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Smaller Food Item Sizes of Snack Foods Influence Reduced Portions and Caloric Intake in Young Adults

DAVID MARCHIORI; LAURENT WAROQUIER, PhD; OLIVIER KLEIN, PhD

ABSTRACT

Studies considering the impact of food-size variations on consumption have predominantly focused on portion size, whereas very little research has investigated variations in food-item size, especially at snacking occasions, and results have been contradictory. This study evaluated the effect of altering the size of food items (ie, small vs large candies) of equal-size food portions on short-term energy intake while snacking. The study used a between-subjects design (n=33) in a randomized experiment conducted in spring 2008. In a psychology laboratory (separate cubicles), participants (undergraduate psychology students, 29 of 33 female, mean age 20.3±2 years, mean body mass index 21.7±3.7) were offered unlimited consumption of candies while participating in an unrelated computerized experiment. For half of the subjects, items were cut in two to make the small food-item size. Food intake (weight in grams, kilocalories, and number of food items) was examined using analysis of variance. Results showed that decreasing the item size of candies led participants to decrease by half their gram weight intake, resulting in an energy intake decrease of 60 kcal compared to the other group. Appetite ratings and subject and food characteristics had no moderating effect. A cognitive bias could explain why people tend to consider that one unit of food (eg, 10 candies) is the appropriate amount to consume, regardless of the size of the food items in the unit. This study suggests a simple dietary strategy, decreasing food-item size without having to alter the portion size offered, may reduce energy intake at snacking occasions.

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D. Marchiori is a PhD student and O. Klein is an associate professor, Social Psychology Unit, Université Libre de Bruxelles, Bruxelles, Belgium. L. Waroquier is a post doctoral researcher, Université de Toulouse, Toulouse, France.

Address correspondence to: David Marchiori, Social Psychology Unit, Université Libre de Bruxelles CP 122 50, Avenue F. D. Roosevelt, B-1050 Bruxelles, Belgium. E-mail: dmarchio@ulb.ac.be

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The effects of food-portion size variations on the volume of food consumed (1-4) are usually analyzed without considering the determinants of portion size (5-7). A food unit corresponds to the amount of a certain food usually consumed at one eating occasion (ie, portion). A unit can correspond to a single food item (pizza) or to several food items (cookies). Portion-size studies keep item size constant and manipulate the size of the overall amount of food (eg, a 10-oz vs 20-oz bucket of chicken nuggets, with each nugget weighing 1 oz), whereas food-item size studies keep the overall amount of food constant and manipulate the size of food items (eg, a 10-oz bucket of chicken nuggets, containing 10 1-oz chicken nuggets vs 20 0.5-oz chicken nuggets). Until now, studies have predominantly focused on manipulating portion size because of the preference to serve amorphous-shaped foods. Amorphous foods assume the shape of the container, such as tossed salad, soup, and rice, where a food-item size manipulation is technically impossible. Prevention strategies therefore suggest educating people in assessing appropriate portion sizes or on reducing them to overcome the difficulties in estimating the portion size of amorphous foods (4,8). However, some authors have suggested that when foods with a distinct shape are served (strawberries, cookies), people estimate their consumption in numbers rather than in quantities (7,9).

Investigating this influence at snacking occasions is of utmost importance with regard to prevention strategies because weight loss programs specifically target snack foods (3) due to their impact on daily energy intake (10). Surveys conducted in the United States between 1978 to 2006 reveal that snacks have increased in energy density, frequency of consumption, and contribution to daily energy intake (11). Furthermore, the 2005 Dietary Guidelines for Americans reported that energy intake from snack consumption substantially exceeded the recommended quantity (12).

Studies by Osterholt and colleagues (13) offered two types of a similar familiar snack that differed in air content and found that participants consumed a greater volume, but less weight and energy, of the more aerated snack. However, due to the differences in energy density and total gram weight, differences in energy intake could be due as much to the food characteristics (eg, the altered energy density) as to the visual cue (eg, the altered food-item size). In contrast, experiments by Geier and colleagues (7) specifically manipulated the item size of snack foods. Containers of a specific snack food were placed in building entry halls, varying food-item size each day of the week while leaving the total amount of food constant.

The intake ratio for the larger items (entire pretzel or Tootsie Rolls [Tootsie Roll Industries, Chicago, IL]) was 1.67 and 2.27 times bigger than for the smaller items (half pretzels or quarter Tootsie Rolls). However, food selection rather than food consumption was assessed and measures were based on aggregated scores rather than on separate ratings of individual consumption.

In a study examining individual consumption, participants were offered nibble- vs bar-size snacks and received either no instruction or had to pay attention to their consumption (ie, chew the snacks properly and swallow each bite before taking the next one) (14). Small food-item size led to a decreased gram weight intake in the control condition. However, participants were not allowed to choose whether to consume or not and were aware of the food-related purpose of the experiment because no other distraction was provided. In contrast, snack foods are usually consumed on a voluntary basis when individuals are distracted by other activities, such as work or watching television (15).

Compared with previous studies, this is the first study examining the effect of modifying food-item size of snack foods on subsequent portion and energy intake in an individualized (increasing internal validity) and free-consumption setting (increasing ecological validity). The hypothesis was that greater food intake will occur with larger pieces of snack foods.

METHODS

Participants

Undergraduate psychology students obtained two course credits of the six required annually in exchange for their participation in the study (computerized and candy experiment, both conducted in a psychology laboratory at the Université Libre de Bruxelles). Students were aware that they could refuse participation once they had signed up for an experiment provided they had a valid reason. Exclusion criteria were: presence of food allergies, weight problems, overweight (body mass index [BMI]>25), dieting behavior, and personal food intake control in order to gain or lose weight. Based on the effect size (means and standard deviations) of similar studies analyzing food-item size variations (6,13,14), a sample size of 30 or more participants is sufficient to obtain a power more than 0.7 when assessing energy intake, at α=.05 (16). Subjects gave their written, informed consent to participate in this study, which was approved by the Ethical Committee of the Faculty of Psychological Sciences of the Université Libre de Bruxelles.

Materials

Foods offered were cherry-shaped gummy candies (Happy Cherries, Haribo, Bonn, Germany) and sweet-sour red gummy ribbons (Flexi Fizz, Lamy Lutti, Manage, Belgium). The US Food and Drug Administration defines a serving of candy as 40 g (1.41 oz). This amount was increased to ensure that the amount of candies served would not be limiting. Consequently, a 90-g (3.17-oz) portion was served to each participant. Total possible calorie content was 318 kcal (1,341 kJ).

Design

The study used a between-subjects design with two experimental conditions. In the first condition, candies were left unchanged, resulting in 10 normal-sized red candies and 10 normal-sized cherry candies. In the second condition, all candies were cut in half: 20 half-sized red ribbon candies (2 g each) and 20 half-sized cherry shaped candies (2.5 g each). In contrast to the experiments by Geier and colleagues (7), the food-item size effect was analyzed in a randomized experiment, providing a control for food and participant characteristics as well as ascertaining that different hunger levels were evenly distributed across conditions.

Procedure

The experiment was conducted during an unrelated computerized experiment (decision-making task about four objects after sequential information presentation), which lasted from 12:00 PM to 5:00 PM. Each experimental session lasted 30 minutes. Participants were seated in individual cubicles, and next to each computer screen was a plate containing candies. Participants were told that the candies were offered for free consumption in recognition for their participation and that they could eat as much as they wanted. Participants were asked to not take any food out, which was further ensured by the experimenter. After the conclusion of the experiment, participants were given a questionnaire in which they were told that the candies were actually part of an experiment about eating habits.

Data Collection

To avoid cueing participants to the issue of food intake, consumption was not experimentally induced nor were premeal hunger ratings assessed. However, a retrospective measure of prestudy hunger was taken and used as a covariate in the analyses (17). Moreover, individualized consumption measures were taken to avoid a measure confound of the number of items consumed by each individual and the number of individuals who consumed at least one item. Using 7-point Likert scales, participants rated their prestudy hunger, their liking of the candies, the extent to which they consumed candies on a regular basis, and the extent to which they controlled their food intake. These questions were validated in preliminary studies with identical populations. The distribution of the responses are congruent with similar measures found in portion-size studies (2,3). Finally, they reported exercise frequency (hours/week) and assessed the cost and the energy content (kcal) of the entire plate. Demographic measures were: age, sex, nationality, weight, height, primary language, and dieting behavior.

The candy plate was weighed before and after the experiment (Digital Kitchen Scales, Brabantia Solid Co, Valkenswaard, the Netherlands) to determine the amount consumed (within 0.1 g). Energy intake (kcal) was determined by data from the manufacturers. The number of candies consumed was assessed by subtracting the number of candies left from the initial count.

Statistical Analyses

Analyses of variance were used to analyze the main outcomes of food intake (number of candy items, gram weight, and energy intake). Food-item size was entered

Table. Differences between characteristics, eating habits, and food evaluations of undergraduate psychology students (n=33, 29 female) to test the effect on energy intake of candy size variations in equal-sized portions (90 g)[a]

	Small candy size[b]	Large candy size[b]
Age (y)	20.2	20.4
Weight (kg)	63.4	60.4
Height (cm)	168.64	168.47
Body mass index[c]	22.4	21.2
Belgian nationality (%)	71.4	73.7
Exercise (h/wk)	2.2	3
Food intake control[d]	3.9	3.5
Liking of the candies[d]	3.8	4.3
Pre-meal hunger[d]	3.3	3.7
Eating candies on regular basis[d]	3.9	3.8
Entire portion (kcal)	348	389
Price of the portion (€)	2.16	2.17

[a]Analysis of variance was used to examine differences between food-item size conditions. No statistically significant differences were observed between conditions.
[b]Candies were cherry shaped gummy candies (Happy Cherries, Haribo, Bonn, Germany) and sweet-sour red gummy ribbons (Flexi Fizz, Lamy Lutti, Manage, Belgium). Candies were cut in half to make the small candy size. Participants were offered small- vs large-sized candies in a free and individualized consumption setting.
[c]Body mass index (BMI) was calculated as kg/m^2. Underweight defined as BMI≤18.5; normal weight as BMI 18.5-24.9; overweight as BMI 25.0-29.9; and obese as BMI≥30.0.
[d]Food intake control, liking of the candies, premeal hunger, and eating candies on a regular basis were assessed on 7-point Likert scales.

as fixed factor. Analysis of covariance was used to examine the influence of participant characteristics on the relationship between food-item size and gram-weight intake. The analyses were done with the statistical software SPSS for Windows (release 14.0.0, 2005, SPSS Inc, Chicago, IL). An α level of .05 was used for all statistical tests.

RESULTS AND DISCUSSION

Thirty-three of 54 participants consumed candies (19 in the large and 14 in the small candy condition). Participants (mean age, 20.3±2.0 years; range, 18 to 27) were mostly female (29 of 33) and of Belgian nationality (27 of 33), and all were normal weight (mean BMI, 21.7±3.7; range 18.8 to 23.9). There were no significant differences across conditions of food-item size in ratings of hunger, liking of the candies, eating candies on a regular basis, and estimates of the price and energy content (kcal) of the entire plate ($P>0.3$), which suggests that random assignment was successful (see Table).

Participants with the smaller candies consumed approximately as many candies (6.2±7.2) as the participants with the larger candies (6.9±4.1; $P>0.7$). Despite variations in food-item size, participants served the smaller candies did not compensate by consuming a greater number of candies.

In studies in which ad libitum consumption is measured over a short period of time, intake is likely influenced more by cognitive and visual cues (15). In this regard, larger portion sizes have been suggested to influence food intake because of their lower unit cost (18). However, as the food was offered for free, this explanation could be ruled out. In addition, participants estimated a similar price for their respective plate of candies. Differences in energy intake could be explained by individuals taking larger bites when larger sized foods are served, leading to a reduced oral sensory stimulation and thus a reduced sensory-specific satiety (14). However, considering our small food-item size ratio (2.25 g vs 4.5 g), this explanation cannot account for the large differences in intake, in contrast to Weijzen and colleagues' (14) food-item size ratio (1.45 g vs 16 g).

A more relevant explanation is given by Herman and Polivy (9), who suggest that people tend to be in a "zone of biological indifference," in which they are neither genuinely hungry nor genuinely satiated. The decision about the appropriate amount of food to consume is then not a response to a basic homeostatic physiology, but is (mainly) based on food characteristics, norms, and cognitive biases. This approach to regulating food intake may be a consequence of a person's poor ability to rely on physiological cues (9) and inability to accurately estimate energy intake (2). It has therefore been suggested that people have a sense that consuming one unit of food is the appropriate amount to consider or consume (7,9), regardless of the size of the food items. Consequently, when consuming candies, a possible norm (or unit) would be to consume a handful (eg, 5 to 10 candies). With the appropriate quantity to consume expressed numerically, excess energy intake is then a consequence of the manipulation of the food-item size.

Given the similar number of candies consumed across conditions, participants offered the larger candies consumed twice as much in gram weight of candies (30.7±18.2 vs 16.3±20.3) as participants who were offered the smaller candies ($F[1, 31]=4.6$, $P=0.04$; Figure), resulting in an increase in nearly 60 kcal (109.04±64.5 vs 49.22±57.2, respectively). This influence was generalized across participants, thereby supporting Geier and colleagues' (7) findings when controlling for individual food intake and Weijzen and colleagues' (14) findings in a free snacking context and extending them to candies.

Analysis of covariance showed that the relationship between food-item size and gram weight intake was not influenced by any of the measured participant characteristics (age, food intake control, prestudy hunger, height, weight, BMI, or time spent exercising). When controlling for these variables, food-item size still influenced food intake ($P=0.016$). No participant asked for a refill or consumed more than 95% of the food. This restriction was probably due to a conscious choice to not "clean the plate" in an attempt to probably avoid looking too greedy. Food intake was also examined after excluding data from participants who were overweight or obese (n=4) and after excluding participants who disliked the candies (n=5): food-item size still significantly influenced gram weight intake ($P=0.048$ and $P=0.025$, respectively). These results are consistent with portion-size studies (2,3) in which this environmental influence seems to have a general effect, which can stretch even beyond the food's taste (19). This further shows how a food-abundant environment can promote excess energy intake and, thus, the

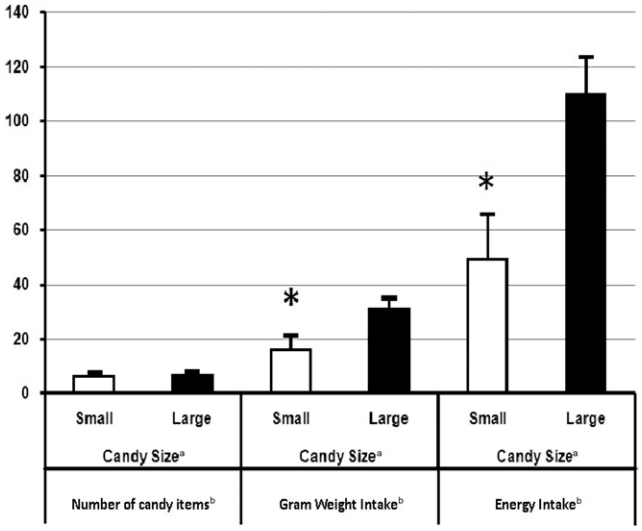

Figure. Differences between mean number of candy items, gram weight, and energy intake consumed by first-year university students (n=33) who were offered equal-sized portions of candies. [a]Candies were cherry-shaped gummy candies (Happy Cherries, Haribo, Bonn, Germany) and sweet-sour red gummy ribbons (Flexi Fizz, Lamy Lutti, Manage, Belgium). Candies were cut in half to make the small candy sizes. Participants were offered small vs large sized candies in a free and individualized consumption setting. [b]Number of candy items refers in the large candy size condition to the number of whole candies consumed by participants and in the small candy size condition to the number of half candies consumed by participants. Gram weight intake refers to number of grams of candies consumed. Energy intake refers to number of kcal consumed. Analysis of variance was used to examine differences between candy size conditions (eg, small vs large candies). *Means between small (n=14) and large candy size conditions (n=19) are significantly different ($F[1, 31]=4.6$, $P=0.04$).

importance of designing appropriate prevention strategies.

This study controlled for several characteristics, which could represent a limitation to the findings. It screened for overweight participants, was mostly confined to Belgian female first-year college students, and focused on short-term consumption of candies. Although studies report that an increase in energy intake due to size manipulations of foods is not well-compensated in subsequent meals (20,21), future research should investigate how food-item size affects energy intake of a wider array of foods in the long term, considering subsequent meals both over the day and on other days. In addition, future research should investigate whether food-item size could decrease energy intake of individuals of all ages, sex, and BMI groups living in varied geographic locations. Studies show that overweight people tend to be more sensitive to external cues, like labels (22). Finally, assessment of weight and height was based on self-reports. Although correlations between self-reported weight and height and body measurements are usually high, (female) college students tend to overestimate height and underestimate weight, leading sometimes to inaccurate detection of proportions of overweight (23).

CONCLUSIONS

This is the first study analyzing, in a free and individualized snacking context, whether altering the size of foods (eg, candies) of equal-sized food portions would affect short-term energy intake. The present findings suggest that reducing the size of candies would lead to a decreased gram weight intake without altering appetitive and physiological sensations. By focusing on a portion-size determinant, this study highlights a source of influence that has so far been overlooked, namely food-item size (5,7), and opens up new research perspectives in areas such as dieting and weight management. An evident barrier to food-intake regulation is consumers' difficulty in accurately estimating portion size (8) and in interpreting label information (24). By contrast, a prevention strategy based on varying food-item size requires no special ability or knowledge and could be more easily applied. The observation that food items are considered and consumed regardless of their size should also be considered in research areas like dietary recall and portion-size evaluation. Food manufacturers who focus on health could help consumers by making packaging changes (eg, subpackaging, multipacks) to reduce food-item size and thereby increase the number of food items in a serving. This would alter the perception of the appropriate quantity of food to consume and provide more cutoff points at which a person could reassess energy intake.

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