest in the present study. Scores for each of the dimensions could range from 1 to 5, with higher scores indicating “more” of that particular temperament characteristic. This questionnaire has been shown to have satisfactory internal and test-retest reliabilities [39].

1.4.4. Maternal Child-feeding Style Questionnaire

The mothers' child-feeding practices and their perception of their children's risk for overweight were assessed by using the Child-Feeding Questionnaire (CFQ) [40]. This questionnaire consists of six subscales; restriction, which is the extent to which mothers control how much, when, and what their child eats; monitoring, which assesses the extent to which mothers keep track of what their child eats; pressure to eat, which is mothers' tendency to pressure their child to eat more food. Additional subscales include perceived child's weight (mothers' perceptions of their child's weight history), perceived parent's weight mothers' perceptions of her own weight history, (which was not reported in the present paper) and concern about child's weight (mothers' concern about their child's risk of becoming overweight). Previous analyses of this sample provided evidence of acceptable internal consistency and criterion validity for the Child Feeding Questionnaire subscales [40].

1.5. General procedure

Each mother brought their child for approximately 1 h to the laboratory on Days 1 and 10 of the experiment. To minimize the effect of

satiation, they were asked not to feed their child for at least 1 h before arriving at the laboratory. All mothers complied with this request; on average children were last fed 3 h before arriving on both test days (Table 1). On each day, children participated individually in the buffet task while their mother was interviewed and completed a variety of questionnaires about their child's eating habits and child-feeding practices in a separate room as described below.

1.5.1. Laboratory testing

On both days children were tested individually in a large room with only the experimenter present. On Day 1, each child was seated at a small table and asked if they had ever eaten at a buffet. They were reminded that at a buffet they could eat as little or as much of any of the foods they wanted. The buffet foods were presented in clear translucent plastic bins in front of the child on the table. On both test days children were asked to walk around the table so that they could look at each of the foods within the bins. Children were then given a plate and told they could begin selecting the foods they would like to eat. Children were allowed to eat until they indicated that they were finished. All food that was left on their plate was returned to the appropriate bin, and each food was weighed.

1.5.2. Home exposure period

Mothers who received books were asked to read one to their child each day in alternation over the eight-day home exposure period. Mothers who received food were asked to offer their children one fruit or vegetable per day in the assigned order (as described above) when their child was hungry. Children were given one opportunity to eat the assigned food each day. If the child refused the food, mothers were asked to present it again later that day. All mothers in Groups F, F/B and B were asked to keep a log of the foods that their children consumed each day. Mothers froze and returned the remaining food (including skin and peels that were not consumed) on Day 10 in their original sealed freezer bags. Each bag was dried off to remove any condensation and weighed after each session to determine intake.

1.6. Statistical analyses

Children's consumption of the buffet and home exposure foods was determined by calculating the difference between pre- and post-weight

Table 1

Mother and child characteristics.

	Food		No food		Total
	Book	No book	Book	No book	
Children, n	12	14	18	15	59
Sex (% female)	75.0	35.7	50.0	40.0	49.2
Age, mean ± SEM, mo	71.8 ± 4.9 ^a	67.4 ± 4.7	76.2 ± 3.6	73.5 ± 4.3	72.5 ± 2.2
BMI, mean ± SEM, kg/m ²	16.3 ± 1.0	15.9 ± 0.6	15.9 ± 0.4	15.5 ± 0.3	15.9 ± 0.3
Temperament; mean scores for each subscale range from 1 to 5.					
Shyness	2.7 ± 0.3	2.2 ± 0.2	2.0 ± 0.2	2.4 ± 0.2	2.3 ± 0.1
Emotionality	3.3 ± 0.3	2.7 ± 0.3	3.0 ± 0.3	3.2 ± 0.3	3.0 ± 0.1
Sociability	3.6 ± 0.2	3.6 ± 0.2	3.8 ± 0.2	3.7 ± 0.2	3.7 ± 0.1
Activity	3.9 ± 0.3	3.9 ± 0.2	4.1 ± 0.2	4.0 ± 0.2	4.0 ± 0.1
Negative reactions to foods	3.1 ± 0.3	2.6 ± 0.3	2.8 ± 0.3	3.3 ± 0.3	3.1 ± 0.1
Neophobia	3.0 ± 0.3	2.8 ± 0.3	3.3 ± 0.3	3.3 ± 0.3	3.1 ± 0.1
Time since last ate (min)	162.9 ± 34.2	186.6 ± 28.0	171.8 ± 32.9	195.5 ± 31.7	180.4 ± 15.4
Mothers					
Age, mean ± SEM, y	37.5 ± 1.8	34.9 ± 2.7	33.1 ± 1.3	33.6 ± 1.9	34.7 ± 1.0
BMI, mean ± SEM, kg/m ²	26.2 ± 1.7	24.9 ± 1.7	24.4 ± 1.3	25.4 ± 1.3	25.2 ± 0.7
Years of schooling, mean ± SEM	15.5 ± 0.6	16.6 ± 0.3	15.7 ± 0.4	15.3 ± 0.6	15.8 ± 0.2
Approach to feeding their child, as measured by the CFQ. Mean scores on each subscale range from 1 to 5.					
Restriction	3.0 ± 0.3	2.8 ± 0.3	2.5 ± 0.2	3.0 ± 0.3	2.8 ± 0.1
Monitoring	4.0 ± 0.3	4.0 ± 0.2	4.0 ± 0.3	3.6 ± 0.3	3.9 ± 0.1
Pressure to eat	2.2 ± 0.3	2.9 ± 0.3	2.0 ± 0.2	2.6 ± 0.3	2.4 ± 0.1
Perceived child weight	3.0 ± 0.1	2.8 ± 0.2	3.0 ± 0.1	3.0 ± 0.1	2.9 ± 0.1
Concern about child's weight	1.6 ± 0.3	1.3 ± 0.1	1.3 ± 0.1	1.3 ± 0.1	1.3 ± 0.1

^a Mean ± SEM.

and converting the difference to calories (i.e., kcal) for each food and summed to determine total fruit and total vegetable consumption. To determine whether changes in children's consumption of the buffet foods presented on Days 1 and 10 were a function of the home exposure, we conducted separate three-way repeated Analyses of Variance (ANOVAs) with Book Exp (books vs. no books at home) and Food Exp (food vs. no food at home) as the between-subjects variables and time (Day 1 vs. Day 10) as the repeated measure. Separate analyses were conducted for fruit and vegetable consumption.

For the Day 10-PC fruit and vegetable that were presented during the buffet only on Day 10, 2×2 between-subjects ANOVAs were conducted with type of book exposure (yes, no) and food exposure (yes, no) as independent variables. Because many of the children did not try the Day 10-Novel fruit and vegetable, chi-square analyses were performed to determine whether the proportion of children who tried the Day 10-Novel foods differed between groups.

Finally, we conducted a series of correlational analyses to determine whether increases in children's intake during the buffet from Days 1 to 10, and their consumption of the new foods on Day 10 were related to their mother's child-feeding style and their food neophobia.

2. Results

2.1. Participant characteristics

Of the 64 children who were recruited, five were excluded from the final analyses because they did not return for the second test day ($n = 3$); or they did not comply during one of the tasks ($n = 2$). As shown in Table 1, the remaining 59 children (29 girls) were randomly assigned to one of four groups, which did not differ in age, sex, BMI, or food neophobia, as reported by their mothers ($p > 0.05$ in all cases). Likewise, their mothers ($N = 49$) did not differ in their age, BMI, years of schooling, eating restraint scores, or their reported food neophobia ($p > 0.05$ in all cases). However, mothers whose children were assigned to receive book exposure were more likely to report that they pressured their child to eat on the CFQ ($F(1, 55) = 4.79$, $p < 0.04$, $\eta^2 = 0.80$).

Mothers reported that their children typically consumed fruit and vegetables approximately once per day (i.e., fruit: 1.49 ± 0.11 times/day; vegetables: 1.32 ± 0.11 times/day). Overall, children who ate vegetables less frequently had higher neophobia scores ($r(58) = -0.32$, $p < 0.02$) and more negative reactions to food ($r(58) = -0.29$, $p < 0.03$). As shown in Table 2, children's regular consumption

Table 2
Mothers' reports of their children's daily consumption of the foods presented during the buffet.

	Consumption (Frequency/Month)	% tried
Fruit		
All of the following were presented on Days 1 and 10		
Apple	13.7 ± 1.3	100
Banana	12.7 ± 1.2	100
Orange	9.1 ± 1.7	100
Two of the following were presented on Day 10 only		
Kiwi	1.1 ± 0.3	78
Papaya	0.04 ± 0.1	25
Starfruit (or other tropical fruit)	0	17
Vegetables		
All of the following were presented on Days 1 and 10		
Carrot	8.9 ± 1.6	100
Broccoli	4.8 ± 0.7	97
Sweet pepper	3.0 ± 0.9	83
Two of the following were presented on Day 10 only		
Sugar snap peas	1.0 ± 0.3	61
Baby corn	0.4 ± 0.2	53
Water chestnuts	0.4 ± 0.2	35

of the six buffet foods presented on Days 1 and 10 ranged from 9 to 14 times a month for fruit and from 3 to 9 times a month for vegetables. For the new fruits and vegetables presented only on Day 10 (i.e., Day 10-Novel and Day 10-PC foods), consumption ranged from once a month to never eaten. There were no between-group differences in children's typical daily fruit and vegetable intake, or in their daily intake of the buffet fruit and vegetables.

2.2. Food intake and time spent reading during the home exposure phase

As a manipulation check we determined the total amount of time the mothers spent reading to their children from the logs submitted by the mother assigned to Groups B and F-B. Similarly, for the children who took home food (Groups F-B and F), we examined the feeding logs to ensure that all of the foods were offered on the assigned days, and computed intake. Overall mothers reported reading the books to their children for approximately 100 min across the eight days, with mean read times varying between 8 and 20 min per day. The children who brought home food consumed more fruit (267.11 ± 23.11 g) than vegetables (73.42 ± 15.71 g) across the eight days of exposure ($F(1, 25) = 77.03$, $p < 0.001$, $\eta^2 = 0.76$). However, there were no between group differences in consumption between Group F (fruit: 236.35 ± 30.79 g; vegetables: 66.36 ± 21.75 g) and Group F-B (fruit: 303.00 ± 33.25 g; vegetables: 81.67 ± 23.49 g; $p > 0.05$). Likewise, while children tried a greater number of fruits (3.65 ± 0.49 fruits) than vegetables (2.88 ± 1.21 vegetables) during the home exposure, the groups did not differ in the number of fruits and vegetables tried ($p > 0.05$). All mothers reported offering each food on its assigned day.

2.3. Did home exposure increase children's consumption of the foods during the buffet tasks on Days 1 and 10?

On average children tried 1–2 of the 3 fruits (i.e., Day 1 = 2.44 ± 0.11 fruits; Day 10 = 2.11 ± 0.12 fruits) and the 3 vegetables (Day 1 = 1.38 ± 0.12 vegetables; Day 10 = 1.00 ± 0.11 vegetables) that were presented on both test days. Groups did not differ in the number of the fruits and vegetables tried. However, analyses of the caloric intake of the fruit presented on both test days revealed Time \times Food Exp ($F(1, 55) = 5.29$, $p < 0.03$, $\eta^2 = 0.09$) and Time \times Book Exp ($F(1, 55) = 4.24$, $p < 0.05$, $\eta^2 = 0.07$) interactions (Fig. 1A). Simple main effects analyses indicated that those who received books (i.e., Groups F-B and B) showed an overall increase in fruit consumption ($F(1, 29) = 5.71$, $p < 0.03$), whereas those who did not receive books did not ($p > 0.6$). Similarly, those who were exposed to foods (i.e., Groups F-B and F) marginally increased their fruit consumption ($F(1, 25) = 4.00$, $p < 0.06$), whereas those who were not exposed to food did not ($p > 0.5$).

Similar analyses failed to reveal significant group \times time interactions for vegetable consumption during the test days. However, as shown in Fig. 1B, children in the book groups consumed more calories of the vegetables on Day 1 than those who were not in the book groups ($F(1, 55) = 4.24$, $p < 0.05$, $\eta^2 = 0.09$). Therefore, an additional 2-way ANCOVA was conducted which included Book exposure and Food exposure as independent variables and caloric consumption of vegetables on Day 1 as a covariate. This additional analysis did not reveal any main effects of book or food exposure consumption of vegetables on Day 10.

2.4. Did home exposure increase children's consumption of the Day 10-Novel and Day 10-PC foods?

Marginally more children were willing to try the Day 10-Novel fruit if they brought home books than if they did not (47% vs. 21%; $\chi^2(1) = 3.26$, $p = 0.07$). For the Day 10-PC fruit, univariate analyses yielded a significant Book Exp \times Food Exp interaction ($F(1, 55) = 5.18$, $p < 0.03$, $\eta^2 = 0.08$). As shown in Fig. 2, simple main effects

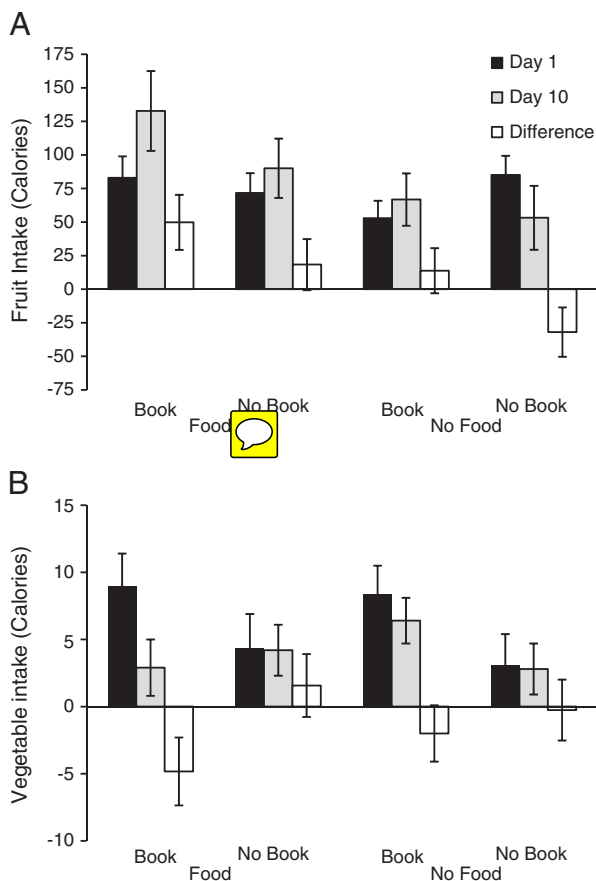


Fig. 1. Caloric intake of the three fruits (1A) and three vegetables (1B) presented on both Days 1 (black bars) and 10 (gray bars) and differences scores (Day 10 intake minus Day 1 intake). Error bars represent standard error of the mean. The groups differed according to whether they received exposure to books about healthful foods and eating, and whether they received a variety of fruit and vegetables during an 8-day home exposure period. Those who received books significantly increased their fruit intake ($F(1, 55)=4.24, p<0.05$), as did those who received food ($F(1, 55)=5.29, p<0.03$) during home exposure. Vegetable intake did not change as a function of the intervention. (Note difference in the y-axis scale between 1A and 1B).

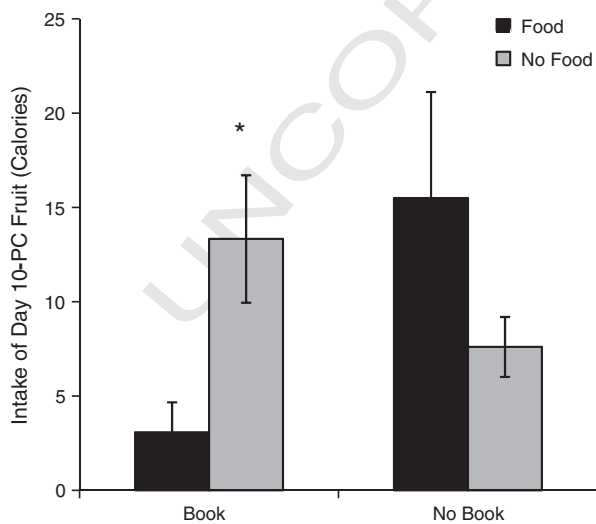


Fig. 2. Children's caloric intake of Day 10-PC fruit (i.e., presented only on Day 10 only and previously consumed by the child according to maternal reports) as a function of their home exposure experience. * indicates that for those who were exposed only to books, caloric consumption of the fruit was significantly higher than those who were exposed to both books and food ($p<0.05$).

analyses revealed that children in Group B ate significantly more of the Day 10-PC fruit than those in Group F-B ($F(1, 28)=5.52, p<0.03$). For children who did not bring home books, consumption of the Day 10-PC fruit did not differ as a function of whether they brought home food ($p>0.25$). Similar analyses conducted for the Day 10-Novel and PC vegetables failed to yield significant effects of the home exposure regardless of the novelty of the vegetable.

2.5. Did Mother's reports of their controlling feeding style and their child's neophobia affect intake during the buffet?

Children whose mothers reported that they pressured their child to eat showed smaller overall increases in intake of the fruit presented on Days 1 and 10 ($r(59)=-0.35, p<0.01$). None of the other CFQ subscales correlated with the children's intake during the buffet tasks. However maternal pressure to eat was negatively correlated with mothers' perceptions of their children's weight ($r(59)=-0.32, p<0.02$), and the child's BMI ($r(59)=-0.30, p<0.03$).

Although neophobia did not correlate with children's increases in food intake from Days 1 to 10, those who tried the Day 10-Novel fruit ($n=21$) had lower neophobia scores (2.34 ± 0.21) than those who did not ($n=38, 3.48 \pm 0.16, F(1, 57)=17.82, p<0.01, \eta^2=0.24$). A similar difference was also found for those who tried the Day 10-Novel vegetables ($n=17, \text{neophobia}=2.47 \pm 0.20$) when compared to those who did not try these vegetables ($n=42, \text{neophobia}=3.32 \pm 0.20, F(1, 57)=7.74, p<0.01, \eta^2=0.12$).

3. Discussion

In the present study, there was evidence that either exposure to a variety of foods or to food information increased children's acceptance of commonly consumed fruit. Moreover, children who were exposed to food information were more marginally likely to try a novel fruit than were those who were not exposed to information. These findings are consistent with those of Houston-Price et al. [36], who found that exposing toddlers to picture books depicting healthful foods increases consumption of these foods. While the present research suggests that some types of information may be as effective as exposure to food variety in increasing children's consumption of fruit, there was no evidence that exposure to information about food and healthy eating habits and food exposure had additive effects. In fact, children who brought home food and books ate less of an infrequently consumed fruit (Day 10-PC) relative to those who brought home only books. It is possible that exposure to both food and books was "too much of a good thing", causing children to become overwhelmed or disinterested in consuming a food that they have eaten before.

Despite the finding that exposure to food or information appeared to increase fruit acceptance, the results of the current study did not provide any evidence that this exposure increased children's willingness to accept vegetables. Although it is possible that important differences may not have been detected because of small sample sizes which led to insufficient power, our findings suggest that if anything, our manipulation may have done more to decrease rather than increase consumption of vegetables. For example, intake of the 3 vegetables presented on both test days tended to decrease in the food groups. Thus, exposure to a variety of fruits and vegetables while effective for increasing fruit consumption may not necessarily be effective at increasing children's vegetable acceptance. This finding is akin to results reported by [41] who reported that infants failed to increase their consumption of a green vegetable after they had been exposed to a variety of fruits. The authors suggested that this may have occurred because the flavor experiences from the palatable fruit offered as part of the home exposure did not generalize to the green vegetable.

Because vegetable consumption was interspersed with fruit consumption in the present study, a contrast effect may have occurred during home exposure. Through comparison of the palatable home exposure fruit with the less palatable vegetables, the children may have perceived the flavor of the vegetables to be less palatable than they would have been had they been presented alone [42]. Over time, the children who were exposed to food may have learned to associate the fruit with positive flavor sensations, and the vegetables with relatively negative flavor sensations.

Rather than the presence of the fruit in the home exposure phase, it is possible that the absolute number of vegetable exposures was too few to increase vegetable consumption in the test. For example, Pliner [43] gave participants three unfamiliar fruit juices to taste 5, 10 or 20 times and found that the number of exposures was positively related to participants' ratings of how much they liked each juice's taste. However, other work has found satiation effects may also occur as a function of these repeated taste exposures, which ultimately leads to dislike of the food [44]. Pliner [43] has suggested that whether repeated exposures actually lead to enhanced liking of the target foods, may be due to participants' initial levels of familiarity with exposed foods. That is, while repeated exposure to unfamiliar foods increases liking, exposure to foods that are already familiar may lead to dislike.

Although other work has reported that children will increase their preference for vegetables after repeated exposure to pictures [36], or to mere exposure to one vegetable or a variety of vegetables [29], these studies have typically either measured children's acceptance of a vegetable presented alone, or with only one or two other foods. In the present study, children's acceptance of vegetables was measured in the presence of several more palatable fruit options, which may have led to the avoidance of the vegetables. It is possible that because fruit is typically consumed as a snack food, whereas vegetables are typically consumed as part of a meal, children may have been less likely to consume the latter during the buffet. Despite this limitation, we would argue that this paradigm more closely approximates situations in which we must choose foods from an array of different items that vary in terms of their palatability. In most cases, however, we must choose from a wider variety of foods which vary not only in palatability, but also nutritional and caloric content.

Our results also indicate that additional factors may mediate the effectiveness of food and exposure to information. While various strategies might serve to increase children's consumption of fruit and, in some cases vegetables, their effectiveness will vary depending on the child's personal characteristics and the environment. In this study, those with higher neophobia scores were less likely to try the new novel foods on Day 10. Moreover those whose mothers indicated that they pressured them to eat were less likely to increase their fruit consumption. Although it has been assumed that parental pressure to eat is a cause of children's poor eating habits [45,46], more recent research suggests that the causal pathway may be reversed; with parental pressure to eat is occurs in response to perceptions of their children's weight [47,48]. Indeed, in the current study, mothers who pressured their children to eat may have done so because of their awareness of their children's lower BMIs. Regardless of the causal direction of this relationship, it is important to remember that strategies to increase consumption of healthful foods may be less effective in this subset of children.

The results of the current study suggests that repeated exposure, whether it is in the form of flavor exposures or information about healthful foods and healthy eating habits, may be a promising strategy for improving children's liking of fruit. Although most two to three year-old children consume recommended amounts of total fruit, older children fail to meet these recommendations. Of the fruit that they do consume, more than half is in the form of juice [49], which lacks dietary fiber and contributes extra calories. Thus, it appears that these findings could have important real-world application after further investigation to answer the following important

questions. First, although the present study, in combination with work by Houston-Price et al. [35,36], demonstrates increased acceptance of familiar and unfamiliar fruit as a function of information, the underlying mechanisms of change remain unclear. Whether this increase in acceptance occurred as a function of enhanced interest in the foods and healthy eating [50] is a topic for further investigation. Second, in order for these interventions to be truly effective, it is important to demonstrate whether exposure to information and food variety produced long-term changes in acceptance. Finally, more research is needed to determine how to increase children's willingness to consume vegetables in the presence of more palatable food options, which is a challenge that faces most children and adults on a daily basis.

Because obese children tend to become obese adults [51,52] with greater risk of adult morbidity and mortality [9,53], it is of primary importance to develop effective strategies to prevent the development of unhealthy eating styles. In order to reach this goal, future research should focus on understanding the long-term implications of various interventions in order to provide effective evidence-based strategies for developing healthy eating habits in our children; a generation which will struggle with the effects of obesity.

4. Uncited reference



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