

# The effect of portion size on food intake is robust to brief education and mindfulness exercises

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Karen Cavanagh<sup>1</sup>, Lenny R Vartanian<sup>1</sup>, C Peter Herman<sup>2</sup> and Janet Polivy<sup>2</sup>

## Abstract

We examined whether a brief education and a brief mindfulness exercise would reduce the effect of portion size on food intake. Participants were randomly assigned to one of the three information conditions (education, mindfulness, or control) and then received a small or large portion of pasta for lunch. Neither education nor mindfulness was effective in reducing the effect of portion size: Overall, participants served a large portion consumed 34 percent more pasta than did those served a small portion. Participants in the mindfulness condition tended to eat less overall than participants did in the two other conditions, but this trend was not significant.

## Keywords

eating, eating behavior, education, food, information

## Introduction

Excess energy intake has been identified as a key contributor to weight gain and obesity, and epidemiological evidence suggests that increases in energy intake over the past few decades have coincided with increases in rates of obesity (Centers for Disease Control and Prevention, 2004). It has also been suggested that the rise in obesity rates could be explained by an increase in average net daily energy consumption of as little as 50–100 kcal (Hill et al., 2003). One factor that has been widely cited as one of the main contributors to excess energy intake, weight gain, and obesity is portion size (Young and Nestle, 2002). The current study tested two approaches to reducing the effect of portion size on food intake.

Portion sizes have increased dramatically since the early 1970s (Nielsen and Popkin, 2003),

and experimental studies have consistently demonstrated that increases in portion sizes result in increased energy intake (Rolls et al., 2002). This association between portion size and energy intake is robust and has been demonstrated with a wide range of foods and beverages (Steenhuis and Vermeer, 2009), and the impact of portion size is not affected by other factors that might be expected to influence food intake, such as hunger (Rolls et al., 2002) and

<sup>1</sup>The University of New South Wales, Australia

<sup>2</sup>University of Toronto, Canada

## Corresponding author:

Lenny R Vartanian, School of Psychology, The University of New South Wales, Mathews Building, Sydney, NSW 2052, Australia.

Email: lvartanian@psy.unsw.edu.au

the taste of the food (Wansink and Kim, 2005). Importantly, individuals do not adjust their intake when served more than they typically serve themselves. Students served 100, 125, or 150 percent of the amount of lunch that they had served themselves at a buffet a week earlier ate more the more they were served (Levitsky and Youn, 2004). Furthermore, individuals do not compensate for the impact of larger portions by reducing their energy intake at subsequent meals. When participants were consistently served larger portions of every meal for 2 days, they had a higher total energy intake across the 2 days than they did when served smaller portions (Rolls et al., 2006).

External influences on food intake, including portion size and social influence, are thought to influence people's food intake without their conscious awareness (Wansink, 2004). For example, Vartanian et al. (2008) found that, although their participants' intake was strongly related to the behavior of others, participants denied being influenced by those social factors and instead attributed the extent of their food intake to commonsense factors such as hunger and the taste of the food. Thus, people may be unaware of the impact of external cues on their food intake. This lack of awareness has important implications for the development of interventions aimed at reducing the portion size effect. Specifically, if people are unaware of the influence of portion size on their food intake, then efforts to raise their awareness may be effective in reducing this influence.

### *Efforts to reduce the influence of portion size*

One strategy that is frequently suggested for people to reduce the effects of larger portions is to simply use smaller plates (Wansink, 2004). However, people do not necessarily serve themselves less food on a smaller plate than on a larger plate and do not necessarily eat less when the same amount of food is presented on a smaller plate (Rolls et al., 2007). Two other approaches that have been suggested in the

literature are to educate people about the effects of portion size on food intake and to increase people's mindful awareness while eating (Steenhuis and Vermeer, 2009). These are the two approaches that we investigated in the current study.

*Education to increase awareness.* Increasing awareness of the portion size effect has been suggested as a strategy for reducing the effect of portion size on food intake (Nielsen and Popkin, 2003; Schwartz and Byrd-Bredbenner, 2006), but no studies have examined the effectiveness of this strategy (Steenhuis and Vermeer, 2009). Given the possibility that people are simply unaware of the external influences on their eating behavior (Vartanian et al., 2008), increasing awareness of these influences through a brief educational exercise may be effective in reducing the impact of portion size on food intake. Indeed, previous research has suggested that increasing awareness of external influences on behavior may lead to attempts to correct for those influences (Wilson and Brekke, 1994). Thus, in the present study, we developed a brief educational exercise aimed at reducing the effect of portion size on food intake by increasing people's awareness of external influences on their food intake.

*Mindfulness.* Another strategy that has been suggested as a means of reducing external influences on food intake is to increase people's awareness of their experience with food, as well as their internal sensations of hunger and satiety, through the use of mindfulness-based strategies. Mindfulness is a key concept in Buddhist meditation that refers to calm, complete, and nonjudgmental awareness of one's behaviors, bodily sensations, thoughts, and feelings (Kabat-Zinn, 1994). With respect to eating behavior, mindfulness involves deliberately attending to all five senses to experience the sensations of eating, internal sensations as the food is digested, and physiological feedback regarding fullness (Albers, 2003). By increasing mindful attention, people should be more likely to eat in accordance with their body's

sensations and should be less likely to respond to external factors that can affect food intake (Albers, 2003; Kristeller and Hallett, 1999).

To date, most evidence relating mindfulness to eating behavior has been in the context of the treatment of binge eating disorder (Kristeller and Hallett, 1999; Smith et al., 2006). "Mindful eating" is also becoming increasingly popular in general nutrition-related practice (Hammond, 2007) and popular diet books (Albers, 2003), but there is little empirical evidence regarding its effectiveness in improving eating habits. One study found that participants who completed a brief (15-minute) mindfulness body-scan relaxation task prior to eating snack foods ate less than did participants who completed a nonmindful relaxation task (Meier and Donatoni, 2011). In another study, participants who took part in a 6-week "mindful restaurant eating" program, which included education and behavioral strategies along with mindfulness meditations, reduced their daily caloric intake by more than 300 kcal (Timmerman and Brown, 2012). Furthermore, Papies et al. (2012) found that having participants take part in mindful attention training eliminated their impulsive approach toward images of attractive foods. Given the promising initial findings regarding mindfulness and food intake, the present study also examined whether a brief mindfulness-based exercise would reduce the effect of portion size on eating behavior.

### Research aims and hypotheses

The present study tested whether a brief education exercise and a brief mindfulness exercise would reduce the effects of portion size on food intake. We hypothesized that participants who are served a large portion of pasta would eat more than would participants who are served a small portion of pasta (H1), but that both the education and mindfulness conditions would reduce the effects of portion size on food intake (H2 and H3). We also examined people's reports of the factors that influenced their food intake. We predicted that participants would

rate internal sensations (hunger and satiety) and palatability of the food as more influential than they would rate external factors (amount of food available) (H4). Furthermore, if the education exercise increases people's awareness of external cues, then participants in the education condition should rate the amount of food available as significantly more influential than should those in the control condition and mindfulness condition (H5). If mindfulness increases participants' awareness of their internal sensations, then participants in the mindfulness condition should rate factors such as taste, hunger, and satiety as significantly more influential than those in the control condition or education condition (H6).

## Method

### Participants

Participants were 96 female undergraduate students enrolled in a first-year psychology course who received course credit for their participation. Past research on environmental influences on food intake has found effect sizes that were medium to large in magnitude (e.g. Rolls et al., 2002; Wansink and Kim, 2005). A power analysis determined that, with alpha set at .05 and power set at .80, 95 participants were required to detect a medium-to-large effect. The mean age of participants was 19.71 years (standard deviation (*SD*) = 4.71 years), and their mean body mass index (BMI) was 21.53 kg/m<sup>2</sup> (*SD* = 3.08 kg/m<sup>2</sup>). The study was approved by the university's ethics committee.

### Experimental manipulations

**Portion conditions.** Participants were served one of the two portion sizes of macaroni pasta with tomato sauce. Participants in the small portion condition were served 350 g of pasta (approximately 440 kcal), and participants in the large portion condition were served 600 g of pasta (approximately 750 kcal). In both portion conditions, participants were also provided with

additional pasta so that their intake would not be artificially limited to the amount they were initially served and to ensure that participants in each condition had access to equal quantities of pasta (approximately 1100 g in total). The additional pasta was placed in a covered serving dish on the table in front of the participants so that they could serve themselves and, therefore, avoid the potential social embarrassment of requesting additional food. The pasta for each experimental session was prepared on the morning of the session and was reheated immediately before being served to participants. The two containers of pasta served to participants (i.e. the bowl of the small or large portion of pasta and the covered dish with the additional pasta) were weighed to the nearest gram using an electronic scale prior to being served to the participant and again after the participant had finished eating. Total food consumed was calculated by subtracting the weight of the two bowls after the participant had finished eating from the weight of the same bowls prior to being served. For ease of interpretation, the results are also provided in kilocalories.

**Information conditions.** Each of the information conditions included an information brochure and an associated 6-minute activity intended to assist with the consolidation of the information that participants were provided. The materials and procedures for all of the conditions were similar in layout, appearance, and level of detail and differed only in content.

**Education condition.** This condition was designed to increase people's awareness of external influences on food intake. The brochure in the education condition included information on internal and external influences on behavior in general (e.g. mood state, social, and cultural standards), influences on eating behavior (e.g. advertising, portion size, and social influences), why being aware of such influences is important (e.g. they can contribute to mindless eating and overeating), and tips for reducing the influence of external factors on

eating at home. The education brochure was created on the basis of recommendations by Steenhuis and Vermeer (2009) and empirically supported literature on the influences on eating behavior (Canetti et al., 2002; Herman and Polivy, 2008; Wansink, 2004). After reading the brochure, participants were asked to reflect for 6 minutes on the external factors that may have affected their eating behavior in the past and to record these reflections on the accompanying worksheet. All participants successfully wrote about external influences on their food intake, including portion size (48%), social influences (85%), and advertising (56%). (Some participants wrote about more than one external influence.)

**Mindfulness condition.** The mindfulness information brochure included information on influences on food intake (e.g. mood state and portion size), consequences of overeating, mindfulness in general, mindless eating (including the importance of focusing on the taste of the food, as well as hunger and satiety signals), and tips for eating mindfully. The information included in the brochure was based on the theoretical foundations of mindfulness (Brown et al., 2007), mindfulness-based interventions for eating problems (Baer et al., 2005; Kristeller et al., 2006; Smith et al., 2006), and specific mindful and mindless eating resources (Albers, 2003; Wansink, 2009). Mindfulness participants were also guided through the 6-minute mindfulness meditation exercise via an audio recording, which involved focused awareness of and attention to the sensory aspects of a raisin. The raisin exercise was used to help attune participants to the sensory aspects of eating, is often included in the first session of standard 8- to 10-week mindfulness courses, and has regularly been incorporated into mindfulness-based interventions for eating-related problems (Baer et al., 2005; Kristeller and Hallett, 1999; Smith et al., 2006).

**Control condition.** Participants in the control condition were given an information brochure

about sleep hygiene and were then asked to reflect for 6 minutes on their sleep habits and hygiene and to record these reflections on the worksheet provided.

## Measures

**Taste-rating scale.** A 10-item taste-rating scale was included to add credibility to the cover story and to control for any possible confounding influence of liking of the food on consumption. Items on this scale assessed the specific taste characteristics of the food (e.g. sweetness and saltiness) 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 *not at all* and *extremely* as the anchors. Participants were asked to complete the taste-rating form after the first mouthful of pasta and again after the last mouthful. Ratings on the liking item assessed after the first mouthful were used as an index of participants' liking of the pasta.

**Hunger level.** Prior to eating the pasta, participants were asked to rate their current hunger level along a 10-cm visual analog scale, with *not at all hungry* and *extremely hungry* as the anchors. Participants also rated their hunger level on an identical scale after eating the pasta.

**Reasons for eating questionnaire.** A 21-item scale adapted from Vartanian et al. (2008) was used to assess participants' perceptions of the factors that influenced the amount of food that they consumed during the experimental session. Participants were asked to rate the degree to which they felt that each factor influenced their eating behavior on a 7-point scale (1 = *not at all an influence*; 7 = *very much an influence*). The individual factors of relevance for the present study were "How hungry I was," "How full I was," "The taste of the food," and "The amount of food available."

**Additional measures.** We also measured dietary restraint (Restraint Scale; Herman and Polivy, 1980) and positive and negative affect (Positive

and Negative Affect Schedule; Watson et al., 1988) to include as potential covariates. Those variables had no impact on the results of the study and are therefore not discussed further.

## Procedure

Experimental sessions were conducted between 11 a.m. and 4 p.m., and participants were instructed not to consume any food within 3 hours of their session time. Upon arrival, participants were informed that the study consisted of two separate components: the first testing different types of health-related information, and the second examining individual aspects of taste sensitivity over the course of a meal. In a between-subjects design, participants were randomly assigned to one of the three information conditions and one of the two portion size conditions. After providing informed consent, participants were asked to read the information and complete the exercise relevant to their condition, at which time the experimenter left the room to reheat the pasta. Next, participants completed an initial hunger questionnaire and took part in the tasting component of the study. They were told that they could eat as much as they wanted of the meal and were asked to complete the taste-rating forms after their first and last mouthfuls. The experimenter then left the room and participants were given 15 minutes to eat the pasta and complete their taste ratings. After 15 minutes, the experimenter returned and participants were asked to again report their level of hunger, to complete some questionnaires, and to provide some basic demographic information (age, height, and weight, which were used to calculate their BMI). Participants were then probed for suspicion (no participant expressed suspicion about the hypotheses) and were debriefed about the true nature of the experiment.

## Statistical analyses

Prior to the main analyses, correlational analyses were conducted to identify potential covariates. Ratings of initial hunger ( $r = .36, p < .001$ )

and liking of the food ( $r = .23, p = .03$ ) were significantly associated with total food consumed, but BMI was unrelated to food intake ( $r = .11, p = .29$ ). Thus, only hunger and liking were included as covariates in all subsequent analyses relating to total food consumed. A 2 (portion condition)  $\times$  3 (information condition) analysis of covariance (ANCOVA) was conducted to examine the effects of portion size and information condition on participants' food intake. Planned contrasts were conducted comparing the differences in total food consumed between the small and large portion conditions for the education condition versus the control condition and for the mindfulness condition versus the control condition. Repeated measures analysis of variance (ANOVA) was used to examine differences in reported reasons for eating as much as they did. Finally, planned pairwise contrasts were conducted to investigate if the ratings of the influence of portion size, taste, hunger, and satiety varied by information condition.

## Results

### *Effects of portion size and information condition on amount eaten*

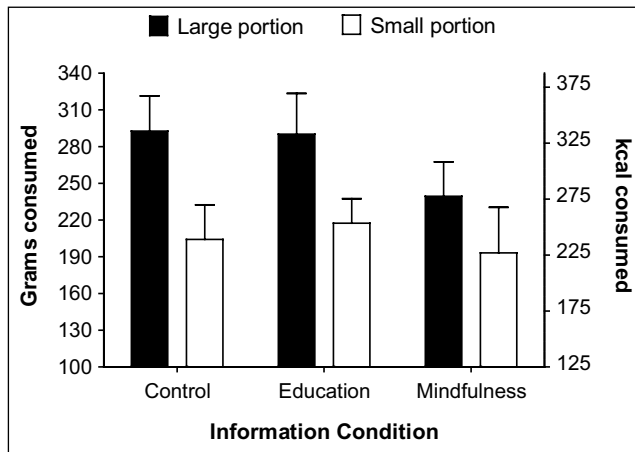
Consistent with H1, there was a significant main effect of portion size on total food consumed,  $F(1,88) = 10.55, p = .002, \eta^2_p = .11$ , with participants who received a small portion of pasta ( $M = 206.40$  g (257.99 kcal),  $SD = 103.43$  g (129.29 kcal)) eating significantly less than did those who received a large portion of pasta ( $M = 275.75$  g (344.69 kcal),  $SD = 126.81$  g (158.52 kcal)). There was no significant main effect of information condition,  $F(2,88) = 1.76, p = .18, \eta^2_p = .04$ , and no significant interaction between portion condition and information condition,  $F(2,88) = 0.11, p = .90, \eta^2_p = .002$  (Figure 1). The results were identical when the analyses were conducted without initial hunger and liking included as covariates.

The planned contrast comparing the effects of portion size on the amount of food consumed in the education and the control conditions revealed no significant interaction,  $F(1,88) = 0.03, p = .86, \eta^2_p < .001$ . Similarly, no significant interaction was detected for the planned contrast comparing the effects of portion size on the amount of food consumed in the mindfulness and control conditions,  $F(1,88) = 0.21, p = .65, \eta^2_p = .002$ . Thus, H2 and H3 were not supported.

Examination of Figure 1 suggests that participants in the mindfulness condition ate less overall than did participants in the control and education conditions, irrespective of portion size. Therefore, a post hoc comparison was conducted to determine whether this apparent difference was statistically significant. Participants in the mindfulness condition tended to eat less overall ( $M = 218.72$  g (273.41 kcal),  $SD = 122.59$  g (153.24 kcal)) compared to participants in the education and control conditions combined ( $M = 255.93$  g (319.91 kcal),  $SD = 120.04$  g (150.05 kcal)), but this trend was only marginally significant,  $F(1,88) = 3.33, p = .07, \eta^2_p = .04$ .

### *Reasons for eating ratings*

Consistent with H4, hunger ( $M = 5.10, SD = 1.74$ ), satiety ( $M = 5.01, SD = 1.83$ ), and taste ( $M = 4.75, SD = 1.46$ ) were rated as significantly stronger influences on participants' food intake than was the amount of food available ( $M = 2.79, SD = 2.07$ ),  $ps < .001$ . In partial support of H5, participants in the education condition rated the amount of food available as significantly more influential than did those in the control condition ( $p = .02$ ); however, ratings did not differ significantly from those in the mindfulness condition ( $p = .23$ ) (Table 1). Contrary to H6, participants in the mindfulness condition did not rate internal sensations of hunger, satiety, or taste as significantly more influential than did those in the control condition or the education condition (all  $ps > .24$ ). No other differences were significant.



**Figure 1.** Total amount of pasta consumed as a function of portion size and information condition. Error bars represent standard error of the mean.

**Table 1.** Mean (SD) reported reasons for eating as a function of information condition.

	Control	Education	Mindfulness
Hunger	4.66 <sup>a</sup> (1.72)	5.29 <sup>a</sup> (1.84)	5.38 <sup>a</sup> (1.59)
Fullness	4.97 <sup>a</sup> (1.69)	5.00 <sup>a</sup> (1.93)	5.07 <sup>a</sup> (1.91)
Taste	4.47 <sup>a</sup> (1.57)	4.97 <sup>a</sup> (1.40)	4.79 <sup>a</sup> (1.40)
Amount available	2.19 <sup>a</sup> (1.87)	3.37 <sup>b</sup> (2.13)	2.76 <sup>a,b</sup> (2.06)

SD: standard deviation.

Means in a row with different superscripts are significantly different at  $p < .05$ .

## Discussion

Consistent with prior study, we found that participants in the large portion condition consumed 69 g (34%) more pasta than did participants in the small portion condition. This difference amounts to approximately 87 additional kilocalories consumed in the large portion condition. Drawing comparisons to the recommended serving size for pasta from the Australian Department of Health and Ageing (1998), participants in the large portion condition ate significantly more than the recommended 180 g ( $p < .001$ ), but participants in the small portion condition did not ( $p = .10$ ). Furthermore, consistent with previous research (Rolls et al., 2002), the effect of

portion size was not influenced by hunger or liking of the food. Because even a small increase in energy intake can have a significant impact on weight gain and obesity over time (Hill et al., 2003), it is important to develop ways to reduce the impact of external cues such as portion size. We tested two approaches suggested by the literature: an education exercise aimed at informing people about external influences on food intake, and a mindfulness exercise aimed at increasing people's awareness of their sensory experience with eating. Contrary to our hypotheses, neither of these exercises reduced the effects of portion size on participants' food intake. With respect to their reported reasons for eating as much as they did, participants rated internal sensations of hunger and

satiety and the taste of the food as having a greater influence on their food intake than they did the amount of food available. There were very few group differences in reported reasons for intake, except that participants in the education condition rated the amount of food available as having a significantly greater influence on their eating behavior than did participants in the control condition (but not the mindfulness condition).

### ***Increasing awareness through education***

The lack of efficacy of the education condition in reducing the influence of portion size on immediate food intake suggests that these types of consciousness-raising exercises are unlikely to be effective in reducing external influences on food intake. Thus, it may be that providing education alone is not an effective strategy for reducing the impact that external factors have on food intake. Instead, providing individuals with more specific strategies that are relevant to their immediate eating environment might increase the effectiveness of these types of interventions (Wansink, 2010). The brief nature and delivery mode of the education exercise may have also limited its efficacy. That is, the exercise relied on participants' comprehension of the written material, which was limited to two pages and did not provide an opportunity for participants to access additional information or clarify their understanding. More in-depth training might therefore be necessary to mitigate the effects of portion size on individuals' food intake. It is also possible that providing individuals with information about the *magnitude* of the portion size effect would elicit more rigorous attempts to correct for those influences (cf. Wilson and Brekke, 1994), which might be more effective in reducing the effect of portion size on food intake.

Another potential explanation for the ineffectiveness of simple education is the distinction between a lack of awareness of the influences of external factors and a failure to

acknowledge the influence of those factors on the participants' own intake (Vartanian et al., 2008). That is, if participants were already aware of the effect of portion size, then an exercise designed to increase awareness would be unlikely to reduce the effect of portion size. Instead, efforts to increase acknowledgement of the influence of external factors on eating behavior might be more effective.

### ***Mindfulness***

The mindfulness exercise was also ineffective in reducing the effect of portion size on food intake, suggesting that increasing individuals' focus on their internal sensations may not be sufficient to reduce their reliance on external cues. Although mindful eating has been suggested as a means of reducing the impact of external cues, it has not previously been tested in this particular context. A recent study by Timmerman and Brown (2012) found that participants who took part in a Mindful Restaurant Eating intervention showed a reduction in their average daily caloric intake but did not show a significant reduction in calories consumed in restaurant settings (the intended target of their intervention and a context in which one might expect portion size to be of particular concern).

It is also possible, however, that the mindfulness exercise used in the current study was too brief for participants to successfully focus their attention on, and attune themselves to, their internal sensations. Clinical interventions using mindfulness, such as those used to reduce binge eating, typically involve an 8- to 10-week course with intensive practice conducted between sessions (Baer et al., 2005). Note, however, that even quite brief mindfulness exercises have been successful at reducing people's food intake. Meier and Donatoni (2011) found that a brief (15-minute) mindfulness body-scan exercise reduced participants' intake of snack foods. In the present study, we also found a trend toward a significant effect of mindfulness on overall food intake, irrespective of portion size, using a simple 6-minute mindfulness exercise. Thus,



mindfulness training might help individuals avoid overeating even if it does not eliminate the influence of external cues on food intake.

### Limitations

One limitation of the current study is that it was conducted in a highly controlled laboratory setting in order to enhance the internal validity of the research. This environment is notably different from the home and the public settings in which people typically eat. Nonetheless, past research has found portion size effects in a variety of settings, including the laboratory (Rolls et al., 2002), restaurants (Diliberti et al., 2004), and movie theaters (Wansink and Kim, 2005). The diversity of contexts within which portion size effects have been observed highlights the need for developing interventions that take into consideration the unique elements of those contexts. The present study also included only female university students. Previous research has found portion size effects among both women and men (Rolls et al., 2002), but in some studies, men show larger effects than women (Rolls et al., 2004). It is possible that demographic characteristics could influence whether or not individuals respond to specific approaches to reducing portion size effects, and those approaches might need to be tailored to the specific characteristics of the group being targeted.

### Conclusions

The results of the current study contribute to the breadth of research demonstrating the robust effect of larger portion sizes leading to increased energy intake and therefore emphasize the need for new approaches to mitigate these portion size effects. The brief education and mindfulness exercises used in the present study were not effective in reducing the portion size effect, although there was a tendency for participants who completed the mindfulness exercise to eat less overall. Future research is needed to identify ways to reduce

the effect of portion size on excess energy intake and also to further investigate the use of mindfulness as a technique for reducing excess energy intake overall. If such approaches continue to prove ineffective in reducing the impact of larger portions on people's food intake, then this would strengthen the argument that policy-related changes are needed to provide a healthier food environment.

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