Pre-exposure to high- versus low-caloric foods: Effects on children's subsequent fruit intake

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The effects of pre-exposure to high- versus low-caloric foods on fruit intake were investigated. A total of 56 children participated in this study, and were randomly assigned to an exposure condition: high-caloric food, low-caloric food, or control. Children who were pre-exposed to a high-caloric food ate more fruit than did those pre-exposed to a low-caloric food. These findings suggest that pre-exposure to high-caloric foods stimulates subsequent intake, including intake of foods that were not previously exposed, while pre-exposure to low-caloric foods does not appear to arouse appetite.

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1. Introduction

Food-related cues, including food advertisements aimed at children, have been targeted as a component of the toxic obesogenic food environment (Brownell, 2002). Food advertisements appear to have a significant impact on children's eating behavior. Viewing candy ads decreased the likelihood of choosing fruit as a snack compared to viewing other advertisements, such as fruit juice advertisements or public service announcements (Gorn & Goldberg, 1982). Similarly, children ate significantly more after viewing food advertisements than after non-food-related advertisements (Halford, Gillespie, Brown, Pontin, & Dovey, 2004). Few studies have investigated the effects of exposure to direct food cues (i.e., sight and smell of food) in children. Jansen et al. (2003) investigated the effects of direct exposure to high-caloric foods on subsequent intake of high-caloric foods. Lean children ate less after food-cue exposure compared to a control condition, whereas overweight children ate nonsignificantly more. The finding that overweight children were differentially susceptible to food-related cues than were lean children is in contrast to the findings of Halford and colleagues (Halford et al., 2004; Halford, Boyland, Hughes, Oliveira, & Dovey, 2007), who reported that lean and overweight children were both susceptible to food-related advertisements, with these food cues increasing intake in all children.

Research on food-cue exposure has typically investigated the effects of food cues on intake of high-caloric foods, (e.g., Fedoroff, Polivy, & Herman, 1997; Cornell, Rodin, & Weingarten, 1989). Although Halford et al. (2007) included low-caloric fruit in their food assortment, they simultaneously provided high-caloric foods (e.g., chocolates, and chips). It is therefore unclear whether food-cue exposure can influence intake of nutritious, low-caloric foods in the absence of high-caloric food. Furthermore, the specificity of the effects of food-cue exposure remains unclear. Previous research on adults has suggested that these effects are specific to the food presented during exposure, as pre-exposure to pizza cues did not increase the subsequent cookie intake of chronic dieters (Fedoroff, Polivy, & Herman, 2003). However, given that the cued foods also differed in basic taste components (sweet versus savory), it remains possible that pre-exposure to sweet food will increase intake of other sweet foods.

The current study was designed to elucidate the effects of food-cue exposure, and to investigate whether food-cue exposure could augment intake of nutritious, low-caloric foods. Less than half of children have an adequate intake of fruit and vegetables (Muñoz, Krebs-Smith, Ballard-Barbash, & Cleveland, 1997). If food-cue exposure can promote intake of nutritious foods, this could provide insights for programs aimed at improving children's diet. We set out to investigate the effects of exposure to high- and low-caloric foods on cue reactivity and subsequent fruit intake in children. Previous research suggests that children eat more after exposure to food-related advertisements (Halford et al., 2004, 2007). We therefore expected that children would also be susceptible to direct exposure to both high- and low-caloric foods, and would exhibit increased intake and cue reactivity (as compared to a control condition).
2. Method

2.1. Participants

Participants were recruited from local elementary schools. Parents of children between the ages of 8 and 12 years of age were sent an information letter outlining the details of the research, and children who returned a signed consent form were subsequently scheduled for an individual experimental session that took place between 10:00 and 15:00. A total of 56 children completed this study (38 girls and 18 boys), with a mean age of 9.98 years (SD=.98), and a mean body mass index of 18.72 (SD = 3.28).

2.2. Materials

2.2.1. Self-Perception Profile for Children (Harter, 1985; Dutch translation: Veerman, Straathof, Treffers, van den Bergh, & ten Brink, 1997)

Scores on the Physical Appearance subscale of this 36-item measure were used as an index of body esteem, with lower scores reflecting lower body esteem.

2.2.2. Adjusted Children’s Eating Disorder Examination-Questionnaire (ChEDE-Q, Jansen, Mulkens, Hamers, & Jansen, 2007)

This 30-item measure assesses eating pathology, with higher scores representing higher levels of eating pathology. An adapted Dutch translation was provided, in which children evaluated the presence/frequency of each question over the past 28 days by coloring in the number of days they had experienced such thoughts/behaviors, and their response was then converted into the original 7-point rating scale to calculate a total score.

2.3. Procedure

After obtaining parental written consent, children signed a consent form prior to obtaining baseline measures of hunger and mood. Baseline salivation was also measured for 1 min using cotton dental rolls (Hartmann, nr 2, 10 × 35 mm). Children placed the rolls on each side of their bottom jaw, between their gums and cheek, and the weight of the rolls was taken pre- and post-measurement to assess total salivation. Participants were assigned to one of three pre-exposure conditions:

High-caloric food
Three small bowls of mini chocolate-chip cookies, jelly beans, and candy-covered chocolates were presented, and participants were asked to think about the appearance and smell of the food, and to inhale deeply while putting the bowls to their noses. Participants were instructed not to taste any of the foods.

Low-caloric food
Three small bowls of pieces of fresh pears, bananas, and mandarin oranges were presented, with identical instructions as in the high-caloric condition.

Control cue
Three small bowls of dried rose petals, salt baths, and wood chips were presented, and participants were instructed to think about the appearance and smell of the items, and to inhale deeply from each bowl.

Participants were exposed to the cue for 5 min, with a second salivation measurement taken during the last minute of exposure. Participants then re-evaluated their hunger before completing a 10 min taste-rating task in which they were provided with large bowls filled with pieces of fresh pear, banana, and mandarin oranges and were informed that they were interested in their liking of the foods. They were invited to taste as much as they liked, and food was surreptitiously weighed to assess intake. Finally, children completed the Self-Perception Profile for Children (Veerman et al., 1997) and the Adjusted Children’s Eating Disorder Examination-Questionnaire (Jansen et al., 2007). Weight and height of the child were then measured, children were debriefed and given a small toy as compensation for their participation, and their parents were sent a debriefing letter.

3. Results

3.1. Participant characteristics

No significant differences across groups emerged for body mass index (BMI), body esteem, or total scores on the ChEDE-Q (see Table 1).

3.2. Cue reactivity

ANOVA demonstrated that there was a significant effect of condition on fruit intake, F(2,53) = 3.22, p < .05, η² = .108. Bonferroni-corrected pairwise comparison revealed that individuals in the high-caloric pre-exposure condition ate more fruit than did those in the low-caloric pre-exposure condition (p < .05). Entering BMI as a covariate did not change the pattern of the results, and this analysis also demonstrated that there was no significant effect of BMI on intake, F(1,52) = 0.003, p > .9, η² = .000.

An ANOVA conducted on the proportional change in salivation from baseline to exposure ([(post-exposure saliva total/pre-exposure saliva total)/pre-exposure saliva total] * 100) indicated that the between-groups differences in salivation were not significant, F(2,53) = 2.37, p < .15, η² = .082. Furthermore, a repeated-measures ANOVA conducted on hunger ratings pre- and post-exposure indicated that while participants reported being more hungry at post-exposure than pre-exposure, F(1,52) = 12.64, p < .001, η² = .193, there were no significant changes in hunger across conditions, F(2,53) = 0.26, p > .8, η² = .010 (see Table 2 for means of cue reactivity measures).

4. Discussion

Children who were pre-exposed to a high-caloric food ate more fruit than did those who were exposed to the low-caloric food. There were no group differences in hunger or salivation. These results were in contrast to the hypothesis that both high- and low-caloric food-cue exposures would increase cue reactivity and intake relative to a control exposure. One of the purposes of the study was to investigate whether pre-exposure to nutritious foods could augment fruit consumption. The results indicate that this is not effective, as the children who were pre-exposed to fruit had the lowest subsequent fruit intake. These results diverge from previous research demonstrating that exposure to high-caloric food advertisements decreased fruit consumption relative to exposure to fruit advertisements (Gorn & Goldberg, 1982). However, there were both candy bars and fruits available in this previous study, whereas only fruit was available in the current study. Therefore, it appears that exposure to sweet high-caloric foods stimulates subsequent intake, including intake of other (sweet) foods that were not presented during pre-exposure. This study adds to research on specificity of food-related cues, demonstrating that direct matching of the pre-exposed food (fruit) led to lower subsequent intake relative to the non-matched group.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Low-caloric cue</th>
<th>High-caloric cue</th>
<th>F (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>18.9 (.3)</td>
<td>18.3 (.3)</td>
<td>18.9 (3.4)</td>
<td>.20 (ns)</td>
</tr>
<tr>
<td>ChEDE total</td>
<td>1.8 (.8)</td>
<td>1.9 (.9)</td>
<td>2.1 (.9)</td>
<td>.06 (ns)</td>
</tr>
<tr>
<td>Body esteem</td>
<td>2.8 (.7)</td>
<td>2.8 (.5)</td>
<td>2.9 (.5)</td>
<td>.72 (ns)</td>
</tr>
</tbody>
</table>
(high-caloric food). It is possible that this generalization of food-cue exposure, in which high-caloric cue exposure stimulates intake of low-caloric foods, occurs only for foods in the same taste category (e.g., sweet), given previous research showing specificity for food-cues that were sweet versus savory (Fedoroff et al., 2003).

The precise mechanisms of the augmented intake in those pre-exposed to high-caloric foods are unclear. While it was initially hypothesized that cue reactivity would be stimulated after food-cue exposure, there were no group differences on salivation or hunger. The lack of difference in salivation across groups is similar to previous research in children which also used dental rolls to measure saliva weight (Jansen et al., 2003), suggesting that it may be difficult to detect differences in children using this method without larger sample sizes.

The fact that children ate more fruit after exposure to high caloric food (relative to low-caloric exposure) could either mean that children always eat more after exposure to high caloric food, from whatever food is available (substituting possible craving for high-caloric food with the available low-caloric food), or that extensive exposure to low-caloric food induced some degree of sensory-specific satiety. To tease apart these two possibilities, manipulation of both food-cue exposure and the presence of low- and high-caloric foods are necessary.

Rolls and Rolls (1997) indicate that partial sensory-specific satiety is activated by merely smelling food (e.g., banana) for 5 min. Perhaps certain foods (such as fruits) are more sensitive to olfactory sensory-specific satiety than others (such as chocolates).

There were no effects of BMI on food intake in the current study, suggesting that body weight does not necessarily interact with exposure. These results are consistent with the findings of Halford et al. (2004, 2007), but not with those of Jansen et al. (2003). Limited sample size in the current study prevented the possibility of further analyzing the data based on weight status (lean versus overweight); however, susceptibility to food cues across weight classifications appears to be an important factor to investigate in future research.

The current study suggests that children eat more fruit after attending to high-caloric food cues (as compared to low-caloric food cues). While it can be viewed positively that children’s consumption of nutritious foods was increased after exposure to high-caloric foods, it is important to note that only low-caloric foods were subsequently available for tasting. Previous research has shown that high-caloric food advertisements decrease subsequent fruit consumption when candy bars are also available (Gorn & Goldberg, 1982). Increasing the understanding of the general effects of food-cue exposure in children, and elucidating the underlying mechanisms, may ultimately improve prevention programs that target overeating and weight gain.

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### Contributors
All authors were involved in study design and protocol development. The second author was involved in participant recruitment and testing. The first author conducted the statistical analyses and wrote the first draft of the manuscript, and all authors contributed to and have approved the final manuscript.

### Conflict of interest
There are no conflicts of interest for any author.

### References


