Health Psychology
2015, Vol. 34, No. 6, 670–676

0278-6133/15/$12.00 http://dx.doi.org/10.1037/hea0000160

The Effect of Portion Size and Unit Size on Food Intake: Unit Bias or Segmentation Effect?

Katerina Kerameas and Lenny R. Vartanian
UNSW Australia

C. Peter Herman and Janet Polivy
University of Toronto

Objective: The "unit bias" has been proposed as an explanation for the portion-size effect; people consider a single unit to be an appropriate amount to eat and thus eat more when served a larger unit than when served a smaller unit. We suggest that the unit bias might be better characterized as a "segmentation effect," such that people eat less when a unit of food is separated into smaller subunits, but may eat more than a single unit. Furthermore, we suggest that portion-size effects should be independent of this segmentation effect. ***Method:*** In Study 1, female participants ($n = 87$) were served either a small or large portion of food that was either presented in the form of a single unit or multiple individually wrapped units. In Study 2, female participants ($n = 42$) were served a fixed portion of food that was either presented in the form of a single unit or multiple units presented on separate plates. ***Results:*** Across both studies, there was no evidence that participants prefer to eat a single unit. Participants served multiple smaller units did eat less than did participants served a single larger unit, even when the overall portion size was the same, but the amount eaten was consistently more than a single unit. Furthermore, perceived norms of appropriate intake mediated the effect of unit number on food intake. ***Conclusions:*** These findings suggest that a segmentation effect, rather than a unit bias, is driving people's food intake, with implications for designing interventions aimed at reducing excessive food intake.

Keywords: portion size, food intake, unit size, unit bias, segmentation effect

Excess energy intake is associated with weight gain, obesity, and overall ill health, and epidemiological data indicate that daily energy intake increased steadily between the 1970s and the early 2000s (Ford & Dietz, 2013; Nielsen, Siega-Riz, & Popkin, 2002). Hill, Wyatt, Reed, and Peters (2003) suggested that an increase in people's energy intake of as little as 50–100 kcal per day is enough to account for the rise in obesity. Thus, even small changes in energy intake over time can have profound effects. One factor that is widely assumed to contribute to excess energy intake is increasing portion size.

Portion sizes have increased markedly since the 1970s (Nielsen & Popkin, 2003; Young & Nestle, 2002, 2003). This increase has been seen not only in the amount of food that restaurants or fast-food chains serve but also in the size of serving utensils and equipment used to prepare food in the home. In addition to observed trends in portion sizes over time, there are many experimental studies demonstrating that people eat more when served larger portions of food than when served smaller portions of food (e.g., Rolls, Morris, & Roe, 2002). Larger portions are associated with increased food intake in adults (Schwartz & Byrd-Bredbenner, 2006) and children (Rolls, Engell, & Birch, 2000), in laboratory settings (e.g., Rolls et al., 2002) and naturalistic environments (Mrdjenovic & Levitsky, 2005), and with a range of different types of foods (Steenhuis & Vermeer, 2009). The portion-size effect is so compelling that an increase in portion size can increase people's food intake even when the food is not particularly palatable (Wansink & Kim, 2005) and even when participants have been informed about the influence of portion size just before eating (Cavanagh, Vartanian, Herman, & Polivy, 2014).

One explanation that has been offered for the portion-size effect is that people tend to consider a single unit to be an appropriate amount to eat. Whether one is served a small plate of pasta or a large plate of pasta, what one is served (i.e., the plate of pasta) is considered to be the unit and therefore the appropriate amount to eat. Consequently, the larger the unit, the more people will eat. This concept has been termed "unit bias" (Geier, Rozin, & Doros, 2006). Geier et al. tested the notion of a unit bias by offering three different types of snack foods in public places for people to take. For two of these foods, the researchers varied the size of the food unit; for the third food, it was the size of the serving utensil that varied. In all three cases, results showed that the amount of food people took increased as the size of the unit increased. Geier et al. argued that the unit size creates a consumption norm that tells participants how much they should eat (see also Vartanian, Sokol, Herman, & Polivy, 2013).

Other studies have also found support for the notion that larger units result in increased food intake. For example, Marchiori, Waroquier, and Klein (2011) investigated the effect of modifying snack food unit size on energy intake. One group of participants

This article was published Online First September 15, 2014.

Katerina Kerameas and Lenny R. Vartanian, School of Psychology, UNSW Australia; C. Peter Herman and Janet Polivy, Department of Psychology, University of Toronto.

This research was supported under the Australian Research Council's *Discovery Projects* funding scheme (project number DP110101124).

Correspondence concerning this article should be addressed to Lenny R. Vartanian, School of Psychology, UNSW Australia, Sydney, NSW 2052, Australia. E-mail: lvartanian@psy.unsw.edu.au

was served 20 full-size pieces of candy, and a second group of participants was served 40 half-size pieces of candy. Therefore, both groups received the same total amount of candy, but the number of units and unit size varied. Participants who were served the full-size candies consumed more energy than did participants who were served the half-size candies, but the number of candy pieces consumed did not vary between groups.

Although the notion of a unit bias driving food intake is appealing in its simplicity, and although there are some studies that provide support for the notion that unit size can influence food intake, other studies have failed to find support for the unit-bias effect. For example, Raynor and Wing (2007) provided participants with a box of four different snacks to take home, and the size and quantity of these snacks varied depending on the condition to which participants were assigned. Participants were given either small or large units of food (e.g., 1-oz. bags of chips vs. 5-oz. bags of chips) that were provided in either small or large quantities. Participants given the larger amount of food ate significantly more overall than did those given the smaller amount of food, but there was no effect of unit size on food consumption.

There are also some methodological issues in past studies on the unit bias that make it difficult to draw definitive conclusions about the effect of a unit bias on people's food intake. First, Geier et al. (2006) left the food in a public space and simply assessed how much had been taken at the end of each day. Thus, it is not known how much each individual took, or if people actually consumed all (or any) of what they took. Second, the "unit" of food may have been ambiguous in some cases. For example, in the Geier et al. (2006) study, one condition consisted of soft pretzels that were cut in half. In this case, should the half-pretzel be considered a single unit or a half a unit? The same ambiguity exists in the study by Marchiori et al. (2011), who cut candies in half. Finally, to determine whether a unit bias can explain the portion-size effect, it would be necessary to provide small and large portions that are each made up of single or multiple units of food, which no previous study has done.

The "unit bias" has been offered as a potential explanation for the portion-size effect, but limitations of past research have made it difficult to draw firm conclusions about this effect. Furthermore, careful examination of previous research indicates that the data do not strongly support the unit-bias hypothesis: First, in previous unit-bias studies, participants consistently selected or consumed more than a single unit of food (Geier et al., 2006; Marchiori et al., 2011); second, most portion-size studies find that participants do not consume the entire portion (unit) of even the smallest portion served (e.g., Cavanagh et al., 2014; Rolls et al., 2002). We propose that the unit bias is better characterized as a "segmentation effect," such that separating a unit of food into smaller subunits results in less food intake than when the food is presented as a single unit (see Geier, Wansink, & Rozin, 2012). This segmentation effect differs from the unit-bias hypothesis in two important ways. First, the segmentation effect does not require the eater to consume a single unit of food; it requires only that people will eat less when a portion of food is presented in multiple smaller units. Second, we propose that a segmentation effect should operate independent of any portion-size effect. That is, participants should eat more from larger portions than from smaller portions, regardless of any segmentation of the portion into subunits. Likewise, people should eat less when the units are smaller than when the units are larger, regardless of the portion size. Thus, the purpose of the present research is to compare the unit-bias and segmentation-effect explanations for people's food intake and to determine whether these effects explain the portion-size effect or operate independent of any portion-size effect.

Study 1

Study 1 tested whether a unit bias could account for the portion-size effect on people's food intake. Participants were served either a small (30 g) or large (90 g) portion of cookies that was either presented in the form of a single unit (i.e., one 30-g cookie or one 90-g cookie) or three smaller units (i.e., three 10-g cookies or three 30-g cookies), and we measured how much participants ate. Each cookie was individually packaged to clearly signify to participants that each cookie was a discrete unit; in the multiple-unit conditions, participants were served three individually wrapped cookies on a single plate. If a unit bias is driving food intake, then participants should consume a single unit of food regardless of the size of that unit and regardless of how many units they are provided. If the segmentation effect is driving food intake, then participants served three smaller cookies should eat less than should participants served a single larger cookie, but they may eat more than a single cookie. We also tested whether the unit bias/segmentation effect could account for the portion-size effect or if the portion-size effect operates independently of those effects. Furthermore, we examined whether participants' perceptions of how much was appropriate to eat would mediate the effects of unit bias/segmentation and portion size on food intake.

Method

Participants. Participants were 87 female undergraduate students between the ages of 18 and 25 years. Their mean age was 20.08 years (SD = 2.26), and their mean body mass index (BMI; kg/m^2) was 21.80 (SD = 3.82). Thirty-six were Caucasian, 45 were Asian, and 6 were of other ethnicities. (Note that the pattern of results did not vary as a function of participants' ethnicity; thus, all analyses are reported for the group as a whole.) Participants received either $10 or course credit in exchange for their participation. This study was approved by the university's ethics committee.

Experimental manipulations. Participants in the small-portion condition were served 30 g of cookies in total (either a single 30-g cookie or three 10-g cookies), and participants in the large-portion condition were served 90 g of cookies in total (either a single 90-g cookie or three 30-g cookies). Consistent with other portion-size research (e.g., Levitsky & Youn, 2004; Rolls, Roe, & Meengs, 2006), participants were also provided with additional cookies to ensure their that intake was not artificially limited to the amount they were initially served. These additional cookies were available from an opaque container within reach of the participants so that they did not have to exert a great deal of effort to obtain extra cookies, nor did they risk the possible social embarrassment of requesting additional food. The cookies for each experimental session were baked fresh the night before the session. Each cookie was placed in an individually sealed, clear cellophane bag to signify to participants that each cookie was a discrete unit.

Two measures of cookie consumption were derived. First, the number of cookies remaining at the end of the session was sub-

tracted from the number of cookies initially provided to determine the total number of cookies consumed. Second, the cookies served to participants were weighed to the nearest gram using an electronic scale before the session and again at the end of the session. Total food consumed was calculated by subtracting the total weight of cookies remaining (on the plate and in the container) after the participant had finished eating, from the weight of the cookies before being served (on the plate and in the container).

Measures.

Recent food intake and hunger level. At the start of the experimental session, and before seeing the cookies, participants were asked to indicate when they last ate and to rate their current hunger level along a 10-cm visual analog scale anchored with *not at all hungry* and *extremely hungry*. Because preexisting hunger levels could potentially influence participants' food intake, we examined initial hunger as a potential covariate during data analysis.

Dining experience rating scale. A nine-item dining experience rating scale was included to heighten the credibility of the cover story ("the dining experience") and to control for any possible confounding influence of the liking of the food on consumption. Items on this scale assessed various environmental and cookie-specific characteristics (e.g., quality of the cookie, presentation, noise, lighting) as well as the individual's liking of the taste of the food. Participants were asked to rate each item on a 10-cm visual analog scale with anchors of *not at all* and *very much*. Participants were asked to complete the dining experience rating scale after they chewed and swallowed their first bite of the cookie and again after their last bite when they had eaten as much as they wanted. Only participants' ratings of how much they liked the cookies after their first bite were used during data analysis as a potential covariate.

Norm of appropriate intake. To assess the perceived appropriateness norm, participants indicated "how many cookies was an appropriate amount to eat in this situation." Because the size of the cookie varied by condition, we multiplied participants' responses to this item by the average size of the cookie for their condition to obtain an index of the perceived appropriate amount to eat.

Demographics. Participants were also asked to provide some basic demographic information, including their age, ethnicity, and height and weight (which were used to calculate their BMI).

Procedure. Experimental sessions were conducted between 11:00 a.m. and 5:00 p.m., and participants took part individually. Participants were randomly assigned to one of the four conditions before their arrival at the laboratory. Upon arrival, participants were informed that the present study was investigating the effects of hunger on the dining experience. After providing informed consent, participants completed the Recent Food Intake questionnaire, and they were then given the snack that they would be rating. The number and size of the cookies that participants were given corresponded to their assigned condition. Participants were told that they could eat as many cookies as they desired, and they were asked to complete the dining experience rating forms after their initial bite and again after their final bite. Participants were informed that there were additional cookies available in the container on the table next to them if they wanted more. Participants were instructed to dispose of each cellophane bag into the provided garbage bin before opening a new cookie. This ensured that participants were not using the wrapping as a marker to track how many cookies they had eaten, which could have potentially influenced participants' food intake (Polivy, Herman, Hackett, & Kuleshnyk, 1986). The experimenter left the room for 10 min so that participants could make their ratings of the dining experience in private.

After the 10 min had elapsed, the experimenter returned to collect the remaining cookies and rating forms. Participants then completed some final questionnaires (including their perceptions of the appropriateness norm and the demographic questionnaire), were probed for suspicion (no participants guessed the purpose of the study), and were debriefed about the true purpose of the experiment.

Results

Number of units consumed. A χ^2 analysis was used test whether participants were more likely to eat a single cookie compared with more/less than a single cookie. In contrast to the unit-bias hypothesis, participants were significantly less likely to consume a single cookie than they were to consume more/less than one cookie (see Table 1). Table 1 also shows the proportion of participants who ate a single cookie compared with more/less than a single cookie separately for each condition. In three of the four conditions, participants were significantly less likely to consume a single cookie than they were to consume more/less than a single cookie. Even in the fourth condition (the single 90-g cookie), only a minority of participants ate a single cookie.

Amount of food consumed. A univariate analysis of variance (ANOVA) was conducted to test the effect of unit number and portion size on how much food participants consumed (see Figure 1). There was a significant main effect of unit number, $F(1, 83) = 6.65$, $p = .01$, $\eta_p^2 = .07$, such that participants who were served three smaller cookies ate less (in grams of cookies) than did those who were served a single larger cookie. There was also a significant main effect of portion size, $F(1, 83) = 24.19$, $p < .001$, $\eta_p^2 = .23$, such that participants who were served a larger portion of cookies ate more (in grams of cookies) than did those who were served a smaller portion of cookies. The interaction between portion size and the number of cookies served was not significant, $F(1, 83) = 0.02$, $p = .88$, $\eta_p^2 < .001$.

Participants' hunger level at the beginning of the study was significantly correlated with the amount of food that they consumed, $r(85) = .41$, $p < .001$, but their initial liking of the cookies was not, $r(85) = .13$, $p = .22$. The analysis above was repeated with initial hunger entered as a covariate, and the results were identical.

Table 1
Proportion of Participants in Study 1 Who Consumed a Single Cookie vs. Participants Who Consumed More/Less Than a Single Cookie

Condition	Single Cookie	Other Than a Single Cookie	χ^2	p
Three 10-g cookies	13.6%	86.4%	11.64	.001
One 30-g cookie	28.6%	71.4%	3.86	.05
Three 30-g cookies	13.0%	87.0%	12.57	<.001
One 90-g cookie	47.6%	52.4%	0.05	.83
Total	25.3%	74.7%	21.25	<.001

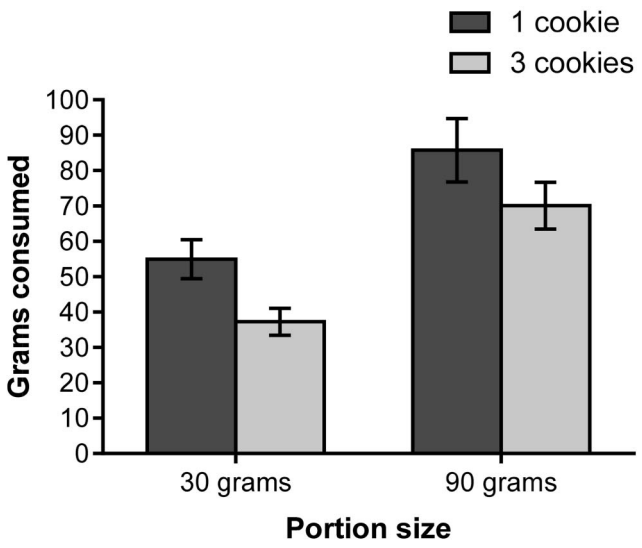

Figure 1. Mean amount of cookies consumed (in grams) as a function of portion size and unit number. Error bars represent standard errors.

Norm of appropriate intake. An ANOVA was conducted to test the effect of unit number and portion size on perceptions of how much was appropriate to eat. There was a main effect of unit number, such that participants served three smaller cookies reported a lower perceived norm of appropriate intake ($M = 53.83$ g, $SD = 33.89$ g) than did participants served a single larger cookie ($M = 76.80$ g, $SD = 27.65$ g), $F(1, 80) = 16.57$, $p < .001$, $\eta_p^2 = .17$. There was also a main effect of portion size, such that participants served a small portion reported a perceived norm of appropriate intake ($M = 46.45$ g, $SD = 24.29$ g) than did participants served a large portion ($M = 81.42$ g, $SD = 31.11$ g), $F(1, 80) = 37.83$, $p < .001$, $\eta_p^2 = .32$. There was no interaction between unit number and portion size, $F(1, 80) = 0.23$, $p = .64$, $\eta_p^2 = .003$. Mediation analysis (following Hayes, 2013) further showed that the perceived norm of appropriate intake mediated the association between the number of cookies served and the amount that participants ate (95% confidence interval [CI] = −30.43, −8.88) and between portion size and the amount that participants ate (95% CI = 16.41, 41.22).

Discussion

The results of Study 1 do not provide support for the notion that a unit bias can explain the portion-size effect. Most participants in Study 1 did not consume a single cookie; rather, they tended to eat more or less than a single cookie. However, we did find that participants consumed less when given multiple cookies compared with when given a single cookie, even though the size of the portion remained the same (i.e., a total of 30 or 90 g). Furthermore, the mean intake in both of the three-cookie conditions was greater than the size of a single cookie from the respective condition. Thus, rather than people simply eating a single unit of food (the unit-bias hypothesis), these results suggest that separating a portion of food into smaller subunits can reduce overall food intake (a segmentation effect).

It is important to note that although we did observe a segmentation effect, with participants eating less when served three smaller cookies than when served one larger cookie, this effect did not explain the portion-size effect. That is, there was also a significant, independent main effect of portion size. In fact, the strongest effect in Study 1 was the main effect of portion size, such that participants served a large portion of cookies ate almost 70% more than did participants served a small portion of cookies, regardless of the number of cookies served or the size of those cookies.

Consistent with the hypothesis that external cues provide a norm of appropriate food intake (Geier et al., 2006; Vartanian et al., 2013), Study 1 also showed that the number of cookies served and the portion size influence participants' food intake by creating a norm of the appropriate amount to eat. Thus, people appear to integrate information about the overall portion size and the individual units in determining how much to eat.

An alternative possible explanation for the segmentation effect observed in Study 1 is that participants needed to exert extra effort to obtain each cookie given that they were individually packaged. As a consequence, this increased effort in the multiple-unit condition may have resulted in decreased overall consumption. This explanation is consistent with previous research that has found increasing the effort required to obtain food reduces people's food intake (Wansink, 2004).

Study 2

The aim of Study 2 was to further test the unit-bias effect versus segmentation effect on people's food intake. Participants were served either a single 60-g cookie or three 20-g cookies, and we measured how much participants ate. Furthermore, to eliminate the possibility that the extra effort involved to obtain cookies was driving the segmentation effect observed in Study 1, the cookies in Study 2 were not individually wrapped but were instead placed on separate plates to designate the unit.

If a unit bias is driving participants' food intake, then people should consume a single unit of food, regardless of the size of that unit or how many units they are served. If the segmentation effect is driving overall food intake, then participants should eat less when provided with three 20-g cookies than when provided with a single 60-g cookie, but they may eat more than a single cookie. However, if the increased effort needed to access the cookies explains the segmentation effect observed in Study 1, then participants in Study 2 should eat the same amount regardless of whether they are given one cookie or three cookies.

Method

Participants. Participants for this study were 42 female undergraduate students between the ages of 18 and 25 years. Their mean age was 19.79 years ($SD = 2.07$), and their mean BMI was 20.67 kg/m^2 ($SD = 2.27$). In regards to ethnicity, 7 were Caucasian, 30 were Asian, and 5 were of other ethnicities. (As in Study 1, that the pattern of results did not vary as a function of participants' ethnicity; thus, all analyses are reported for the group as a whole.) Participants received either $10 or course credit in exchange for their participation. This study was approved by the university's ethics committee.

Materials and procedure. Study 2 followed the same procedure used in Study 1 except for the following variations: All participants were served the same portion size of cookies (60 g), but this portion was served in the form of either a single unit or multiple units. Specifically, participants in the single-unit condition were served one 60-g cookie, and participants in the multiple-unit condition were served three 20-g cookies (a total of 60 g). Participants in the single-cookie condition were served one cookie on a plate whereas participants in the multiple-cookie condition were served three cookies each on a separate plate. Placing each cookie on an individual plate removed any additional effort required of participants; however, it still signified that each cookie was a discrete unit.

Results

The effect of unit number on the number of cookies consumed. A χ^2 analysis revealed that only 50% of participants consumed a single cookie (with the rest consuming less/more than a single cookie; see Table 2). Table 2 also shows the proportion of participants who ate a single cookie compared with more/less than a single cookie separately for each condition. In both conditions, only about half of the participants consumed a single cookie.

The effect of unit number on the amount of cookies consumed. There was a significant main effect of unit number on the amount of food consumed, $F(1, 40) = 11.74$, $p = .001$, $\eta_p^2 = .23$, such that participants who were served three smaller cookies consumed less ($M = 35.24$ g, $SD = 17.78$) than did those who were served a single larger cookie ($M = 62.91$ g, $SD = 32.45$), even though participants in each condition were served the same initial portion of cookies (60 g).

Participants' hunger level at the beginning of the study was significantly correlated with the amount of food that they consumed, $r(40) = .39$, $p = .01$, but their liking of the cookies was not, $r(40) = .20$, $p = .21$. The analysis above was repeated with initial hunger entered as a covariate, and the results were identical.

Norm of appropriate intake. Participants served three smaller cookies reported a lower perceived norm of appropriate intake ($M = 48.42$ g, $SD = 18.03$) than did participants served a single larger cookie ($M = 73.50$ g, $SD = 24.77$), $F(1, 37) = 12.95$, $p = .001$, $\eta_p^2 = .26$. Furthermore, mediation analysis showed that the perceived norm of appropriate intake mediated the association between the number of cookies served and the amount that participants ate (95% CI = −45.26, −13.24).

Discussion

Once again, the results of Study 2 do not provide support for the notion of a unit bias: only approximately half of the participants ate a single unit. Instead, these findings are more consistent with a segmentation effect in that participants consumed less when given three cookies than when given a single cookie, even though they ate more than a single unit in the three-cookie condition. The findings from Study 2 also indicate that increased effort cannot explain the segmentation effect observed in Study 1 because, even when the effort was removed, participants consumed less (in grams) when served three smaller cookies than when served a single larger cookie. Moreover, as in Study 1, the perceived norm of appropriate intake mediated the effect of number of cookies served on participants' food intake. Overall, the results of Study 2 are more indicative of a segmentation effect than a unit-bias effect.

Table 2
Proportion of Participants in Study 2 Who Consumed a Single Cookie vs. Participants Who Consumed More/Less Than a Single Cookie

Condition	Single Cookie	Other Than a Single Cookie	χ^2	p
Three 10-g cookies	47.6%	52.4%	0.05	.83
One 30-g cookie	52.4%	47.6%	0.05	.83
Total	50.0%	50.0%	0.00	1.00

General Discussion

The purpose of the present study was to test the possibility that a unit bias drives the effect of portion size on food intake. Previous research has suggested that people may be eating according to a unit bias (Geier et al., 2006); that is, people will eat a single unit of food regardless of the size of that unit (within reason). Overall, the results of the present research do not support the unit-bias hypothesis. Study 1 showed that very few participants ate a single cookie, and Study 2 found that only about half of the participants ate a single cookie. We did find, in both studies, that participants ate less when given multiple cookies than when given a single cookie, even though the size of the portion remained the same. Furthermore, Study 2 ruled out increased effort as an explanation for the reduced intake. It is also important to note that, in each of the multiple-cookie conditions, participants ate substantially more than the single unit. A weaker version of the unit-bias hypothesis might be that people eat "in units"; that is, once a person starts eating a unit, she or he is likely to completely consume that unit. However, this weaker version of the unit-bias hypothesis is not particularly useful because it does not allow one to make predictions about how much food people would eat in any given situation (only that they will eat in some number of whole units).

We also did not find any evidence that a unit bias could account for the effect of larger portions on food intake. Indeed, in Study 1, the strongest effect was that participants ate more when served a larger portion (regardless of whether it was a single cookie or multiple cookies) than when served a smaller portion (regardless of whether it was a single cookie or multiple cookies). Thus, portion-size effects appear to be orthogonal to any effects of unit size/number.

Overall, then, our results suggest that rather than reflecting a unit bias, which leads people to eat a single unit regardless of its size, the effect is better characterized as a segmentation effect, such that people eat less when a quantity of food is separated (or segmented) into multiple subunits. Note that this explanation is entirely consistent with the findings of Geier et al. (2006) and Marchiori et al. (2011), who also found that participants ate more than a single unit of food. It may be that the smaller subunits provide participants with a norm of appropriate consumption, such that they consider it appropriate to eat less overall. Indeed, both of our studies showed that the number of cookies served influenced participants' perceptions of how much was appropriate to eat, which in turn influenced their actual food intake. Participants must, and do, integrate multiple pieces of information in deciding on the appropriate amount to eat: The greater the number of

cookies provided, the more cookies people think it is appropriate to eat. However, participants do not blindly follow that principle; they adjust according to the size of the cookie (i.e., it is appropriate to eat fewer large cookies than small cookies). Furthermore, portion size also plays a role in dictating the appropriate amount to eat.

The findings from the present research indicate that dividing a larger unit of food into smaller subunits can reduce people's food intake, and this has practical implications for the way that foods are packaged and marketed. For example, if food manufacturers presented foods in a way that clearly indicated the unit size, this could help people eat less (even if they do not stop at a single unit). Labeling on food packages (e.g., "contains two servings") might be one way of approaching this (Wansink & Chandon, 2006). However, clear physical demarcations may be a particularly potent means of conveying consumption norms. Support for this idea comes from a study by Geier et al. (2012), who found that segmenting a tube of potato chips with a distinctive red chip reduced overall consumption. The importance of clear demarcation is further emphasized in a study by Vermeer, Bruins, and Steenhuis (2010). Those authors found that consumers who had purchased a king-sized chocolate bar that contained two 35-g chocolate bars wrapped together mostly reported that they intended to consume both pieces immediately (compared with saving one piece for later), presumably because they considered the package to be the appropriate unit of consumption. It is possible that if the cookies in our study had been packaged together, then participants would have eaten more than they did when the cookies were individually packaged.

One limitation of the current research is that it was conducted in a controlled laboratory environment, which is unlike the free-living conditions under which people typically eat. Consequently, the results from this research may not be representative of what occurs in natural eating environments. It is important for future research on the segmentation effect to examine these processes in more naturalistic settings while maintaining some of the rigor and internal validity of laboratory research (e.g., Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Wansink & Kim, 2005). Another respect in which the eating environment of the current research differs from most other settings is that the food that was offered to participants was provided without cost. The operation of a segmentation effect might differ when individuals pay for their own food. For example, providing free food might minimize the segmentation effect because doing so might eliminate participants' motivation to finish the cookie that they initially had started. In other words, food that is offered without cost may not be perceived as being as valuable as food that has been paid for, and this may influence people's food intake. Another limitation of the present study is that although we demonstrated that our results held when controlling for participants' initial hunger level, we assessed hunger using a single-item self-report measure. Future studies should include more reliable assessments of hunger when attempting to demonstrate the robustness of the portion-size and segmentation effects. Finally, the present study was limited to female undergraduate students and involved only a single snack food (cookies); therefore, it is possible that the effects would not generalize beyond this population or to other types of foods (e.g., meal foods). Research is needed to test the generalizability of these effects.

Another important goal for future research is to further clarify how people define a food unit. In some past studies, the food unit may have been ambiguous (e.g., Geier et al., 2006; Marchiori et al., 2011; Vermeer et al., 2010). In the present studies, we attempted to clearly define the unit by either individually packaging the cookies or by placing them on separate plates. Research will be needed to clearly define the boundary conditions for a unit because this would have implications for efforts to help people regulate their food intake. For example, in a package containing two cookies, is it the package that is the unit, or is it the individual cookie that is the unit? What if each cookie within the larger package were individually wrapped, or if the package were clearly labeled as "contains one serving" versus "contains two servings"? It might also be the case that the appropriateness of a unit of food will depend on the context and on the type of food in question (e.g., countable foods such as cookies vs. less countable foods such as pasta). Finally, the absolute size of the unit might be an important consideration. As Geier et al. (2006) pointed out, the unit needs to be of some minimal size before it will be considered a "unit." However, it is unknown what that "minimal" size is. Understanding what constitutes a unit could inform the development of product packaging that would better assist consumers in regulating their food intake.

In conclusion, the present studies did not find evidence that people eat a single unit of food. However, we did find that people ate less when the portion of food is divided up into smaller subunits. Furthermore, this segmentation effect appears to be driven by a norm of appropriate intake that is created by the way the food is presented. It is important to note that our findings do not support the hypothesis that a unit bias (or a segmentation effect) can explain the portion-size effect; rather, our results suggest that the effect of portion size influences people's food intake independent of how the portion is presented. These findings contribute to our understanding of how the presentation of food influences people's eating behavior and have implications for designing interventions aimed at reducing excessive food intake.

References

Cavanagh, K., Vartanian, L. R., Herman, C. P., & Polivy, J. (2014). The effect of portion size on food intake is robust to brief education and mindfulness exercises. *Journal of Health Psychology, 19,* 730–739. doi:10.1177/1359105313478645

Diliberti, N., Bordi, P. L., Conklin, M. T., Roe, L. S., & Rolls, B. J. (2004). Increased portion size leads to increased energy intake in a restaurant. *Obesity Research, 12,* 562–568. doi:10.1038/oby.2004.64

Ford, E. S., & Dietz, W. H. (2013). Trends in energy intake among adults in the United States: Findings from NHANES. *American Journal of Clinical Nutrition, 97,* 848–853. doi:10.3945/ajcn.112.052662

Geier, A. B., Rozin, P., & Doros, G. (2006). Unit bias: A new heuristic that helps explain the effect of portion size on food intake. *Psychological Science, 17,* 521–525. doi:10.1111/j.1467-9280.2006.01738.x

Geier, A., Wansink, B., & Rozin, P. (2012). Red potato chips: Segmentation cues can substantially decrease food intake. *Health Psychology, 31,* 398–401. doi:10.1037/a0027221

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.

Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the environment: Where do we go from here? *Science, 299,* 853–855. doi:10.1126/science.1079857

Levitsky, D. A., & Youn, T. (2004). The more food young adults are served, the more they overeat. *Journal of Nutrition, 134,* 2546–2549.

Marchiori, D., Waroquier, L., & Klein, O. (2011). Smaller food item sizes of snack foods influence reduced portions and caloric intake in young adults. *Journal of the American Dietetic Association, 111,* 727–731. doi:10.1016/j.jada.2011.02.008

Mrdjenovic, G., & Levitsky, D. A. (2005). Children eat what they are served: The imprecise regulation of energy intake. *Appetite, 44,* 273–282. doi:10.1016/j.appet.2005.01.005

Nielsen, S. J., & Popkin, B. M. (2003). Patterns and trends in food portion sizes, 1977–1998. *JAMA: Journal of the American Medical Association, 289,* 450–453. doi:10.1001/jama.289.4.450

Nielsen, S. J., Siega-Riz, A. M., & Popkin, B. M. (2002). Trends in energy intake in US between 1977 and 1996: Similar shifts seen across age groups. *Obesity Research, 10,* 370–378. doi:10.1038/oby.2002.51

Polivy, J., Herman, C. P., Hackett, R., & Kuleshnyk, I. (1986). The effects of self-attention and public attention on eating in restrained and unrestrained subjects. *Journal of Personality and Social Psychology, 50,* 1253–1260. doi:10.1037/0022-3514.50.6.1253

Raynor, H. A., & Wing, R. R. (2007). Package unit size and amount of food: Do both influence intake? *Obesity, 15,* 2311–2319. doi:10.1038/oby.2007.274

Rolls, B. J., Engell, D., & Birch, L. L. (2000). Serving portion size influences 5-year-old but not 3-year-old children's food intake. *Journal of the American Dietetic Association, 100,* 232–234. doi:10.1016/S0002-8223(00)00070-5

Rolls, B. J., Morris, E. L., & Roe, L. S. (2002). Portion size of food affects energy intake in normal-weight and overweight men and women. *The American Journal of Clinical Nutrition, 76,* 1207–1213.

Rolls, B. J., Roe, L. S., & Meengs, J. S. (2006). Larger portion sizes lead to a sustained increase in energy intake over 2 days. *Journal of the American Dietetic Association, 106,* 543–549. doi:10.1016/j.jada.2006.01.014

Schwartz, J., & Byrd-Bredbenner, C. (2006). Portion distortion: Typical portion sizes selected by young adults. *Journal of the American Dietetic Association, 106,* 1412–1418. doi:10.1016/j.jada.2006.06.006

Steenhuis, I. H. M., & Vermeer, W. M. (2009). Portion size: Review and framework for interventions. *International Journal of Behavioral Nutrition and Physical Activity, 6,* 58. doi:10.1186/1479-5868-6-58

Vartanian, L. R., Sokol, N., Herman, C. P., & Polivy, J. (2013). Social models provide a norm of appropriate food intake for young women. *PLoS One, 8,* e79268. doi:10.1371/journal.pone.0079268

Vermeer, W. M., Bruins, B., & Steenhuis, I. H. M. (2010). Two pack king size chocolate bars. Can we manage our consumption? *Appetite, 54,* 414–417. doi:10.1016/j.appet.2010.01.008

Wansink, B. (2004). Environmental factors that increase the food intake and consumption volume of unknowing customers. *Annual Review of Nutrition, 24,* 455–479. doi:10.1146/annurev.nutr.24.012003.132140

Wansink, B., & Chandon, P. (2006). Can "low-fat" nutrition labels lead to obesity? *Journal of Marketing Research, 43,* 605–617. doi:10.1509/jmkr.43.4.605

Wansink, B., & Kim, J. (2005). Bad popcorn in big buckets: Portion size can influence intake as much as taste. *Journal of Nutrition Education and Behavior, 37,* 242–245. doi:10.1016/S1499-4046(06)60278-9

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health, 92,* 246–249. doi:10.2105/AJPH.92.2.246

Young, L. R., & Nestle, M. (2003). Expanding portion sizes in the US marketplace: Implications for nutrition counselling. *Journal of American Dietetic Association, 103,* 231–240. doi:10.1053/jada.2003.50027

Received March 21, 2014
Revision received August 13, 2014
Accepted August 16, 2014 ■