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Portion Size Me: Plate-Size Induced Consumption Norms and Win-Win Solutions for Reducing Food Intake and Waste

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Research on the self-serving of food has empirically ignored the role that visual consumption norms play in determining how much food we serve on different sized dinnerware. We contend that dinnerware provides a visual anchor of an appropriate fill-level, which in turn, serves as a consumption norm (Study 1). The trouble with these dinnerware-suggested consumption norms is that they vary directly with dinnerware size—Study 2 shows Chinese buffet diners with large plates served 52% more, ate 45% more, and wasted 135% more food than those with smaller plates. Moreover, education does not appear effective in reducing such biases. Even a 60-min, interactive, multimedia warning on the dangers of using large plates had seemingly no impact on 209 health conference attendees, who subsequently served nearly twice as much food when given a large buffet plate 2 hr later (Study 3). These findings suggest that people may have a visual plate-fill level—perhaps 70% full—that they anchor on when determining the appropriate consumption norm and serving themselves. Study 4 suggests that the Delboeuf illusion offers an explanation why people do not fully adjust away from this fill-level anchor and continue to be biased across a large range of dishware sizes. These findings have surprisingly wide-ranging win–win implications for the welfare of consumers as well as for food service managers, restaurateurs, packaged goods managers, and public policy officials.

Keywords: optical illusions, consumption norms, Delboeuf, serving size, plate size, food waste

Shortly after its introduction, "100 calorie packs" of snacks were heralded as one of the "10 Best Product Innovations of 2007" (Karaim, 2007, p. 15). These higher margin products represented a win–win way for food companies to profitably help consumers reduce how much they ate and still be satisfied. Shortly after the discovery that taller glassware can reduce overpouring (Wansink & van Ittersum, 2003, 2005), *Smart Money* claimed it represented a win–win way for restaurant and bar owners to profitably decrease alcohol costs while simultaneously helping consumers drink less alcohol yet remain satisfied (Parmar, 2007, p. 31). As with the 100 calorie packs and taller glasses, there is a possibility that reducing the size of plates may have a referred win–win impact on consumer waistlines and the financial performance of restaurateurs. And although our understanding about the impact of plate size on serving behavior is growing, critical questions remain. This research examines plate-size induced consumption norms and the implications they have for consumers and companies.

Recent research on the plate-size induced serving biases suggests that the Delboeuf illusion—the phenomenon that the perceived size of a circle changes as a function of the size of a concentric circle surrounding it—may explain why consumers serve more on larger plates and bowls (van Ittersum & Wansink, 2012). Building on this research, we examine the impact that plate size has on one's consumption norms (the portion size deemed appropriate by the consumer) and on one's behavior. Understanding how these norms evolve and influence food intake offers two key benefits. First, it broadens the theoretical understanding of how ineffective education and training is in reducing biased consumption norms. Second, it extends earlier research on plate-size suggestibility by examining its impact on consumption norms, the consequences, and by identifying innovative strategies that reduce food intake and waste.

This research is organized as follows. After briefly introducing the notion of consumption norms, Study 1 demonstrates that consumers are able to visually differentiate between their own consumption norms and what they think is generally appropriate. Study 2 uses the unconstrained food levels at a Chinese buffet to show the wide-ranging impact this visual norm has on overconsumption and food waste. Study 3 shows that this serving bias even occurs shortly after conference-goers received a 60-min education about the bias. Following Study 3, a detailed discussion of the Delboeuf illusion is offered

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as a contributing explanation as to why this serving bias persists. Specifically, the relationship between consumption norms, plate size, and serving biases is elaborated upon, and the conditions triggering the largest biases are identified. Study 4 examines this in a controlled lab experiment. We conclude with wide-ranging implications toward how the findings in this research could have a win–win influence on both the welfare of consumers and companies.

Consumption Norms

People can be very impressionable when it comes to how much they will eat. There is a flexible range as to how much food an individual can eat (Herman & Polivy, 1984), and one can often "make room for more" (Berry, Beatty, & Klesges, 1985). For this reason, if a person generally eats 3 oz. of pasta for dinner, he or she may be quite content eating 2 oz. to 4 oz. of pasta for dinner without feeling either overly hungry or overly full at the end of the meal.

For many individuals, determining how many ounces of pasta to serve themselves for dinner is a relatively low-involvement behavior that is a difficult nuisance to repeatedly and accurately monitor. As a result, people tend to rely on consumption norms—the serving size individuals deem appropriate—to help them determine how much they would like to consume (Wansink & van Ittersum, 2007). Food-related estimation and consumption behavior can be based on how much one normally consumes, yet consumption can also be unknowingly influenced by other norms or cues that are present in the environment (Wansink, 2004; Folkes & Matta, 2004; Herman & Polivy, 1984). For instance, larger kitchenware in homes all suggest a consumption norm that very subtly influences how much people believe is appropriate to eat (Sobal and Wansink, 2007; Sharp and Sobal, 2012). Large-sized dinnerware may perceptually suggest to us that it is more appropriate, typical, reasonable, and normal to serve and to eat more food than smaller plates would instead suggest. As such, this influences our personal consumption norm for that situation.

This use of consumption norms, as with normative benchmarks in other situations, may be relatively automatic and may often occur outside of conscious awareness (Schwarz, 1996). This is what makes these norms so powerful. Even when made aware of them, most people are unwilling to acknowledge that they could be influenced. This would lead us to hypothesize that conventional education campaigns and training efforts may not be effective in reducing the influence of these biases. First, many people would not believe themselves to be influenced. Second, the visual bias could seemingly be hard-wired. In one study, professional bartenders showed a consistent bias of pouring 32% more alcohol in short-wide tumblers than tall-narrow high-ball glasses of the same volume. Yet when shown their bias and asked to repour, they still showed a significant 21% pouring bias in the same direction (Wansink & van Ittersum, 2005).

Study 1: How Full Should the Plate Be?

The purpose of Study 1 is to initially estimate the visual fill-level size of one's consumption norm relative to the level they perceive as generally appropriate. It specifically examines whether consumers can visually differentiate between appropriate portion sizes and their personal consumption norms. The study involved 219 students (116 male) from a large university, ranging in age from 18 to 28 with an average age of 20. The participants received partial course participation credit for their involvement in this study. Study 1, like all other studies, was IRB-approved.

Method

To examine whether consumers differentiate between portion and consumption norms, all participants were shown three sets of six bowls (d = 21.0 cm) filled with different serving sizes of cereal. Each set of six bowls used different types of cereal (Cheerios, Corn Pops, Cornflakes). The work by van Ittersum and Wansink (2012) suggests that estimation biases are most extreme at 1:3 and 2:3 ratios, and estimation biases approach zero for the 1:2 diameter ratio. Therefore, the serving sizes of cereal filled the bowls such that the ratios between the diameters of the serving sizes and the bowls were 1:4, 1:3, 1:2, 2:3, 3:4, and 1:1 (completely full). The sets were presented to participants independently (in three different lab rooms), sequentially, and in a random order. All bowls within a set were presented to participants simultaneously, although the order was randomized.

For each set, consumers were asked to make two selections. First, to assess participants' portion norm, they were asked "Please select the bowl that you believe is filled to an appropriate level." Next participants' consumption norms were determined by asking them "Please select the bowl that is filled to a level that you would typically serve yourself." Because there was no effect for the type of cereal used, we analyzed and report the results in the aggregate.

Results and Discussion

As Figure 1 shows, portion norms, $\chi^2(5) = 636.6$, $p < .01$ and consumption norms, $\chi^2(5) = 578.1$, $p < .01$ vary significantly with fill levels. Although 44.6% of the participants indicated that the bowl filled 2:3 contained the portion norm, only 21.9% felt that this bowl best represented their consumption norm ($p < .05$). Instead, 47.3% indicated that the bowl filled 3:4 best captured their consumption norm; with 17.0% actually selecting the bowl filled 1:1 as representing their consumption norms ($p < .01$). These results suggest that many consumers realize that their consumption norms exceed portion norms. This then begs the question of why this exaggerated norm develops, and more importantly, whether and how can it be downsized.

Study 1 provides evidence that people have a normative view as to how much is the appropriate amount of food to serve on a particular size of plate or bowl. It would seem that people know how much is generally the right amount to serve, but the results of Study 1 also suggest this is moderated by how much a person originally *intends* to serve.

This study suggests that with normal-sized dinnerware, people appear to visually anchor around the 70% fill level for dinnerware. This is what they consider to be their consumption norm and as generally being appropriate for others. Although Study 4 in this article will demonstrate that this fill level can expand or contract with the size of dishes, people appear to be stubbornly visually anchored to this consumption norm. For instance, even experts–nutrition science professors and researchers–overserved themselves by 37% when at an ice cream social and given a large bowl (Wansink, van Ittersum, & Painter, 2006). The next study gener-

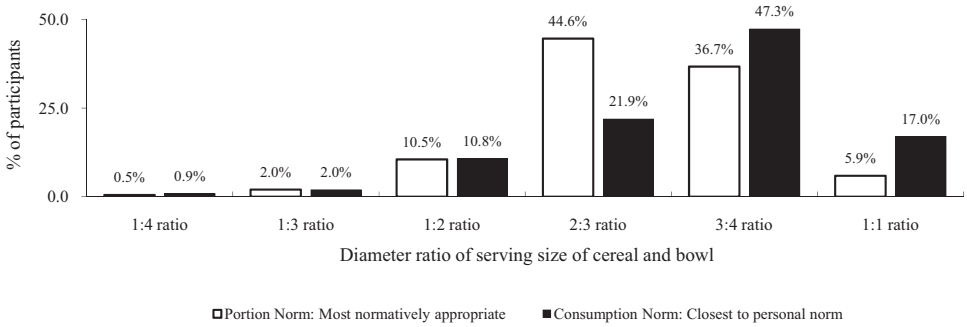


Figure 1. Which fill levels reflect portion norms and consumption norms.

ally examines the wide-ranging impact this visual consumption norm has on overconsumption and on waste.

Study 2: Large Plate Consumption and Waste in All-You-Can-Eat Chinese Buffets

Consumption norms should be powerful and have a consistent impact on serving behavior. To examine whether these norms influence serving and consumption in a natural eating environment, we conducted a field observation study in four Chinese restaurants located in New York and Pennsylvania with all-you-can-eat buffets. Of the 43 unsuspecting diners who were observed by trained observers, 22 were female (51%) with an estimated average age of 40.7 years (range 18–80 years). Diners took an average of 2.7 trips to the buffet (min = 1, max = 5, median = 3) and had the option to select either a smaller (d = 21.0 cm) or a larger plate (d = 26.5 cm).

Method

The food-related behaviors of the randomly selected diners were observed during their entire time in the restaurant. Participants were unobtrusively observed as they selected and filled their plate. Using age, weight, and height benchmarks, trained observers who were unaware of the research objectives noted the sex, age, weight, height, and the plate size the participants selected. To minimize intrusiveness, each participant was observed by one observant. Pretests confirmed that observer training yielded reliable ratings (Wansink & Payne, 2008). Using a series of accepted visual reference standards (Hanks, Just, & Wansink, in press), observers next estimated the plate's fill level (as a percentage of plate surface) each time a person returned from the buffet. Each time diners went to the buffet for another visit, the observers also estimated the amount of palatable food left on the plate (as a percentage of plate surface). This was facilitated by wait staff who insisted that diners use a clean plate when returning to the buffet. We accounted for the different observers in the analyses by adding an observer covariate. This covariate was not significant and did not influence the effect of plate size on serving, consumption, and waste. The fill levels and waste levels were averaged across trips and then translated into a serving size measure based on the size of the plate.

Eighteen participants selected the smaller plate and 25 selected the larger plate. Although we do not find differences in the sex (61.1% vs. 40.0%; $\chi^2(1) = 1.87$, $p = .22$), estimated age (37.7 vs. 42.8; $F(1, 41) = 1.20$, $p = .28$), Body Mass index (BMI; 26.1 vs. 28.5; $F(1, 41) = 1.82$, $p = .19$), or number of trips (2.8 vs. 2.6; $F(1, 41) = .38$, $p = .54$), one's hunger may have led him or her to select a larger versus smaller plate. It is not clear whether people serve themselves in proportion to their hunger. If they do, however, we should find no proportional differences between the amounts of food that very hungry diners waste compared with less hungry diners.

Results and Discussion

Diners who selected the larger plate served themselves 52.0% more total food than those who selected the smaller plate (1,216.9 vs. 800.5 cm^2; $F(1, 35) = 32.7$, $p < .01$, $\eta^2 = .48$). In addition to serving themselves 52.0% more food, they also consumed 45.1% more food than people with smaller plates (1,072.5 vs. 739.1 cm^2; $F(1, 35) = 11.9$, $p < .01$, $\eta^2 = .25$). As mentioned, these findings could in part be driven by plate size but also by differences in how hungry people were. However, if the participants served themselves proportional to their hunger, we should find differences in the proportion of food each group wastes. This was not, however, the case.

Although those with larger plates served and ate more, they also wasted 135.2% more food than those with smaller plates (144.4 vs. 61.4 cm^2; $F(1, 35) = 9.0$, $p < .01$, $\eta^2 = .20$). Diners with larger plates not only wasted more in an absolute sense, they also wasted relatively more. As Figure 2 indicates, although both diners wasted a significant percentage of the food they served, diners with larger plates wasted 14.4% of all the food they served themselves, compared with 7.9% among diners with smaller plates ($F(1, 35) = 6.4$, $p < .05$, $\eta^2 = .15$). These results suggest that participants' consumption norms are subject to the environmental cues such as the size of plates. Furthermore, plate size does not only affect food consumption, it also increases food waste.

Although there is power in observing unconstrained behavior—such as in not limiting one to a bowl size they would not have otherwise chosen—it is important to not overlook the concurrent limitation of self-selection. People with larger appetites might have taken larger plates, but they should have also eaten a higher percentage of what they took. Because this was not the case, it may be that the effects of self-selection may be weaker than the effects of large plates.

From a restaurant's perspective, Study 2 shows that even a restaurant's procurement decision about what plates to purchase could have a dramatic influence on subsequent food costs per

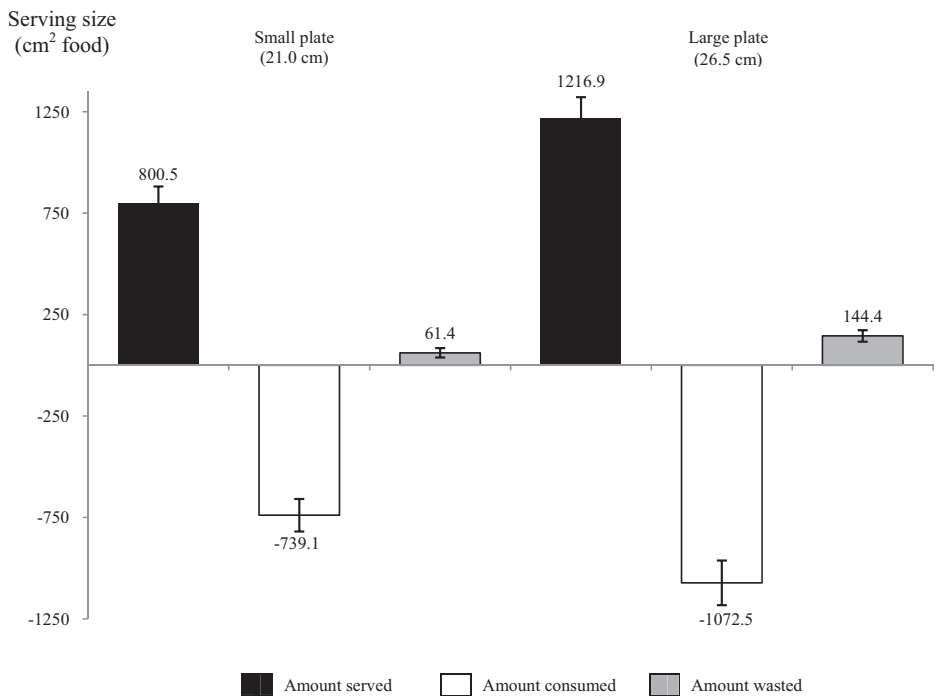


Figure 2. Larger plates are associated with more food being served, consumed, and wasted in all-you-can-eat Chinese buffets. * $p < .05$. ** $p < .01$.

individual (Wansink, 2014). Smaller plates were associated with smaller serving sizes and less waste. If people waste less of the food they serve themselves, it will likely lead them to serve less on subsequent visits. In this way, smaller plates could lead to cost savings from (a) smaller *initial* servings, and (b) less food waste (which may lead to even smaller subsequent servings). Because earlier studies indicated that consumers are generally unaware of serving and consuming less from smaller dinnerware (Wansink, 2006), this reduction in food cost (and potential increase in profitability) might be achieved without diminished customer satisfaction. This basic finding could also have a key implication for pricing. If consumers are unaware of serving themselves more on larger plates and bowls, they may underestimate the value they are receiving. In the hospitality industry, this could mean oversized portions are not appreciated or valued as highly as a restaurant might think.

Study 3: Conference Buffet Behavior Following a Large Plate Lecture

Study 1 indicated people may have a visual anchor of what is the appropriate amount to serve and that this might vary with dinnerware size. Study 2 indicated that larger dinnerware is associated with larger servings, larger consumption, and larger waste. This next study examines the extent to which vividly educating a group of professionals at a health conference about this large plate bias would influence their conference buffet serving behavior 2 hr later.

Method

Study 3 was conducted at a 3-day health education event at a hotel conference center in Salt Lake City, Utah involving 237 Human Resource managers and consultants who were attending a conference on changing health behavior in organizations. The 60-min keynote presentation of the event, the accompanying videos, the discussion, and even the preconference readings focused on how the environmental cues around us bias both our serving and consumption, with the specific focus being on plate-size and serving bowl-size (e.g., Wansink & Cheney, 2005). The presentation included descriptions of studies in which people overserved on to large plates, videos of this occurring, cartoons and photographs, and a discussion as to how it could prevented. Two hr following the presentation, the conference-goers were led to another room for lunch.

Two identical separate serving lines were set up 54 feet from each other. There was no difference in the type, amount, or order of food at the two buffets. The only difference was that one buffet line had only large plates ($d = 29.2$ cm) available for serving and the other line had only smaller plates ($d = 24.6$ cm) available.

As the conference going diners entered the main door to receive their lunch ticket, they were escorted to one table or the other in an alternating sequence. At this time—as well as during an earlier announcement—diners were told this was going to be a working lunch, and they had time to make one trip through the buffet before training would resume. Because many of these diners arrived in groups of two to four, care was made to keep them with their group and to escort the entire group to one of the buffet tables, and then to escort the next small group to the other table. In all, 209 individuals went through the buffet line within the allotted conference lunchtime (12:05 p.m.–1:10 p.m.).

The study did not involve direct contact with the diners other than escorting them to a buffet table. The buffet lines had seven different meal items on them: lettuce salad, vegetable salad, beef,

enchiladas, fried fish, tacos, and soup. No individual weights or measures were taken in order to keep the study as unobtrusive as possible. Instead, careful measures were taken of how much food was served in total to each of the two buffet tables and how many people served themselves from each table. Before food was served to each of the two tables (in full chafer pans), the weight of each food was taken. When it was returned (either empty or nearly empty), it was both reweighed as well as visually assessed as to its fill level (to the nearest 25%; see Hanks et al., 2013). The total volume of food served by the diners (the amount placed on the buffet line less the amount not served by the diners) was determined for each of the seven foods on each of the two buffet lines. To better standardize the volumes, the total amount served by the diners will be specified based on the number of standard-sized serving pans placed on the buffet and the aggregate volume (to the nearest 25%) taken from those pans. (Soup was not served in the standard-sized chafer pan but was placed on the buffet in heated crocks.)

Results and Discussion

As would be expected because of rotating assignment to the buffet tables, a similar number of people went through the buffet with the smaller plates ($n = 106$) as with the larger plates ($n = 103$). Consistent with expectations, those who were given larger plates served a great deal more food on to their plates than with smaller plates. As Figure 3 indicates, this was true for lettuce salad (7.25 vs. 2.25 trays), vegetable salad (6.25 vs. 1.75 trays), beef (6.0 vs. 3.75 trays), enchiladas (6.5 vs. 3.5 trays), and fried fish (5.25 trays vs. 3.0 trays). There was no difference in how much soup was taken (.75 vs. .75 trays), and diners with smaller plates took more tacos (1.25 vs. 2.25 trays).

When examining the total trays of food taken, those with large plates took 90% more volume of food (4.75 vs. 2.50 trays; $t(12) = 2.10$, $p = .057$). This was significant when employing a nonparametric sign test ($w = 19$, $p = .038$).

Although this study moves the examination of plate-size induced serving biases into a commonly encountered situation—conference buffets—such field studies come with limitations. In this case, in order to more accurately monitor the total amount served by both groups of conference goers, they were limited to only one trip to the buffet by being told it was a working lunch and by closing the line after the last person served themselves. It could be that the notion of this being a last chance situation could have influenced how much people took. Although this could have exaggerated how much people put on their plates, it is important to note that most if not all of the smaller and larger plates appeared to have ample room for additional food.

To be as unobtrusive as possible, aggregate production and serving differences were observed instead of intercepting diners and measuring individual items. As a result, it is unclear whether the differences in what was taken by individuals were the result of a small bias by all people or a large bias by a few. No measures of individual differences were taken, such as gender or one's level of hunger when entering the buffet line. As a result, it is not clear whether the larger plates influence men differently than women, or whether they influence hungry diners differently than less hungry diners. Last, although serving biases are our primary focus, it is of practical interest how much of a food that is served is eaten versus how much is wasted. These two issues will be examined in the next study.

These conference goers had received preconference readings focusing on the large plate bias, they had heard a 60-min lecture,

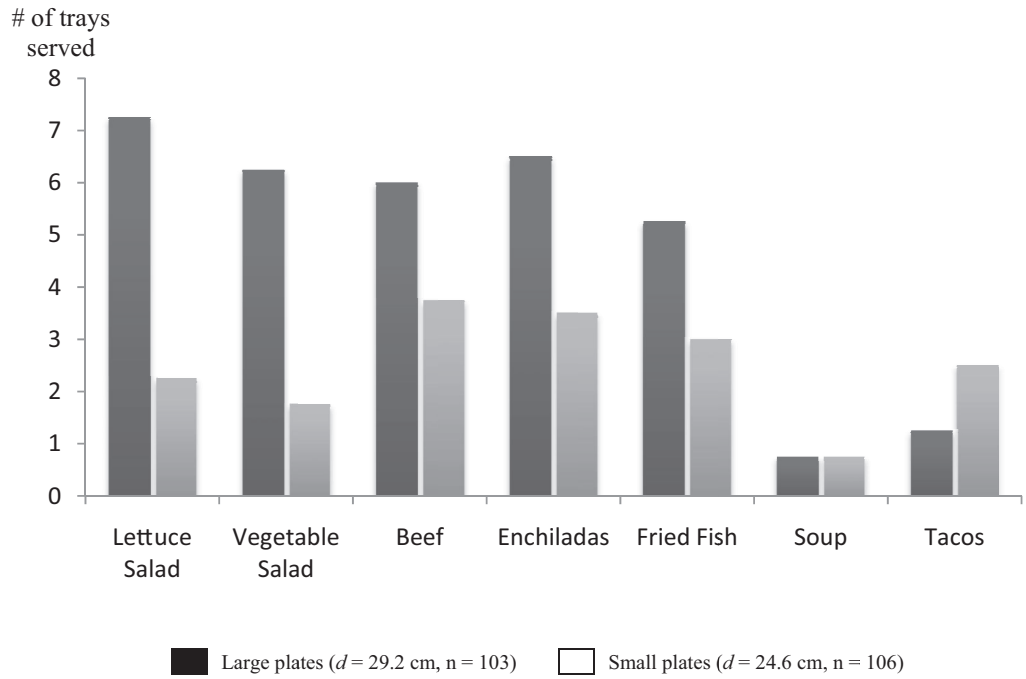


Figure 3. Even warned buffet diners with larger plates serve more total trays of food.

and seen video demonstrations of it occur, and they had participated in an engaged discussion related to it. Still, only 2 hr later, for five of the seven foods offered at lunch, they served themselves twice as much when given a larger plate.

Study 4: Plate Size as a Visual Anchor

The prior studies have demonstrated the consumption and waste consequences associated with large plates (Study 2), and that even a focused, multimedia education effort could not eliminate the effect (Study 3). The objectives are now to examine when and why dinnerware causes these biases, how they gradually change as dinnerware changes, and whether a bias-free practice task works as an intervention strategy to help mitigate the impact of plate-size induced consumption norms on food intake. With these objectives in mind and to understand when and why dinnerware causes serving biases, we turn to the work by Joseph Delboeuf.

In the late 1800s, Joseph Delboeuf, a Belgian philosopher, documented a puzzling perceived difference in the size of two identical circles when one of the circles was surrounded by a much larger circle and the other one was surrounded by a slightly larger circle (Delboeuf, 1865a). The Delboeuf illusion is visually robust with two-dimensional objects—the illusion is shown to exist for perfectly concentric circles but also for eccentric circles and, for instance, noncircular shapes such as squares, triangles, and rectangles (Weintraub & Cooper, 1972; Weintraub & Schneck, 1986). Although not thought to be of practical use (Delboeuf, 1865b; Coren & Girgus, 1978), it recently has been suggested that the Delboeuf illusion may be the missing link between dinnerware size and biases in serving and consumption behavior (see Figure 4).

Building on the Pool and Store Theory, van Ittersum and Wansink (2012) show a relationship exists between one's serving biases and the relative size of the space or gap between the edge of the target serving size of food and the edge of the plate and serving biases (Goto et al., 2007; Jaeger & Lorden, 1980; Nicolas, 1995; Roberts, Harris, & Yates, 2005). This gap is reflected in Figure 5 by the ratio between the diameter of food (d_{target}) and the diameter of the bowl (d_{bowl}): The smaller this ratio, the larger the gap. When this gap between both circles is relatively small—typically when the ratio between the diameter of the test and inducing circle is larger than 0.5—and both circles are perceived as a whole (Morinaga, 1935), people holistically pool and *assimilate* them in the short-term sensory store, leading the test circle to be perceived as larger than it actually is (Girgus & Coren, 1982). This is reflected in the dashed line in the right half of Figure 5—it represents the level of the estimation bias as a function of the gap. When the gap between both circles is relatively large—typically when the ratio between the diameter of the test and inducing circle is smaller than 0.5—and both circles are perceived as two separate percepts, people emphasize the differences between them and *contrast* both circles during the encoding process (Weintraub, Wilson, & Greene, 1969), leading the test circle to be perceived as smaller than it actually is (Pollack, 1964). This is shown by the dashed line on the left half of Figure 5. Van Ittersum and Wansink (2012) show that people seem most susceptible to assimilation when the ratio between the test and inducing circle is close to 0.67 (Piaget, Boesch, & Von Albertini, 1942), and they seem to be most susceptible to contrast when this ratio is closer to 0.33 (Gentaz & Hatwell, 2004; Ogasawara, 1952). Serving biases approach zero when the diameter ratio approaches 1:2. The authors next go on to show that the perceptual biases have a corresponding effect of actual serving behavior, shown by the solid line in Figure 5.

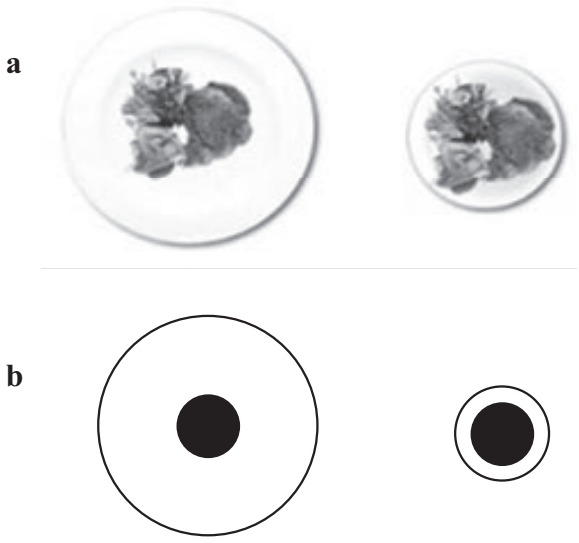


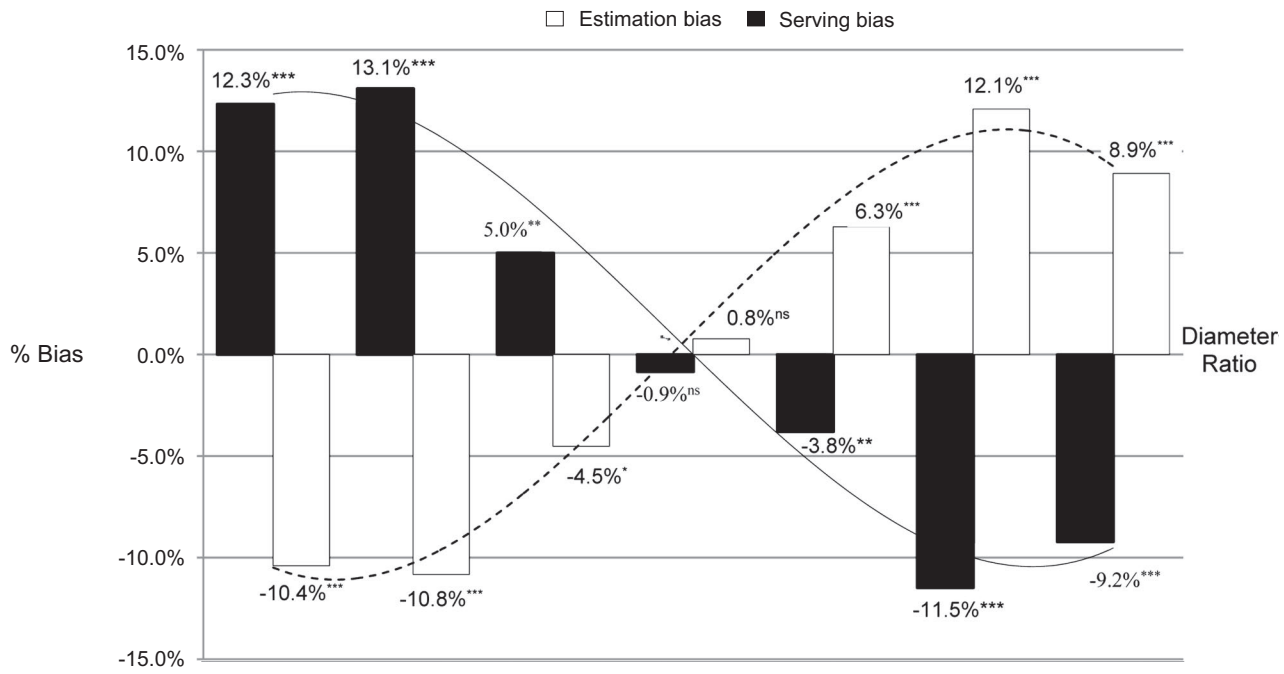
Figure 4. Dinnerware size and the Delboeuf illusion. *a*. Food on large versus small plate. *b*. Delboeuf illusion.

Study 1 showed that consumers are able to differentiate between a portion norm and a consumption norm. Yet when given a specific portion norm, consumers have been unable to reproduce this portion size in other contexts (van Ittersum & Wansink, 2012). The size of a plate systematically influences the serving size. At home, these systematic biases will significantly influence consumption norms. That is, even if a consumer consistently tries to serve him- or herself the portion norm on a larger bowl or plate, the Delboeuf illusion will cause him or her to overserve. In time, the biased serving size will be perceived by the consumer as a new consumption norm.

Perhaps the Delboeuf illusion is what serves as the adjustment mechanism to the visual consumption norm anchor suggested by the size of the plate. Suppose people roughly target 70% of the area of a normal plate as the appropriate amount. If the size of the plate doubled, surely this consumption norm would drop lower than 70%. If the size of the plate was halved, surely this would increase. This adjustment, however, appears to not be proportional, and might be explained by the Delboeuf illusion. To examine this, an experiment was conducted with 135 students (48.9% female) from a large university. Their average age was 21.0 years (range 19–26).

Method

Study 4 consisted of a between-subjects design with seven bowl-size conditions. All participants were shown a target serving size of Campbell's tomato soup in a Petri dish ($d = 9$ cm). To determine what the portion norm would be of a standard serving of soup, we used the serving size guidelines suggested on the packages of the two most common brands of soup. The diameter of 9 cm closely resembles the diameter of one serving of soup in a standard soup bowl with a diameter of



	Larger bowls			Control bowl		Smaller bowls	
	Bowl 1	Bowl 2	Bowl 3	Bowl 4	Bowl 5	Bowl 6	Bowl 7
d_{target} (cm)	9	9	9	9	9	9	9
d_{bowl} (cm)	36	25.7	20	18	16.4	13.8	12
Diameter Ratio	0.25	0.35	0.45	0.50	0.55	0.65	0.75
# Participants	31	31	35	32	32	33	31

Figure 5. Estimation and serving Biases as a Function of the Diameter Ratio of the Target Serving Size and Dinnerware Size (from van Ittersum & Wansink, 2012). *Note.* $^{*}p < .10$. $^{**}p < .05$. $^{***}p < .001$. The asterisks in the figure show whether the bias is significant ($\neq 0$). The study consisted of a between-subjects design with seven bowl-size conditions. All participants were shown a target serving size of Campbell's tomato soup in a Petri dish ($d = 9$ cm). The diameter of 9 cm closely resembles the diameter of one serving of soup in a standard soup bowl with a diameter of 18 cm. Next, participants were asked to serve soup with the exact same 9 cm diameter in one of seven randomly assigned bowls. After a short break, participants were asked to determine to what extent the diameter of a preserving of soup in each of these bowls was either smaller or larger than the diameter of a target serving of soup ($d = 9$ cm).

18 cm—the portion norm. Next, participants were asked to serve soup. After this first pouring task, participants were guided to a different part of the lab and asked to repeat the task into a different sized bowl.

Two sets of seven white bowls were custom-made for this research by a professional potter. The diameters of the bowls were determined based on the desired ratios between the target and the bowl diameter. Research has shown that the maximum over- and underestimation takes place at ratios about 0.33 and 0.67. To capture these, the range of ratios studied was 0.25 to 0.75 (ratios beyond 0.75 and 0.25 result in unrealistically small and large serving sizes and bowls). We included one bowl that resulted in a diameter ratio of 0.50, which research suggests may be the transition point between under- and overestimation. We expected that the average bias for this control bowl will be close to zero.

Thirty-two participants first poured soup in the control bowl. Next, they were randomly assigned to one of the other six bowls for their second pour. The other participants first poured in one of the six smaller or larger bowls, and then went on to pour in the control bowl for their second serving. We expect that those who first served in the control bowl will exhibit smaller serving biases on their second serving in one of the smaller or larger bowls (compared with those who served in one of these bowls during their first serving). Furthermore, we expect that the serving biases among participants who first served into one of the larger or smaller bowls carry over to the second serving in the control bowl.

Procedure

Upon entering the lab, participants were explained that they would be presented with a Petri dish of soup and asked to reproduce the target diameter of soup by pouring soup into two bowls. Participants were then guided to a booth in the lab where they were presented with the Petri dish filled with tomato soup on a white table cloth and asked to take a good look at the target diameter of soup. Next, participants walked to a different booth where they would find one of the seven white bowls on a Bordeaux red table cloth and a white hot pot (with a cap) that was filled with 40 oz. tomato soup. Participants picked up the hot pot and poured tomato soup in the bowl until they felt that the soup in the bowl reached the same diameter as the target diameter. Next, participants were guided to a different part of the lab where they were presented with a second bowl and asked to reproduce the target serving size (participants were not allowed to take another look at the target serving size). Participants who served into one of the three larger (smaller) bowls during their first task, serving into the control bowl or one of the smaller (larger) bowls during the second task. Next, participants were asked to take a seat while the researcher measured the diameter of the poured soup with a digital inside caliper and cleaned the bowls. After the participants were done, they were asked for their gender, age, soup liking, and how hungry they were.

Results and Discussion

In general, practice tended to improve performance and reduce the bias. Those consumers who practice serving in the control bowl—for which serving biases are minimal—are expected to benefit most from the practice. That is, they are asked to reproduce a portion size and should do fairly well given the fact that the effect of the Delboeuf illusion is marginal. However, even though they should benefit from their practice, we still believe that the Delboeuf illusion will influence their serving behavior when they are next asked to serve in a smaller or larger bowl. The exact opposite is expected to happen for those who practice on a larger or smaller bowl first. For instance, someone practicing with a larger bowl will overserve relative to the portion norm—the portion norm has been compromised. Next, she will turn to the control bowl with the updated portion norm in mind. We expect that there will be a carry-over effect, whereby people who practice in a larger bowl are more inclined to overserve in the control bowl, and those who practice in a smaller bowl are more prone to underserving in the control bowl. If so, this would empirically demonstrate how plate size can bias and transform a portion norm into a consumption norm in just two subsequent serving tasks.

Consistent with expectations, we find a significant three-way interaction effect, $F(5, 123) = 11.39$, $p < .01$, $\eta^2 = .32$: Biases exhibited during a second pouring task are significantly influenced by the serving biases experienced during the first pouring task. Figures 6a and 6b show the results.

Figure 6a shows that participants who served into the control bowl during the first serving task, exhibit smaller serving biases in their second serving task, serving soup in one of three smaller or larger bowls. Notably, the practice serving task did not eliminate the serving biases.

Figure 6b shows that no significant biases are found when participants' first serving task involves the control bowl. However, participants who during their first serving task poured into one of the smaller or larger bowls do exhibit significant serving biases when serving into the control bowl during the second pour. Furthermore, these serving biases are consistent with the assimilation and contrast effects that constitute the Delboeuf illusion.

It is important to note that once participants were asked to make the second pouring into the second bowl, some of them might have tried to estimate the amount or volume of soup in the bowl and try and commit this metric to memory (this looks like a cup and a quarter). This could make the link to the Delboeuf illusion more tenuous, if anything, it should have dampened the effect. Instead the dramatic variations were found.

The results of Study 4 suggest that the Delboeuf illusion influences serving biases and may explain why people cannot fully recover from these biases even with repeated training. The results further suggest carry-over effects between serving tasks that hinder serving experience to be effectively applied. This should bias what people perceive as an appropriate serving. Although it does not necessarily suggest that people will always eat more when serving themselves on to larger dinnerware, it does suggest they are likely to overserve themselves to begin with.

General Discussion

For nearly 150 years, the Delboeuf illusion has been regarded as robust, but of "little practical value" (Coren & Girgus, 1978). In the context of serving behavior, however, it takes on an undiscovered dimension of everyday importance. The studies reported here show how this illusion biases serving size perceptions, serving behavior, and consumption. Unfortunately, although education or training may temporarily reduce these biases, they do not eliminate them.

Many wish to influence a consumer's food intake. Those in the hospitality industry want to decrease costs (via serving size) without decreasing customer satisfaction. Those in public policy want to decrease waste. Those in health and dietetics fields want to decrease overconsumption. Those on restricted diets want to decrease caloric, fat, or sugar intake. The results of this research not only corroborate the idea that the Delboeuf illusion may be the missing link between dinnerware size and serving biases, they also offer opportunities for consumers and companies to cope with dinnerware-size induced biases.

The Delboeuf illusion is robust and offers a consistent explanation for why the size of dinnerware can bias serving size perceptions, and consequently impact waistlines, food waste, profitability, and even perceptions of normative appropriateness. Although it is not yet known whether people would adapt to smaller cues over time, these findings have widespread implications for consumers, nonprofit food service managers, and public policy officers as well as for managers working in the hospitality and the packaged goods industry.

Consumer-Related Implications

It is often assumed that education and vigilance are effective tools to combat obesity. In the context of dinnerware-size induced biases, the results presented here are less sanguine. Educating people may temporarily reduce their biases, but research also suggests that this mitigating effect erodes as people gradually

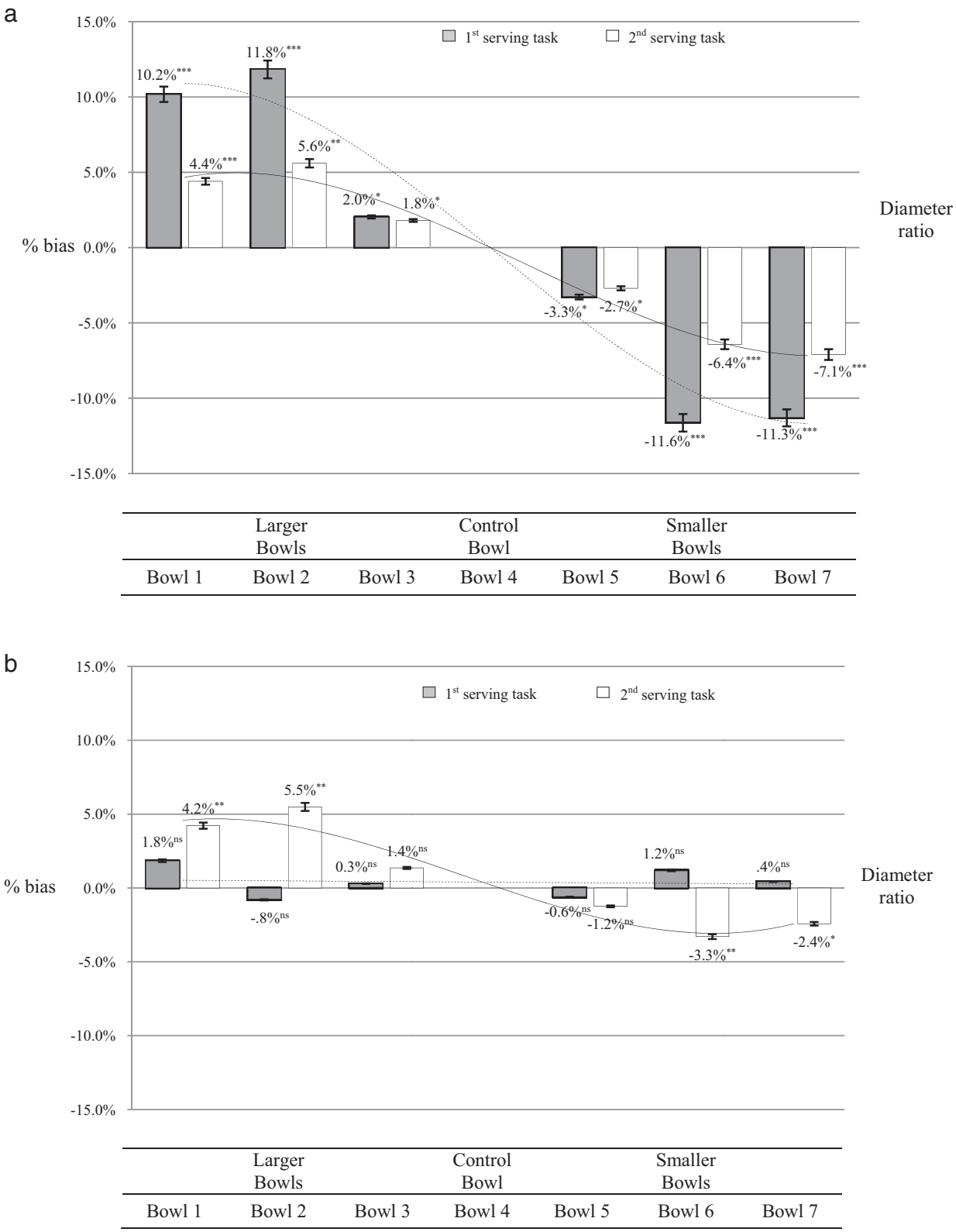


Figure 6. *a*. How serving Biases change with repetition. *b*. How serving biases with larger or smaller bowls change with repetition.

reacclimate to their habitual behavior. In similar illusory contexts, even practice trials and immediate reminders were unable to erase visual biases even with professional servers–veteran bartenders (Wansink & van Ittersum, 2005).

The best approach to reducing or eliminating the perils of large plates and bowls is not through education and training. Instead, it may be best to simply encourage people to replace larger bowls and plates with smaller ones. As B. F. Skinner's work suggested, it is often easier to change one's environment than to change one's mind. Education would be useful in persuading consumers to replace their dinnerware, but much less useful in otherwise helping them repeatedly resist this bias.

Smaller plates and satisfied hunger. The recommendation to replace larger with smaller dinnerware is not driven by the simplified premise that smaller dinnerware merely holds less food. Replacing larger by smaller dinnerware has a dual influence: (a) it reduces the contrast effects that stimulate overserving and overconsumption, and (b) it increases the assimilation effects that stimulate underserving and underconsumption (van Ittersum & Wansink, 2012). Because consumers are unaware of these dinnerware-size induced biases, the reduction in serving size will go largely unnoticed as a result of which the satisfaction level with how much they served or ate will remain unchanged. In addition to helping control food consumption, smaller dinnerware also may reduce household food waste.

Larger plate solutions for better nutrition. Whereas much of this discussion has focused on controlling or limiting consumption, there are circumstances—with the undernourished young and old—where there is a desire to stimulate increased consumption of healthy foods. For instance, a parent may want his or her child to eat more hot cereal and a dietician may want nursing home patients to consume more stew or applesauce in the cafeteria. In these cases, larger bowls and plates are likely to encourage more consumption than the smaller ones that might be currently used. As a general rule-of-thumb, the size of dinnerware should vary proportional to the healthfulness of what is being consumed—small plates for starchy entrees and large plates for salads.

Plate size may bias public policies and programs. Our findings on the effects of the size of plates and bowls on serving size perceptions also have key implications for sensory and nutrition studies, which track food intake to the nearest tenth of a gram. Accurately understanding serving sizes and daily intake of food is critical to policy decisions related to food stamps (Supplemental Nutrition Assistance Program; SNAP), the National School Lunch Program, and the Women, Infants, and Children (WIC) program, among many others.

Currently the primary food intake instrument of the government is the U.S. Department of Agriculture's NHANES survey, which uses self-reported measures of serving size. The serving size estimation instructions, given to the 42,000 households who are involved in each year's survey, ask participants to report absolute serving sizes (i.e., volume estimates), ignoring biases that the size of dinnerware might lead them to make. By not accounting for the sizes of the bowls and plates used in each individual household, these self-reports erode the precision of these measurements and they reduce the ability to make comparisons across studies. Even more concerning, some of these self-reported measures of food intake may be systematically biased, which actually may have detrimental consequences. For instance, the food intake estimates for children may be inflated because children are more likely to eat from smaller bowls and plates. Likewise, systematic food-specific biases may be reported as certain foods are more likely to be consumed from smaller or larger bowls and plates.

Managerial Implications

Because plate size—including the size of the serving trays used to sell frozen single-serve foods—influences perceptions, behavior, and satisfaction, it has far-reaching relevance for managers of restaurants, food services, and packaged goods (see Table 1). Yet these implications need to be balanced with considerations toward competition and a growing consumer concern for better nutrition and reasonable portion sizes. In the hospitality industry, for example, a basic recommendation would be that providing customers with smaller dinnerware is likely to help control consumption, decrease food waste, and raise profitability. Despite the appeal of such a straightforward suggestion, a far-sighted manager would also consider the resulting impact on food costs, nutrition, customer satisfaction, and perceptions of value.

Cutting food costs and food waste. When a fixed price is being charged for food—such as at all-you-can-eat buffets and fixed-price restaurants—there are two ways managers can minimize costs. First, managers can encourage greater intake of low-cost foods and lesser intake of high-cost foods. That is, if pizza is more expensive to produce than salad, a manager would want to encourage customers to eat more salad and less pizza. This can be encouraged by the size of plates that are placed next to these items. Whereas many all-you-can-eat buffets (such as Pizza Hut) have smaller plates near the salad and larger plates near the pizza, switching the plates would be a win–win action that would decrease food costs and increase the healthfulness of the total amount of food that is being served and eaten.

A second cost-saving strategy for these managers is to reduce the amount of food people serve themselves but do not eat. Food waste is a deceptively large contributor to food costs for both buffet restaurants and fixed-price cafeterias. In general, smaller plates would lead to two types of cost savings: (a) smaller *initial* servings, and (b) less food waste, which may lead to even smaller *subsequent* servings.

Nudging a healthier meal. In addition to saving food costs, the strategic placement of dinnerware can be used to subtly direct or nudge people to serve and eat more of some foods than others. Food service managers of school lunch programs and health care facilities may consider placing larger dinnerware near the more healthy food items of a buffet, while placing smaller dinnerware near the less healthy items.

Pricing by the plate. There has been a gradual supersizing of restaurant portions sizes over the past 25 years (Young & Nestle, 2002). The managerial assumption is that people want more food for their dollar. In contrast, a consumer's determination of value may be based more on visual perception than economic reason. The study results suggest that when these supersized portions are put onto larger plates and into larger bowls, people do not recognize it as being more food and, therefore, do not value the bonus amount. Serving supersized portions may produce more waste than profitability.

Aesthetically, the plate-fill level of preserved foods is also relevant in product design, packaging design, and advertising. Advertisers and package designers need to balance the ratio of the diameter of the

Table 1
Implications for Waist, Waste, and Wallet

Stakeholders	Context	Objectives	Implications
Consumers	Parents and nutritional gatekeepers	Stretch food budget.	• Stretch leftovers by serving them on smaller plates to make them appear more plentiful.
		Increase intake of healthy foods.	• Smaller plates can help perceptually stretch food for unexpected dinner guests.
		Decrease intake of less healthy foods.	• Serve healthier food on larger plates to encourage greater intake. • Serve less healthy food on smaller plates to reduce intake while maintaining satisfaction.
	Dieters	Decrease food intake.	• Use the larger dinner plate for the salad, and the smaller salad plate for the entrée.
		Decrease intake of less healthy foods.	• Serve indulgent foods from smaller serving bowls to make them appear more plentiful.
Nonprofit food service managers	School lunch programs	Increase intake of healthy foods.	• Serve healthier foods on larger plates to encourage a greater percentage of intake.
		Decrease intake of less healthy foods.	• Serve less healthy food on smaller plates to reduce intake while maintaining satisfaction.
	Hospitals and assisted living facilities restaurants	Increase food intake.	• Use larger plates to make the (healthy) servings appear smaller, thereby leading to a higher percentage of intake than might be otherwise normal.
		Increase intake of healthy foods.	• A 3:4 full plate is most aesthetically pleasing in most conventional restaurants. Overfilling has diminishing returns to perceptions of value.
		Increase customer satisfaction. Increase perceived value. Increase sales and repatronage.	• Overfull plates might decrease the likelihood of additional purchases, such as desserts.
Hospitality industry managers	All-you-can-eat cafeterias	Reduce waste.	• Smaller plates lead to less food being taken and less food being wasted, reducing food costs.
		Reduce food costs.	• Put larger plates by the food items with the lower food costs (higher margins).
	Frozen (single-serving) foods	Increase consumer preference.	• Avoid large trays with small amounts of food. It does not look aesthetically pleasing, nor does it communicate high-value.
		Increase perceived value.	• To maintain tray footprint without increasing the amount of food, make the trays more shallow.
		Increase purchase likelihood.	• Filling the trays above a 3:4 ratio appears wasted.
Packaged good managers	Diet foods	Manage consumer expectations.	• Do not exaggerate the food:dish ratio on the package. It does not fit aesthetic norms, nor would it appear consistent with a dieter's objective of intake regulation.
		Increase purchase likelihood. Encourage appropriate consumption norms.	• Stay below the 3:4 fill level, closer to 2:3 fill level, because dieters may be seeking appropriateness more than value.
	Advertising and package design	Increase consumer preference.	• Depict food portions in the manner appropriate for positioning. Full plates may connote value, but they risk looking inappropriate and may suggest too large of a consumption norm.
		Increase purchase likelihood.	• Less full plates are perceived as more pleasant (3:4 ratio) and may be more appropriate (2:3 ratio) for diet foods or for indulgent treats.
		Increase customer satisfaction. Encourage appropriate consumption norms.	• Advertising a full plate may lead to disconfirmation if a larger plate is used by a consumer.
Public policy officials	Food assistance programs and special nutrition programs	Encourage appropriate consumption norms.	• The USDA's Special Nutrition Programs (including WIC, EFNEP, and SNAP) should provide normative suggestions that plate size vary in proportion to healthfulness of the food. • Smaller plates can be procured for Federal facilities instead of larger ones. • Federal surveys of food intake (such as the NHANES survey) should take plate size in to account when estimating the consumption volume of food in day-after recalls.
	Research	Collect precise food intake data.	• Account for dinnerware size in food diary panels and food intake surveys. • Start longitudinal benchmark studies with standardized dinnerware.

serving size and the diameter of the plate, bowl, container, or serving tray (e.g., microwavable dish in a frozen package) to accommodate perceptions of aesthetic pleasantness and perhaps normative appropriateness. An online search of American frozen food packages indicates that most depict full plates as the norm. Although full plates may connote value, they tend to be perceived as less aesthetically pleasant and normatively inappropriate. Further, the depiction of these full—even overflowing—plates may also create undesirably high consumption norms. These norms lead us to consume more than is needed to satisfy our hunger.

A brief survey of the frozen food aisle in American grocery stores shows that most manufacturers sell frozen (single-serving) dinners in deep trays with small footprints. As with small footprint plates, small footprint trays provide little size-contrast to the food. Although this might make people believe they are getting a good deal, if they were to transfer the food to larger dinnerware, they may experience dissatisfaction. Our results further suggest that consumers will not perceive this exaggerated fill level as aesthetically pleasant.

Limitations and Future Research

The reasons behind basic behaviors are often difficult to assess. To better understand how consumers believe they serve themselves, we conducted in-depth interviews with a subset of study participants. The resulting insights led us to assume that when people serve themselves a food, they first determine how much they need to serve into the bowl or plate to reach a target serving size. Focusing on the diameter as opposed to the height of the serving size (cf., Krider, Raghubir, & Krishna, 2001), they then serve themselves and continue to do so until they believe they reached their target serving size. It has generally been shown that the amount a person consumes would be in proportion to how much they serve themselves. Indeed, past studies suggest that people will generally consume an average of around 92% of what they serve themselves (Wansink & Johnson, 2014; Wansink, 2006, p. 59). The results of our studies confirm this.

Interestingly, although the effect sizes in these studies are large, not everyone is influenced to the same degree. From an individual difference perspective, it is not clear whether this is a stationery trait or whether it might be explained by one's thinking style or personality. For instance, it has recently been discovered that extroverted children served themselves 33.1% more sugared breakfast cereal into larger cereal bowls while introverted children only served themselves an insignificant 5.6% more (van Ittersum & Wansink, 2013). If related to thinking style (such as need for cognition or contextual independence), there may be additional interventions that hold promise for reducing the bias.

There are a wide range of design elements that provide opportunity for more extensive theory development as well as having promising applications. These include:

- How does the diameter of the verge ring (the point where a plate or bowl's interior surface goes from flat to sloped) influence serving and perceptions?
- Does the diameter band on the lip of a bowl or plate bias perceptions?
- Which designs or colors of a plate or bowls ridge influence size estimations?

Conclusion

We eat off of plates and out of bowls without thinking how their size proportionately influences how much we serve and eat. Yet the basic implications this has for waistlines, food waste, and wallets are of substantial importance to managers, policymakers, health professionals, and consumers.

The solution to our tendency to overeat from larger plates and bowls is not simply education. In the midst of hard-wired perceptual biases, a more straightforward action would be to simply eliminate large dinnerware—replace larger bowls and plates with smaller ones. It is easier to change your food environment than to change your mind.

References

Berry, S. L., Beatty, W. W., & Klesges, R. C. (1985). Sensory and social influences on ice-cream consumption by males and females in a laboratory setting. *Appetite, 6,* 41–45. doi:10.1016/S0195-6663(85)80049-0

Coren, S., & Girgus, J. S. (1978). *Seeing is deceiving: The psychology of visual illusions*. Hillsdale, NJ: Erlbaum.

Delboeuf, F. J. (1865a). Note sur certaines illusions d'optique: Essai d'une théorie psychophysique de la manière don't l'oeil apprécie les distances et les angles [Note on certain optical illusions: Essay on a phychophysical theory concerning the way in which the eye evaluates distances and angles]. *Bulletins de l'Académie Royale des Sciences, Lettres et Beaux-arts de Belgique, 19,* 195–216.

Delboeuf, F. J. (1865b). Seconde note sur de nouvelles illusions d'optique: Essai d'une théorie psychophysique de la manière don't l'oeil apprécie les grandeurs [Second note on new optical illusions: Essay on a phychophysical theory concerning the way in which the eye evaluates sizes]. *Bulletins de l'Académie Royale des Sciences, Lettres et Beaux-arts de Belgique, 20,* 70–97.

Folkes, V., & Matta, S. (2004). The effect of package shape on consumers' judgments of product volume: Attention as a mental contaminant. *Journal of Consumer Research, 31,* 390–401. doi:10.1086/422117

Gentaz, E., & Hatwell, Y. (2004). Geometrical haptic illusions: The role of exploration in the Muller-Lyer, vertical-horizontal, and Delboeuf Illusions. *Psychonomic Bulletin & Review, 11,* 31–40. doi:10.3758/BF03206457

Girgus, J. S., & Coren, S. (1982). Assimilation and contrast illusions: Differences in plasticity. *Perception & Psychophysics, 32,* 555–561. doi:10.3758/BF03204210

Goto, T., Uchiyama, I., Imai, A., Takahashi, S., Hanari, T., Nakamura, S., & Kobari, H. (2007). Assimilation and contrast in optical illusions. *Japanese Psychological Research, 49,* 33–44. doi:10.1111/j.1468-5884.2007.00330.x

Hanks, A. S., Just, D. R., & Wansink, B. (in press). Reliability and accuracy of real-time visualization techniques for measuring school cafeteria tray waste: Validating the Quarter-waste method. *Journal of the Academy of Nutrition and Dietetics*. doi:10.1016/j.jand.2013.08.013

Herman, C. P., & Polivy, J. (1984). A boundary model for the regulation of eating. In A. B. Stunkard & E. Stellar (Eds.), *Eating and its disorders* (pp. 141–156). New York, NY: Raven.

Jaeger, T., & Lorden, R. (1980). Delboeuf illusions: Contour or size detector interactions. *Perceptual and Motor Skills, 50,* 376–378. doi:10.2466/pms.1980.50.2.376

Karaim, R. (2007, January). Innovations 2007—Future forward. *USA Weekend Magazine, January 28, 2007,* 14–16.

Krider, R. E., Raghubir, P., & Krishna, A. (2001). Pizzas: π or square? Psychophysical biases in area comparisons. *Marketing Science, 20,* 405–425.

Morinaga, S. (1935). Conditions of the size-assimilation and size-contrast. *Memorial pp. for Dr. Masuda* (pp. 22–48). Tokyo, Japan: Iwanami. (In Japanese).

Nicolas, S. (1995). Joseph Delboeuf on visual illusions: A historical sketch. *The American Journal of Psychology, 108,* 563–574. doi:10.2307/1423073

Ogasawara, J. (1952). Displacement-effect of concentric circles: A review of experimental works. *Japanese Journal of Psychology, 22,* 224–234.
Parmar, N. (2007). 10 things your bartender won't tell you. *Smart Money,* (July), 31–32.
Piaget, J., Lambercier, M., Boesch, E., & Von Albertini, B. (1942). Introduction à l'etude des perceptions chez l'enfant et analyse d'une illusion relative à la perception visuelle de cercles concentriques (Delboeuf) [Introduction to the study of perception of children and analysis of an illusion related to the visual perception of concentric circles (Delboeuf)]. *Archives de Psychologie, 29,* 11–34.
Pollack, R. H. (1964). The effects of fixation upon the apparent magnitude of bounded horizontal extent. *The American Journal of Psychology, 77,* 177–192. doi:10.2307/1420125
Roberts, B., Harris, M. G., & Yates, T. A. (2005). The role of inducer size and distance in the Ebbinghaus illusion. *Perception, 34,* 847–856. doi:10.1068/pp.5273
Schwarz, N. (1996). *Cognition and communication: Judgmental biases, research methods and the logic of conversation*. Mahwah, NJ: Erlbaum.
Sharp, D., & Sobal, J. (2012). Using plate mapping to examine sensitivity to plate size in food portions and meal composition among college students. *Appetite, 59,* 639–645.
Sobal, J., & Wansink, B. (2007). Kitchenscapes, tablescapes, platescapes, and foodscapes: Influences of microscale built environments on food intake. *Environment and Behavior, 39,* 124–142.
Van Ittersum, K., & Wansink, B. (2007). Do children really prefer large portions? Visual illusions bias their estimates and intake. *Journal of the American Dietetic Association, 107,* 1107–1110. doi:10.1016/j.jada.2007.05.020
Van Ittersum, K., & Wansink, B. (2012). Plate size and color suggestibility: The Delboeuf illusion's bias on serving and eating behavior. *Journal of Consumer Research, 39,* 215–228. doi:10.1086/662615
Van Ittersum, K., & Wansink, B. (2013). Extroverted children are more biased by bowl sizes than introverts. *PLoS ONE, 8,* e78224.
Wansink, B. (2004). "Environmental factors that increase the food intake and consumption volume of unknowing consumers." *Annual Review of Nutrition, 24,* 455–479.
Wansink, B. (2006). *Mindless eating – Why we eat more than we think*. New York, NY: Bantam Books-Dell.
Wansink, B. (2014). *Slim by design – Mindless eating solutions for everyday life*. New York, NY: William Morrow.
Wansink, B., & Cheney, M. M. (2005). Super bowls: Serving bowl size and food consumption. *Journal of the American Medical Association, 293,* 1727–1728.
Wansink, B., & Johnson, K. A. (in press). What percentage of self-served food is eaten? A preliminary investigation of how serving size influences intake. *International Journal of Obesity*.
Wansink, B., & Payne, C. R. (2008). Eating behavior and obesity at Chinese buffets. *Obesity, 16,* 1957–1960.
Wansink, B., & van Ittersum, K. (2003). Bottom's up! The influence of elongation on pouring and consumption volume. *Journal of Consumer Research, 30,* 455–463. doi:10.1086/378621
Wansink, B., & van Ittersum, K. (2005). Shape of glass and amount of alcohol poured: Comparative study of effect of practice and concentration. *British Medical Journal, 331,* 1512–1514.
Wansink, B., & van Ittersum, K. (2007). Downsizing our consumption norms. *Journal of the American Dietetic Association, 107,* 1103–1106.
Wansink, B., & van Ittersum, K. (2012). Fast food restaurant lighting and music can reduce calorie intake and increase satisfaction. *Psychological Reports, 111,* 228–232. doi:10.2466/01.PR0.111.4.228-232
Wansink, B., van Ittersum, K., & Painter, J. E. (2006). Ice cream illusions: Bowl size, spoon size, and serving size. *American Journal of Preventive Medicine, 31,* 240–243. doi:10.1016/j.amepre.2006.04.003
Weintraub, D. J., & Cooper, L. A. (1972). Coming of age with the Delboeuf illusion: Brightness contrast, cognition, and perceptual development. *Developmental Psychology, 6,* 187–197. doi:10.1037/h0032098
Weintraub, D. J., & Schneck, M. K. (1986). Fragments of Delboeuf and Ebbinghaus illusions: Contour/context explorations of misjudged circle size. *Perception & Psychophysics, 40,* 147–158. doi:10.3758/BF03203010
Weintraub, D. J., Wilson, B. A., & Greene, R. D. (1969). Displacement versus diameter, arc deletions and brightness contrast. *Journal of Experimental Psychology, 80,* 505–511. doi:10.1037/h0027424
Young, L., & Nestle, M. (2002). The contribution of expanding portion sizes to the U.S. obesity epidemic. *American Journal of Public Health, 92,* 246–249. doi:10.2105/AJPH.92.2.246

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