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The portion size effect on food intake is robust to contextual size information

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ABSTRACT

Larger portion sizes have consistently been shown to lead to greater food intake. However, studies of the portion size effect typically provided participants with a single portion of food at a time without any objective information about the size of the portion, and hence failed to consider the potential significance of contextual size information. In order to investigate whether contextual size information moderates the portion size effect, participants were served small or large portions of pasta for lunch in the presence or absence of contextual size information. Study 1 found that the portion size effect on food intake was robust to contextual size information. Study 2 replicated this finding in an online paradigm, showing that contextual size information also had no influence on prospective intake, even when participants chose the portion size they preferred. Both studies also showed that participants' perceptions of how much was appropriate to eat mediated the effect of portion size on intake. A practical implication of our findings is that modifying consumption norms may be an effective way to promote healthier consumer food decisions.

1. Introduction

A significant body of research has shown that people eat more food when they are served larger portions than when they are served smaller portions. This "portion size effect" has been repeatedly demonstrated in both laboratory and naturalistic settings and across a variety of different populations (for reviews, see Benton, 2015; English, Lasschuijt, & Keller, 2015; Herman, Polivy, Pliner, & Vartanian, 2015). The portion size effect is a powerful effect that persists even if the food provided is unpalatable (Wansink & Kim, 2005). Further, the portion size effect is also robust to various psychological interventions, including mindfulness and direct education about the influence of portion size on food intake (e.g., Cavanagh, Vartanian, Herman, & Polivy, 2014; Marchiori & Papies, 2014). The portion size effect is particularly concerning because people seem to be insensitive to changes in portion size and the impact that it has on their food intake. For example, ratings of satiety do not differ when people eat from a large portion compared to a small portion, despite consuming significantly more food when served the large portion (e.g., Kral, Roe, & Rolls, 2004; Levitsky & Youn, 2004; Rolls, Morris, & Roe, 2002). Furthermore, larger portions appear to increase intake without any reduction in caloric intake (i.e., compensation) at subsequent meals (e.g., Rolls, Roe, & Meengs, 2007).

1.1. Contextual size information and the portion size effect

One potential limitation of most existing studies of the portion size effect is that they served participants a single portion of food at a time without giving them any objective information about the size of the portion. Thus, these studies failed to consider the possible significance of contextual cues that could influence the portion size effect. Given that context influences object perception (see Bar, 2004; for review), it may be that context also plays a role in how different portion sizes are perceived. In particular, providing portion size labels (e.g., explicitly defining a small portion as small and a large portion as large) or visual information in the form of an alternative portion size may influence how these portions are perceived, evaluated, and consumed. Furthermore, because food products are often sold in multiple sizes (e.g., small, regular, and large) in fast food outlets and food courts, examining how people perceive and compare different portion sizes at point-of-purchase may be a more ecologically valid paradigm for investigating

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effects of portion size.

There is some evidence for the significance of context to food appraisal and eating behavior. For example, Spanos, Kenda, and Vartanian (2015) served participants either a small (200 g) or large (400 g) portion of cheese pizza and also provided them with information about the number of servings contained in the portion of pizza. Participants who were told that the large portion contained four servings ate less than did those told that it contained two servings, but their intake was not significantly different from those who received the small unlabeled portion. Studies of consumer behavior have also investigated the effect of labeling on food intake by using comparative size labels (e.g., "small", "medium", "large", and "regular") rather than objective serving size information (Aydinoğlu & Krishna, 2010; Just & Wansink, 2014). One recent field study found that participants consumed more cookies when the portion was arbitrarily labeled as "medium" compared to when the same-sized portion was labeled as "large" (Aydinoğlu & Krishna, 2010). In contrast to the above studies, Ueland, Cardello, Merrill, and Lesher (2009) failed to find any effect of portion size labeling on intake when they served participants a fixed portion of pasta accompanied by a written description of the pasta as either half of a "normal" portion, equivalent to a "normal" portion, or one-and-a-half times the size of a "normal" portion of that pasta.

Additional evidence for the potential importance of contextual size information comes from a study showing that comparing the relative size of one's portion to that of another person can influence consumption. Polivy, Herman, and Deo (2010) served all participants the same-sized slice of pizza, but manipulated their perceptions of its size by having a confederate receive a noticeably smaller or noticeably larger slice. After finishing the pizza, participants took part in a cookie taste test in which their food intake was unknowingly measured. Polivy et al. found that unrestrained eaters (i.e., non-dieters) who perceived their slice of pizza to be larger than the confederate's slice ate fewer cookies than did those who perceived their slice to be smaller. This finding suggests that relative portion size can influence how portions are perceived as well as subsequent food intake.

In summary, the existing research on contextual cues suggests that contextual size information that reduces the perceived size of the portion can lead to increased consumption, and contextual size information that amplifies the perceived size of the portion can lead to decreased consumption. Therefore, when multiple portion options are available, a small portion may be perceived as even smaller in comparison to a large portion than when it is presented alone. Similarly, a large portion may be perceived as even larger in comparison to a small portion than when it is presented alone. However, no studies have directly assessed whether the contextual size information associated with multiple portion size options attenuates the portion size effect on food intake.

1.2. A potential mechanism underlying the portion size effect: consumption norms

Although the evidence for the portion size effect is well-established, less is known about the mechanism through which portion size influences food intake. One proposed explanation for the portion size effect is that the size of the portion provides normative information about how much one "should" eat (Herman et al., 2015). That is, in the absence of other information, people are likely to assume that the amount that they are served represents a normal or appropriate amount to eat in the situation. Such a normative account is also reflected in Marchiori, Papies, and Klein's (2014) suggestion that the portion size provided is used as an anchor or reference point around which intake is adjusted. Similar explanations have been provided for the influence of social models on people's eating behavior (e.g., Vartanian, Sokol, Herman, & Polivy, 2013). Some studies provide indirect support for the idea that portion size implies a norm of appropriate consumption (e.g., Diliberti, Bordi, Conklin, Roe, & Rolls, 2004), but only one study to date has directly tested whether consumption norms mediate the portion size effect on food intake (Kerameas, Vartanian, Herman, & Polivy, 2015). Kerameas et al. (2015) served participants a small or large portion of cookies and found that the size of the portion influenced participants' perceptions of how much was appropriate to eat, which in turn influenced their food intake. Further research that directly tests the consumption norm mechanism is needed to corroborate these findings. Furthermore, if contextual size cues do moderate the portion size effect on food intake, it will be important to determine whether these differences in food intake are due to the contextual cues influencing perceptions of how much is appropriate to eat.

1.3. The present research

The primary purpose of the present research was to examine whether contextual size information associated with portion size moderates the portion size effect. Study 1 assessed whether portion size and contextual size information would influence food intake within the laboratory. Study 2 examined portion size and context effects on prospective intake when participants were free to choose their preferred portion size. The secondary aim of this research was to elucidate the mechanism underlying the portion size effect. Specifically, we tested whether perceptions of the appropriate amount to eat explained any portion size and context effects on food intake (Study 1) and on prospective intake (Study 2).

2. Study 1

This first study examined the combined effects of portion size and contextual size information on food intake. Participants were given a small or large portion of pasta to eat for lunch. In addition, the portion that they were served was accompanied by no contextual size information, was presented with the relevant size label (i.e., small or large), or was presented alongside the alternative portion size to provide a visual comparison. First, we hypothesized that participants who received the large portion would eat more than would those who were given the small portion (i.e., the quintessential portion size effect). Second, based on the suggestive evidence regarding contextual size information (Aydinoğlu & Krishna, 2010; Just & Wansink, 2014; Polivy et al., 2010; Spanos et al., 2015), we hypothesized that the strength of the portion size effect would be diminished for those who were shown contextual size information compared to those who were not shown contextual size information. Third, following recent portion size research (Kerameas et al., 2015), we hypothesized that perceptions of how much was appropriate to eat would mediate the effect of portion size on food intake. Finally, building on previous research (e.g., Levitsky & Youn, 2004), we also sought to determine whether participants were sensitive (or insensitive) to any effects of the portion size and context manipulations on their food intake (i.e., whether there were between-group differences in self-reported intake and hunger ratings after eating).

2.1. Method

2.1.1. Participants

Participants ($N = 164$) were female first-year psychology students at an Australian university or female community members recruited through advertising. Students participated in exchange for course credit and community participants were reimbursed

AUD $15 for participation. Ten participants were excluded from the study for the following reasons: correctly identifying the study hypotheses ($n = 7$), failing the attention check ($n = 2$), and technical difficulties ($n = 1$). The final sample consisted of 154 participants with a mean age of 19.90 years ($SD = 2.84$) and mean body mass index (BMI; kg/m^2) of 22.10 ($SD = 3.55$). With regards to ethnicity, 52.6% were Asian, 35.1% were Caucasian, 0.6% were of Aboriginal or Pacific Islander origin, and 11.7% identified as "other". The study was approved by the university's ethics advisory panel.

2.1.2. Materials

2.1.2.1. Portion size manipulation. Participants were served either a small (300 g; 748 kcal) or large (600 g; 1496 kcal) portion of pasta (macaroni noodles with tomato sauce). These portion sizes were based on previous research in a similar population (e.g., Cavanagh et al., 2014), and were intended to be larger than the average female participant would consume in one sitting so that food availability would not a limiting factor on participants' intake. Participant's food intake (in grams) was calculated by weighing the bowl of pasta before and after participants had eaten, and then subtracting the final weight of the bowl from the initial weight.

2.1.2.2. Context manipulation. There were three levels of context: no context, label only, and label + visual comparison. In the no context conditions, participants were given an unlabeled small or large portion of pasta without any reference made to its size (i.e., the typical portion size manipulation). In the remaining conditions, participants were told that they had been randomly allocated to receive the small or the large portion of pasta. Participants in the label only conditions were given one contextual cue in the form of a size label on their portion (i.e., "small" for the small serving and "large" for the large serving). Participants in the label + visual comparison conditions were given the size labels as well as a second contextual cue: the presence of the alternative portion size option (i.e., they were shown the labeled small and large portions together before being told which one they were allocated to receive).

2.1.2.3. Hunger levels and recent food intake. Hunger ratings were obtained immediately before and immediately after eating by having participants rate how hungry they felt using a 10 cm visual analogue scale with *not at all* and *extremely* as the anchors. The hunger item was embedded in four filler mood items that were rated using the same scale. Prior to eating the pasta, participants also recorded the day and time of their last meal, which was used to calculate the number of hours since they last ate. The initial hunger rating and hours since their last meal were examined as potential covariates.

2.1.2.4. Taste ratings. Participants made taste ratings based on the first mouthful of pasta they ate, and then again for their last mouthful once they had eaten as much as they wanted to for lunch. There were seven items assessing the specific taste properties of the pasta (e.g., saltiness, chewiness, etc.), and two items assessing how much they liked the pasta and how good-tasting the pasta was. All items were rated on 10 cm visual analogue scales with *not at all* and *extremely* as the anchors. Only the items assessing liking and good tasting were of interest, and both were examined as potential covariates.

2.1.2.5. Intake estimates and perceived appropriateness. Participants' estimates of how much they had eaten and how much they thought was an appropriate amount to eat were assessed using a pictorial approach that was adapted from the procedure of Brunstrom, Shakeshaft, and Scott-Samuel (2008). This approach was chosen because estimations using images have been shown to be reliable and valid (e.g., Byrd-Bredbenner & Schwartz, 2004; Turconi et al., 2005; Williamson et al., 2003). Two series of pasta images were created (one for the small portion and one for the large portion) by beginning with the full bowl and then removing food to mimic the bowl being eaten out of. Each series consisted of 11 images of the bowl of pasta (taken from a birds-eye-view) in which the amount of pasta in the bowl increased arithmetically in increments of 10% of the total portion size, from 0% (an empty bowl) to 100% (a full bowl; see Fig. 1). After they finished eating, participants were asked to select the image that most closely approximated the amount of pasta they left behind in their bowl (estimated intake) and to select the image that best represented how much pasta they thought was an appropriate amount to leave in the bowl in this situation (perceived appropriateness).[1] The two percentages obtained from participants' responses were converted into grams of pasta by subtracting the percentage of pasta left in the bowl from 100%, and then multiplying that value by the weight of the portion they received (i.e., 300 g for the small portion and 600 g for the large portion). Intake estimates were used to test whether participants' sensitivity to their own intake varied by condition, and appropriateness ratings were used to test appropriateness as a potential mechanism for any effect of portion size or context on intake.

2.1.2.6. Perceptions of portion size. Participants' perception of the portion size they received was assessed by asking them to rate how the size of that portion compared to the amount they normally serve themselves for lunch from 1 (*much smaller*) to 5 (*much larger*; hereafter referred to as "serving size comparisons"). Participants also compared the amount they ate in the experiment to the amount they would normally eat for lunch on a scale from 1 (*much less*) to 5 (*much more*; hereafter referred to as "intake comparisons"). Serving size comparisons and intake comparisons were used to test whether perceptions of portion size and sensitivity to their own intake differed by condition.

2.1.2.7. Dietary restraint. Dietary restraint was examined as a potential covariate. Participants' restraint status was measured using the Restraint Scale (Herman & Polivy, 1980) which consists of 10 items pertaining to dieting, weight fluctuations, and eating behavior. Items are summed to obtain a total restraint score, with higher scores indicating greater dietary restraint. In the present study, Cronbach's $\alpha = 0.73$.

2.1.2.8. Attention check. A two-item attention check was included to verify that participants in the label only conditions and the label + visual comparison conditions were attending to the contextual size information provided. They were asked to indicate which portion size they received (small or large) and whether they noticed a label in front of their portion (yes or no). Participants who responded incorrectly to either of these questions were excluded from the analyses.

2.1.2.9. Demographics. Participants provided basic demographic information, including their age, ethnicity, number of years living in

[1] Note that, in both cases, participants were asked to indicate the proportion of pasta *left behind* because this approach more closely approximated their experience with the meal. If we would have asked participants how much they had eaten/how much was appropriate to eat, they would have needed to reconstruct the meal by trying to recall the amount that they ate (i.e., the amount they *removed* from the bowl) and then imagine that amount inside the bowl, even though they never actually experienced this image directly.

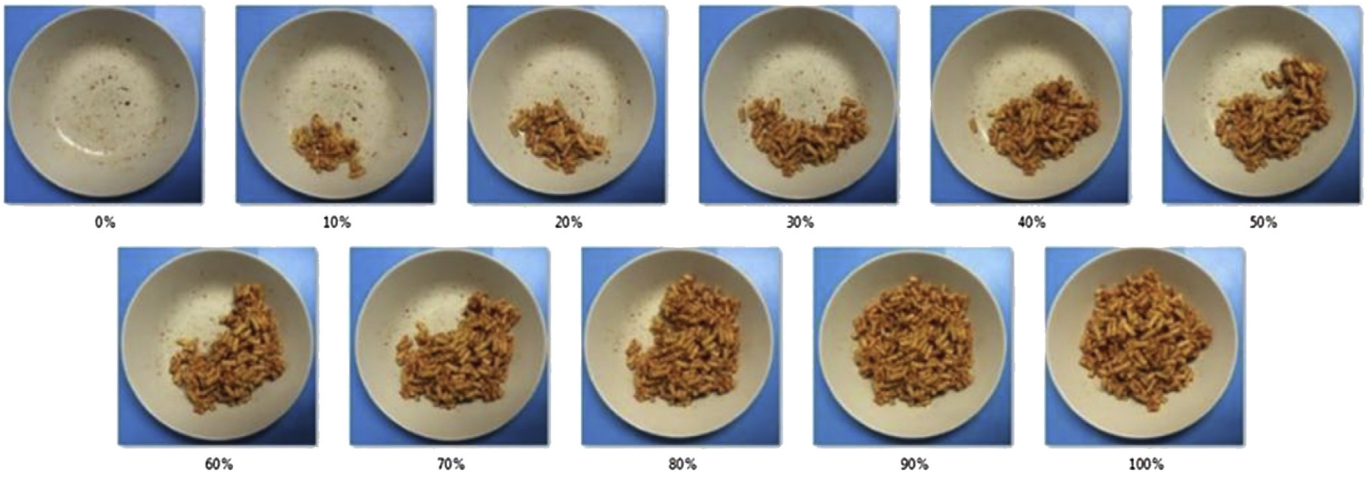

Fig. 1. Small (300 g) portion image series (Study 1). Images were used for intake estimates and perceived appropriateness ratings. Amount of pasta in the bowl increases in increments of 10% (i.e., 30 g).

Australia, and height and weight (used to calculate their BMI). Age and BMI were examined as potential covariates.

2.1.3. Procedure

Participants signed up for a study on "hunger and taste perception" and were tested individually in 45 min sessions between 11 a.m. and 2.45 p.m. At the time when they signed up, participants were informed that they would eat lunch during the study, and that they should abstain from eating for 3 h prior to the session. Participants were randomly assigned to one of the six experimental conditions (with the constraint that each condition contained roughly equal numbers of participants).

Upon arrival, participants provided informed consent, reported their baseline hunger level and reported their recent food intake. They were then served a small or large portion of pasta, which was presented along with the contextual size information that was relevant to their assigned condition. Participants were instructed to complete two sets of taste ratings of the pasta based on the first mouthful and the last mouthful they ate. They were told that once they had completed their initial ratings, they could eat as much of the pasta as they wanted for lunch. Participants were left alone for 12 min to complete their taste ratings and have lunch. After eating, they were asked to re-rate their hunger level. Participants then completed the final questionnaires on the computer, including their intake estimates and perceived appropriate amount to eat, their perceptions of the portion they were served, basic demographic information, the attention checks, and a suspicion check. Participants were debriefed at the conclusion of the experiment.

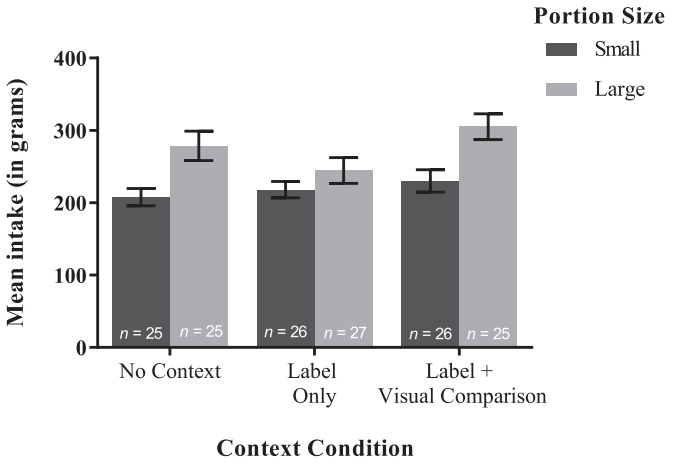

Fig. 2. Mean pasta intake (in grams) for each portion size × context condition for Study 1. Error bars represent standard errors.

2.1.4. Statistical analyses

Data were screened for statistical outliers. However, because removing these outliers had no impact on the pattern of results, the analyses below include the full sample. A two-way ANOVA with portion size and context as the independent variables and food intake as the dependent variable was carried out to assess whether participants' intake was influenced by the experimental manipulations. Mediation analysis was then conducted to determine whether participants' perceptions of appropriate intake mediated any between-group differences in food intake. This analysis was carried out using the PROCESS macro (Hayes, 2013), which uses a non-parametric bootstrapping procedure involving resampling and replacement (in this case, 5000 resamples) to generate an approximation of the sampling distribution for the indirect effect. Confidence intervals for this indirect effect can be estimated from this sampling distribution, and the indirect effect is deemed significant if the confidence interval does not cover zero. To test whether participants were sensitive to the influence of the experimental manipulations on their food intake, a two-way MANOVA was conducted to examine group differences in serving size comparisons, intake comparisons, self-reported intake, and changes in hunger levels over the course of the meal.

With respect to the proposed covariates, participants' age, BMI, Restraint Scale scores, and the number of hours since they last ate were uncorrelated with their food intake during the experiment, and were therefore not included in the subsequent analyses. Participants' baseline hunger ratings, their initial ratings of how much they liked the pasta, and their initial ratings of how good-tasting the pasta was had small to medium positive correlations with food intake ($rs = 0.17–0.26$, $ps < 0.05$). However, controlling for these variables did not impact on the pattern of results, and they were therefore not included as covariates in the main analysis.

2.2. Results

2.2.1. Portion size effect and context effects on food intake

As was predicted, there was a significant main effect of portion size on food intake, $F(1, 148) = 19.15$, $p < 0.001$, $\eta^2_p = 0.12$. Averaged across context conditions, participants who were given the large portion ate more grams of pasta ($M = 276.05$, $SD = 94.37$) than did those given the small portion ($M = 218.59$, $SD = 66.13$).[2] There was, however, no main effect of context on food intake, $F(2, 148) = 2.69$, $p = 0.07$, $\eta^2_p = 0.04$, and no significant portion size × context interaction, $F(2, 148) = 1.42$, $p = 0.24$, $\eta^2_p = 0.02$. See Fig. 2.

2.2.2. Mediation analysis

Because there was no significant context main effect and no portion size × context interaction on food intake, context was not included in the mediation analysis. Portion size was a significant predictor of perceived appropriateness, $F(1, 152) = 47.58$, $p < 0.001$, $R^2 = 0.24$, with the larger portion leading to larger estimates of how much was appropriate to eat. Furthermore, consistent with our hypothesis, there was a significant indirect effect of portion size on participants' food intake through ratings of how much was appropriate to eat (point estimate = 25.21, $SE = 9.38$, 95% CI = 8.61, 45.73).

2.2.3. Sensitivity to portion size

In the multivariate analysis, there was only a main effect of portion size, $F(4, 145) = 31.49$, $p < 0.001$, $\eta^2_p = 0.47$. The main effect of context, $F(4, 292) = 1.45$, $p = 0.18$, $\eta^2_p = 0.04$, and the portion size × context interaction, $F(8, 292) = 0.68$, $p = 0.71$, $\eta^2_p = 0.02$, were not significant. Given the significant multivariate effect of portion size, we proceeded to examine the univariate effect of portion size on each of the dependent variables (see Table 1). There was an effect of portion size on participants' serving size comparison ratings, such that those who received the large portion reported a larger discrepancy between the portion they were served and their usual lunch than did those who were served the small portion. There were, however, no significant differences between groups in intake comparisons, self-reported intake ratings, or change in hunger levels.

2.3. Discussion

Consistent with previous portion size research, we found a portion size effect on intake such that providing a larger portion resulted in greater food intake than did providing a smaller portion. Furthermore, the portion size effect was mediated by participants' perceptions of how much was an appropriate amount to eat, providing further experimental support for the idea that norms of appropriateness may be the mechanism underlying the effect. In addition, our results suggest that participants are insensitive to the impact that larger portions have on their food intake (see also Kral et al., 2004; Levitsky & Youn, 2004; Rolls et al., 2002). That is, even though participants in the large portion condition ate an average of 26% more pasta than did those in the small portion condition, there were no group differences in self-reported intake estimates, comparisons of how much they ate compared to how much they normally eat, or changes in hunger across the course of the meal.

Contrary to the hypotheses, contextual size information did not attenuate the magnitude of the portion size effect. The absence of an interaction between portion size and context was surprising given that previous research has demonstrated that contextual cues can influence food intake (e.g., Aydinoğlu & Krishna, 2010; Just & Wansink, 2014; Polivy et al., 2010; Spanos et al., 2015). One possibility is that contextual size information is particularly influential when participants are selecting their own portion size (participants in Study 1 were randomly assigned to portion size condition). Specifically, giving participants the opportunity to choose their preferred portion size based on contextual size information rather than assigning them to eat from a particular portion (in the presence of that same contextual information) might have a different effect on subsequent food intake. Indeed, the main value of contextual size information would be to facilitate consumer choice between multiple portion size options at point-of-purchase. Therefore, research that takes choice into consideration might provide a more externally valid examination of the effects of contextual size information on food intake. Thus, Study 2 explored whether an effect of context on food intake emerges when participants are offered a choice of portion size.

Table 1
Serving size comparison, intake comparison, self-reported intake, and change in hunger for the small and large portion conditions (Study 1).

Variable	Small portion		Large portion		$F(1, 148)$	η^2_p
	M	*SD*	*M*	*SD*		
Serving size comparison	3.64	0.71	4.65	0.64	84.89*	0.37
Intake comparison	2.70	1.08	2.71	1.10	0.01	<0.01
Self-reported intake	206.49	78.17	226.75	104.66	2.19	0.02
Hunger (pre-post)	48.53	24.18	53.92	21.05	2.19	0.02

Note. Serving size comparison = ratings of how the size of their portion compared to the amount they would normally serve themselves for lunch, (1 = *much smaller*; 5 = *much larger*); Intake comparison = ratings of how much they ate in the experiment compared to the amount they would normally eat for lunch (1 = *much less*; 5 = *much more*).
Change in hunger level was examined by calculating a difference score from the pre- and post-hunger ratings. When hunger was examined as a repeated-measures variable, there was still no significant difference in change in hunger levels between the small and large portion groups.
*$p < 0.001$.

3. Study 2

The aim of Study 2 was to determine whether contextual cues influenced the portion size effect when participants were allowed to choose their own portion size. In an online study, participants were asked to imagine they were having lunch and that they had been served a small or large portion of pasta. In order to draw parallels with Study 1, some participants were randomly assigned to the small portion or large portion condition along with no context information or with the label + visual comparison information. A new condition was added in which participants were also given contextual size information but, rather than being assigned to a portion size, were asked to choose the portion they preferred. All participants then reported how much of the portion of pasta they would eat (referred to as "prospective intake"; see Ferriday & Brunstrom, 2008). First, based previous research demonstrating that the portion size effect holds for intended food consumption (Robinson, te Raa, & Hardman, 2015), we hypothesized that participants in the large portion conditions would report a higher prospective intake than would those in the small portion conditions. Second, given that Study 1 failed to find an effect of context of the portion size effect when participants were assigned to a particular portion size, we hypothesized that contextual size information would attenuate the portion size effect for those who chose their portion but not for those who were randomly allocated

[2] Although some participants in the small portion condition finished their entire serving ($n = 21$) removing these participants from the analysis had no impact on the pattern of results, consistent with previous studies (e.g., Kral et al., 2004; Rolls et al., 2002).

to portion size condition.

3.1. Method

3.1.1. Participants

Participants were 355 females residing in the United States who were recruited online via the Amazon Mechanical Turk website and were reimbursed USD $1.00 for their participation. Five participants were excluded for responding incorrectly to the attention check questions, resulting in a final sample consisted of 350 participants with a mean age of 25.88 years ($SD = 3.05$) and a mean BMI of 25.49 ($SD = 6.89$). With regards to ethnicity, 77.4% were Caucasian, 10.3% were African American, 5.1% were Asian, 4.6% were Hispanic, 0.3% were of American Indian origin, and 2.3% identified as "other". The study was approved by the university's ethics advisory panel.

3.1.2. Materials

3.1.2.1. Portion size manipulation. Pilot testing was carried out using an online forced-choice task to identify the two portion sizes that would be suitable for use as the small and large portions in Study 2. An image series was created that consisted of eight different-sized portions of pasta. The portions were presented on a placemat with cutlery and a glass of water in the picture to provide a reference point for the bowl size (cf. Hieke, Palascha, Jola, Wills, & Raats, 2016). The portions increased in increments of 75 g of pasta (119 g in total of pasta and sauce). This 75 g increment was chosen based on the Australian dietary guidelines which state that one serve of carbohydrate is approximately equivalent to 75 g of pasta (National Health and Medical Research Council, 2013). Thus, portions ranged from 119 g to 953 g (representing approximately one to eight standard servings). Pairs of images were created combining each portion size with every other portion size, resulting in 28 pairs in total. Order of presentation of the 28 pairs was randomized, and the position of the larger portion (left or right) was randomized within each pair. For each pair, pilot participants ($N = 107$) were asked to select the portion they preferred to eat for lunch. Ranked pairs analysis showed that the most preferred portion size was 358 g (*Image 3*) and that the two next most preferred portion sizes were the 238 g portion (*Image 2*) and the 477 g portion (*Image 4*). These latter two portions were selected for use as the small and large portion sizes in the main study because: (a) they were the portions that were one size smaller and one size larger than the most preferred portion, (b) 50% of participants preferred Image 2 and 50% of participants preferred Image 4 when those two images were paired together, and (c) the large portion was twice the size of the small portion.

3.1.2.2. Context manipulation. As in Study 1, in the no context condition, participants were shown an unlabeled small or large portion without any reference made to its size, and were asked to imagine they had been served that portion for lunch. Again following Study 1, participants in the label + visual comparison condition were shown both labeled portions and were then asked to imagine they had been served either the small portion or the large portion for lunch. Study 2 added a choice condition in which participants were shown both labeled portions and were then asked to choose which one they would prefer for lunch.

3.1.2.3. Prospective intake. Prospective intake ratings were obtained using the same method used for self-reported intake ratings in Study 1. That is, participants were shown a series of 11 images of pasta ranging from 100% (a full bowl) to 0% (an empty bowl), decreasing in decrements of 10% of the original serving size. They were asked to select the image that most closely approximated how much pasta they would leave behind in their bowl after they were finished eating. This percentage was subtracted from 100% and multiplied by the weight of the portion they viewed (238 g for the small portion and 477 g for the large portion), and this value (in grams) was used as their prospective intake rating. Previous research has demonstrated that self-reported ratings of ideal portion size made using pictorial stimuli provide a good approximation of intake in the laboratory (Wilkinson et al., 2012).

3.2.2.4. Perceived appropriateness. Ratings of how much was appropriate to eat were obtained using the same method as Study 1. These ratings were again used to test perceptions of appropriateness as a potential mechanism of any effects of portion size or context on prospective intake.

3.1.2.5. Perceptions of portion size. Using the same method as Study 1, perceptions of portion size were assessed by having participants rate how the size of the serving they were assigned or chose compared to the amount they normally serve themselves for lunch on a scale from 1 (*much smaller*) to 5 (*much larger*). Given that participants' choice in portion size may be influenced by how much they typically eat or typically serve themselves, serving size comparison ratings were examined as a potential covariate.

3.1.2.6. Hunger levels, recent intake and food preferences. Participants rated their hunger level on a sliding visual analogue scale from 0 (*not at all*) to 100 (*extremely*) and indicated the number of hours since they last ate. They also rated how much they generally liked pasta with tomato sauce on a visual analogue scale from 0 (*not at all*) to 100 (*very much*) and indicated how frequently they eat pasta on a six-point scale ranging from 1 (*never*) to 6 (*once a day*). Hunger, hours since previous meal, liking of pasta, and frequency of eating pasta were all examined as potential covariates.

3.1.2.7. Attention check. Attention check questions were included to verify that participants in the label + visual comparison conditions and choice condition were attending to the contextual size information provided. They were shown both the small and large portion images and were asked to indicate which portion they answered questions about during the study. A multiple choice picture identification question was also included as an additional general attention check for all conditions: Participants were asked to select the correct name of the household object depicted in the image. Participants who responded incorrectly to any of the attention check items were excluded.

3.1.2.8. Demographics. Participants provided their age, ethnicity, country of residence, height and weight. Age and BMI (calculated from participants' height and weight) were examined as potential covariates.

3.1.3. Procedure

Participants signed up for a study on "hunger and food perception". After providing informed consent, they were instructed to imagine they were just about to have lunch and to think about how hungry they typically are at lunch time, and how much they typically feel like eating for lunch. They were then shown the portion size images relevant to their randomly-allocated condition: an unlabeled small or large portion in the no context conditions; both labeled portions followed by one of the two portions alone in the label + visual comparison conditions; or both labeled portions from which they chose their preferred portion in the choice condition. Participants then imagined that they were served their assigned or chosen portion for lunch, and reported their prospective intake. They also reported how much was appropriate to eat, and rated the size of the portion in comparison to their usual lunch.

They then completed further questions about their hunger levels, recent intake, food preferences, basic demographic information, and completed the attention check questions. The entire study was conducted online.

3.1.4. Statistical analyses

Data were screened for statistical outliers but, given that removing these outliers had no impact on the pattern of results, the analyses reported below include the full sample. Prospective intake was significantly correlated with serving size comparison ratings ($r = -0.14$, $p = 0.01$) and with BMI ($r = 0.12$, $p = 0.02$). Therefore, the primary analysis was an ANCOVA with portion-size condition and context condition as the independent variables, prospective intake as the dependent variable, and comparative serving size ratings and BMI as covariates. None of the other proposed covariates (age, baseline hunger, liking of pasta, frequency of eating pasta, and hours since last meal) were correlated with prospective intake, and were therefore not included in the subsequent analyses. Mediation analysis was then conducted to determine whether participants' ratings of how much was appropriate to eat mediated any between-group differences in prospective intake.

3.2. Results

3.2.1. Portion size effect and context effects on prospective intake

Consistent with the hypothesis and with Study 1, the ANCOVA revealed a main effect of portion size on prospective intake, $F(1, 342) = 534.36$, $p < 0.001$, $\eta^2_p = 0.61$. Averaged across context conditions, participants who were allocated to or chose the large portion reported a higher prospective intake ($M = 357.49$ g, $SD = 108.46$) than did those who were allocated to or chose the small portion ($M = 199.10$ g, $SD = 52.62$). There was no significant main effect of context on prospective intake, $F(2, 342) = 0.58$, $p = .56$, $\eta^2_p < 0.01$. Contrary to expectations, there was also no significant portion size × context interaction, $F(2, 342) = 0.30$, $p = 0.74$, $\eta^2_p < 0.01$. See Fig. 3.

3.2.2. Mediation analysis

As with Study 1, portion size was a significant predictor of appropriateness ratings, $F(1, 348) = 343.84$, $p < 0.001$, $R^2 = 0.50$, with the larger portion leading to greater estimates of how much was appropriate to eat. As predicted, there was also a significant indirect effect of portion size on prospective intake through ratings of how much was appropriate to eat (point estimate = 87.48, $SE = 10.22$, 95% CI = 67.24, 107.40).

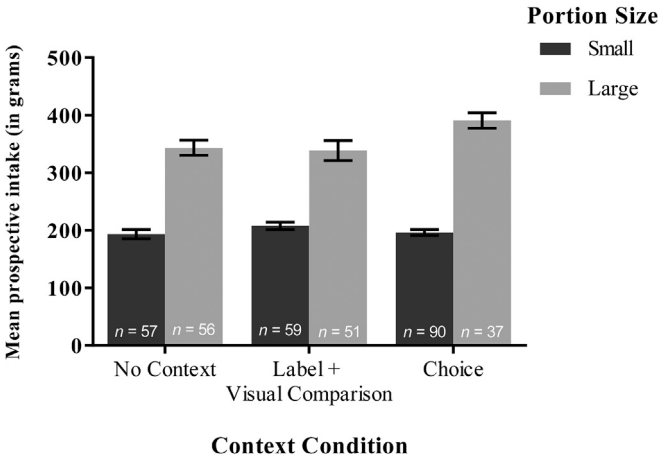

Fig. 3. Mean prospective pasta intake (in grams) for each portion size × context condition for Study 2. Error bars represent standard errors.

3.3. Discussion

Consistent with previous research (Robinson et al., 2015), we found a portion size effect on prospective intake such that those in the large portion conditions reported a higher prospective intake than did those in the small portion conditions (regardless of whether they chose or were assigned these portions). Furthermore, as in Study 1, appropriateness was a significant mediator of the portion size effect on prospective intake. Contrary to expectations, we found that contextual size information did not attenuate the portion size effect even for those who chose their preferred portion size. Therefore, in accordance with Study 1, Study 2 failed to find evidence that contextual size information influences the portion size effect on prospective intake.

4. General discussion

The aim of the present research was to explore whether contextual size information attenuates the portion size effect on food intake. First, consistent with previous research, we replicated the portion size effect, demonstrating that serving people larger portions results in increased food intake (Study 1) and increased prospective food intake (Study 2). Second, the portion size effect was robust to context across studies—that is, the contextual size information did not reduce the portion size effect. Third, perceived appropriateness mediated the portion size effect such that the size of the portion influenced ratings of how much was appropriate to eat, which in turn influenced (actual or prospective) food intake.

4.1. Contextual size information and the portion size effect

In order to explore the influence of context on the portion size effect, some participants were given additional contextual size information in the form of size labels or labels and visual comparisons to the other available portion size. This approach may more closely approximate the manner in which portion size options are presented at point-of-purchase than the typical portion-size study. Contrary to expectations, however, we found that providing contextual size information did not attenuate the portion size effect, regardless of whether people were randomly allocated to receive their portion (Study 1) or chose their own portion size (Study 2). The lack of context effect was surprising given that changing the contextual size information associated with a fixed portion of food can influence eating behavior (e.g., Aydinoğlu & Krishna, 2010; Spanos et al., 2015). Our findings suggest that the portion size effect is powerful enough to offset other factors that might be expected to influence food intake (cf. Cavanagh et al., 2014; Wansink & Kim, 2005).

One potential explanation for the absence of a context effect on the portion size effect is that, context may have had only a transient influence on perceptions of size. In Study 1, participants viewed the contextual size information while they were being served their assigned portion, but the contextual cues were removed before they started eating. The contextual size information may have influenced *initial* perceptions of portion size, but once participants had been given their portion, the contextual size information they had seen previously was no longer salient and so the portion size per se became the strongest determinant of food intake. This same transient effect of context cues might explain why, although the contextual size information provided by plate size influences how the size of a portion is perceived (e.g., van Ittersum & Wansink, 2012), there is little evidence to suggest that plate size can influence subsequent food intake (see Robinson et al., 2014; for a

review). Similarly, although researchers have suggested that the size of the food packaging might influence perceptions of serving size (see English et al., 2015), package size has been shown to have no impact on intake when portion size is held constant (Raynor & Wing, 2007).

In order to clarify the lack of context effect observed in the present studies, and the time course of any context effects more generally, future research could test whether an effect of contextual size information on food intake emerges when contextual cues are made more salient (e.g., by leaving the alternative portion size in a visible location as a cue present while participants are eating). One previous study (Choplin & Motyka Joss, 2012) has explored this idea by having participants consume lunch *ad libitum* from a target portion of pasta salad in the presence of either a much larger comparison portion or a slightly larger comparison portion that was purportedly for another participant who was running late. Participants who ate in the presence of the much larger comparison portion consumed more from their own smaller portion than did those who saw the slightly larger comparison portion, providing some evidence that salient comparative contextual size information can influence food intake. Although this "continuous exposure" approach does not parallel most real-word eating situations (and thus lacks external validity), research along this line might nonetheless help clarify how contextual size information can influence food intake.

4.2. Mechanism of the portion size effect: consumption norms

Across the two studies, we found that ratings of how much was appropriate to eat mediated the portion size effect on intake or prospective intake, providing support for the normative account of the portion size effect (Herman et al., 2015). Our findings suggest that larger portions imply that a larger amount of food is appropriate to eat, and this perception of appropriateness leads to greater food intake with larger portions. Kerameas et al. (2015) demonstrated that ratings of appropriateness mediate the portion size effect on snack food intake, and we extended their findings by showing that perceived appropriateness mediated the portion size effect on intake of meal foods, as well as on *prospective* intake in an imaginal setting, suggesting that perceptions of appropriateness also influence planned eating behavior.

It is important to note that, in order to reduce demand characteristics that could have biased their eating behavior, participants were asked how much they thought was appropriate to eat *after* they had eaten or reported their prospective intake. To conclusively demonstrate mediation by perceived appropriateness, portion size would need to be shown to influence appropriateness ratings prior to eating. However, other research has shown that perceived norms of appropriateness mediate the effects of social models on consumption, regardless of whether ratings of appropriateness are taken before or after eating (Vartanian et al., 2013).

An alternative approach would be to directly manipulate perceived appropriateness and examine its impact on food intake. For example, a recent study demonstrated that repeated visual exposure to either small or large portions can influence peoples' perceptions of what constitutes a "normal" portion size and an "ideal" portion size (Robinson et al., 2016). However, exposure to small or large portions did not influence subsequent food intake in that study. It may be that appropriateness norms need to be specific to the particular setting in order to influence food intake. For example, the norm created by the size of the portion from which the participant is eating is relevant to that specific meal, but the more general notion of what is appropriate might not be as strong a predictor of food intake in any given setting. In any case, future research is needed to further understand how and when norms of appropriateness influence food intake.

4.3. Insensitivity to the portion size effect

We also found that participants were not sensitive to the effect of portion size on their own food intake. Specifically, in Study 1, participants that were served the large portion ate more food, and perceived there to be a greater discrepancy between the size of the portion they were served and the amount they normally serve themselves for lunch, compared to participants that were served the small portion. However, there was no between-group difference in their change in reported hunger levels after eating, consistent with previous research (e.g., Kral et al., 2004; Levitsky & Youn, 2004; Rolls et al., 2002; Wansink & Kim, 2005). In addition, we found that there were no differences in participants' self-reported estimations of how much they had eaten or comparative intake ratings across portion size groups, further indicating that participants were insensitive to the influence of portion size on their eating behavior.

The contribution of portion size to unintentional overconsumption has implications for the architecture of the food environment. Public health advocates and researchers alike have suggested limiting the availability of large portions of unhealthy, nutrient poor food (e.g., soft drinks) on the bases that: (a) relatively small energy deficits (e.g., 100 kcal a day) are thought to be sufficient to offset weight gain in adults (Hill, Wyatt, & Peters, 2012; Hill, Wyatt, Reed, & Peters, 2003), and (b) the increased intake associated with large portions often exceeds 100 kcal for a single meal alone (e.g., Diliberti et al., 2004; Levitsky & Youn, 2004; Rolls et al., 2002). Indeed, in Study 1 of the present research, we found that participants in the large portion conditions consumed approximately 143 kcal more pasta than did those in the small portion conditions. Although interventions that reduce the availability of large portions are likely to be efficacious in reducing overconsumption (Steenhuis & Vermeer, 2009), they are also perceived as unacceptably paternalistic by the general public and are thus unlikely to be successful (Vermeer, Steenhuis, & Seidell, 2010). Thus, alternative approaches that impact food intake by shifting consumption norms might be more effective in the long term.

4.4. Limitations and future directions

One limitation of the present research is that our samples consisted exclusively of young women. However, previous research has shown that portion size effect also occurs in men (Zlatevska, Dubelaar, & Holden, 2014), and there is no empirical basis for expecting that men and women, or younger and older adults, would differ in their responses to contextual size information. Furthermore, although our samples were homogenous in terms of gender and age, we did find consistent results across the two studies which differed somewhat in their ethnic composition (approximately half of the participants in Study 1 identified as Asian, whereas participants in Study 2 predominantly identified as Caucasian). In addition, the present studies only looked at one type of food, though again there is little evidence to suggest that effects of context on intake might emerge for other foods, given that the portion size effect is found for a variety of different types of food (Zlatevska et al., 2014). Nonetheless, future research should investigate portion size and context effects in more diverse samples and using a wider array of foods.

The current research was also limited by the use of an online paradigm in Study 2. First, self-reported prospective intake was used in place of actual intake. Although prospective intake has been shown to provide a reasonable approximation of consumption (e.g.,

Robinson et al., 2015; Wilkinson et al., 2012), there may be demand characteristics associated with asking people to report how much they would eat which could result in biased estimates. Second, participants' ratings were based on two-dimensional images of portions, rather than viewing the actual portion sizes. Although we aimed to increase the accuracy of ratings by using images with varying proportions of the full portion (following Brunstrom et al., 2008; Ferriday & Brunstrom, 2008) and by providing a reference for size by photographing the bowls next to cutlery and a glass of water (following Hieke et al., 2016), viewing portions *in vivo* is likely to result in more precise size estimations. Third, imagining the choice one would make in a particular situation may differ from the actual choice executed in the real world where other factors such as cost of the food, mood, and presence of other people may also be considered. Although one validation study found that portion size decisions and actual purchasing behavior were highly correlated with virtual purchasing (Sharpe, Staelin, & Huber, 2008), online choice is unlikely to be a perfect approximation for real world choice. Further research should examine portion size decisions in the field to validate the present findings.

4.5. Concluding remarks

We examined the potential importance of contextual size information in people's food intake and found little evidence that contextual cues (either portion size labels or visual comparisons) attenuate the portion size effect. Thus, the portion size effect appears to be robust to contextual size information. In addition, we provided further support for the consumption norm account of the portion size effect by demonstrating that perceived appropriateness underlies increased intake with larger portions. A key implication of our findings is that interventions that modify consumption norms (e.g., public health campaigns that provide normative information about how other people behave) may be an effective way to address increasing portion sizes and promote healthier consumer food decisions.

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References

Aydinoğlu, N. Z., & Krishna, A. (2010). Guiltless gluttony: The asymmetric effect of size labels on size perceptions and consumption. *Journal of Consumer Research, 37*, 1095–1112. http://dx.doi.org/10.1086/657557.

Bar, M. (2004). Visual objects in context. *Nature Reviews Neuroscience, 5*, 617–629. doi:10.1038.nrn1476.

Benton, D. (2015). Portion size: What we know and what we need to know. *Critical Reviews in Food Science and Nutrition, 55*, 998–1004. http://dx.doi.org/10.1080/10408398.2012.679980.

Brunstrom, J. M., Shakeshaft, N. G., & Scott-Samuel, N. E. (2008). Measuring 'expected satiety' in a range of common foods using a method of constant stimuli. *Appetite, 51*, 604–614. http://dx.doi.org/10.1016/j.appet.2008.04.017.

Byrd-Bredbenner, C., & Schwartz, J. (2004). The effect of practical portion size measurement aids on the accuracy of portion size estimates made by adolescents. *Journal of Human Nutrition and Dietetics, 17*, 351–357. http://dx.doi.org/10.1111/j.1365-277X.2004.00534.x.

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. http://dx.doi.org/10.1177/1359105313478645.

Choplin, J. M., & Motyka Joss, L. (2012). Simultaneous and sequential comparisons of food quantity and consumption. *Eating Behaviors, 13*(4), 310–316. http://dx.doi.org/10.1016/j.eatbeh.2012.05.002.

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 meal. *Obesity Research, 12*, 562–568. http://dx.doi.org/10.1038/oby.2004.64.

English, L., Lasschuijt, M., & Keller, K. L. (2015). Mechanisms of the portion size effect. What is known and where do we go from here? *Appetite, 88*, 39–49. http://dx.doi.org/10.1016/j.appet.2014.11.004.

Ferriday, D., & Brunstrom, J. M. (2008). How does food-cue exposure lead to larger meal sizes? *British Journal of Nutrition, 100*, 1325–1332. http://dx.doi.org/10.1017/S0007114508978296.

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

Herman, C. P., & Polivy, J. (1980). Restrained eating. In A. J. Stunkard (Ed.), *Obesity* (pp. 208–225). Philadelphia, PA: Saunders.

Herman, C. P., Polivy, J., Pliner, P., & Vartanian, L. R. (2015). Mechanisms underlying the portion-size effect. *Physiology and Behavior, 144*, 129–136. http://dx.doi.org/10.1016/j.physbeh.2015.03.025.

Hieke, S., Palascha, A., Jola, C., Wills, J., & Raats, M. M. (2016). The pack size effect: Influence on consumer estimates of portion size. *Appetite, 96*, 225–238. http://dx.doi.org/10.1016/j.appet.2015.09.025.

Hill, J. O., Wyatt, H. R., & Peters, J. C. (2012). Energy balance and obesity. *Circulation, 126*, 126–132. http://dx.doi.org/10.1161/circulationaha.111.087213.

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. http://dx.doi.org/10.1126/science.1079857.

van Ittersum, K., & Wansink, B. (2012). Plate size and color suggestibility: The Delboeuf illusion's bias on serving and eating behaviour. *Journal of Consumer Research, 39*, 215–228. http://dx.doi.org/10.1086/662615.

Just, D. R., & Wansink, B. (2014). One man's tall is another man's small: How the framing of portion size influences food choice. *Health Economics, 23*, 776–791. http://dx.doi.org/10.1002/hec.2949.

Kerameas, K., Vartanian, L. R., Herman, C. P., & Polivy, J. (2015). The effect of portion size and unit size on food intake: Unit bias or segmentation effect? *Health Psychology, 34*, 670–676. http://dx.doi.org/10.1037/hea0000160.

Kral, T. V. E., Roe, L. S., & Rolls, B. J. (2004). Combined effects of energy density and portion size on energy intake in women. *American Journal of Clinical Nutrition, 79*, 962–968.

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., & Papies, E. K. (2014). A brief mindfulness intervention reduces unhealthy eating when hungry, but not the portion size effect. *Appetite, 75*, 40–45. http://dx.doi.org/10.1016/j.appet.2013.12.009.

Marchiori, D., Papies, E. K., & Klein, O. (2014). The portion size effect on food intake. An anchoring and adjustment process? *Appetite, 81*, 108–115. http://dx.doi.org/10.1016/j.appet.2014.06.018.

National Health and Medical Research Council. (2013). *Eat for health: Australian dietary guidelines summary*. Canberra, Australia: Author.

Polivy, J., Herman, C. P., & Deo, R. (2010). Getting a bigger slice of the pie. Effects on eating and emotion in restrained and unrestrained eaters. *Appetite, 55*, 426–430. http://dx.doi.org/10.1016/j.appet.2010.07.015.

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

Robinson, E., Nolan, S., Tudur-Smith, C., Boyland, E. J., Harrold, J. A., & Halford, J. C. G. (2014). Will smaller plates lead to smaller waists? A systematic review and meta-analysis of the effect that experimental manipulation of dishware size has on energy consumption. *Obesity Reviews, 15*, 812–821. http://dx.doi.org/10.1111/obr.12200.

Robinson, E., Oldham, M., Cuckson, I., Brunstrom, J. M., Rogers, P. J., & Hardman, C. A. (2016). Visual exposure to large and small portion sizes and perceptions of portion size normality: Three experimental studies. *Appetite, 98*, 28–34. http://dx.doi.org/10.1016/j.appet.2015.12.010.

Robinson, E., te Raa, W., & Hardman, C. A. (2015). Portion size and intended consumption. Evidence for a pre-consumption portion size effect in males? *Appetite, 91*, 83–89. http://dx.doi.org/10.1016/j.appet.2015.04.009.

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. *American Journal of Clinical Nutrition, 76*, 1207–1213.

Rolls, B. J., Roe, L. S., & Meengs, J. S. (2007). The effect of large portion sizes on energy intake is sustained for 11 days. *Obesity, 15*, 1535–1543. http://dx.doi.org/10.1038/oby.2007.182.

Sharpe, K. M., Staelin, R., & Huber, J. (2008). Using extremeness aversion to fight obesity: Policy implications of context dependent demand. *Journal of Consumer Research, 35*, 406–422. http://dx.doi.org/10.1086/587631.

Spanos, S., Kenda, A. S., & Vartanian, L. R. (2015). Can serving-size labels reduce the portion-size effect? A pilot study. *Eating Behaviors, 16*, 40–42. http://dx.doi.org/10.1016/j.eatbeh.2014.10.007.

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). http://dx.doi.org/10.1186/1479-5868-6-58.

Turconi, G., Guarcello, M., Gigli Berzolari, F., Carolei, A., Bazzano, R., & Roggi, C. (2005). An evaluation of a colour food photography atlas as a tool for quantifying food portion size in epidemiological dietary surveys. *European Journal of Clinical Nutrition, 59*, 923–931. http://dx.doi.org/10.1038/sj.ejcn.1602162.

Ueland, Ø., Cardello, A. V., Merrill, E. P., & Lesher, L. L. (2009). Effect of portion size information on food intake. *Journal of the American Dietetic Association, 109*, 124–127. http://dx.doi.org/10.1016/j.jada.2008.10.002van.

Vartanian, L. R., Sokol, H., Herman, C. P., & Polivy, J. (2013). Social models provide a norm of appropriate food intake for young women. *PLOS ONE, 8*(11), e79268. http://dx.doi.org/10.1371/journal.pone.0079268.

Vermeer, W. M., Steenhuis, I. H. M., & Seidell, J. C. (2010). Portion size: A qualitative

study of consumers' attitudes toward point-of-purchase interventions aimed at portion size. *Health Education Research, 25*, 109–120. http://dx.doi.org/10.1093/her/cyp051.

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. http://dx.doi.org/10.1016/S1499-4046(06)60278-9.

Wilkinson, L. L., Hinton, E. C., Fay, S. H., Ferriday, D., Rogers, P. J., & Brunstrom, J. M. (2012). Computer-based assessments of expected satiety predict behavioural measures of portion-size selection and food intake. *Appetite, 59*, 933–938. http://dx.doi.org/10.1016/j.appet.2012.09.007.

Williamson, D. A., Allen, H. R., Davis Martin, P., Alfonso, A. J., Gerald, B., & Hunt, A. (2003). Comparison of digital photography to weighed and visual estimation of portion sizes. *Journal of the American Dietetic Association, 103*, 1139–1145. http://dx.doi.org/10.1052/jada2003.50567.

Zlatevska, N., Dubelaar, C., & Holden, S. S. (2014). Sizing up the effect of portion size on consumption: A meta-analytic review. *Journal of Marketing, 78*(3), 140–154. http://dx.doi.org/10.1509/jm.12.030.