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How Much Serving-Size Affects Consumption: Catch-22

The effect of serving-size on consumption is well-established: the larger the serve, the greater the amount consumed. But what is the size of the effect, what are the processes driving the effect, and what are the conditions that facilitate vs. inhibit the effect? The present research uses a meta-analysis of 67 studies to quantify the effect of serving-size on amount consumed and to test two competing explanations of why the effect occurs. One view is that the serving-size is mediated by a perceptual effect, the other that it is mediated by a consumption norm. The meta analysis demonstrates that when serving-sizes double, consumption can be expected to increase by 22%; the effect is consistent with a perceptual effect rather than a consumption norm; the effect is stronger among adults than children, and stronger when attention is not on the food is ‘incidental’ rather than ‘focal’ to the situation.

Keywords: serving-size, food consumption, unit bias, perceptual effect, psychophysical effect
As the Western world sees a general rise in BMI, and increasingly greater proportions of people are classified as ‘overweight’ or ‘obese’, much attention has turned to understanding the factors contributing to this phenomenon. One factor that is thought to have an important contribution to the problem is the serving-size effect where people consume more from larger serves than smaller serves (e.g., Rolls 2003; Young and Nestle 2002). As serving-sizes grow and as people eat more due to the serving-size effect, without additional energy output, weight and BMI will go up (Young and Nestle 2002; 2003; 2007). Attention is being given to interventions in view of the serving-size effect’s presumed contribution to the widely observed general rise in weight and BMI (Steenhuis and Vermeer 2009).

The evidence that increasing serving-sizes have contributed to increasing BMI is to a large extent correlational and historical. A number of researchers have observed that individual serving-sizes have grown simultaneously with increases in BMI (Matthiessen et al. 2003; Nielsen and Popkin 2003; Schwartz and Byrd-Bredbenner 2006; Wansink and Wansink 2010).

Some studies have shown a more direct link between serving-size increases and weight gain. Rolls and colleagues have shown that the serving-size effect can be sustained over multiple meals (Rolls, Roe, and Meeks 2004) and even many days (Rolls, Roe, and Meings 2006a; Rolls, Roe, and Meings 2007). While they did not report on weight gain, Jeffery et al. (2007) did show that those receiving larger serving-sizes over a period of a month gained 0.64kg by month-end relative to those receiving a smaller serving-size.

While the serving-size has a well-established effect on amount consumed (Chandon and Wansink 2011; Wansink 2004), what is not clear is the size of this effect, the process through which the effect occurs, and the moderators of the effect. Knowing this would usefully inform public policy and industry practices that are explicitly aimed at reducing consumption volume by manipulating the size of food servings offered to consumers. So the questions we sought to
answer are: (a) how much does consumption increase with an increase in serving-size? (b) what is driving the effect? and (c) are there conditions where the effect is weaker or stronger?

In the following sections we review the literature on the serving-size effect and describe two competing theories that explain the effect. We then describe how we gathered data for a meta analysis to answer the above questions, report the results of the analyses and offer a discussion of our findings and their implications for research and practice.

**How Serving-Size Influences Consumption**

In order to measure the size of the serving-size effect, we start by exploring how serving-size comes to influence the amount consumed. In principle, we might expect that the amount of food that a person consumes is determined purely by the body’s energy requirements. In this view, the consumption of food is driven by the body’s process of monitoring and synthesizing internal cues of energy requirements (such as physical fullness of the stomach, blood sugar levels, energy output, etc). Under this view, the sensations of hunger and its inverse, satiation, would drive consumption (Brunstrom, Collingwood, and Rogers 2010; Vermeer, Bruins, and Steenhuis 2010).

On this basis, many external factors such as serving-size should not have any effect at all on hunger / satiation and resulting consumption. That is, the individual would consume the quantity of food their body requires from a serving, and then stop. Therefore, serving-size should not have an effect. However, multiple studies have shown that this is not so, in particular, the experience of satiation is insensitive to the amount consumed even though it has been increased with serving-size (Chang et al. 2012; Hoefling and Strack 2010; Kissileff et al. 1984).

By way of contrast, one external factor that would be expected to be relevant to the consumption decision is the energy density of the food (Rolls, Morris, and Roe 2002; Rolls 2010). Surprisingly however, energy density appears to have limited effect on the amount consumed.
(Devitt and Mattes 2004; Ello-Martin, Ledikwe, and Rolls 2005; Kral, Roe, and Rolls 2004). The relatively small effect of energy density and the relatively strong effect of serving-size on consumption suggests that there are irrelevant, external factors at play.

Why do external cues such as serving-size have an impact on amount consumed? Birch et al. (1987) suggest that this happens because these external cues are more easily perceived and monitored while internal cues of satiety are more ambiguous. Herman and Polivy (2005) offer something similar suggesting that serving-size influences actually have their greatest effect in ‘the zone of biological indifference’ (p. 764) where a person feels neither hungry nor satiated. As a consequence, external cues such as the amount of food served on a plate, in a packet, bowl or glass (Bublitz, Peracchio, and Block 2010; Wansink 2004) or the appeal of food in terms of its appearance, smell, or taste (Wansink and Park 2000) can all affect consumption even though all are arguably irrelevant.

What is the underlying process driving the serving-size effect? The literature presents two alternate views of how serving-size might have an impact on consumption. One is that the serving-size effect is the result of a perceptual process, and the other that it is a function of a consumption norm. We consider each in the following.

**Serving-Size Effect as Perceptual**

While the serving-size effect describes the impact of serving-size on amount consumed, we note that judgments of quantity tend to be similarly affected by serving-size manipulations (Chandon 2009). A series of recent papers show that people’s perceptions, specifically their estimates of changes in serving-sizes tend to be inelastic (Chandon and Ordabayeva 2009; Van Ittersum and Wansink 2011). People tend to underestimate the serving-size increase. These results fit a standard psychophysical function whereby perceptions are a diminishing function of the
intensity of a physical stimulus as described by Steven’s Power Law (Chandon and Wansink 2007b).

The perceptual nature of these serving-size effects on judgments is seen in multiple other ways. First, as might be expected with perceptually-based effects, they have been widely observed across a range of individual traits (e.g., BMIs, interest in nutrition), food categories and even operating among ‘experts’ with high levels of involvement with nutrition (Chandon and Wansink 2007b; Tangari et al. 2010). Moreover, quantity judgments are sensitive to perceptual illusions (Wansink and van Ittersum 2003). For instance, subjects who receive a fixed serving-size on a larger plate judge the quantity to be less than those receiving the same size serve on a smaller plate (Van Ittersum and Wansink 2011; Wansink, van Ittersum, and Painter 2006). These results are consistent with the size-contrast effect that underlies the Ebbinghaus-Titchener and Delboeuf illusions.

While quantity judgments are subject to the serving-size effect and these appear to have been established as perceptual in nature, does it follow that the serving-size effect on consumption is (mediated by) a perceptual process? There are some studies that suggest this could be the case. In particular, Wansink and colleagues have shown that amount served and consumed can be subject to the same perceptual illusions as quantity judgments. For instance, Wansink, Van Ittersum and Painter (2006) have shown how people invited to self-serve ice-cream give themselves more if they receive larger bowls than those given smaller bowls, which they attribute to a size-contrast effect. Moreover, they demonstrated this effect with nutrition experts, namely members of a department of food and nutritional science.

If the serving-size effect on consumption is mediated by a perceptual process, the expectation is that consumption will decline with increasing serving size. The exact rate of decline is difficult to specify a priori, but we can predict that people’s change in consumption (from smaller to larger serve) will be less than the change in serving-size itself.
**Serving-Size Effect as Consumption Norm**

One challenge to the notion that the serving-size effect is perceptual is that it operates even when subjects are literally blind to the serving-size. While food-visibility does appear to have a main effect on consumption (Wansink, Painter, and Lee 2006), the serving-size effect continues to operate even when serving-size is not visible. Scheibehenne, Todd and Wansink (2010) showed a serving-size effect even for subjects eating in a ‘dark restaurant’ where people eat in complete darkness and are typically served by blind people. In addition, Wansink, Painter and North (2005) showed that people ate significantly more from a ‘bottomless bowl’ of soup that was continually refilled versus those eating from a regular soup bowl. Both of these studies support the alternate notion that serving-size effect is based on a consumption bias where people eat a fixed amount of what they are served. This therefore offers the alternative theory to the serving-size effect as perceptual.

The alternative view suggests that people will eat an amount dictated by some consumption norm such as ‘eat everything on your plate’ (e.g., Birch et al. 1987; Fay et al. 2011; Geier, Rozin, and Doros 2006; Wansink 2004; Wansink, Painter, and North 2005). Someone displaying this so-called ‘unit-bias’ (Geier, Rozin, and Doros 2006) would obviously be subject to a serving-size effect.

However, we define the consumption norm a little more broadly as being when someone eats a *fixed percentage* of the unit-serve. Someone may eat 100% of what they are served, but some may always leave say 10% because it is ‘polite’ to do so or eat only 50% of what is served because they are ‘on a diet’. These people are still following a consumption norm defined as eating a fixed percentage of what they are served. And by following this norm, they would be subject to the serving-size effect.
The prediction for how the serving-size effect will operate under a consumption norm scenario is fairly straightforward. As stated by Geier, Rozin and Doros (2006 p. 522), a “percentage change in [serving] size would change consumption by the same percentage.” So someone who eats “everything on their plate” will eat 100% of the smaller serve and 100% of the larger serve. A dieter however who consumes only half of what is served on their plate as a means of limiting consumption, will consume 50% of a smaller serve and 50% of a larger serve.

So whereas the perceptual explanation predicts that the change in consumption will be a fixed proportion of the change in serving-size, under the consumption norm, the change in consumption will exactly equal the change in serving-size. That is, the serving-size effect will be 100% of the change in serving-size.

**Method**

Studies relevant for the meta analysis were identified using an initial search of ABI/Inform, ProQuest Digital Dissertations, Business Source Premier, Web of Science, and other databases using keywords related to portion-size, serving-size, unit bias and more generally, consumption volume and consumption amount. We manually searched journals such as *Journal of Marketing, Journal of Marketing Research, Journal of Consumer Research, Journal of Public Policy and Marketing, Annual Review of Nutrition, American Journal of Clinical Nutrition, Body and Society, British Journal of Sociology, Social Science and Medicine, Appetite*, and the *Journal of Obesity Research*. Conference proceedings that were also manually searched included *Advances in Consumer Research*, *American Marketing Association Proceedings*, and the *Obesity Society Abstract Supplements*. Once a paper was identified, references were examined to identify further studies. The approach is consistent with the recommendations made by several authors (Hunter and Schmidt 1990; Rosenthal 1979).
In addition, Web of Science, Scopus, and Google Scholar were used to search the citations of included papers. To counteract the file drawer problem often associated with a meta analysis, a call was placed on ELMAR (Electronic List for Marketing Academics And Researchers) for working papers. Finally, emails were sent to researchers in the domain asking for published and unpublished works.

The primary interest in the present paper was the effect of serving-size on consumption volume. Accordingly, the first criterion for the meta-analysis was that all studies to be included had to have a manipulation of the serving-size. A preliminary process returned 150 studies, a full listing of these studies is available from the authors. However, we found that although some studies manipulated serving-size, they also manipulated, and indeed confounded, serving-size with plate or bowl size (e.g., Koh and Pliner 2009; Rolls et al. 2007; Stroebel, Ogden, and Hill 2009; van Kleef, Shimizu, and Wansink 2011; Wansink 1996), or utensil size (e.g., Mishra, Mishra, and Masters 2012). Still others did not manipulate serving-size overall, but varied the size and number of units making up the total serving-size package-size (e.g., Do Vale, Pieters, and Zeelenberg 2008; Scott et al. 2008). In sum, only studies that had a clear and unconfounded manipulation of serving-size were included in this analysis.

The second criterion for inclusion in the meta analysis was that the dependent variable had to include an interpretable measure of consumption volume. It was disconcerting to discover that papers reported a wide variety of measures: grams, ounces, kJ, calories, or even percentages of a basic meal size (e.g., Levitsky and Youn 2004). Even more disconcerting was when the serving-size and consumption measures were mis-matched: for instance, when when amounts of sandwich served was reported in inches and consumption was reported in grams (Rolls et al. 2004). Others aggregated across several days or even weeks of consumption to come up with a total amount of food consumed over periods of up to eleven days (Rolls, Roe, and Meengs 2007). Some papers provided charts showing one or more of these metrics, but only reported percentage-change as
their dependent variable in their text. Finally, some studies reported consumption of foods of varying energy densities.

Ultimately, 67 separate studies (from 24 papers) were identified that met the specified requirements on both the serving-size manipulation and the dependent variable.

The effect-size metric selected for the analysis was the standardized difference in means expressed as Cohen’s $d$ (1988). The consumption at the smaller serving-size (control) was subtracted from consumption at the larger serving-size (treatment). As such, a positive value will reflect the expected serving-size effect (larger serves lead to greater consumption), and the value of ‘$d$’ reflects the size of the effect. When calculating effect-sizes, a random effects perspective was taken whereby it is assumed that the true effect size varies from one study to the next and that the studies represent a random sample of effect sizes (Hunter and Schmidt 1990). Our aim was to estimate the mean of the serving-size effect across manipulations and studies.

The heterogeneity of effect-sizes was established through Cochran’s $Q$ statistic test (Hunter and Schmidt 1990) and the $I^2$ index (Higgins and Thompson 2002; Huedo-Medina et al. 2006). Heterogeneity is considered present if the term $(Q-df)$ is greater than 0 (Huedo-Medina et al. 2006). The $I^2$ index (i.e., $100 \times (Q-df)/Q$) quantifies heterogeneity as being low (25%), medium (50%), or high (75%) (Higgins and Thompson 2002).

**Results**

**Size of the Serving-Size Effect**

The meta-analysis examining $k = 67$ separate studies revealed what Cohen (1988) would label a “medium” size effect of serving-size on consumption: $d = .469$ (see Table 1 below). While the serving-size effect was positive and significant, $(CI_{95\%} = .376, .562)$, it varied considerably across studies: $(Q-df)$ was greater than 0 and the $I^2$ index was 77% indicating a “high”
level of variability (Higgins and Thompson 2002). We address the contributors to the high level of observed heterogeneity later.

(“Insert Table 1 about here”)

One problem with meta-analytic estimates of effect size is that they are subject to the file-drawer problem whereby unpublished non-significant results might weaken or undermine the reported effect-size (Rosenthal 1979). Rosenthal’s fail-safe N for our study was calculated to be 6059, this being “the number of studies that would need to be added to a meta-analysis to reduce an overall statistically significant observed result to non-significance” (Rosenberg 2005, p.464). This number comfortably exceeds Rosenthal’s (1991) recommendation that for a robust meta-analysis, the fail-safe N should exceed $5k + 10$ which is 345 in the current study.

Nonetheless, we note that a plot of standard error on effect size, a ‘funnel plot’ as recommended by Sterne and Harbord (2004, see Figure 1) suggests that there was a bias towards publication of large effect sizes, and especially those with larger standard errors. We further note that Rosenberg (2005) criticises Rosenthal’s fail-safe N as over-estimating the number of studies that would reduce the effect. Notwithstanding these limitations and noting the arbitrariness of the critical fail-safe N, we feel confident that the results we report can be considered robust.

(“Insert Figure 1 about here”)

At this point, we have provided standard meta-analytic results for the serving-size effect, but these do not help quantify the serving-size effect except in a relative way. The problem is that meta-analytic effect-sizes such as standardised mean-differences ($d$) allow comparisons across
studies, but they do not offer absolute measures of effect-size (Cohen 1988), and given the degree of variation in the serving-size manipulations, this seems essential.

We therefore needed to develop an approach that would allow us to estimate the absolute effect-size of serving-size manipulations, specifically one that would allow us to state how much consumption increased for a unit change in serving-size. Such absolute measures of effect-size were also needed to test the two competing explanations for the serving-size effect as we explain later.

In the first instance, and allowing for the many metrics used to measure both serving-sizes and consumption, we simply created two measures of change expressed as proportions. The independent variable, serving-size was recorded as a proportional change in serving-size relative to the small serve (see equation ‘1’ below). The dependent variable and so the effect-size was expressed as a proportional change in consumption relative to the amount consumed from the small serve (see equation ‘2’ below).

\[
\text{(1)} \quad \frac{\Delta S}{S_s}
\]

\[
\text{(2)} \quad \frac{\Delta C}{C_s}
\]

\(\Delta S\) = change in serving-size (large serving-size –smaller serving-size)

\(S_s\) = smaller serving-size

\(\Delta C\) = change in consumption (amount eaten from large serve – amount eaten from small serve)

\(C_s\) = consumption from smaller serving-size

Using these measures of the change in serving-sizes and the change in consumption allowed us to compare the change in consumption relative to the change in serving size.

Specifically, we regressed the change in consumption (2) on the change in serving-size (1). Each study included in the regression was weighted by the meta-analytic weights which are a function of the studies’ sample sizes and variances.

Our results show that the change in serving-size significantly predicts the change in consumption (\(B=.22, t=26.43, p < .001\); see Figure 3). Importantly, the regression coefficient tells
us that if the serving-size doubles (i.e., the large serve is 100% larger than the small serve), consumption goes up by 22%.

(“Insert Figure 2 about here”)

**Explanation of the Serving-Size Effect**

Having established the size of the serving-size effect, we now go on to examine the two competing explanations advanced for this effect. The simplest explanation is that serving-size effect is mediated by consumption norms (e.g., Geier, Rozin, and Doros 2006). Specifically, if someone eats everything – or some other fixed proportion, say 80% – of what is on their plate, then the change in consumption will exactly reflect the change in serving-size. In effect, the ratio of change in consumption to change in serving-size will be one.

The alternative explanation is that the serving-size effect reflects a perceptual process. It has been observed that quantity judgments are subject to the serving-size effect such that people tend to underestimate the size of the change (Chandon and Wansink 2007b). This result reflects a standard feature of psychophysical functions whereby a change in perception is modelled as a proportion of the change in the physical stimulus. If the serving-size effect on consumption is mediated by a perceptual process, then the ratio of change in consumption to change in serving-size will be less than one.

Again, the result we found for the regression of change in consumption on change in serving-size was as follows: \( \Delta C/C_s = 0.22 \times (\Delta S/S_s) \). The coefficient of 0.22 provides fairly strong support to the interpretation of the serving-size effect as being mediated by a perceptual process rather than a consumption norm. This is strengthened by our finding that a regression fitting a logarithmic line to the data was significant (B=12.915, t=27.164, p<.001). However, we
acknowledge that the logarithmic function was barely different from the simple linear function (see Figure 2).

We note however, that the observed change in consumption for any given change in serving-size varied considerably (as seen in Figure 2). While our change measures captured the variation between serving-sizes, they did not capture the considerable variation in the actual serving-sizes themselves. In concrete terms, a 100% increase (i.e., doubling) of serving size might be expected to lead to a greater change in consumption if the small serve was just 50g than if the small serve was 500g. This is of course a restatement of the psychophysical function under Steven’s Power Law. In this view, perception is a diminishing function of physical variation described by an exponent to the physical stimulus.

To include the absolute measures of the serving-sizes themselves and to provide an even stronger test of whether the serving-size effect was mediated by perceptions or norms, we limited our sample to only those studies that used grams (or other weights which we could convert to grams) for both amounts served and amounts consumed. This gave us 24 studies, although two of these measured aggregated consumption over multiple days. Dropping these latter two, we had 22 usable studies although each study gave us a ‘smaller’ serving-size and a ‘larger’ serving size for a total of 44 data points.

Our prediction was that if the serving-size effect was mediated by a perceptual process, then quantities consumed should have a non-linear and decreasing relationship to quantities served. By contrast, if the serving-size effect was driven by consumption norms, then the relationship between amount consumed and amount served should be linear and approaching a slope of one.

(“Insert Table 2 about here”)
The results (see Table 2 and Figure 3) clearly show that there is a diminishing impact of increasing serving-size on amount consumed. In particular, it is noted that the weight for the logarithmic function is significant (B= 230.714, t= 8.388, p < .001). We are particularly encouraged to note that the $R^2$ was .628. If consumption norms were driving the serving-size effect, the logarithmic function would have been unlikely to be significant, and the linear weight would be one.

(“Insert Figure 3 about here”)

Both the results based on the ratio of consumption change to serving-size change, and those based on the absolute amounts served and consumed point compellingly to a perceptual interpretation. We now proceed to examine the factors that facilitate or inhibit the serving-size effect.

Moderators of the Serving-Size Effect

We have already noted that there was a ‘high’ level of heterogeneity between studies: $I^2 = 77\%$. In general, such variability between studies implies that there are many other factors that are ‘moderating’ the effect of interest. We have noted already however, that there are at least two factors that contributed substantially to the heterogeneity of the serving-size effect: (a) the size of relative change in serving-size (from smaller to larger); and (b) the absolute size of the smaller serve. Nonetheless, we consider that an exploration of moderating variables might be usefully conducted to see if there is any evidence that they may also be contributing to the observed heterogeneity in effect sizes.

The moderating factors that we chose to examine were, to a large extent, dictated by what was reported in the original studies although it might be reasonable to presume that the reporting
of such factors implies that previous researchers thought such factors could be important. We examined two individual factors, gender (male or female) and age of the participants (children or adults). We also examined two situational factors, healthiness (unhealthiness) of the food; and whether food was the focus of the study or not. With regard to food-focus, in some studies such as those typically presented in nutrition journals, the food was the focus of the study and participants had no doubt that they were in a food study. In other studies such as those conducted with a consumer behavior focus, the food was sometimes presented to consumers as being incidental, e.g., as a snack while doing something else. In these cases, the participants did not know they were in a food study, and may not have known they were in a study at all (Rolls et al. 2004; e.g., Wansink and Kim 2005).

All studies were coded on these four moderators by two independent individuals who were not familiar with the aims of the meta analysis. For the coding of children vs. adult, if participants were under the age of 10, they were coded as children, and adults otherwise. There were few differences of opinion and these were resolved through discussion as done by other authors (e.g., Szymanski and Henard 2001).

A list of all of the studies used in the meta analysis and the way they were coded for all the moderators is provided in Table 3.

(“Insert Table 3 about here”)

In the following sections, we elaborate on our expectations of each moderator and report on the results that we observed. The meta-analytic results are shown in Table 4. Results based on regressions of the change in consumption on change in serving-size including the moderator variables are reported in Table 5. We reported linear coefficients for ease of interpretation.
Gender. While studies often show that males prefer larger portion sizes to females (Rangan et al. 2009), most researchers report that gender does not moderate the serving-size effect; that is, they find consistent effects for both males and females (Kral, Roe, and Rolls 2004; Rolls, Morris, and Roe 2002; Rolls et al. 2004).

However, many studies reported the results for each gender separately. In addition, weight is stereotypically more of a concern for women than men, and therefore, we might expect women in monitoring their intake to be less susceptible to the serving-size effect.

The meta-analytic results (see Table 4) show that the serving-size effect appeared to be somewhat stronger among males than females, but that the difference in effect size was not significant (i.e., the CL_{95%} for each gender overlapped).

The regression results (see Table 5) show that when gender was included as a dummy (females=0, males=1) along with change in serving-size in predicting change in consumption, the coefficient for gender was .108 and significant (p < .001) implying that the serving-size effect was greater for males than females.

Age. There are of course main effects of serving-size on consumption for children relative to adults. More interesting is the evidence suggesting that the serving-size effect may be moderated by age. A number of studies suggest that the serving-size effect has no effect among pre-school age children (Birch, Engell, and Rolls 2000; Looney and Raynor 2011), but does have an effect among young adults (Levitsky and Youn 2004). However, the evidence is mixed with at least one study showing that serving-size can have an effect on children as young as two (Fisher 2007). The meta-analysis offered an ideal opportunity to examine the matter.

The meta-analytic results show that the effect-size is .246 among children, and is .560 among adults (see Table 4). The effect-sizes are significantly different (i.e., the CL_{95%} are non-
overlapping). We also note also that the heterogeneity index halved for the estimation of the effect-size for children confirming that age is an important moderator of the effect.

The regression of change in consumption on change in serving-size and age included as a dummy variable (0=adult, 1=children) confirmed that children were significantly less affected than adults (see Table 5). The coefficient for the dummy variable for children was negative and significant ($B = -.110, p<.001$).

**Food Healthiness.** Healthiness is clearly a key issue for food and nutrition scientists and social marketers. Studies have shown that the healthiness of the food can have multiple effects on various aspects such as perceived tastiness (Raghunathan, Naylor, and Hoyer 2006), evaluations (Kozup, Creyer, and Burton 2003), perceived calorie-content (Wansink and Chandon 2006), and intended and actual consumption (Chandon and Wansink 2007a; Irmak, Vallen, and Robinson 2011). Combining healthy and unhealthy foods on a menu or in an offering can have complex and often undesired effects on perceptions (Chernev and Gal 2010; Chernev 2011) and choice / consumption (Finkelstein and Fishbach 2010; Stroebel et al. 2008; Wilcox et al. 2009).

Knowing that consumers tend to underestimate calories in larger serving-sizes (Harnack et al. 2004; Wansink and Chandon 2006; Wansink and van Ittersum 2007), and underestimate the calorie-content of unhealthy foods in general (Chernev and Chandon 2010; Chernev and Gal 2010), we wondered whether food-healthiness would moderate the serving-size effect on consumption.

The results from the meta-analysis (see Table 4) show no evidence of an interaction between serving-size and healthiness of foods.

We also ran a regression of change in consumption on change in serving-size including a dummy for healthy (=1) vs. unhealthy (=0) food. The regression analysis however, revealed a significant negative effect of healthiness on the serving-size effect ($B = -.030, p<.001$). That is, the serving-size effect is reduced for healthy foods relative to unhealthy foods.
Food Focus. Consumer researchers in general are often interested in effects that occur without awareness. This is perhaps best illustrated by Wansink’s (2004) reference to influences on “unknowing consumers.” Wansink in particular has demonstrated serving-size type effects in situations where the participants were unaware that the food was the focus, and in some instances, that they were participants in a study at all (e.g., Wansink, van Ittersum, and Painter 2006)

If the serving-size effect is mediated to some extent by attention (or rather by lack of attention), then it would be expected to be stronger when the focus is not on the food. Someone who is paying attention might be protected against the perceptual bias. So when someone is eating incidentally to some other activity such as eating snacks while watching television, they might be more subject to a serving-size effect.

The meta-analytic results however show that food focus does not have a significant impact on the serving-size effect – i.e, the CL95% for the serving-size effect under a food-focus overlap with those observed when there is no focus on food (see Table 4).

In the regression of change in consumption on change in serving-size, we added a dummy variable for food-focus (0=no food focus, 1=food focus) and we did find a significant negative coefficient for food focus ($B = -0.113, p < 0.001$).

Conclusion

Our intention here was to establish how much the serving-size effect affects consumption, what are the processes by which this effect operates, and to identify any boundary conditions to the effect.

The meta-analysis demonstrates that serving-size has a ‘moderate’ effect on consumption ($d = .496$). More practically, we developed measures of change in both serving-size and consumption in order to show how much serving-size affects consumption. Across all studies, we
found that consumption increased by an average of 22% for a doubling of serving-size. While there is considerable variation in this rate (for which there are multiple contributing factors), the result highlights that the serving-size effect is robust and is a quite plausible contributor to the problem of obesity.

Our results revealed that the serving-size effect appears to be mediated more perceptually than by a consumption norm. If a consumption norm was driving the serving-size effect, we would expect change in consumption to match the change in serving-size. However, the change in consumption is only a fraction (22%) of the serving-size change. Moreover, we find evidence that consumption declines as serving-sizes get bigger.

The perceptual nature of the effect is also reinforced by its robustness and was observed across a variety of both individual and environmental factors. While not eliminated, we did observe some evidence that the serving-size effect was stronger among adults than children, and stronger among males than females. We also found some evidence of it being stronger among those who were not focused on the food as opposed to those who were focused on food.

Managerial Implications

The clear implication of this research is that super-sizing comes with a catch – a catch-22. A doubling of serving-size leads to a 22% increase in consumption. While the meta-analytic effect ($d=0.496$) would be labeled ‘moderate’ in Cohen’s (1988) terms, it is substantial in absolute terms. While guidelines have been developed requiring the food industry to at least offer a range of serving-sizes, the obvious but unpalatable truth is that to combat obesity, serving sizes ought to be restricted or reduced.

However, downsizing is unpopular among both marketers and consumers. Consumers are sorely tempted by the offer to supersize “for a few cents more” (Dobson and Gerstner 2010). A recent report by the National Alliance for Nutrition and Activity (2002) highlighted the disproportionate increase in volume and calories that can be bought for a few extra cents: e.g., 37c
for an additional 450 extra calories of a 7-Eleven Double Gulp Coca-Cola Classic; 71c for an additional 500 extra calories of popcorn at a movie theatre. Moreover, consumers may choose larger serves as a signal of social status (Dubois, Rucker, and Galinsky 2012).

Food marketers are of course also reluctant to give up in view of the apparent profitability of larger sizes or at least established sizes (Jain 2012). However, two responses to Jain suggest that there may be profitability in smaller packages (Rao 2012; Wansink 2012). Ultimately however, food marketers may have more to fear in the long run if they do not endeavour to address the increasing public concern about obesity and the contribution of supersize packages (Chandon and Wansink 2011). The unattractive options include bans, taxes and/or warnings on large packages to make them economically less attractive to susceptible consumers (Dobson and Gerstner 2010). Perhaps most encouragingly is the evidence that consumers themselves are willing to pay for smaller serves and fewer kilojoules (Schwartz et al. 2012; Wansink 2012).

The challenge presented here is that the serving-size effect is perceptual. Most perceptual biases are difficult to overcome. Nevertheless, if children are less inclined to the serving-size effect, then a change in parental admonitions of children to ‘eat up’ and forcing them to eat more in order to rewarded with a snack might be encouraged as a means of limiting the effect of serving-size. And for adults who are subject to the effect, cues to overcome the bias might be used such as a portion control plate (Kesman et al. 2011). Or illusions might be harnessed to limit intake such as serving of food in smaller bowls or plates (Van Ittersum and Wansink 2011).

Encouragingly, the serving-size effect is limited. First in line with mediation by perception, consumption is a declining function of serving-size. There are also of course physical limits to the serving-size effect – as so vividly satirized by the portrayal of Mr. Creosote in Monty Python’s film, The Meaning of Life who explodes as a result of eating too much. Together, these limits suggest that even if pressure cannot be applied to food marketers to limit serving size, there may be a point where the consumers ‘burn out’ (Wansink 2012)or blow up!
Future Directions

We note that the field would be better served if researchers adopted a common approach in examining and reporting serving-size effects. As reported in our method, we encountered a wide variety of measures used for serving-sizes and consumption. We tried to avoid some of the issues by creating measures of the change in serving-size and corresponding changes in consumption. However, the problem of the actual amount served remains – and while we were able to drill down to this level in 24 studies, this seemed a disappointing lost opportunity for aggregating the considerable research that has been done in this area. Ideally, future studies will be mindful to include measures in weights, and if the food being consumed is of mixed-energy density, energy consumed as well.

We note that we had considerable variability in our meta-analysis. Part of the problem is that which has been addressed in the paragraph above. To aggregate studies usefully, we needed measures of relative change in serving-size (and consumption), and the absolute size (ideally by weight) of the smaller serving-size. With this variation accounted for, attention could be directed to confirming the moderators of the serving-size effect we investigated and others. Other moderators that might be useful could include location of consumption (home versus lab), and intended versus actual consumption.

The serving-size effect is robust, it is moderate in size, and it extends across both gender and variations in the characteristics of the food. The serving-size effect is stronger for adults than it is for children and when distracted while eating. Considering that the effect is perceptual, not based on a consumption norm, adjustments in health policy should be made accordingly. In summary, there is a Catch-22 to large serving-sizes. Serve twice as much and you will eat 22% more!
Table 1

Meta-Analysis Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>k&lt;sup&gt;a&lt;/sup&gt;</th>
<th>d&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Z</th>
<th>p</th>
<th>CI&lt;sub&gt;95&lt;/sub&gt; Lower Bound</th>
<th>CI&lt;sub&gt;95&lt;/sub&gt; Upper Bound</th>
<th>Q</th>
<th>(d.f)</th>
<th>I&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERVING-SIZE</td>
<td>67</td>
<td>.469</td>
<td>9.907</td>
<td>&lt;0.001</td>
<td>0.376</td>
<td>0.562</td>
<td>285.190</td>
<td>(66)</td>
<td>76.858</td>
</tr>
</tbody>
</table>

<sup>a</sup> k = number of studies

<sup>b</sup> d = standardized difference in means
As there were some apparent outliers present in the funnel plot, we conducted a one study removed sensitivity analysis (Borenstein et al. 2009). The analysis shows that there are no single studies that have undue influence on the meta analytic results. Specifically, the effect size when removing the two most extreme outliers are $d = 0.478$ (extreme negative outlier) and $d = 0.448$ (extreme positive outlier).
Figure 2

Ratio of Change in Consumption to Change in Serving-Size

% change in consumption

100.00-
75.00-
50.00-
25.00-
0.00-
-25.00-

% change in serving-size

k (number of studies) = 62

All observations (studies) were weighted by meta-analytic weights
### Table 2
Regression Results for Amount Consumed on Amount Served

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Std error</th>
<th>B</th>
<th>t</th>
<th>p</th>
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<td>(Constant)</td>
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<td>.124</td>
<td>.191</td>
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<td>Z(Amount Served)²</td>
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<td>.086</td>
<td>-.220</td>
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<tr>
<td>Z(Amount Served)</td>
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<td>.097</td>
<td>.859</td>
<td>8.841</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>
Figure 3

Amount Served and Amount Consumed

Consumed gms

$k = 22$ (where $k$ = number of studies), $R^2$ (logarithmic) = 0.626

There are 44 data-points presented as smaller and larger serving-size results are shown independently.
<table>
<thead>
<tr>
<th>#</th>
<th>Author(s) (Year)</th>
<th>(d^a)</th>
<th>(p)</th>
<th>(n^b)</th>
<th>Relative weight</th>
<th>Food Healthiness</th>
<th>Gender</th>
<th>Age</th>
<th>Food Focus?</th>
</tr>
</thead>
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<td>1</td>
<td>Burger, Cornier, Ingebrigsten, Johnson (2011)</td>
<td>0.052</td>
<td>0.555</td>
<td>129</td>
<td>1.974</td>
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<td>Both</td>
<td>Adults</td>
<td>Y</td>
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<td>0.036</td>
<td>0.682</td>
<td>129</td>
<td>1.974</td>
<td>Combined</td>
<td>Both</td>
<td>Adults</td>
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<td>Both</td>
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<tr>
<td>#</td>
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<td>(d^a)</td>
<td>(p)</td>
<td>(n^b)</td>
<td>Relative weight</td>
<td>Food Healthiness</td>
<td>Gender</td>
<td>Age</td>
<td>Food Focus?</td>
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\(^a\) d = standardized difference in means  
\(^b\) n = study sample size

<p>| 0.469 | &lt;.001 | 2792 |</p>
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<th>p</th>
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<sup>a</sup> k = number of studies  
<sup>b</sup> d = standardized difference in means
Table 5 Moderator Analysis (Regression)

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<th>$B_{(moderator)}$</th>
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All observations (studies) were weighted by meta-analytic weights
References


Chang, Un J. et al. (2012), "Distinct Foods with Smaller Unit would be an Effective Approach to Achieve Sustainable Weight Loss," *Eating Behaviors*, 13 74-77.


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