

# The effect of playing advergames that promote energy-dense snacks or fruit on actual food intake among children<sup>1–3</sup>

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## ABSTRACT

**Background:** Previous studies have focused on the effects of television advertising on the energy intake of children. However, the rapidly changing food-marketing landscape requires research to measure the effects of nontraditional forms of marketing on the health-related behaviors of children.

**Objectives:** The main aim of this study was to examine the effect of advergames that promote energy-dense snacks or fruit on children's ad libitum snack and fruit consumption and to examine whether this consumption differed according to brand and product type (energy-dense snacks and fruit). The second aim was to examine whether advergames can stimulate fruit intake.

**Design:** We used a randomized between-subject design with 270 children (age: 8–10 y) who played an advergame that promoted energy-dense snacks ( $n = 69$ ), fruit ( $n = 67$ ), or nonfood products ( $n = 65$ ) or were in the control condition ( $n = 69$ ). Subsequently, we measured the free intake of energy-dense snacks and fruit. The children then completed questionnaire measures, and we weighed and measured them.

**Results:** The main finding was that playing an advergame containing food cues increased the general energy intake, regardless of the advertised brand or product type (energy-dense snacks or fruit), and this activity particularly increased the intake of energy-dense snack foods. Children who played the fruit version of the advergame did not eat significantly more fruit than did those in the other groups.

**Conclusion:** The findings suggest that playing advergames that promote food, including either high energy-dense snacks or fruit, increases the energy intake in children. This trial was registered at [www.controlled-trials.com](http://www.controlled-trials.com) as ISRCTN17013832. *Am J Clin Nutr* doi: 10.3945/ajcn.112.047126.

## INTRODUCTION

Childhood obesity is a major global health concern (1). Obese children are likely to remain obese over the years and to develop diseases, including diabetes and cardiovascular diseases, at a younger age (1). The WHO concluded that the intense advertising of energy-dense, micronutrient-poor food and beverages is a probable causal factor in childhood obesity (2). Many empirical studies have supported these claims (3–10), which indicates that exposure to food advertising significantly influences children's consumption of energy-dense food. Cue reactivity theory explains these findings by stating that food cues that signal food intake may begin to act as conditioned stimuli that trigger cue reactivity or conditioned responses, such as cravings and actual eating behavior (11, 12). Most studies have focused their re-

search on the effects of television food advertising. However, the food-marketing landscape is rapidly changing and adopting new digital and online media technologies as marketing tools (5). One important new form of such online marketing is advergames, which are free online games that integrate advertising messages, logos, and trade characters. Content analyses indicate that food marketers use advergames largely to promote their products (13–22), especially food products that are high in sugar and fat (14).

Previous research has shown that playing advergames has a positive effect on liking, preferring, and recognizing an advertised brand (23–25), but research on the effects on actual caloric intake is scarce. Harris et al (22) reported that children who played an advergame with energy-dense food ate more energy-dense snacks and fewer fruit and vegetables than did children who played an advergame with fruit or those in the control condition. Pempek and Calvert (21) showed that children who played a version of Pac-Man with fruit ate significantly more fruit than did those who played a version of Pac-Man with energy-dense food. Although these studies encountered some methodologic difficulties [ie, small samples (21, 22), or the use of different games in different conditions (22)], we attempted to address these difficulties by using a large representative sample and one memory game that varied only according to the advertised content.

The main objective of this study was to examine the effect of advergames that promote energy-dense snacks or fruit on children's ad libitum snack and fruit consumption and to examine whether this consumption differs according to brand and product type (energy-dense snacks and fruit). The second objective was to examine whether advergames can stimulate fruit intake (14, 21, 22). We designed the current experiment to test 3 hypotheses. Hypothesis 1 proposes that playing advergames that promote food increases general caloric intake. Hypothesis 2 proposes that playing an advergame that promotes food increases product type–related food intake (21, 22). The expectation is that

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advergames that promote energy-dense snacks will increase energy-dense snack intake, whereas advergames that promote fruit will increase fruit intake. Finally, hypothesis 3 suggests that increased food intake after playing an advergame is not specific to a certain brand (21, 22) but will also enhance the intake of a brand promoting products in the same product category (eg, snacks) (26).

## SUBJECTS AND METHODS

### Experimental design and stimulus materials

The children were randomly assigned to 1 of 4 conditions, which involved playing 1) the energy-dense snacks advergame (ie, promoting a popular candy brand and 8 different gummy and jelly sweets from this popular candy brand), 2) the fruit advergame (ie, promoting a popular fruit brand and 8 different fruits, fruit drinks, or cups with fruit from this popular brand), 3) the nonfood advergame (ie, promoting a popular Dutch toy brand and 8 individual toys from this popular toy brand), or 4) no game at all (control condition). We randomized the conditions within schools, and the conditions were counterbalanced to start with a different condition every day, so that none of the conditions were tested more in the morning or just before or after the break. The order of conditions was also counterbalanced to avoid any order effects. A professional game designer designed the advergames. All games were identical, except for the advertised brands and products. The game involved a memory game with 16 cards, whereby the brands appeared on the back of the cards, and the individual products (candy, fruit, or toys) appeared on the front of the cards. These products clearly displayed the brand logos. Furthermore, we showed the brand on the right side of the screen to enhance the awareness of the advertised brand. Similarly to regular advergames, we integrated 2 specific features to immerse the children into the game. First, a digital timer appeared on the top left of the screen, and a time bar appeared in the top center of the screen to exert time pressure on the children. Second, the game played an unpleasant sound when a child selected a false pair and a pleasant sound when a child selected a correct pair. All children were seated at a different table and were presented 4 bowls that contained 4 different food snacks directly after they played the advergame. Two bowls contained energy-dense food snacks [jelly candy (cola bottles) and milk-chocolate candy shells], and 2 bowls contained sliced fruit snacks (bananas and apples). Two bowls of test food, such as cola bottles and bananas, were identical to one of the food products shown in the advergame. In addition to these food snacks, we used other popular candy (milk-chocolate candy shells) and fruit (apples) to test possible spillover effects. The effect of the advergame could possibly affect the intake of other snacks that are not directly involved with the advergame. When children see a food commercial, they often do not directly have the advertised snacks available, but the effect of the food cue might spill over to comparable available snack foods that are eaten to fulfill the craving.

### Procedures

The committee for ethical concerns in the Faculty of Social and Behavioral Sciences at the University of Amsterdam ap-

proved the current study. The data collection occurred between November 2011 and February 2012. After obtaining consent from the schools to participate, we sent the parents of the children a letter with detailed information regarding the study, and we asked them to inform us if they did not want their child to participate in the experiment or if their child was allergic to one of the test foods. Children who were allergic to the test food did not participate in the experiment. More than 90% of the children whose parents we approached were allowed to participate. We emphasized that all of the data that we collected would remain confidential and that children could cease participation at any time. We individually tested the children at their schools during regular school hours. The experimenter collected one child at a time from the classroom; the teacher assigned the children (in alphabetical order) to the experimenter. The experimenter brought each child to another classroom or office containing a computer running one of the advergames. The children in the advergame groups played the game online. The experimenter read the instructions from the screen, which stated that the child would be playing a memory game for 5 min and should attempt to finish as many games as possible, which were unlimited. The children were exposed to the advergame for 5 min because comparable studies (21, 23) have used approximately the same amount of time, and we reasoned that 5 min would be enough time to process the food cues. A pretest with a different group of children ( $n = 5$ ) showed that children enjoyed this game when they played it for 5 min.

Further instructions stated that, after each game, the time bar would stop and the score would appear; then, the time would continue when the new game started. After reading the instructions, each child began the game and signaled the experimenter when the game stopped after 5 min. The experimenter then left the room. The total score appeared on the screen when the game ended.

While the experimenter recorded their scores, the children waited at a different table. When the children sat down, the experimenter told them that they had a break for 5 min and could eat as much as they liked. When the assigned child was in the control condition, the child directly started with the eating part of the experiment and did not do something prior. Providing the children with a free task would result in too much variation in activities. The children in the control condition were used as a baseline condition to estimate how much children ate when 4 different bowls containing food were presented to them, without playing an advergame. Because the children in the control condition did not play an advergame, they were 5 min shorter in the room. The experimenter placed a glass of water and 4 different preweighed bowls in front of the children on the table. The brand of the food was visible on all of the food bowls. The questionnaire consisted of questions that assessed sex, age, hunger levels, brand and product recognition, and attitude to the products and brands that were in the advergames. The experimenter read the questions and answers aloud, and the children gave their answers. When the questionnaire was finished, the experimenter measured the height and weight of the children. The children were then accompanied back to their classrooms, and the experimenter then invited the next child to participate. The experimenter requested that all children refrain from discussing the experiment with their classmates. After each session, the experimenter weighed the bowls to calculate caloric intake. The

experimenter refilled and weighed the bowls before the next child entered the room to make sure that the children did not notice how much the previous child had eaten.

## Measures

### BMI

We calculated BMI, measured as weight (kg)/height (m)<sup>2</sup>, from measured height and weight. We measured weight to the nearest 0.1 kg while the children were wearing clothing and no shoes. We also measured height according to standard procedures (no shoes) to the nearest 0.5 cm. We calculated whether the children were underweight, normal weight, overweight, or obese by using international cutoff scores (27).

### Caloric intake

To measure caloric intake after playing the advergaming, we allowed the children to eat ad libitum for 5 min. We weighed the amount of snack food that a child ate before each child entered the room and reweighed it after consumption. We used a professional balance scale to estimate the weight to the nearest 0.1 g. We recalculated the number of grams that a child ate (in kcal) for use as a dependent measure. The amount of energy-dense snack food that a child ate is the sum of the kilocalorie intake of jelly candy and milk-chocolate candy, and the amount of fruit is the sum of the kilocalorie intake of bananas and apples. The total number of kilocalories that a child ate is the sum of energy-dense snacks and fruit.

### Hunger

We controlled for individual differences in hunger by presenting the children with a visual analog scale (VAS; 14 cm) to measure the extent to which they felt hungry before the experiment began. We assessed hunger after the children played the game and ate, because we wanted to avoid the influence of demand characteristics on caloric intake and to approach a daily life situation as much as possible. VASs are widely used and are reliable and valid rating scales for measuring subjective experiences related to food intake (28, 29). The anchors were “not hungry at all” and “very hungry.”

Furthermore, at the end of the experiment, we examined whether there were differences in recognition of the brand and product that we used in the 3 advergaming. We measured brand or product recognition by presenting the children with the logos or products from the advergaming that they played and 2 comparable other brands or products that did not appear in the advergaming. We asked the children to indicate whether they remembered each brand and product from the advergaming. We tabulated the correct answer with the false responses. False responses were the brands or products that did not appear in the game. We found no differences in brand or product recognition between the advergaming. The attitude to the brand and foods that were in the advergaming were assessed with 6 different items (nice, stupid, tasteful, untasteful, cool, and boring) on a VAS. Finally, at the end of the experiment, we asked the children to indicate whether they were aware of the goal of the research, but no child gave the correct answer.

## Statistical analysis

Before testing our hypotheses, we conducted randomization checks with a 1-factor ANOVA for sex, hunger, BMI, and age. The means and SDs for all variables are presented separately for each condition in **Table 1**. We estimated outlying scores on caloric intake that could affect the results by computing residual scores and testing them for Mahal's distance, Cook's distance, and leverage scores, but we found no indications to assume outlying scores. To examine which factors should be used as covariates, we conducted correlational analyses. Pearson's correlations between the variables in the model are shown in **Table 2**. Because hunger, age, and sex were significantly related to caloric intake, we included these variables as covariates in the analyses. Furthermore, we tested the hypotheses with a multivariate analysis of covariance. We conducted post hoc Bonferroni tests to examine the differences between the advergaming. In addition, we examined the interaction effects for sex, hunger, BMI, and age because, according to earlier research, these factors can have a combined effect with food advertisements (26, 30). To correct for the multiple comparisons (4), we Bonferroni adjusted the significance levels. The adjusted *P* value that was considered significant was 0.05. We calculated effect sizes for Cohen's *f* and Cohen's *d*. Cohen's *f* effect sizes of 0.02,

**TABLE 1**  
Variables measured, by condition<sup>1</sup>

	Energy-dense snack ( <i>n</i> = 69)	Fruit ( <i>n</i> = 67)	Nonfood ( <i>n</i> = 65)	Control ( <i>n</i> = 69)
Sex (boy = 1, girl = 0)	1.58 ± 0.5	1.43 ± 0.5	1.51 ± 0.5	1.49 ± 0.5
Hunger on VAS <sup>2</sup> (cm)	3.8 ± 2.3	4.0 ± 3.0	3.9 ± 2.9	4.3 ± 2.7
BMI, corrected (kg/m <sup>2</sup> )	2.3 ± 0.6	2.2 ± 0.5	2.2 ± 0.5	2.1 ± 0.4
Age (y)	8.9 ± 0.7	8.9 ± 0.8	8.9 ± 0.8	8.9 ± 0.8
Total energy intake (kcal)	197.2 ± 111.4	184.1 ± 117.1	128.9 ± 83.4	121.7 ± 104.4
Total energy-dense food intake (kcal)	164.8 ± 106.6	151.4 ± 116.2	104.7 ± 83.3	94.5 ± 71.1
Total fruit energy intake (kcal)	32.4 ± 27.1	32.7 ± 28.2	24.2 ± 24.0	27.2 ± 28.8
Jelly cola bottle intake (kcal)	85.9 ± 85.2	79.0 ± 74.2	59.9 ± 52.6	41.8 ± 39.3
Milk-chocolate candy shell intake (kcal)	78.9 ± 80.8	72.4 ± 79.7	44.7 ± 58.3	42.6 ± 45.8
Banana intake (kcal)	15.7 ± 19.9	18.1 ± 19.9	14.3 ± 19.6	16.2 ± 25.0
Apple intake (kcal)	16.7 ± 16.1	14.5 ± 14.2	9.9 ± 9.9	11.0 ± 12.3

<sup>1</sup> All values are means ± SDs; *n* = 270.

<sup>2</sup> VAS, visual analog scale.

**TABLE 2**  
Pearson's correlations between the mode variables<sup>1</sup>

	Sex	Hunger	BMI	Age	Total energy-dense snack intake (kcal)	Total fruit intake (kcal)
Sex (boy = 1, girl = 0)						
Hunger on VAS <sup>2</sup> (cm)	-0.16 <sup>3</sup>					
BMI, corrected (kg/m <sup>2</sup> )	-0.14 <sup>4</sup>	-0.00				
Age (y)	-0.13 <sup>4</sup>	0.03	-0.03			
Total energy-dense snack intake (kcal)	-0.14 <sup>4</sup>	0.24 <sup>3</sup>	0.08	-0.08		
Total fruit intake (kcal)	-0.08	0.20 <sup>3</sup>	-0.00	0.17 <sup>3</sup>	-0.01	
Total intake (kcal)	-0.15 <sup>4</sup>	0.28 <sup>3</sup>	0.07	-0.04	0.97 <sup>3</sup>	0.25 <sup>3</sup>

<sup>1</sup>  $n = 270$ .

<sup>2</sup> VAS, visual analog scale.

<sup>3</sup>  $P < 0.01$ .

<sup>4</sup>  $P < 0.05$ .

0.15, and 0.35 indicated small, medium, and large effects, respectively. Cohen's  $d$  effect sizes of 0.2–0.3, ~0.5, and 0.8 to infinity indicated small, medium, and large effects, respectively.

## RESULTS

The total sample consisted of 277 children (grades 3–4) from 6 primary schools in the Netherlands, and 51.5% of the participants were boys. We excluded 7 children from the analyses because teachers interrupted the experimental session ( $n = 4$ ) or because the children had not finished the session completely as a result of a lack of motivation ( $n = 3$ ); thus, the final sample consisted of 270 children. The mean ( $\pm$ SD) age of the children in grade 3 ( $n = 142$ ) was  $8.4 \pm 0.58$  y and that in grade 4 ( $n = 128$ ) was  $9.42 \pm 0.54$  y. In our sample, 1.9% of the children were underweight, 80% were normal weight, 15.6% were overweight, and 2.6% were obese. The percentage of children in our study who were overweight and obese (17.8%) was comparable with the current percentage of overweight and obese children in the Netherlands (13.3%). The BMI category distribution was not equally distributed between sex groups, because girls were more often overweight than were boys (Table 2). We found no differences in the BMI category distribution between the age groups. We found no significant differences between the experimental conditions for sex, hunger, BMI, and age. We also found that brand recognition and attitudes toward the game did not differ significantly between the advergames. We also tested whether the scores influenced the amount of caloric intake, but we found no effect. Cronbach's alphas for attitude to the energy-dense brand was 0.79, to the fruit brand was 0.58, to the energy-dense snacks was 0.79, and to fruit was 0.72. We found no differences between the 4 groups for attitude to the energy-dense brand [ $F(3, 267) = 1.829, P = 0.142$ ] or fruit brand [ $F(3, 267) = 0.877, P = 0.454$ ] and not for the attitude to the energy-dense foods [ $F(3, 267) = 0.668, P = 0.572$ ] or fruit [ $F(3, 267) = 1.449, P = 0.229$ ].

The results of the multivariate analysis of covariance are shown in Table 3. In our first hypothesis, we expected that the children who played an advergame containing food would have a higher total caloric intake than did the children in the other conditions. We found that the children who played an advergame that promoted food (energy-dense snacks or fruit) ate significantly more than did the children who played an adver-

game that promoted nonfood products. A post hoc Bonferroni test showed that the children who played an advergame promoting food [energy-dense snacks ( $P < 0.01$ ) or fruit ( $P < 0.01$ )] ate much more than did the children who played the nonfood advergame. The children who played an advergame that promoted food [energy-dense snacks ( $P < 0.01$ ) or fruit ( $P < 0.01$ )] also ate significantly more than did the children in the control condition. We found no significant differences between the other conditions with regard to total caloric intake. The results of the post hoc Bonferroni tests are shown in Table 4. Furthermore, we found that male children ( $P < 0.01$ ) and children who reported being hungry ( $P < 0.01$ ) had a higher caloric intake.

To test our second hypothesis, we tested the differences in product type-related food intake. We found that the children who played an advergame promoting energy-dense snacks ( $P < 0.01$ ) or fruit ( $P < 0.01$ ) ate significantly more energy-dense snacks than did the children who played the advergame promoting nonfood products. Further, the children who played an advergame promoting energy-dense snacks ( $P < 0.01$ ) or fruit ( $P < 0.01$ ) ate more energy-dense snacks than did the children in the control condition. A post hoc Bonferroni test showed no significant differences between the other conditions with regard to energy-dense snack intake; thus, the advergames that promoted energy-dense snacks or fruit had a similar effect on energy-dense caloric intake. Furthermore, we found that sex ( $P < 0.05$ ), hunger ( $P < 0.01$ ), and age ( $P < 0.05$ ) were significantly related to energy-dense caloric intake. Male children, children who reported being hungry, and younger children ate more energy-dense snacks. The analyses with fruit caloric intake as the dependent variable showed no differences between the 4 conditions. To test our third hypothesis, we used the caloric intake of the separate brands as dependent variables. First, with cola bottle kilocalorie intake as the dependent variable, we found significant differences between the conditions. A post hoc Bonferroni test showed that the children who played an advergame that promoted energy-dense snacks ( $P < 0.01$ ) or fruit ( $P < 0.01$ ) ate significantly more jelly cola bottles than did the children in the control condition. We found no significant differences for the other comparisons. Second, the analyses with the kilocalorie intake of milk-chocolate candy shells as the dependent variable also yielded a significant effect for the advergame. We found that the children who played the advergame

**TABLE 3**  
Results from a multivariate analysis of covariance with energy intake as a dependent variable<sup>1</sup>

	Total intake	Total energy-dense snack intake	Total fruit intake	Jelly cola bottle intake	Milk-chocolate candy shell intake	Banana intake	Apple intake
Sex (boy = 1, girl = 0)	$F(1, 263) = 6.700^2$	$F(1, 263) = 6.176^3$	$F(1, 263) = 0.234$	$F(1, 263) = 11.601^2$	$F(1, 263) = 0.025$	$F(1, 263) = 0.051$	$F(1, 263) = 0.352$
Hunger on VAS <sup>4</sup> (cm)	$F(1, 263) = 25.364^2$	$F(1, 263) = 17.410^2$	$F(1, 263) = 10.607^2$	$F(1, 263) = 1.501$	$F(1, 263) = 21.458^2$	$F(1, 263) = 7.450^2$	$F(1, 263) = 4.283^3$
Age (y)	$F(1, 263) = 1.114$	$F(1, 263) = 4.242^3$	$F(1, 263) = 11.981^2$	$F(1, 263) = 5.813^3$	$F(1, 263) = 0.283$	$F(1, 263) = 10.863^2$	$F(1, 263) = 2.460$
Advergame	$F(3, 263) = 15.703^2$	$F(3, 263) = 13.744^2$	$F(3, 263) = 1.491$	$F(3, 263) = 8.097^2$	$F(3, 263) = 6.104^2$	$F(3, 263) = 0.265$	$F(3, 263) = 3.806^3$
Effect size <sup>5</sup>	0.40	0.37	NS	0.28	0.24	NS	0.18
Explained variance (%)	21.3	18.1	—	12.9	11.2	—	6.8

<sup>1</sup>  $n = 270$ .

<sup>2</sup>  $P < 0.01$ .

<sup>3</sup>  $P < 0.05$ .

<sup>4</sup> VAS, visual analog scale.

<sup>5</sup> Cohen's  $f$ .

with energy-dense snacks ( $P < 0.05$ ) ate significantly more milk-chocolate candy shells than did the children who played the nonfood advergame. The results also showed that the children who played the advergame with energy-dense snacks ( $P < 0.01$ ) or fruit ( $P < 0.05$ ) ate significantly more milk-chocolate candy shells than did the children in the control condition. We found no significant difference between the advergame that promoted energy-dense snacks and the game that promoted fruit. Third, the analysis of the kilocalorie intake of bananas yielded no effects of the advergames on banana intake. Fourth, with apple intake as the dependent variable, we found an effect of the advergames. We found that the children who played the advergame that promoted energy-dense snacks ate more ( $P < 0.05$ ) apples than did the children who played the advergame that promoted nonfood products. The children who played the advergame that promoted energy-dense snacks also ate more ( $P < 0.05$ ) apples than did the children in the control condition.

In all analyses, we tested for interaction effects between the conditions and sex, game attitude, or BMI, but we found no significant effects for these interactions. Sex, game attitude, and BMI did not moderate the effect of the advergames on food intake.

## DISCUSSION

The main objective of this study was to examine the effect of advergames that promote energy-dense snacks or fruit on the ad libitum snack and fruit consumption of children. Furthermore, we examined whether this consumption was specific to product types and brands. The results show that the children who played an advergame with energy-dense snacks or fruit had a higher caloric intake after playing the game than did the children who played an advergame with nonfood products or those who did not play the game.

In addition, the results show that children who played the advergame with energy-dense food ate significantly more energy-dense food after the game than did the children in the control condition or those who played the advergame with nonfood items; however, the children playing the game with energy-dense snacks did not consume more than the children who played the advergame promoting fruit. A separate analysis showed that the results for the energy-dense food are based on both the effect of the advertised brand and the consumption of an energy-dense snack from a different brand. We found the same result for the children who played the advergame promoting fruit. Thus, consistent with our expectations, the effects were not product type or brand specific but transferred to other energy-dense snacks that were available. This spillover effect of food commercials on different products other than the advertised product and brand has also been found with television commercials (26). We found no interaction effects for age, attitude toward the game, and sex; therefore, the effects of the advergames were the same for these groups.

Our second aim was to examine whether children who played an advergame promoting fruit consumed more fruit after playing the game than did children in the other conditions. The results show that the children who played the advergame with fruit ate more energy-dense food than fruit. This result refutes our expectations; advergames that promote fruit do not necessarily stimulate fruit intake. The cues that the advergames presented

**TABLE 4**Adjusted means and SDs of food intake (in kcal) controlled for sex, hunger, and age, by condition and food intake<sup>1</sup>

	Total intake <sup>2</sup>	Total energy-dense snack intake <sup>3</sup>	Total fruit intake <sup>4</sup>	Jelly cola bottle intake <sup>5</sup>	Milk-chocolate candy shell intake <sup>6</sup>	Banana intake <sup>7</sup>	Apple intake <sup>8</sup>
Energy-dense snacks ( <i>n</i> = 69)	202 <sup>a</sup> ± 111	170 <sup>a</sup> ± 107	32 <sup>a</sup> ± 27	89 <sup>a</sup> ± 85	80 <sup>a</sup> ± 81	16 <sup>a</sup> ± 20	17 <sup>a</sup> ± 16
Fruit ( <i>n</i> = 67)	183 <sup>b</sup> ± 117	150 <sup>b</sup> ± 116	33 <sup>b</sup> ± 28	78 <sup>b</sup> ± 74	72 <sup>b</sup> ± 80	18 <sup>b</sup> ± 22	15 <sup>b</sup> ± 14
Nonfood ( <i>n</i> = 65)	130 <sup>c</sup> ± 83	106 <sup>c</sup> ± 83	24 <sup>c</sup> ± 24	60 <sup>c</sup> ± 53	45 <sup>c</sup> ± 58	14 <sup>c</sup> ± 20	10 <sup>c</sup> ± 10
Control ( <i>n</i> = 69)	106 <sup>d</sup> ± 75	80 <sup>d</sup> ± 71	29 <sup>d</sup> ± 29	39 <sup>d</sup> ± 39	40 <sup>d</sup> ± 46	16 <sup>d</sup> ± 22	11 <sup>d</sup> ± 12

<sup>1</sup> *n* = 270.<sup>2</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with total intake as the dependent variable showed significant differences between <sup>a</sup> and <sup>c</sup> (*P* < 0.01, Cohen's *d* = 0.73), between <sup>b</sup> and <sup>c</sup> (*P* < 0.01, Cohen's *d* = 0.52), between <sup>a</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 1.01), and between <sup>b</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.78).<sup>3</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with total energy-dense snack intake as the dependent variable showed significant differences between <sup>a</sup> and <sup>c</sup> (*P* < 0.01, Cohen's *d* = 0.67), between <sup>b</sup> and <sup>c</sup> (*P* < 0.01, Cohen's *d* = 0.44), between <sup>a</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.99), between <sup>b</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.73), and between <sup>a</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.99).<sup>4</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with total fruit intake as the dependent variable showed no significant differences.<sup>5</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with jelly cola bottle intake as the dependent variable showed significant differences between <sup>a</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.76) and between <sup>b</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.66).<sup>6</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with milk-chocolate candy shell intake as the dependent variable showed significant differences between <sup>a</sup> and <sup>c</sup> (*P* < 0.05, Cohen's *d* = 0.49), between <sup>a</sup> and <sup>d</sup> (*P* < 0.01, Cohen's *d* = 0.61), and between <sup>b</sup> and <sup>d</sup> (*P* < 0.05, Cohen's *d* = 0.49).<sup>7</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with banana intake as the dependent variable showed no significant differences.<sup>8</sup> ANOVA post hoc pairwise comparisons (Bonferroni) with apple intake as the dependent variable showed significant differences between <sup>a</sup> and <sup>c</sup> (*P* < 0.05, Cohen's *d* = 0.52) and between <sup>a</sup> and <sup>d</sup> (*P* < 0.05, Cohen's *d* = 0.42).

signaled food intake, which led to a higher caloric intake than did the conditions that did not signal food intake. The presence of sensory inputs that have been associated with past consumption primes cravings and, when available, actual food intake. Therefore, the general conclusion was that exposure to food cues in advergames influences the direct food intake of children.

Harris et al (22) also found a direct relation with food intake, reporting that children who played an advergame with energy-dense food ate more energy-dense snacks and fewer fruits than did children in the control condition or those who played an advergame with fruit. Contrasting our results, Harris et al (22) found that playing an advergame that promoted fruit and vegetable intake increased the intake of fruit and vegetables. In their study, Harris et al (22) used different forms and types of advergames, which can affect the manipulation of the independent variable because the gameplay and persuasive intent differ in each game and thus may provide an alternative explanation for their findings. These authors used real online advergames in which children could play these games for any length of time as long as they played each game once. Because these games differed in their gameplay and persuasion, whether the experimental conditions (energy-dense snacks compared with fruit and vegetables) can explain the intake differences is unclear. The study by Pempek and Calvert (21) also showed that children who played a version of Pac-Man with fruit ate significantly more fruit than did those who played a version of Pac-Man with energy-dense food. A possible explanation of why we found different effects of advergames that promote fruit could be our use of large representative groups and branded games, whereas Pempek and Calvert (21) did not make such choices. The use of large representative groups decreases the likelihood of obtaining false-positive results (31). The inconsistencies between our study and those of earlier studies indicate that it remains unclear whether children will eat more fruit after playing an advergame promoting fruit. Our results show that these advergames can increase general caloric intake. More research is needed, particularly because

health communicators already use advergames to promote fruit and vegetables.

Playing advergames that contain food messages, regardless of whether they promote energy-dense snacks or fruit, resulted in greater energy-dense caloric intake. These findings build on previous findings that playing energy-dense food advergames increases the energy-dense caloric intake of children (21, 22). Furthermore, the results support the existing evidence that food-branded advergames can contribute to increased consumption of energy-dense food snacks among children between 8 and 10 y of age, and this increased consumption can lead to obesity over time (2). Our findings illustrate that fruit advergames can affect energy-dense snack intake rather than fruit intake (21, 22). The results of the current study advance the current knowledge base regarding advergames that promote energy-dense snacks and fruit by expanding the literature from selection and preferences to actual behavior. Further investigation is required, especially because childhood obesity remains a major health concern worldwide and because food companies continue to develop new forms of digital marketing. Playing advergames differs from regular food advertisements with regard to the persuasiveness of food advertisements in 3 different ways (24, 32, 33). First, online games provide a more highly involving, interactive, and entertaining brand experience than is possible with conventional media forms (15, 18, 19). Second, advertiser-sponsored video games embed brand messages in entertaining animated adventures, which makes it more difficult for children to recognize the persuasive purposes of such games (16, 23, 34). Therefore, embedded marketing messages in advergames reduce the skepticism of children and create more openness to brand messages (35). Third, children are exposed for a longer period of time to a food brand when playing such a game than when they watch a 30-s television advertisement. These aspects may explain why we observed such strong effects on food intake.

The first strength of this study was that we were able to manipulate a popular advergame with different food content and

brands, which was identical or comparable to advergames that are used by many different food producers to promote their brands and products, thereby increasing the external validity of our study. The second strength was that the large number of children who participated in this study can be considered an adequate test for the effects of advergames promoting food on actual snack intake. The third strength was that we not only tested the effect of advergames promoting energy-dense snacks, but also the effect of advergames promoting fruit on fruit intake. One limitation of this study was that children played the advergame for only 5 min, whereas, in real life, children can play for an unlimited amount of time. When children play the game more frequently, it could lead to even stronger effects of the advergame on caloric intake than observed in this study (22). Furthermore, it must be noted that the availability of food that we presented in our study after playing an advergame is not totally comparable with a truly naturalistic setting. In real life, children might not have access to different types of snack foods and/or fruit, which they can freely eat from. However, the results show that the effects of playing a game containing food cues spill over to other kinds of foods than promoted in the game, which suggest that children would eat more of other foods when available.

Additional research is needed to examine the psychological mechanisms that can explain the individual susceptibility to advergames and to measure the effects of these games on the health-related behaviors of children. The marketing landscape will continue to change rapidly, and such changes will require a greater understanding of the effectiveness of advergames to examine the potential influence on children's health and thus to inform public policy.

The authors' responsibilities were as follows—FF, DJA, MB, and PMV: designed the research; FF: conducted the research, provided essential materials for the research, analyzed the data, performed the statistical analyses, and had primary responsibility for the final content; and FF, DJA, and MB: wrote the manuscript. None of the authors had a potential conflict of interest.

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